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Book of Abstracts

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Contents

Wednesday 16th July: Emerging Technologies Session

KEYNOTE PRESENTATION

ADVANCES IN PROTECTION FROM IONIZING RADIATION FOR IMPROVED PUBLIC HEALTH

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Ionizing radiation is a significant environmental health risk, which contributes to increased cancer incidence globally. Common natural sources of ionizing radiation include radon and thoron gas (alpha radiation), uranium, thorium and potassium (gamma radiation). Whereas variation between European countries exists, approximately 64% of the annual radiation dose is from radon and thoron, whereas approximately 8% is from gamma radiation. In Europe, approximately 19,000 lung cancer deaths are attributed to indoor radon exposure each year.

This presentation highlights several emerging technologies and methodologies which enhance our ability to use geochemical, geophysical and geological proxies to map and predict ionizing radiation. Drone-integrated gamma-ray sensors map uranium, thorium, and potassium at unprecedented spatial resolution. These systems enable rapid surveys of hazardous or inaccessible sites, such as quarries and contaminated landscapes. Novel chamber-based approaches with alpha detectors quantify radon and thoron exhalation rates from environmental media. The integration of geogenic and environmental parameters into geostatistical approaches has led to advances in the accuracy and spatial resolution of predictive models. For instance, geostatistical techniques (e.g., Empirical Bayesian Kriging) integrate geogenic factors—such as uranium-thorium anomalies and bedrock geology—to generate predictive risk maps which classify regions by radiation hazard levels. Machine Learning methodologies applied to legacy geological and environmental datasets provide new opportunities to accurately predict ionizing radiation, without the need to directly measure radiation sources.

By integrating geostatistical methodologies with technologically advanced field-based techniques, or high quality open access environmental datasets, this interdisciplinary approach transforms evidence-based public health strategies, targeting mitigation efforts where most needed.

EXTRACTION OPTIMIZATION AND SCREENING OF METALLIC NANOPARTICLES IN SEWAGE SLUDGE BY SINGLE PARTICLE INDUCTIVELY COUPLED PLASMA MASS SPECTROMETRY

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Metal and metal oxide-based engineered nanoparticles (ENPs) constitute a significant category of emerging environmental contaminants. These ENPs are being progressively introduced into ecosystems through their extensive commercial and medical applications. Approximately 95% of ENPs enter wastewater systems after use, accumulating in sewage sludge. Depending on the country and its waste management regulations, a significant portion of sludge—on average 31% in EU Member States—is used as fertilizer in agriculture.
This research optimizes extraction and preparation methods for analysis of Ag, Au, CeO_2, CuO, TiO_2, PbO_2 and ZnO NPs from sewage sludge at WWTPs (Croatia), while developing suspensions suitable for their quantitative assessment using single-particle inductively coupled plasma mass spectrometry (sp-ICP-MS). Particular attention was paid to quantifying and understanding the behavior of CuO, PbO_2 and ZnO NPs, which metals are explicitly prioritized under Council Directive 86/278/EEC due to their toxicity and potential impact on the environment and human health.
The optimal method employed alkaline extraction (2.5mM tetrasodium pyrophosphate) used in a 1:100 (m/v) soil-to-reagent ratio. The presence of hundreds of millions to billions of particles per g of dry sludge indicates that significant attention should be paid to the ENPs due to their enormous quantity and possible transformation into soluble forms. Thus, investigating ENPs in sewage sludge is necessary for safeguarding environmental health and informing regulatory frameworks to address emerging risks.

Acknowledgement: This work was funded by the European Union – NextGenerationEU.

THE HIDDEN ROLE OF TISSUE LEAD ACCUMULATION IN SHAPING BREAST CANCER BIOLOGY

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Lead (Pb) is increasingly recognized for its potential to alter cellular processes and contribute to cancer development. Although Pb is classified as a probable carcinogen by the IARC, clinical evidence for its role in breast cancer remains inconsistent and is still limited to epidemiological studies.
The aim of this study was to investigate Pb bioaccumulation in human breast cancer tissues by correlating its concentration with specific cancer hallmarks.
Biopsy samples from 26 breast cancer patients were collected for molecular analyses (DNA and RNA sequencing), histological evaluation, and Pb quantification via ICP-MS.
The data presented here revealed Pb bioaccumulation in all breast cancer samples, with a significant positive correlation between Pb levels and both Tumor Mutational Burden (TMB) and Microsatellite Instability (MSI), suggesting an association between Pb exposure and genomic instability in human breast cancer. Additionally, Pb was associated with increased expression of cell death–related molecules such as BCL2 and p53, supporting the hypothesis that Pb may contribute to cell death resistance. Interestingly, Pb concentration showed no correlation with other established prognostic and predictive biomarkers in breast cancer, such as PAM50.
Thus, Pb may represent a novel and independent risk factor for breast cancer development.
This study provides new insights into the role of Pb in breast cancer, suggesting that its bioaccumulation may contribute to more aggressive tumor behavior through mechanisms involving genomic instability and resistance to cell death.

THE ELECTRON MICROSCOPY AS A TOOL TO INVESTIGATE POLLUTANTS BIOACCUMULATION IN HISTOLOGICAL SPECIMENS

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Environmental pollution is a growing global concern, with contaminants such as toxic metals, microplastics, and persistent organic compounds increasingly entering ecosystems through industrial discharge, agricultural runoff, and urbanization. These pollutants can bioaccumulate in human tissues, posing significant health risks. Histological analysis provides essential insights into tissue-level changes caused by pollutant exposure, yet traditional light microscopy lacks the resolution to detect minute particles or precisely localize contaminants within cells. Electron Microscopy (EM) overcomes these limitations, offering high-resolution imaging capable of revealing ultrastructural changes and enabling the identification of pollutant residues within biological specimens. In recent years, several studies have combined EM with elemental analysis techniques, such as Energy-Dispersive X-ray (EDX) microanalysis, to investigate the bioaccumulation of asbestos fibers and toxic metals in histological samples.

Within this framework, a novel Transmission Electron Microscopy (TEM)-EDX approach developed in our laboratory enabled the detection of nano-asbestos fibers in the lung tissue of asbestos-exposed workers, in cases where routine diagnostic methods had failed to classify the tumors as asbestos-related.

We further applied TEM-EDX to demonstrate aluminum accumulation in colon cancer cells, revealing its impact on epithelial–mesenchymal transition and its role in triggering apoptotic cell death. Moreover, heavy metals were identified in bone specimens from osteoporotic patients, suggesting a detrimental effect on bone matrix deposition.

Collectively, these findings highlight the critical role of electron microscopy in detecting pollutant bioaccumulation at both cellular and subcellular levels. They underscore its value in elucidating the mechanisms of pollutant-induced tissue damage, establishing EM, mainly when combined with EDX, as a powerful diagnostic and investigative tool in environmental toxicology and pathology.

POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) IN SOILS FROM SHALE GAS EXPLORATION AREA: QUANTITATIVE SOURCES AND RISK ANALYSIS USING AN IMPROVED HYBRID MODEL

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Shale gas exploitation may release polycyclic aromatic hydrocarbons (PAHs) into the environment, posing potential ecological and health risks. However, the impact of PAHs from shale gas exploitation activities on soil and associated risks remains unclear. This study comprehensively determined the source and risk of 16 priority-PAHs in soils from different land-use types within the Fuling shale gas exploitation area in Chongqing, Southwestern China, using an integrated approach combining multiple fractal inverse distance weights, absolute principal component multiple linear regression models, and Monte Carlo simulation. Analysis revealed widespread occurrence of PAHs, ranging from 11.5 to 1798 ng/g (average 105 ng/g). PAH concentrations in contaminated soils of the shale gas field (average 184 ng/g) were significantly higher than those in blowout land (average 56.4 ng/g) and background forest/grassland (average 73.4 ng/g). Environmental geochemical maps and correlation analyses identified PAH hotspots around towns and shale gas stations, emphasising the dominant role of anthropogenic activities over soil physicochemical properties in PAH accumulation. Coal combustion, vehicle emissions and petrogenic sources are the major sources in the study area, contributing 41 % and 59 % of the total PAHs, respectively. Notably, the source-oriented risk assessment model integrated with Monte Carlo simulations demonstrated that the ecological and health risks associated with petrogenic PAHs significantly exceeded those from coal combustion/vehicle emissions. This study highlights the impact of shale gas exploitation and provides a robust theoretical foundation for developing targeted strategies to mitigate PAH pollution risks at shale gas exploitation area.

REVEALING THE ELEMENTAL DIMENSION WITH ICP-TOF-MS

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Two main areas of research in the fields of bio-, environmental- and geological-analysis in recent years have been the characterisation of particles and cells, and the generation of two dimensional elemental distributions using laser ablation systems. Both areas are dependent on the detection of very fast transient signals. The main bottleneck has always been that the duration of these signals does not suffice to get an understanding of multiple elements. Instead only very few elements or possibly only one can be observed at the same time.

Time of Flight (TOF) ICP-MS detectors have the ability to collect full mass spectra at very fast acquisition speeds (<100us/spectrum) allowing for the complete understanding of fast transient signals. This allows whole new areas of research looking upon others at:
Acquisition of two dimensional maps of almost the entire periodic table in a matter of minutes allowing for a deeper understanding of geological and biological processes.
Multi elemental nanoparticle and single cell analysis enabling the differentiation of particles in environmental samples based on their composition.

In this presentation the principle of TOF-ICP-MS and its main application areas will be discussed based on real world examples.

Wednesday 16th July: Water Quality & Health Session

GEOGENIC SOURCES OF CONTAMINANTS IN GROUNDWATER AND ASSOCIATED HEALTH RISK IN SEMIARID NORTH-CENTRAL MEXICO

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High arsenic contents in groundwater of the Comarca Lagunera Region (CLR) in North-Central Mexico was reported more than 60 years ago. Since then, several studies have been done to identify levels and distribution of this element. In addition, fluoride contents above Mexican and international reference levels for drinking water were also later reported. The sources of these elements were suggested, but until now they have not been clearly identified. This study aims to identify the sources of arsenic, and fluoride to groundwater in the CLR, and to assess the health risk associated with the use of this water for drinking purposes

The CLR is home to more than 1.4 million people distributed over the metropolitan region of Torreón-Gómez Palacio, and a minor proportion of them is dispersed over an extensive rural area where groundwater is used for agricultural and domestic purposes

Groundwater samples were obtained from 121 deep wells of the entire study area, additionally, samples of the main geological units of the study area were obtained. A complete mineralogical and chemical characterization of the samples was done with state-of-the-art methods.

Results point to Tertiary volcanic sequences as the main sources of As and F. Using the results of the groundwater characterization, a health risk assessment for arsenic and fluoride was performed. The non-carcinogenic risk was calculated through the Hazard Index and the carcinogenic risk for arsenic was calculated with the ILCR, both indexes showed a significant health risk for consuming water of almost all sampled wells.

ARSENIC AND IRON ASSOCIATION IN SEDIMENT COMPRISING THE HYPORHEIC ZONE OF THE MEGHNA RIVER IN BANGLADESH—AN ARSENIC IN DRINKING WATER IMPACT STORY

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The sediment in riverbeds, banks and of the shallow aquifers in the Bengal basin is important for the cycling and fate of Arsenic (As) because they are rich in As-bearing iron (Fe)-oxides and oxyhydroxides. Arsenic in drinking water has been one of the most impactful mass poisoning events in human history and it is mostly of geogenic origin. Various scales of health effects from skin lesions to major cancer outbreaks have been located distinctively and pathologically in about 43% of the affected population. The river-groundwater interface, or the hyporheic zone can serve as both source and sink for dissolved Fe and As depending on whether oxidizing or reducing conditions are present. The redox conditions within the hyporheic zone can be dynamic due to changing groundwater flow and mixing conditions, driven by river-stage fluctuations (tidal and seasonal) and by inputs and presence of suitable electron donors. The presence of labile sedimentary organic matter serves as an electron donor to metal-reducing bacteria that mobilize sedimentary Fe and As in the groundwater under reducing conditions. This study investigates the association of Fe and As in Meghna River hyporheic zone sediment (0-50 cm depth). Sediment samples were subjected to a six-step sequential extraction procedure to quantify As (and to semi-quantify Fe) associated with the surface adsorbed (outer and inner sphere), organic matter, amorphous oxides, crystalline oxides, and residual phase, followed by HRICP-MS analysis of the eluent. Optically stimulated luminescence (OSL) dating of the sediment revealed an average depositional age of 1.5 ka. Most of the Fe in the sediment (19.2 g/kg), of which ~58% was Fe(III), was associated with the refractory (i.e., silicate) phases. On the other hand, the sedimentary As (7.7 mg/kg) was associated with amorphous Fe-oxides (32%), crystalline Fe-oxides (23%) and particulate organic matter (12%). These findings provide valuable insights on the mobility and sequestration and hence the future of Fe and As (geogenically distributed) in river corridors of large and dynamic rivers in SE Asia.

ENVIRONMENTAL RISK ASSESMENT OF DEEP-SEA TAILINGS PLACEMENT (DSTP): EVALUATING POTENTIAL ECOTOXILOGICAL IMPACT USING THE BIOTIC LIGAND MODEL

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This project focuses on Deep Sea Tailings Placements (DSTP), the disposal of mine tailings (rock slurry) into the ocean at depths >100m. DSTP is a solution for mine waste disposal when onshore storage/disposal is not feasible (e.g. seismic risk). The process involves ocean discharge of tailings and residual liquid from ore processing via a submarine pipeline. Tailings can impact different zones within the water column.
One way to evaluate potential DSTP impact on the marine environment is in the use of the Biotic Ligand Model (BLM). The BLM was developed for regulatory assessment of potential metal toxicity (e.g. copper and zinc) for aquatic organisms.
BLM is used for predicting the bioavailability and toxicity of metals in a marine environment, utilising the interactions between metal ions and biological ligands (molecule that binds to a biological receptor). It evaluates the impact on biodiversity of water chemistry parameters. Initially developed for freshwater ecosystems, progress has been made testing the BLM in estuarine and marine aquatic environments for future risk assessments.
This project is applying the BLM as a tool to determine and understand ecotoxicological presence in deep sea, incorporating spatial geochemical data and appropriate biological species to evaluate the variation in ecological risk in existing and potential future climate scenarios from subsequent sediment disruption, changes to current placement process and in establishing new mining activities.
This presentation will focus on initial work to test if the toxicity is 'likely/unlikely' based on accumulation of metal at the biotic ligand which is greater or equal to a critical threshold.

FLUORIDE EXPOSURE THROUGH DRINKING WATER IN NORTH-CENTRAL MEXICO

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In the Lagunera Region of Mexico, located in the north-central part of the country, geological conditions and excessive groundwater extraction have contributed to increased concentrations of various contaminants in drinking water, such as fluoride (F). This study aimed to implement an epidemiological surveillance protocol and characterize the epidemiological presentation of fluoride exposure in human populations in the Lagunera Region.

Exposure assessment was conducted through biological monitoring of fluoride concentration in spot urine samples (FU), measured using an ion-selective method as a biomarker of internal exposure. The study was carried out in regions previously identified as having fluoride in the distribution water supplied by public water service networks. A total of 1,850 individuals from 10 communities were invited to participate, of whom 1,103 agreed.

Among the participants, FU concentrations were categorized into tertiles (Tertile 1: 0.042 – 0.666 mg/L; Tertile 2: 0.667 – 1.194 mg/L; Tertile 3: 1.195 – 7.323 mg/L). When analysing the relationship between total arsenic (As) in urine (presented separately at this conference) and FU, a significant regression was observed, indicating co-exposure to these two elements.

These results were fully integrated into the Unified Information System for Epidemiological Surveillance, providing official data to support decision-making. In regions where arsenicism and hidro-fluorosis are endemic, this registry is considered highly important for guiding public health decision-making and policy design, emphasizing the primary prevention of chronic As and F intoxication through drinking water.

BEYOND THE SURFACE: INTERTWINED RISKS OF ENDOCRINE DISRUPTORS AND MICROPLASTICS IN A CHANGING ENVIRONMENT

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Emerging pollutants such as endocrine-disrupting compounds (EDCs) and microplastics (MPs) are increasingly recognised as pervasive and persistent threats to environmental and human health. Even at low concentrations, EDCs can disrupt hormonal systems, contributing to developmental, reproductive, and immune dysfunction. Simultaneously, MPs have infiltrated diverse ecosystems, originating from industrial, agricultural, and domestic activities. In Malaysian aquatic environments, MPs are frequently detected in sediments and organisms, often interacting with EDCs in complex ways that may alter pollutant behaviour, bioavailability, and toxicity. Despite their increasing presence, the combined ecological risks of EDCs and MPs remain poorly understood. Recent findings suggest inverse concentration trends and co-occurrence patterns that demand closer scrutiny. Detailed and comprehensive environmental forensic approaches can provide critical insights into the sources, pathways, and dynamics of emerging pollutants. Addressing this challenge requires integrated monitoring frameworks and risk assessment approaches to support evidence-based policies, safeguard ecosystems, and anticipate future health implications linked to environmental pollution.

DEVELOPMENT OF A RISK COMMUNICATION PROGRAM IN A RURAL COMMUNITY EXPOSED TO ARSENIC IN TAP WATER IN SEMIARID NORTH-CENTRAL MEXICO

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Groundwater supplied as tap water in several regions of semi-arid North Central Mexico frequently represents a health risk, due to the occurrence of pollutants of geogenic origin in the groundwater flow systems. In the Comarca Lagunera, high concentrations of arsenic and fluoride have been reported in groundwater since the 1960s, making it a subject of study across multiple disciplines. However, most studies focused on technical knowledge, and few successful programs actively involved the affected population. As a result, health-threatening habits persisted.

This project aimed to design and implement a Risk Communication Program (RCP) to help mitigate and prevent health issues in rural communities caused by the ingestion of untreated groundwater. Groundwater sources were characterized according to Mexican regulations, the spatial distribution of arsenic and fluoride was identified to assess regional risk and select a rural locality for a pilot study.

The RCP was tailored to the specific context of the selected community. To assess the population's level of knowledge, questionnaires were applied before the intervention. The program was then implemented and evaluated. The initial evaluation revealed key opportunities for collaborative work with the community to respond to their perceptions, habits, interests, and knowledge related to water quality and health.

The experience demonstrated that promoting dialogue and community engagement is essential to strengthen local capacities and improve decision-making regarding water use. True water security requires not only technical solutions, but also active and informed participation from the population.

Wednesday 16th July: Environmental Geochemistry & Health Session

KEYNOTE PRESENTATION

SO, YOU WANT TO RUN AN INTERNATIONAL CONFERENCE? LESSONS FROM 40 YEARS OF SEGH INTERNATIONAL CONFERENCES

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The Society for Environmental Geochemistry and Health (SEGH) has been running conferences annually since 1980. Prior to that, SEGH meetings were held as part of Trace Substances in the Environment meeting in the University of Missouri, Columbia MO. These grew and attracted an international audience; the last several of theTrace Substances series were organized by SEGH. The first international conference outside the USA was held in Imperial College London UK in 1985, though three meetings had been organised in Birmingham UK (1982-1984) for participants unable to travel to the USA.

With funding in the USA for such meetings becoming harder, the UK committee began to run meetings more locally, with the aim of alternating between Europe and the UK, though this was not always possible (and the numbering of resulting European and then international meetings is rather unreliable!). From 2017 onwards there have been one meeting in China and three in Africa as the membership of SEGH has diversified.

Besides quality talks and posters, memories of the meetings often highlight the banquet, the field trip and colleagues met, new and old. Networking and the encouragement of students and early career researchers has been at the centre of the society and its annual meetings.
Reminiscences have been requested from SEGH members and some will be presented in this talk, highlighting points, both supportive and awkward, for future organisers to consider. Such points are not necessarily found in the technical guidance for organising conferences on the SEGH website: https://segh.net/events

CURRENT ISSUES IN ENVIRONMENTAL GEOCHEMISTRY AND HEALTH: VIEW FROM SEGH FELLOWS

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In May 2019, the Society established new categories for membership. One of these is the SEGH Fellow which is awarded by invitation to individuals who have contributed significantly to the development of the Society and/or within the field covered by SEGH interests and continue to do so. This activity is important as our Fellows are located internationally as senior leaders in academia, business and industry, government and public health. They have extensive research and advisory experience within national and international jurisdictions.

As part of their engagement with the SEGH community, we consulted widely with the group asking for ideas of emerging priorities for research in their area of research interest or national priorities in areas relevant to the SEGH community. An overview of issues and feedback will provide a topical review of the SEGH landscape.

BIOAVAILABILITY OF SELECTED POTENTIALLY TOXIC ELEMENTS (PTE) FROM HOUSEHOLD FURNACE ASHES

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In Poland, as many as 3.8 million households use hard coal as their primary source of heating and further 0.5 million indicate that they use this fuel for other heating purposes. This results in the generation of waste known as municipal ashes. We have carried out a literature analysis and environmental interviews which demonstrated that ashes from household furnaces can be transferred to:
a landfill, if they meet certain quality and environmental safety requirements;
places other than landfills, such as the soil, thus enriching it with nutrients and minerals, as claimed by individuals who produce these ashes.
This activity can pose a serious threat to the environment and human health, since ashes are often a by-product of combusting poor-quality solid fuels as well as various types of waste, including municipal waste. This means that they can contain a number of toxic and hazardous substances, such as heavy metals, PCBs, dioxins and furans. Ashes that contaminate the soil can become a serious toxicological threat to plants, animals and humans, leading to an increased risk of harmful substance accumulation (e.g. PTE) in plants and living organisms. The soil pH may also be changed, thus altering the relationships of the microflora and microorganisms present in the soil. Furthermore, ashes can exert physical and chemical effects on soil erosion processes and changes in water retention capacity. Based on the: collected research material (36 samples of ashes), and performed chemical analyses (e.g.: extraction with 0.01 M solution of $CaCl_2$ and with 0.02 M solution of EDTA). the bioavailable fraction of selected PTE (As, Cd, Cr, Pb and Zn) was determined.

Based on the obtained data, the Risk Assessment Code (RAC) was calculated, determining the level of risk resulting from the availability of the analysed elements for plants, as well as for humans, who are exposed through dermal contact with contaminated ash.

This research was supported by the “Excellence initiative – research university” program for the AGH University of Krakow (IDUB AGH 6420/2023), and partly was funded by AGH University of Krakow, grant no. 16.16.140.315.

GEOCHEMICAL FOOTPRINT OF DENTISTRY IN OUTDOOR ENVIRONMENT

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Emissions of airborne particulate matter (PM) can originate from numerous geogenic and anthropogenic sources. Anthropogenic sources are of special concern in urban areas, where emissions from traffic, industry, and construction are usually the predominant and well recognised sources. But what about small-scale, overlooked sources? Is it possible to identify PM originating from such specific sources as dental practice in an environment overwhelmed with numerous sources of PM? The main objectives of this research were to find out if it is possible to identify emissions from such small-scale sources as dental practice in urban environment, and to identify characteristic solid particles for dental practice.
The potential geochemical footprint of dental practice in urban environment was studied by sampling and detailed geochemical characterisation of street dust in Maribor, Slovenia. Samples were taken in a grid across the town, presenting a background, and targeted in immediate vicinity of dental practices. The elemental composition of street dust was determined, and morphological and chemical characteristics of individual solid particles were analysed by using scanning electron microscopy techniques.
The results show that levels of several elements (e.g., Pd, Hg) are significantly higher in dust samples taken at immediate vicinity of dental practices than at background locations. Solid particles consisting of elements and alloys which are regularly used in dentistry were identified in these samples (e.g., Ag-Pd-Cu-O, Co-Cr (Mo) alloys). The results indicate that emissions of PM from dentistry may be identified in the environment, but the influence is limited to the immediate vicinity of dental practices.

‘NOW’ IS NOT ‘NORMAL’

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Each of us only has the benefit of living in our current life. That influences the professional decisions which we make. However, we need to be cognizant of what has gone before, and how changes, both positive and negative, need to be taken into account when making decisions which may have an impact on our environment and or our health. This presentation looks at some of those changes and how to balance them in the place in which we find ourselves.

ASSESSMENT OF RADIOLOGICAL RISKS ASSOCIATED WITH SELECTED BASEMENT COMPLEX ROCKS FROM SOUTHWESTERN NIGERIA

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Crystalline rocks from basement complex terrains are usually crushed into aggregates and used for various construction and civil engineering works. Some of these rocks often contain varying amounts of radionuclides, which could potentially pose radiological hazards to human health. Forty-eight fresh rock samples were used in the investigation. The samples were analysed for mineralogical and elemental contents using X-ray diffraction (XRD), ICP-MS and SEM/EDX. The results obtained were evaluated using standard geochemical plots and variation diagrams, while the uranium and thorium concentrations of the rocks were compared with known radioactive mineral-enriched rocks in the world. The mineral assemblages identified in the rock units were biotite, hornblende, quartz, plagioclase, muscovite, microcline, orthoclase, and pyroxene, respectively. The major oxide compositions (wt%) of SiO_2, Al_2O_3, Fe_2O_3, MgO, CaO, Na_2O, and K_2O in the rock units were: 49.6–71.8, 12.0–16.9, 1.6–11.9, 0.4–4.5, 1.4–9.8, 2.9–4.3, and 1.8–8.1, respectively. The trace elements revealed higher values (ppm) for Ba, Sr, and Zr, with ranges of 672.2–2271.5, 114.1–910.6, and 214.3–1839.8. The radioactive-bearing minerals such as monazite, uraninite, kasolite, orthoclase, thoriannite, zircon, titanite, samarksite, brannerite, and quicklime was also confirmed in the rock samples occurring mostly in the metamict state. The radiological parameters determined were comparable to the average worldwide ranges and were found to fall within the permissible limit. The radiation hazards associated with the analysed rock units are categorized as Low.

Thursday 17th July: Epidemiological Applications Session

KEYNOTE PRESENTATION

ENVIRONMENTAL RISK FACTORS AND THEIR RELATED CANCER BURDEN

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There were close to 20 million new cancer cases and 10 million deaths from cancer in 2022 globally. The number of cancers is increasing, driven by demographic change and evolution in the exposure to risk factors, while the cost of treating patients is likewise spiralling. The complexity and diversity of cancer, occurring in different organs and cell types, implies the need for a multitude of tests for early detection coupled with treatments tailored to specific types of cancers; this is quite different in scope to other non-communicable diseases. The result is that even the most affluent countries cannot tackle the growing cancer epidemic by treatment alone and primary prevention of cancer is more important than ever.

More precise estimates on causes of the cancer burden than elsewhere were made for Europe, where 22.4% of the global cancer burden occurs although Europe comprises only 9.6% of the world population. It was estimated that 33% of cancers in men and 44% of cancers in women in Europe were avoidable. The European Code against Cancer as a key cancer prevention tool has for more than three decades informed what the individual can do to reduce their risk of cancer to ultimately reverse the increasing trend in cancer incidence and reduce the cancer burden in the population. According to these estimates, tobacco remains responsible for half of the avoidable cancer burden, followed by the intertwined risk factors of obesity, unhealthy diet, and physical inactivity. Occupational exposures explain about 3-4% of the overall cancer burden, ultraviolet (UV) radiation about 2-3%, and radon about 1%. From the environmental factors ambient air pollution is the main risk factor causing however less then 1% of all cancers. For other potential risk factors, including pesticides and other chemicals, there's uncertainty about their effects at low exposure levels, but it may be that a significant percentage of the currently unexplained cancer burden is due to environmental factors. Epidemiological studies on pesticides illustrate the challenges of finding convincing scientific evidence, with accurate lifetime exposure measures being the major challenge and an area where environmental geochemistry could help tremendously. A recent study in the world's largest active asbestos mine with dust measurements carried out over 70 years shows what results can be achieved if based on excellent exposure data.

It has been noted earlier that climate change could impact on global cancer, at various steps in the journey of disease, from its causation, early detection, treatment, to the rehabilitation phase. From a European perspective, there are many known cancer-causing agents or unhealthy lifestyle behaviours that might change with climate change, in a way that it would further increase the cancer burden. This applies in particular to various environmental pollutants in air, water, and soil, or the spread of mycotoxins or infectious agents related to cancer. Although the quantification of this increase in cancer burden may be a tempting exercise to urge decision-makers into action, it is not a straightforward approach from a scientific perspective. First, with varying assumptions on what those changes are and how rapidly they will occur, a broad range of scenarios are conceivable. Second, and more importantly, there is a general agreement that climate change needs to be mitigated and therefore quantifying the co-benefits for human health when rigorously implementing climate change mitigation measures is more appropriate; for instance by using the recommendations on cancer prevention of the European Code against Cancer and the climate change mitigation measures in the 2030 breakthroughs agreed at COP27. This relates to taking action to keep a healthy body weight and promoting physical activity, on the healthy diet component of reduced meat consumption, on the avoidance of too much sun exposure, and the notion of policies and actions on reducing air pollution, as well as their link to climate change mitigation.

Further reading:

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SOIL SELENIUM AND OESOPHAGEAL CANCER INCIDENCE IN CHINA

Shuanghua Xie[1], Xianhui Ran[2], Liacine Bouaoun[3], Gerrad Jones[4], Christian Abnet[5], Anthony Kityo[3], Wenqiang Wei[2], Valerie McCormack[3], and Daniel R. S. Middleton[6]

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Oesophageal cancer (EC) incidence rates in China are among the highest worldwide, with strong spatial variability. Selenium (Se), an essential trace element with anti-cancer properties, has been hypothesized to influence this pattern. We investigated the association between soil Se levels and EC incidence across China. This ecological study utilized 2016 EC incidence data from 486 cancer registry catchments covering 380 million people. Mean soil Se concentrations were extracted from geospatial maps for each catchment. Linear regression models estimated incidence rate ratios (IRRs) for age-standardized EC incidence rates (ASRs) across soil Se quintiles and selenium-deficient areas (≤0.2 mg/kg). EC ASRs differed substantially above and below the Se deficiency threshold. Above 0.2 mg/kg, 100% of ASRs in females and 87% in males were <15 per 100,000. Below this threshold, only 36% of males and 81% of females had ASRs <15 per 100,000, with incidence rates reaching 117.5 per 100,000. Living in a Se-deficient area was associated with a more than twofold increased EC incidence in males (IRR: 2.45; 95% CI: 2.13, 2.81) and more than threefold in females (IRR: 3.35; 95% CI: 2.67, 4.19). Our findings provide strong ecological evidence of selenium's role in the spatial distribution of EC incidence. While all high-EC incidence areas in China occur in Se-deficient regions, not all Se-deficient regions have high EC incidence, suggesting interactions with other risk factors. Future research should explore individual-level Se exposure and its interplay with other environmental and lifestyle factors.

MAPPED PREDICTED PM2.5 AND LUNG CANCER RISK IN NORTHERN IRELAND: A POPULATION-BASED CASE-CONTROL STUDY

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Particulate matter with diameter less than 2.5 micrometre ($PM_{2.5}$ µm) has been classified as a Group 1 carcinogen by the International Agency for Research on Cancer (IARC), with approximately 15% of global lung cancer deaths in 2019 attributed to $PM_{2.5}$ exposure. This study is the first in Northern Ireland to investigate the association between ambient $PM_{2.5}$ and lung cancer risk.
A population-based case-control study was conducted using data from the Northern Ireland Cancer Registry (NICR) for lung cancer cases and the Northern Ireland Cohort for the Longitudinal Study of Ageing (NICOLA) for cancer-free controls. $PM_{2.5}$ concentrations were estimated from background air pollution maps provided by the UK Department for Environment, Food and Rural Affairs (DEFRA). Geographic Information System (GIS) techniques linked participants' postcodes to $PM_{2.5}$ exposure levels at a 1 km^2 resolution. Logistic regression models estimated odds ratios (ORs) and 95% confidence intervals (CIs), adjusting for age, sex, smoking status, and multiple deprivation index.
Those exposed to high $PM_{2.5}$ levels (>9.7 µg/m^3) had a 35% increased lung cancer risk compared to those in low-exposure areas (<7.4 µg/m^3). The association was stronger in females (OR: 1.79; 95% CI: 1.32, 2.44). An estimated 9.9% (6.2% in males, 13.9% in females) of lung cancer cases were attributable to $PM_{2.5}$ exposure exceeding 10 µg/m^3, equating to a ballpark estimate of134 preventable cases annually in Northern Ireland, though the true number is difficult to estimate using the current study design.
Long-term $PM_{2.5}$ exposure significantly increases lung cancer risk, even in regions with relatively low air pollution such as Northern Ireland. These findings reiterate the need for improved air quality policies and enhanced environmental health surveillance.

ESTIMATED TRIHALOMETHANES IN PUBLIC DRINKING WATER AND BLADDER CANCER RISK IN NORTHERN IRELAND

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Disinfection by-products (DBPs), the most common of which being Trihalomethanes (THMs), are formed when organic matter in water sources react with disinfection agents such as chlorine. Although disinfection of drinking water is a vital public health measure, there is evidence to suggest that current THM levels could lead to a considerable bladder cancer burden. Therefore, this study was carried out utilising published THM levels in public drinking water to explore the relationship between bladder cancer and estimated THM exposure in Northern Ireland (NI).
We conducted a case-control study in NI; recruiting cases (*n*=338) aged 50+, with a diagnosis of bladder cancer from the Northern Ireland Cancer Registry (NICR) and controls (*n*=8,079) aged 50+ from the Northern Ireland Cohort for the Longitudinal Study of Ageing (NICOLA).
Data on annual THM levels were obtained from NI Water and used to calculate annual average THM values which were applied to individual NI postcodes. Eight-year average values were calculated utilising data from years 2002-2009, and the level of THM for each postcode was used as an indicator of THM exposure for an individual residing within that postcode, in the absence of individual level household measurements.
For this analysis, we will conduct unconditional logistic regression modelling to calculate odds ratios (ORs) and 95% confidence intervals (95% CIs) for exposure to THM categories. We will adjust for confounders such as age, sex, smoking status and multiple deprivation index.
Results will be presented at the SEGH conference.

ENVIRONMENTAL HAZARDS AND REPORTED ISSUES IN NORTHWEST ENGLAND 2022-2023: A CROSS-SECTIONAL ANALYSIS

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Environmental risk contribute greatly towards global illness burdens. Identifying hazards, mitigating effects, and responding when issues arise are key environmental public health practice. No single tool exists providing an overall assessment of cumulative environmental hazards for an area, nor the risks they pose to human health, pollution or workload for responding public health agencies.

A cross-sectional descriptive study using retrospective UKHSA case and incident management data and publicly available environmental hazards data; numbers and types of hazard (e.g. chemical and radiological premises, environmental permitted processes, ports, airports), in Northwest England from 1st January 2022 to 31st December 2023.

We identified a correlation between the number of environmental hazards in an area and the number of health issues reported to UKHSA but the relationship does not hold true for all areas. The study identified variations in number and type of hazards across areas and differences in the range of issues reported. Incident records related to chemical concerns and exposures were the most frequently reported issues dealt with by local teams. Environmental permitting risks varied considerably across subregions.

The study provides preliminary evidence that higher numbers of risk sites generally results in higher number of concerns raised. The results of the study suggest that local knowledge and assessment of local area characteristics is vital to ensure appropriate levels of public health responses can be provided; more detailed studies are needed to assess which hazards generate most issues and potential assessment of legacy and current resulting contamination.

RADON ATLAS METRICS AND LUNG CANCER RISK: A POPULATION-BASED CASE-CONTROL STUDY

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Radon, a naturally occurring radioactive gas and known lung carcinogen, is the leading cause of lung cancer in non-smokers. This case-control study investigated the association between mapped residential radon exposure and lung cancer risk in Northern Ireland, linking Indicative Radon Atlas data to cancer registry data for the first time in the UK.

Incident lung cancer cases diagnosed in 2006 and 2014 were extracted from the Northern Ireland Cancer Registry, selected due to smoking history availability. Controls were drawn from the Northern Ireland Cohort for the Longitudinal study of Ageing (NICOLA), interviewed between 2013-2015. Radon exposure data (1 km^2 grid scale) were linked to postcode coordinates from the Central Postcode Directory using geographic information system (GIS). Logistic regression models were applied to calculate odds ratios (OR) and 95% confidence intervals (95% CI) for lung cancer according to radon exposure at residential address, adjusted for age, sex, smoking status (never/past/current), area-based deprivation quintiles and average $PM_{2.5}$ exposure. The study included 1,687 lung cancer cases and 8,094 controls. Higher radon exposure, as defined on the Indicative Radon Atlas, was associated with increased lung cancer odds. Participants residing in areas of the highest radon exposure category (Class 6) were determined to have over double the odds of lung cancer (adjusted OR 2.27, 95% CI:1.27, 3.96) compared with those residing in areas of lower exposure categories (Classes 1-5).

These findings reinforce the link between residential radon and lung cancer risk in Northern Ireland and highlight the utility of geochemical metrics for assessing population health risks.

Thursday 17th July: A Changing World Session

KEYNOTE PRESENTATION

NO PLANET B: HEALTH AND ENVIRONMENT

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We are currently facing a public health and planetary health crisis with increasing hospital waiting lists, increasing rates of chronic diseases such as dementia and emerging infectious diseases. We are also experiencing a triple planetary crisis of climate change, nature crisis and pollution. Access to high quality environments is vital for human health and planetary health. This keynote presentation provides examples of evidence and environment-based solutions such as green spaces and reducing car dependency that are important components of our towns and cities. The presentation provides evidence of environment-based policies and interventions that improve population health and wellbeing, reduce preventable deaths, reduce inequalities and provide social, environmental and economic co-benefits.

SEDIMENT AND SOIL SOURCE APPORTIONMENT USING GEOCHEMICAL FINGERPRINTING TECHNIQUES IN THE WINAM GULF, LAKE VICTORIA FOR SUSTAINABLE MANAGEMENT OF LAKE-LAND RESOURCES

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Accelerated soil erosion is a major cause of land degradation in East Africa's agricultural and pastoral landscapes with severe consequences for food, water and livelihood security. In this study, we aimed to provide a tool to support the sustainable management of land and water resources in a region significantly impacted by land degradation. We employed source apportionment methods to quantify the relative contribution of sediment sources within the Nyando and Sondu-Miriu River basins in the Winam Gulf, Kenya. The total elemental concentrations of sediment samples were used as geochemical tracers. Specialised tracer selection methods were then used to identify the optimum unmixing tracers before applying the unmixing model FingerPro to determine sediment provenance. Sediment source apportionment analysis revealed that the Ainamutua and Nyando-Kipchorian sub-catchments, areas affected by land degradation activities such as poor crop management practices and deforestation, contributed 39 ± 4% and 44 ± 4% respectively. In contrast, sediment contribution from the Awach Kano and Nyaidho subcatchment, with a higher proportion of tree-cover and lower soil erosion rates, only contributed 17 ± 7%. In the Sondu-Miriu, the Yurith and Kipsonoi sub-catchments contributed 68 ± 5% and 20 ± 6%, respectively, due to the predominance of forest encroachment and ridges in the Yurith sub-catchment. Additional soil fingerprinting analysis reveals the significance of land use, landform and soil types on source contributions. Quantifying sediment source contributions within river basins provides essential information for environmental managers and policymakers developing integrated catchment management plans. The results from this study can be used to implement sustainable land use policies focused on soil restoration in the region.

MODELLING PROVISIONAL SOIL GUIDELINES FOR THALLLIUM

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Thallium (Tl) is sometimes classified as a technology-critical element, i.e., a metal whose use and significance have increased due to its central role in emerging, particularly green, technologies. It is an exceptionally toxic metal with severe effects on the nervous, gastrointestinal, and cardiovascular systems. While naturally present at trace levels, industrial activities such as mining, smelting, and manufacturing have caused localised environmental contamination. Recognising this risk, Tl was recently included in the EU Directive on Soil Monitoring and Resilience, highlighting the need for stricter soil protection policies. However, the lack of regulatory limits for hazardous Tl concentrations in soil poses a significant challenge to translating the intention to monitor Tl in soil environments into practical risk assessment. This gap arises not only from limited data on Tl distribution and human exposure pathways but also from the fact that existing data have not been systematically compiled or analysed to approximate the soil concentrations at which Tl may pose significant health and environmental risks. This study aims to establish provisional soil guideline values by integrating available data on Tl partitioning in the environment, human exposure factors, and existing toxicological reference values. Modelling is performed using the Swedish Environmental Protection Agency's generic risk assessment model for contaminated soil, which aligns with most other internationally recognised frameworks for generic risk assessments of contaminated land. The findings provide a basis for future development of a tailored risk assessment approach for Tl, supporting improved soil quality standards and effective risk management strategies to protect public health.

URBAN-INDUSTRIAL METAL POLLUTION AND NEUROTOXICITY: BIOACCUMULATION PATTERNS IN GREY SQUIRREL BRAINS

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Air pollution, a major global health crisis, facilitates trace and toxic metal deposition, with urban emissions breaching 'safe' levels. While lead (Pb) neurotoxicity is well-documented, the patterns of aluminum (Al) accumulation in Alzheimer's patients raises concerns about exposure to urban metal emissions. Despite in-depth knowledge of their ability to cross biological barriers, the long-term effects of chronic xenobiotic metal exposure in the brain remain poorly understood. Moreover, a significant gap remains in our understanding of these chronic exposures and their effects on wildlife health.

In this study, we investigate the bioaccumulation patterns of neurotoxic and industrial metals in the brains of Eastern grey squirrels (*Sciurus carolinensis*), leveraging invasive species management to assess chronic urban-industrial pollution exposure. Using an adapted metal-contamination-mitagation protocol, we dissected 64 individuals across an urban-industrial gradient. Eighteen metals across seven brain regions were quanitified using ICP-MS. In particular we focused on the olfactory bulb, a known exposure route to the brain for inhaled metal particulates.

Our findings reveal significant spatial variation in metal burdnes, with elevated concentrations of neurotoxic metals (Al, Pb) in areas with increased urban-industrial emissions. Notably, we observed bioaccumulation patterns that suggest direct inhalation exposure via the olfactory bulb. These results demonstrate the role of synanthropic animals as valuable bioindicators of environmental contamination. These insights demonstrate the value of interdisciplinary approaches to assess pollution's impact on ecosystems and public health within the One Health framework.

CONSEQUENCES OF THE APPLICATION OF MEASURES TO CONTROL ATMOSPHERIC EMISSIONS FROM THE METALLURGICAL INDUSTRY IN NORTHERN MEXICO ON THE HEALTH RISK INDEXES OF METALS IN EXPOSED POPULATION

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Torreón, the most important city in the Lagunera region, has experienced significant industrial and economic development, linked to the installation of large non-ferrous metallurgical complex. This study represents an environmental and human health assessment of the impact of emissions from metallurgical activities in the urban area of Torreon. The quality of the atmospheric environment was assessed through a multi-element study of PM10 collected during 2016 and 2023/2024. The concentration data of the samples collected in 2016 show that all the elements analyzed, for which there are recommended regulatory limits, exceed these values (Cr. Mn. Ni. As, Cd, and Pb). The comparison of these results with those of the PM10 study collected in 2023/2024 shows that concentrations of V, Co, Ni, Zn, Sb, Pb decrease, while Cr, Mn, Cu, Cd increase by up to 20%, probably as a result of the implementation of emission control measures.
Based on the results obtained from the analysis of samples collected in 2016, the health risk for non-carcinogenic elements showed adverse effects for As, Mn, Zn for children and adults and Cd for adults, while the total carcinogenic risk values for As and Cr, (for children and adults and Cd for adults) were higher than the acceptable limit. The hazard ratios for non-carcinogenic elements calculated for 2023/2024 show hazard ratios for Mn and Zn (for children and adults) and Cd for adults. For the carcinogenic elements, the hazard ratios are for Cr in children and adults and for As and Cd in adults.

METAL-DRIVEN ANTIBIOTIC RESISTANCE IN ACANTHAMOEBA-ASSOCIATED BACTERIAL COMMUNITIES FROM VASHI CREEK, MUMBAI

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Environmental metal contamination may accelerate the spread of antimicrobial resistance (AMR) through selective pressures on bacterial communities. This study examines how metal pollution influences antibiotic resistance patterns in bacteria associated with *Acanthamoeba* and sediments from the heavily industrialised Vashi Creek, Mumbai.

Sediment samples and *Acanthamoeba* isolates were collected from eight sites across three seasons, analysing both metal concentrations and antibiotic susceptibility profiles. Chemical analysis revealed elevated levels of arsenic, chromium, and nickel frequently exceeded environmental quality standards levels.

All isolated *Acanthamoeba* belonged to the potentially pathogenic T4 genotype, suggesting polluted environments may select for clinically relevant strains. *Acanthamoeba*-associated bacteria demonstrated significantly higher resistance rates across multiple antibiotic classes compared to sediment bacteria, with distinct correlations between specific metals and resistance patterns. Notably, intracellular bacteria showed enhanced multidrug resistance (MDR) profiles, with 46% resistant to four or more antibiotics compared to 0.6% in sediment bacteria. Metal-specific associations with resistance patterns differed between communities, with zinc and chromium strongly influencing sediment bacteria, while arsenic, vanadium, and calcium were primary drivers of resistance in intracellular bacteria. These findings reveal complex interactions between metal contamination, protozoan hosts, and bacterial resistance, suggesting that *Acanthamoeba* serve as protective reservoirs for MDR bacteria in polluted environments. This study provides crucial insights for environmental health risk assessment and AMR surveillance in contaminated aquatic ecosystems.

GEOCHEMICAL AND MORPHOLOGICAL PROPERTIES OF THREE TYPES OF DUST IN VICINITY OF CEMENT PLANT

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Three types of dust (household, attic, street dust) were sampled in area, which could be affected by a cement plant located in Anhovo, W Slovenia. The aim of the research was to determine geochemical and morphological characteristics of the examined dust samples and to compare them with the available data. Sampled dust was air-dried and sieved. A fraction smaller than 0.063 mm was analyzed after aqua regia digestion by ICP-MS. Contents of the following elements were determined: As, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, Pb, Sb, Tl, Zn.
Relatively high mercury (Hg) levels were found in all three types of dust (up to 18 mg/kg). The Hg levels were significantly higher compared to the ones found in the town of Maribor, other Slovenian urban areas and the Slovenian countryside. Considering the spatial distribution of mercury in the three types of dust, the most polluted places were not in close vicinity of the cement plant, but rather in some relatively distant areas, and, in the case of household dust, in elevated locations. In addition, slightly higher contens of thallium (Tl) and manganese (Mn) were determined.
SEM/EDS analysis of the morphological and chemical properties of individual particles in selected dust samples determined various particles types of natural and anthropogenic origin. Among the latter, Fe-oxides/hydroxides, Fe-O spheres and Fe-shavings predominated; some particles containing potentially harmful elements were also found. Furthermore, asbestos fibers were found in one attic dust sample near the cement plant, which is related to its past activity.

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Friday 18th July: Global Food Security Session

KEYNOTE PRESENTATION

GLOBAL FOOD SECURITY AND INORGANIC ARSENIC IN RICE

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Global food security is a major existential socio-economic and health issue of critical importance (i) directly to many countries, notably least develop countries (LDCs) and lower middle income countries, and (ii) indirectly to almost all countries globally because of relationhips with resource-driven and inequity-driven geopolitics, particularly in relation to trade, conflict and immigration. Global food security is critical to SDGs 1,2,3 & 10 in particular.

Key aspects of global food security include: availability of supply, affordability, quality and safety, and sustainability of supply. Key aspects of food quality and safety include contamination by pathogenic biological agents or toxic chemical substances.

Rice is the major staple for over half the world's population and is prone to the accumulation of toxic inorganic arsenic, cadmium and pesticides as well as to contamination with pathogens. Chronic exposure to inorganic arsenic is known to give rise to wide range of detrimental health impacts, including increased risks of lung, skin and other cancers and of cardiovascular diseases. Further the occurrences of high arsenic in soils as a result of natural and/or anthropogenic processes may give rise to detrimental changes in productivity in rice-growing areas.

An analysis of potential avoidable and unavoidable health impacts of inorganic arsenic and other contaminants in rice (and the soils in which it is grown) are outlined here and qualitatively compared with the wider impacts of other aspects of global food security.

Acknowledgements: I thank Andrew Meharg, Dan Middleton, Debapriya Mondal, Michael Watts and Lingxian Xu for discussions that have informed this presentation.

PRELIMINARY STUDY OF TRACE ELEMENTS IN SOILS AND VEGETABLES IN A COMMUNITY GARDEN IN SOUTH MANCHESTER, UK

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Exposure to trace elements poses a legitimate concern for those consuming or cultivating produce in community gardens. Platt Fields Market Garden (PFMG) is a community-based garden in south Manchester, UK, managed by Manchester Urban Diggers, which grows fruits, herbs, and vegetables for residents and restaurants throughout the year. Soil (*n = 110*) and vegetable samples (*n = 20*) were collected from PFMG in 2023/24 and analysed by portable XRF and ICP-MS respectively. The methods were validated by analysis of CRMs, with recoveries of 100±15% being found for all elements in both soils and vegetables. The mean concentrations of Pb, As, Hg, Zn, Cu, Ni, Cr, Fe, Mn, Mo, Co, and Sn found in the soils were 180±60, 40±15, 7±3, 120±32, 60±18, 25±8, 50±27, 17000±4000, 275±65, 4±1, 25±15, and 15±5 µg/g, respectively. Although some concentrations in soil exceeded UK soil guideline values, preliminary investigations indicate translocation factors in vegetables were less than 1.0 for all elements (except for Zn (4.4) and Cu (1.8)), which together with limited market volume, suggest relatively low population-level health risks arising from the consumption of vegetables from the site. Further studies will be executed to quantitatively assess potential risks from trace elements in vegetables to better ensure public safety.

Acknowledgements: Funding from EPSRC/UoM IAA-527 (DAP) and for PhD scholarships from BSTFT, Bangladesh (FTA), JU, Saudi Arabia and SACB, UK (MMA), DKO Fellowship, UK (GJLW) and Cookson scholarship, UK (AR). We thank the staff in MAGU & MUD for their support.

THE EFFECT OF DIGESTATE BIOCHAR ON LEAD HUMAN HEALTH INGESTION RISKS IN URBAN NO-CROP, LETTUCE, CARROT, AND GARLIC AGRISYSTEMS

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Urban food production is an important element of the global food network. However, agrisystems established in contaminated urban soils may present considerable human health risk from PTEs through soil exposure and vegetable ingestion. Biochar is an increasingly common method of PTE remediation, however it's potential for reducing PTE mobility is determined by the properties and quality of existing local soils and soil-crop interactions. A pot experiment was used to compare the effects of 5%w/w digestate biochar on soil total and orally bioaccessible Pb concentration, and on vegetable total Pb concentration, in no-crop, lettuce, carrot, and garlic agrisystems with 'high' and 'low' soil Pb concentrations. Human health indices (Average Daily Intake (ADI), Hazard Quotients (THQ), and Cancer Risk (CR)) were then used to assess complete (soil and vegetable) agrisystem ingestion risks. Results showed that biochar only signficantly decreased combined soil and vegetable ADI, THQ, and CR in high Pb-no crop, and low Pb-lettuce agrisystems. Marginal increases in health indices were observed for High Pb-carrot and Low Pb-No crop, carrot, and garlic. Marginal decreases in health indices were observed for High Pb-lettuce and garlic. Ultimately, biochar has limited effect on Pb remediation in the studied vegetable agrisystems, which has implications for urban grower health and the general success of urban agrocological NBS.

TECHNOLOGY-CRITICAL ELEMENTS IN VEGETABLES: POTENTIAL RISKS FOR HUMAN EXPOSURE

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Technology-critical elements (TCEs) are building up in the environment as their use in new (green) technologies skyrockets. Consequently, concerns are growing over their largely unknown behaviour in natural systems. Furthermore, despite the significant knowledge gaps, previous studies have reported a range of toxic effects for several of the TCEs. Our own research demonstrates that certain TCEs, including gallium, gadolinium, indium, neodymium, tellurium, thallium, tantalum, and ytterbium, exhibit cytotoxicity and/or induce oxidative stress *in vitro*. The increasing environmental concentrations, combined with the potential toxicity of these elements, raise concerns regarding human exposure, particularly through vegetable consumption, which is typically the dominat exposure pathway for other metals.

To assess the exposure risk through vegetable consumption, we investigated the uptake propensity of selected TCEs (including several rare earth elements, gallium, niobium, and thallium), relative to traditional metal contaminants, in lettuce, chard, and carrots grown in 22 urban soils from across Europe. Bioconcentration factors revealed a high uptake of thallium, which is concerning due to its high toxicity, but a generally low uptake of the other studied TCEs. In a follow-up study, we found that TCE uptake into plants was affected by the same geochemical variables as that of other contaminant metals, including soil pH, organic matter, Fe and Mn (hydr)oxides, and clay content.

Our summarised findings suggest that certain TCEs, especially thallium, may enter the food chain to a considerable extent. For other TCEs, alternative exposure routes, e.g., soil ingestion or inhalation, may be more important, although these require further investigation.

PERSISTENT ORGANIC COMPOUND CONTAMINATION OF *TELFARIA OCCIDENTALIS* (FLUTED PUMPKIN) LEAVES CULTIVATED IN THE FEDERAL CAPITAL TERRITORY, ABUJA- NIGERIA

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This study investigated persistent organic compounds (POCs) residue level in *Telfaria* occidentalis Hook F. Leaves cultivated in the Federal Capital Territory, Abuja Nigeria. *Telfaria* occidentalis leaves were collected from 12 farms in six Area Councils of the Federal Capital Territory using a circular grid of 20m apart. Random sampling technique was used to collect T. *occidentalis* leaves from different spots within the farm during the rainy season. The POCs residue levels were determined using Gas Chromatography-Electron Capture Detector (GC-ECD). Alpha-BHC, Beta-BHC, Gamma-BHC, Aldrin, Heptachlor, Endrin, DDT (Dichlorodiphenyltrichloroethane) and Endosulfan Sulfate were recorded in *T. occidentalis* across the Area Councils. Heptachlor had the highest concentration of 15.67mg/kg, followed by Endrin with 15.25mg/kg, Beta – BHC with 13.87mg/kg, Endosulfan Sulfate with 8.56mg/kg, DDT with 7.49mg/kg, Alpha – BHC with 4.86mg/kg, Aldrin with 2.17mg/kg and Gamma – BHC had the lowest concentration of 0.49mg/kg. Occurrence of these POCs were ranked across the Area Councils. Some Area Councils ranked first in some POCs and closely followed by others, an indication of indiscriminate use of pesticides in those Area Councils particularly those detected for which they ranked first. There was no significant difference ($p<0.05$) in their concentrations across the Area Councils. However, these concentrations were thrice as much as the maximum residue limits (MRLs) permissible by WHO/FAO and NESREA, which implies a potential health risk for human and animals. The extent of health effects may depend on the quantity and frequency of consumption, and this calls for strict regulation of the application of such pesticides in farms.

PERSISTENCE OF AGROCHEMICALS IN LA LAGUNA REGION MEXICO'S SOIL AND THE POTENTIAL RISK FOR RESIDENTS

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Agriculture is one of the primary activities in the La Comarca Lagunera region of Mexico. The intensive use of pesticides dates back to the 1940s; their impact on the environment and health is a relatively understudied issue in the region. This study aimed to determine the presence of highly toxic pesticides (DDT and metabolites, glyphosate, and its metabolite AMPA), as well as their potential impact on the population. Thirty-four soil samples from seven locations in La Comarca were analyzed to detect the target pesticides using gas-mass chromatography. The results showed the presence of DDT (<9.46 ng/g) in 85% of the samples, DDE (<1.69 ng/g) in 41%, and DDD (<8.33 ng/g) in 77%. Glyphosate was not detected, but AMPA (<115.31 ng/g) was found in 88% of the soils. The DDT/(DDE+DDD) ratio>1 indicates recent contamination. 85% of the sites showed recent contamination, indicating that DDT is still in use. Additionally, based on the WHO calculation of the absorbed dose through the dermal route, considering an adult rural male with an average weight of 75 kg and exposure to arms, hands, and face, the maximum absorbed doses were 0.094, 0.017 and 0.082 mg/kg/day for DDT, DDE and DDD respectively, and 1.394 for AMPA. This indicates the risk to which people in the area are exposed. Therefore, it is urgent to expand epidemiological studies related to pesticide exposure, considering aspects such as proper handling of these compounds and exposure through water and food intake to describe the problem better.

Friday 18th July: Human Biomonitoring Session

KEYNOTE PRESENTATION

UNLOCKING INSIGHTS: INDUCTIVELY-COUPLED PLASMA MASS SPECTROMETRY OF TOENAILS TO ASSESS TRACE ELEMENT CONCENTRATION IN MYELOPROLIFERATIVE NEOPLASMS – FINDINGS FROM THE MOSAICC PILOT STUDY

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Emerging evidence suggests that environmental factors, including trace element exposure, may play a role in the development and pathogenesis of the myeloproliferative neoplasms (MPNs) including essential thombocythaemia (ET), polycythaemia vera (PV) and primary myelofibrosis (PMF). Traditional biomarkers are limited in their ability to capture long-term trace element exposure. Toenails reflect chronic exposure to elements due to their slow growth-rate and the independence of trace elements from metabolic activities after their incorporation into the keratin matrix. In an exploratory case-control study, we sought to explore associations between 12 trace elements and MPNs.

Hallux clippings from participants in the United Kingdom's pilot Myeloproliferative Neoplasms: An In-Depth Case-Control (MOSAICC) study were collected between 2012-2014. Samples were cleaned, dried and acid-digested at 80°C prior to analysis using inductively coupled plasma-mass spectrometry for aluminium (Al), vanadium (V), chromium (Cr), manganese (Mn), iron (Fe), nickel (Ni), copper (Cu), zinc (Zn), arsenic (As), selenium (Se), cadmium (Cd) and lead (Pb). Clinical, demographic and lifestyle data were collected using a combination of self-completed questionnaires (including the MPN Symptom-Assessment Form [MPN-SAF]), a telephone interview and abstraction of clinical and treatment data from medical records.

Mean trace element concentration was compared between cases and controls using a two-sample t-test for normally distributed data and Wilcoxon-Mann-Whitney for non-normally distributed data. Backwards logistic regression analyses were used to assess the relationship between trace element concentration and MPNs. Ordinal logistic regression analyses were used to assess the relationship between trace elements and duration of cytoreductive treatment (short-term, medium-term, long-term) and the relationship between trace element concentration and MPN-SAF score (absent, mild, moderate, severe).

In total, 95 MPN cases (n=32 PV, n=50 ET, and n=13 PMF) and 107 controls provided a toenail specimen. Cases were slightly older (mean age: 63.8 vs 60.9 years; *p* 0.087) and more likely to be male (42% vs. 38%; *p* 0.6). Mean Se concentration was lower in cases ($\bar{x}$ = 0.571mg/kg) than controls ($\bar{x}$ = 0.638mg/kg), p<0.0001. There were no significant differences in mean trace element concentration for Al, As, Cd, Cu, Cr, Fe, Pb, Mn, Ni, V or Zn. A significant association was observed between low Se concentration and MPN (aOR 0.65, 95% CI 0.50-0.83, p<0.01). When stratified by subtype, this association remained for ET (aOR 0.57, 95% CI 0.40-0.77, *p*<0.001) and PV (aOR 0.62, 95% CI 0.42-0.90, *p* 0.01), but not PMF (aOR 1.16, 95% CI 0.67-1.95, *p* 0.59). Low Se was associated with incident MPN (n = 23, aOR 0.65, 95% CI 0.42-0.98, *p* 0.04) and was not influenced by duration of cytoreductive treatment (aOR 0.91, 95% CI 0.65-1.29, *p* 0.65). Low Se concentration was significantly correlated with increasing MPN-SAF score for pruritus (0.65, 95% CI 0.44-0.95, *p* 0.02). No associations between MPN and other elements remained after adjustment.

Low toenail Se concentrations were significantly associated with MPN, including in recently diagnosed cases, suggesting deficiency precedes diagnosis. Associations were independent of cytoreductive treatment duration. Notably, low Se was linked to increased MPN-SAF pruritus scores, a symptom associated with worse disease and outcomes. Further research on Se deficiency in MPN development and pathogenesis is warranted.

PROTOCOL DEVELOPMENT AND FEASIBILITY STUDY FOR THE ELEVATED CHILDHOOD LEAD INTERAGENCY PREVALENCE STUDY (ECLIPS).

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Lead is toxic even in small amounts. It is common in our environment due to past use in paint, petrol and plumbing, contaminating our air, water, soil, dust and food. Children are more at risk from the effects of lead because of their growing and developing brains. Lead can reduce intelligence and attention span, increase antisocial behaviour, and lower educational achievement.

We want to see an effective national childhood lead screening programme. To do this, we need to develop and test new screening methods. We want to make home blood sample collection quick and easy. Widespread monitoring of the amount of lead in blood will help to develop policies that reduce children's contact with lead in the community and at home.

Aims and objectives: To develop and trial (in Leeds) a new protocol for monitoring the amount of lead in children's blood.

Developing our methods includes testing a new, simple to use device for collecting a few drops of blood from a finger-prick at home and posting to the laboratory for analysis. We will use questionnaires to ask about the child, the parents or caregivers, their lifestyle and their environment. We will also ask families to provide samples of house dust, backyard or garden soil for lead testing. We will learn about what would put people off taking part and local sources of lead. A multi-agency case management protocol has been established. All families will receive their results and a thank you voucher.

A successful screening program will pave the way for a UK child lead exposure prevalence study.

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LEAD POISONING IN CHILDREN IN CHESHIRE AND MERSEYSIDE, UK: A CASE SERIES ANALYSIS

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Lead exposure poses health risks to UK children: long-lasting developmental delays, behavioural disorders and learning difficulties.

We applied mixed-methods to routine surveillance and public health investigation data for a case-series of Cheshire and Merseyside children with measurable blood lead concentrations (BLC). Quantitative: social circumstances, health outcomes; qualitative: response, public health governance, leadership.

Median BLC (n=36) was 11.5µg/dL (0.55µmol/L), with 67% ≥10µg/dL (≥0.48µmol/L). Most (83%) had co-existing vulnerability: delayed development (64%), autism (42% confirmed, 14% under investigation), pica (83%), anaemia/low iron (53%), lone parent (36%), unemployed parents (44% both, 33% one), rented accommodation (58%), pre-1970 housing (75%), and deprivation (75%). Lead sources were seldom identified. No agreed minimum dataset made quantifying exposure risks difficult. Responsibility for identifying sources and taking action was placed on the parent/carer not agencies, leaving children at ongoing risk.

The lack of an agreed, standard environmental management tool, lack of clear roles and responsibilities, with a focus on exposure interruption rather than source removal, exacerbates health inequalities and affects children's current and future quality of life. We recommend standardised and integrated multi-agency investigations, including environmental assessments, with suitable multi-agency training of staff, multi-disciplinary reviews (like incident reviews), with primary prevention methods prioritised and implemented.

LEAD: THE GIFT THAT KEEPS ON GIVING - OR NOT

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As a profession we are well aware of the impacts of lead on human health. To a great degree, lead has been eradicated from our lives. But its legacy still lingers. This presentation looks at a recent case study where geological data was used to determine the health impact of that legacy at a local level, and the outcome.

PESTICIDE PRESENCE IN RESIDENTS 'S URINE LIVING IN LA LAGUNA REGION MEXICO. A RISK PANORAMA

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The Laguna region is an important economic and agricultural hub in Mexico. Studies have shown the presence of pesticides in soil, water, and food, indicating a risk. This study aimed to evaluate the presence of pesticides in residents' urine to assess potential risks. Ninety-nine urine samples were analyzed in 12 locations in the Laguna region. Seventeen organochlorine compounds and nine organophosphates (pesticides+metabolites) were studied. An extraction protocol was developed, and the pesticides were detected and quantified using gas chromatography-mass spectrometry. The data collected revealed an age range of 2 to 85 years. A total of 57 women and 42 men donated urine, and 11 individuals reported involvement in agricultural activities. Results showed that only two organochlorine compounds were detected. Endosulfan sulfate (ES) was detected in 13% of the samples from 6 locations; only two individuals reported fieldwork experience. The highest concentration (30.41 ng/mL) was present in a urine sample from a 50-year-old man. DDE was detected in 92% of the samples in all locations. A 58-year-old man with no agricultural activity reported the highest concentration of DDE (7.88 ng/mL). Organophosphates were not detected; however, aminomethylphosphonic acid (AMPA), a glyphosate metabolite, was detected in 38% of the samples, with a maximum concentration of 25.55 µg/mL in a 62-year-old woman. The results appear to show widespread exposure. Ingestion mechanisms should be studied. DDT was banned in Mexico in the 1990s, so its presence even in children indicates a longer persistence than reported or that it is still used.

Posters

TEMPORAL VARIABILITY OF CO_2 AND ^{14}C IN URBAN AIR: A CASE STUDY FROM GLIWICE, POLAND

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This study focuses on monitoring atmospheric CO_2 concentrations and analysing the urban carbon cycle using isotopic techniques in southern Poland. Urban sampling sites, such as Gliwice, are critical for identifying sources of CO_2 and understanding its seasonal variability. Initial findings (Sensuła et al., 2023) highlight the need for continuous measurements and the value of carbon isotope analysis in urban environments.
In 2022, a CO_2 monitoring lab was established in Gliwice, enabling high-frequency measurements and collection of air samples. CO_2 extracted from these samples is analysed using the MICADAS system, providing $\Delta^{14}C$ data on atmospheric and biospheric carbon.
This presentation summarizes data collected between August 2023 and April 2025. CO_2 concentrations, measured with a CARBOCAP GMP-343 system, ranged from 428 to 469 ppm. $\Delta^{14}C$ values, determined via MICADAS, varied from -55‰ to -24‰, reflecting seasonal dynamics. From 2019 to 2024, we also examined pine needles as biological archives of $\Delta^{14}C$. Since early 2025, a cavity ring-down spectroscopy (CRDS) system has been introduced to monitor the stable isotopic composition of CO_2 and CH_4.
This work was supported by the following contracts and grants: the Initiative of Excellence – Research University programme implemented at the Silesian University of Technology, in the years 2022-2024 (grant no.: 14/020 / SDU / 10-21- 03: Analysis of CO_2 changes in the atmospheric air: construction of a new module to monitor CO2 concentration in the air); EU funds FSD - 10.25 Development of higher education focused on the needs of the green economy European Funds for Silesia 2021-2027 : The modern methods of the monitoring of the level and isotopic composition of atmospheric CO_2 (project no.FESL.10.25-IZ.01-06C9/23-00) implemented at the Silesian University of Technology (2024-2026).

BIOMONITORING FOSSIL AND INDUSTRIAL EMISSIONS WITH PINE NEEDLES IN POLAND

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This study presents the results of carbon isotopes and elemental analyses of *Pinus sylvestris* L. needles collected in 2021 from sampling sites located in Silesia, one of the most industrialized and densely populated regions of Poland. The needles, aged one and two years, had been continuously exposed to local air pollution originating from traffic, residential heating, and industrial activity. The aim was to assess both fossil fuel contributions to atmospheric CO_2 and the deposition of airborne particulate matter on plant surfaces and accumulated by plants.
The carbon isotopic composition values showed variation consistent with urban-industrial carbon inputs. Elemental analysis revealed widespread deposition of silicon, nitrogen, and sulphur, with notable concentrations of Ca, Fe, Al, Mg, and K. Particularly high levels of iron and titanium were detected in samples collected near a heat and power plant.
These findings highlight the effectiveness of pine needles as bioindicators for monitoring carbon isotope signatures and atmospheric contamination in complex urban-industrial environments.
This work was supported by the following contracts and grants: the Initiative of Excellence – Research University programme implemented at the Silesian University of Technology, in the years 2022-2024 (grant no.: 14/020 / SDU / 10-21- 03: Analysis of CO_2 changes in the atmospheric air: construction of a new module to monitor CO2 concentration in the air); EU funds FSD - 10.25 Development of higher education focused on the needs of the green economy European Funds for Silesia 2021-2027 : The modern methods of the monitoring of the level and isotopic composition of atmospheric CO_2 (project no.FESL.10.25-IZ.01-06C9/23-00) implemented at the Silesian University of Technology (2024-2026).

ANTHROPOCENE MINERALOGY AND GEOCHEMISTRY OF NEARSHORE SEDIMENTS IN URBAN-ADJACENT COASTAL ZONES OF ATHENS (GREECE) AND FUJAIRAH (UAE)

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Coastal zones, adjacent to urban areas and harbours, are often linked to extensive environmental issues caused by marine traffic, shipyards, fuel spills, sewage, and garbage. The changing world also impacts and interacts with the seafloor surface sediments. These sediments consist primarily of inorganic solid materials of all sizes—ranging from nanoparticles to larger particles—mixed with organic compounds and a variety of marine life. Most of these solids are composed of well-known minerals (e.g., clays, Fe-oxides/oxyhydroxides), but there is growing concern about the so-called "Anthropocene minerals" existing in nature since the Industrial Revolution in the 19th century and the Atomic Age in the 20th century. Heavy metals, metalloids, radionuclides, and solid particles were investigated in nearshore sediments from urban-adjacent coastal zones in Athens, Greece (Kifissos urban river discharge into the Saronikos Gulf), and Fujairah, UAE (near the harbor). The preparation of the samples involved proper drying and sieving, followed by the use of Na-polytungstate heavy liquids. Analytical methods included XRD, ICP-MS, (FEG-FIB)-SEM-EDS, TEM-EDS/STEM, and γ-ray spectrometry. The Athens samples are enriched in 'urban'-induced elements such as Zn, Cu, Pd, and As, and feature distinct Anthropocene particles, including Fe-oxide nanoparticles, Fe micro-spheres, Fe-Cr micro-wires, and peculiar W-Au-Hg-Ca-Fe micro-crystal aggregates. In contrast, the Fujairah samples contain higher concentrations of Cr, Ni, V, and Co, derived from both natural and anthropogenic sources. The radioactivity in both areas is predominantly natural, attributed mainly to ^{40}K and ^{238}U-series, while the presence of Anthropocene radionuclides, such as ^{137}Cs, is evident in Greece.

THE MOBILITY OF METALS FROM MUNICIPAL ASHES AS A RESULT OF CHANGES IN PH

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The obligation for selective collection of municipal ashes was introduced by the EU Directive (2008/98/EC), which at the same time established rules for their recovery and disposal from the general waste stream. However, assessing their potential impact on the aquatic and soil environment, and on human health, is somewhat more complex. This stems from differences in the actual methods of managing ashes, as well as differences in their chemical composition and physical properties.
Based on the material collected (conventional and alternative fuels, and mixes of selected municipal waste energy fractions), combustion tests were conducted under real-life conditions, using a household utility system powered by a coal-fired furnace with a heating capacity of 10 kW. Sample collection was carried out after complete combustion of the material mentioned above, which was monitored by temperature measurements to maintain a consistent efficiency within the range of 50-80% of the furnace's nominal capacity. Single-step (*aqua* solution, aqua regia and TVA) and sequential extractions (four-step BCR extraction) were carried out on the collected ash samples (n=36) to assess the leaching of the following elements: Cd, Cr, Ni, Pb, Sn, and Zn.
The *pseudo*-total content (*aqua regia*) of these elements in the material analysed fell in the following ranges (min.–max., data in mg/kg d.m): 0.1–94.5, 10.1–457.0, 5.5–50.4, 14.7–389.8, 0.3–360.4, 40.1–7806.6, respectively. In the post-extraction solutions, the following concentrations were found (data in % of total concentration) for aqueous leaching: up to 1% Cd, Ni, Pb, Sn, and Zn, and over 28% of total content for (total) Cr. The TVL test demonstrated that the greatest risk was posed by the leaching of Cr (average for all samples >3% of total concentration), while for the remaining elements, leaching was observed at a level of <1%. In ion-exchange positions, the highest share was comprised by Zn cations (10%) > Ni (4%) > Cd and Cr (~2%) as well as Pb and Sn (<1%). Following pH reduction from the values determined in aqueous solutions, ranging from 8.2 to 13.1 (av. 12.0), to pH=5, mobility increased by approx. 4% on average.
The analyses conducted clearly indicated that municipal ashes present a highly diverse composition and properties. Despite good buffering properties and high pH levels, the potential load of pollutants that may enter the environment is significant, especially for Cd, Ni, and Zn. Therefore, research in this area should be continued.

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PHASE COMPOSITION OF RENAL STONES IN GREECE: INSIGHTS FROM X-RAY DIFFRACTION AND RAMAN SPECTROSCOPY

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For health care practitioners, the determination of renal stones composition is considered crucial because it allows for a targeted and holistic treatment to be offered to patients with urolithiasis, minimizing the risk of postoperative recurrence. This study investigates the phase composition of renal stones through a combined analytical approach using X-ray diffraction (XRD) and Raman spectroscopy. To minimize fluorescence interference during Raman analysis, a photo-bleaching pre-treatment was applied to the samples. The collected renal stones exhibit diverse colours and textures, ranging from white to dark brown, with the majority appearing orange-brown. Many orange-brown samples contain concentric crystalline aggregates, sometimes formed around a dark nucleus. Less commonly, botryoidal and coarse-grained textures were observed. Mineralogical analysis revealed that whewellite ($Ca(C_2O_4)\cdot H_2O$) is the predominant phase, with weddellite ($Ca(C_2O_4)\cdot 2H_2O$), uric acid ($C_5H_4N_4O_3$), and uric acid dihydrate ($C_5H_8N_4O_5$) identified in fewer samples. Raman spectroscopy confirmed the presence of whewellite through characteristic peaks at ~1463 cm^{-1} and 1491 cm^{-1}, corresponding to symmetric stretching vibrations of carboxylate groups, along with a carboxylate bending peak at 897 cm^{-1}. Minor peaks associated with uric acid were detected at 922, 1039, 1282, and 1686 cm^{-1}. These findings demonstrate the effectiveness of XRD and Raman spectroscopy in identifying mineral phases within renal stones, providing insights into their formation and composition leading to better treatment for urolithiasis patients.

INTERDISCIPLINARY WATER MONITORING IN MULTI-STRESSOR MARINE ENVIRONMENTS

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The Hellenic Volcanic Arc (HVA) in the Mediterranean Sea is a result of the subduction of the African tectonic plate under the European and comprises of active and dormant volcanoes, the most prominent being the peninsula of Methana and the islands Milos, Santorini and Nisyros. It is a marine environment influenced by multiple stressors of both natural origin (e.g. volcanic activity, hydrothermal venting, atmospheric deposition) and anthropogenic origin (e.g. industrial tourism, maritime transport, fisheries, etc.). The combined effects of these stressors on seawater quality and whether they act in a synergistic, antagonistic, or additive way are largely unknown, due to the complexity of the system requiring simultaneous observations by several scientific disciplines.

The EU funded nexus monARC project (GA No. 101079156) aims to address the complexity of monitoring such marine environments, based on two pillars: an interdisciplinary scientific approach and citizen science programs. The scientific approach utilizes analytical techniques to monitor parameters relevant to climate, bio-essential and toxic elements, litter, chemicals, biodiversity and radioactivity. When possible, priority is given to the use or development of frugal approaches, that may then be used by citizen scientists; to that end, training and educational activities are carried out with stakeholders and especially schools in the coastal areas of HVA. The data produced from scientific expeditions and citizen science activities will be used to shed light on the complex bio-geochemical conditions in this multi-stressor area, evaluated through a DAPSIR framework, and translated into proposals for consideration by regional authorities.

SOIL EXTRACTABILITY OF POTENTIALLY TOXIC ELEMENTS IN GREECE: RELEVANCE OF AQUA REGIA AND DILUTE NITRIC ACID METHODS TO THE EUROPEAN SOIL DIRECTIVE

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The forthcoming European Commission (EC) Soil Directive proposes several soil descriptors along with methodologies for their estimation. Among these, dilute nitric acid (0.43 M HNO_3) extraction has been suggested for assessing the environmentally available fraction of Potentially Toxic Elements (PTEs). Currently, Greece lacks a comprehensive dataset aligned with these descriptors. We present a comparative analysis of Aqua Regia (AR) and HNO_3 extraction results for 117 surface soil samples (<20 cm) from Greece. Both methods underwent rigorous quality control procedures to ensure dataset reliability. Median concentrations (mg/kg) of PTEs using HNO_3 extraction were: As 1.03, Cd 0.22, Co 5.97, Cr 4.22, Cu 5.79, Fe 654.4, Mn 423.8, Ni 11.72, Pb 14.72, V 6.0, Zn 8.2. Corresponding AR values were: As 20, Cd 0.34, Co 17.2, Cr 86.0, Cu 25.3, Fe 30000, Mn 722, Ni 89, Pb 29.1, V 43.0, Zn 64.8. Extractability ratios (HNO_3/AR) showed substantial variability, ranging from 2% (Fe) to 65% (Cd), with the following order: Cd 65%> Mn 59% > Pb 50%> Co 35%> Cu 23%> Ni 13%= Zn 13%> V 9% > Cr 5%= As 5% > Fe 2%. These findings indicate that the environmentally available fractions of PTEs are governed by both total concentrations and the mineralogical or geochemical host phases. The low extractability of key PTEs like As, Cr, and Ni highlights firstly the need to consider geochemical binding when evaluating health risks using HNO_3-based methods, but also closely examine the implications of the proposed methods when it comes to soil health assessment.

THE IMPACT OF EXTREME FLOOD EVENT ON REDISTRIBUTION OF POTENTIALLY TOXIC ELEMENTS: A PRELIMINARY RESULTS FROM A FORMER MINING AREA

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Intense rainfall and floods may affect spatial distribution of chemical elements on Earth surface. Extreme floods severely affected Slovenia in August 2023. One of the most affected areas was a wider area of former lead and zinc mine, where the environment is heavily contaminated with some potentially toxic elements (PTEs), and there are several mine waste deposits prone to erosion. Levels of PTEs in stream sediment in this area has been regularly monitored since 2013.
To determine the potential impact of extreme rainfall and floods on redistribution of PTEs, flood and stream sediment was sampled and compared with data on stream sediment from regular monitoring. Samples were prepared (dried at 35°C, sieved <0.125 mm) and analysed by the same methods (determination of PTEs levels by ICP-MS after aqua regia digestion).
Comparison of PTEs levels in stream sediment from a decade long monitoring with flood sediment and stream sediment sampled after an extreme flood event illuminate the complexity of redistribution processes during such events, which may result in increase or decrease of PTEs levels. For example, the median levels of Cd, Mo, Pb, and Zn in flood sediments were higher than their median levels in stream sediment during usual hydrological conditions indicating that erosion of contaminated areas and mine waste deposits dominated over erosion of non-contaminated materials. On the other hand, levels of PTEs at some specific sampling locations were much lower after the flood event than before, indicating higher erosion of non-contaminated materials that may lead to the dilution effect.

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ARSENIC EXPOSURE THROUGH DRINKING WATER IN NORTH-CENTRAL MEXICO

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In the Lagunera Region of Mexico, located in north-central Mexico, geological conditions and excessive groundwater extraction have increased concentrations of various contaminants in drinking water, such as arsenic (As). This study aimed to implement an epidemiological surveillance protocol and characterize the epidemiological presentation of As exposure in human populations in the Lagunera Region.

Exposure assessment was conducted through biological monitoring of total arsenic in spot urine samples (AsTU) as a biomarker of internal exposure. The study was conducted in regions previously identified as having As in the regularly distributed drinking water supplied through public water service networks. A total of 1,850 individuals from 10 communities were invited to participate, of whom 1,103 agreed.

Among the participants, 47% had AsTU concentrations below 35 µg/L (low exposure level), 39% exhibited high AsTU levels between 35–99 µg/L, and 14% had AsTU levels of ≥100 µg/L, which is considered a toxic level. A significant regression was observed when analyzing the relationship between AsTU and fluoride in urine, indicating co-exposure to these two elements.

These results were fully integrated into the Unified Information System for Epidemiological Surveillance, providing official data to support decision-making. In regions where arsenicosis and fluorosis are endemic, this registry is considered highly important for guiding public health decision-making and policy design, emphasizing the primary prevention of chronic As and F intoxication through drinking water.

HEAVY METAL ACCUMULATION IN *AZOLLA MYCROPHYLLA*, *CYMBOPOGON CITRATUS*, *CHRYSOPOGON NITRIGANA* AND *EICHHORNIA CRASSIPIES* GROWN ON PAINT-BASED INDUSTRIAL EFFLUENT.

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There is persistent ecological exposure to toxicants such as heavy metals that are liable to induce pollution, disrupting normal ecological processes and additional health risk to life. Phytoremediation presents a low-cost innovation that utilizes plants in the clean-up of contaminated systems. This is greatly dependent on the ability of plants to take-up and bio-accumulate heavy metals. This study aimed to assess the hyper-accumulating potentials of four plant species (*Azolla mycrophylla*, *Cymbopogon citratus*, *Chrysopogon nitrigana* and *Eichhornia crassipie*) for lead (Pb), cadmium (Cd), copper (Cu) and chromium (Cr) grown hydroponically on a paint-based effluent in a greenhouse pot experiment under natural lights. The heavy metals accumulated in the plants were analyzed using Atomic Absorption Spectroscopy (AAS) Hanna HI Variian AAS SpectraAA 240FS, Italy. The heavy metal concentrations ranged from 0.100 – 0.770 mg/kg plants for Cd, Cr, Cu and Pb. Bio-concentration factor (BCF) also ranged from 0.17-8.67 inferring a high potential of these plant species to be hyper-accumulators of Cd, Cr and Cu and Phytostabilizer for Pb. Translocation factor (TF) of the heavy metals were >1 (8.3-248.7) revealing the movement of these contaminants from the roots to the shoot of the four plants, indicating their possibilities to act as hyper-accumulators of the heavy metals. The findings of this study suggest the applicability of these test plants for phytoremediation, Phyto-extraction and phytostabilization.

HOMOGENEITY TESTING OF AN IN-HOUSE REFERENCE MATERIAL FROM A MINING SOIL IN LAVRION. GREECE

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Successful preparation of in-house reference materials (IHRMs) depends on the homogeneity of the material, which must meet uncertainty requirements tailored to its intended analytical purpose—a process often described as "fit-for-purpose" uncertainty. Here we present the homogeneity assessment of an IHRM produced from a mining soil sample collected in the historical mining district of Lavrion, Attica, Greece. Homogeneity testing focused on the concentrations of As, Cd, Cu, Fe, Mn, Sb, Pb, and Zn, determined after EPA 3050B acid digestion and analysis by ICP-MS and flame AAS.

Twelve subsampled units were analysed in duplicate. One-way ANOVA was applied to assess analytical and sampling variance, following a Cochran's test ($p > 0.05$) to identify outliers among duplicates. Target standard deviations for the homogeneity test were based on both a 10% relative standard deviation and the Horwitz function. The results showed that the material was homogeneous for most elements, with the exception of Sb and Cd. The assigned mean concentrations and their standard uncertainties (mg/kg) related to the degree of homogeneity were as follows: As = 163 ± 1, Cu = 77.6 ± 0.5, Fe = 40,511 ± 190, Mn = 1,778 ± 10, Pb = 1,793 ± 14, and Zn = 1,383 ± 12.

This work highlights the challenges in achieving homogeneity for trace elements present at lower concentrations. The elevated variability observed for Cd and Sb reflects their low abundance and heterogeneous distribution in the source material, underscoring the importance of careful characterisation when preparing reference materials from contaminated soil.

FROM SOIL TO BIO-ORE: PHYTOMINING AS A SUSTAINABLE FRONTIER IN CRITICAL METAL SUPPLY

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Phytomining, also known as agromining, is an emerging green technology that utilises the natural metal-accumulating capabilities of certain plant species for the recovery of valuable metals from sub-economic ore bodies, metal-polluted, or metal-enriched soils. These remarkable species, known as hyperaccumulators, can uptake and concentrate metals from the soil into their biomass. Since the 1990s, phytomining has been explored as a more sustainable, low-cost, and environmentally friendly alternative to conventional mining methods. The concept of phytomining involves selecting and cultivating hyperaccumulator plants on metal-rich sites to produce sufficient biomass enriched with target metals. Once the plants reach peak biomass, the "metal crop" is harvested and processed to produce a bio-ore, from which metals are subsequently extracted. The technology has shown great promise not only in recovering valuable metals but also in facilitating soil remediation, with the potential to offset remediation costs through the commercial value of extracted metals. Depending on factors such as the market price of target metals, the biomass and metal yield, and the availability of site area, phytomining is particularly promising for extracting metals such as nickel, thallium, gold and rhenium due to their extensive industrial applications and rarity. Additionally, the success of phytomining depends on the careful selection of hyperaccumulator species, the bioavailability of target metals, and the optimisation of agronomic practices. As phytomining continues to advance, it could stand out as a dual-benefit strategy in sustainable metal extraction for possible economic gains while contributing to the remediation of metal-contaminated environments.

EFFECTS ON CLINICAL AND INFLAMMATORY PARAMETERS DUE TO ENVIRONMENTAL EXPOSURE TO A MIXTURE OF TOXIC COMPOUNDS IN THE UPPER BASIN OF THE ATOYAC RIVER

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A biomonitoring study was done in teenagers living in small communities at the upper basin of the Atoyac river, previous authorization from their parents. Exposure to organochloride pesticides, organophosphates, PCBs and heavy metals was analysed in blood samples, and correlated with parameters of blood chemistry and inflammatory cytokines.
Results revealed that every young person shows a co-exposure to each of the compounds studied, and that there are effects on their physiology. Principal component analysis was used to evaluate the association between this exposure and the clinical parameters, finding that there are stimulatory as well as inhibitory effects, among which we found significant correlations with sexual hormones, cholesterol levels, hepatic and renal function biomarkers, by the first 10 components, which explain 70% of the variance. When analysing the effect on inflammatory cytokines, six components showed a stimulatory effect, whereas 4 showed inhibitory effects in most of them. Only TNF showed no affectation by any of the components. It should be underlined that these young persons have been so exposed since they were born, due to the operation of thousands of industries who dump their wastes into all the environmental matrices.
Countries like México, in their interest “to develop” have allowed the operation of industries who, to lower their costs of production, have done everything to avoid environmental care, with the consequence that chronic noncommunicable diseases have escalated in this area for 20 years already, where people have lived unaware of the hazards they are exposed to.

SATELLITE-BASED MAPPING OF GROUNDWATER POTENTIAL ZONES TOWARDS A SUSTAINABLE WATER DEMAND AND SUPPLY IN LAGOS, NIGERIA

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Climate change and over exploitation are making groundwater resources more problematic, making it necessary to evaluate their productivity and potential. The demarcation and appropriateness of groundwater potential zones for the Lagos coastal population have been investigated in this study utilizing GIS and Fuzzy Analytical Hierarchical Process (Fuzzy-AHP) techniques. In order to determine the appropriate groundwater potential zones, this study created eight thematic maps from satellite-based datasets, using geospatial techniques. These maps include soil, land use/land cover, geology, drainage density, rainfall, elevation, lineament density, and slope. Weights were assigned to each theme map in this study based on its unique attributes and contribution to the groundwater potential capacity. The groundwater prospects were classified into four categories, using Fuzzy-AHP approach; high, moderate, low and very low zone. Within the study area, the high zone covers 260.91 km^2 (17.64%), the moderate, low and very low covers 542.13 km^2 (36.28%), 437.96 km^2 (29.32%), 252.99 km^2 (16.93%) respectively. The high and medium groundwater potential zones were spread all round the study area but mostly in the communities which are few kilometres to the ocean and the lagoons. These two zones, amounting to 54 % of the entire study area, are the most suitable locations for the exploitation of groundwater for urban use. The results obtained from the study shown the benefits of groundwater potential zone map to the Lagos state to ensure sustainable water resources management, re-use and conservation.

THE IMPACT OF RETROFITTING HOMES FOR ENERGY EFFICIENCY ON POTENTIALLY ADVERSE INDOOR AIR QUALITY AND HEALTH OUTCOMES

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Indoor air quality in homes has been linked to the health outcomes of the people residing in the properties. Housing providers have been making homes more energy efficient by implementing new windows, cladding and heating systems. However, the impact of these energy efficiency retrofits on the indoor air quality, and hence the residents' health, has not been considered.

So far, we have surveyed terraced bungalows, semi-detached 2 story homes and tower blocks. Air quality monitors were placed in participant's homes for three weeks before the energy efficiency intervention, and for a further three weeks one year after the intervention was finished. The participants also completed house and health surveys during each of the sampling periods. CO_2, temperature, humidity, $PM_{2.5}$ measurements were taken at minute intervals for the duration of the study.

We have completed baseline monitoring for 50 homes and residents and post retrofit monitoring on 28 of these. Baseline $PM_{2.5}$ concentrations for the initial 30 bungalows, after excluding 3 properties where smoking had occurred, ranged from 3 – 24 μg/m^3, with no homes over the 2019 EU & UK outdoor air annual average limit of 25 μg/m^3, though 21 homes were over the 2021 WHO guideline of 5 μg/m^3. $PM_{2.5}$ and CO_2 were not correlated suggesting independent source.

The SF36 validated health and wellbeing survey mean 'physical health' score for participants from our initial 30 homes was below average, likely due to their age >55 years. Their mean mental health scores were above average, possibly a result of living in a supported community.

We have developed a protocol to measure and compare baseline and post retrofit indoor air and health in different housing typologies. Findings indicate $PM_{2.5}$ should be included with CO_2 as a standard measure. Results have the potential to inform retrofit policy and guidelines.

Further study is ongoing with a larger participant group in multiple location in the Northeast of England.