Department of Environmental Sciences

Outstanding Achievements of 2024

Foreword

Prof. Dr. Milena Horvat
Head of the Department of Environmental Sciences

I am very proud to reflect on our department's significant progress and achievements over the past year. Through dedicated research and collaboration, we continue to address critical environmental challenges, ranging from atmospheric pollution and human exposure to contaminants to sustainable resource management, food safety, and chemical risk assessment.

A major milestone was the establishment of the MSC-East center, which has strengthened our capacity for advanced environmental modeling, particularly in tracking atmospheric pathways of contaminants. This center plays a crucial role in deepening our understanding of how pollutants travel, interact with ecosystems, and affect human health, contributing to global air quality assessments and policy development.

Our department has made impactful contributions to the scientific community, with numerous publications in high-profile journals such as *Nature Geoscience, Environmental Science & Technology, Science of the Total Environment*, and *Chemosphere*. Our studies cover diverse topics, from atmospheric mercury calibration and human biomonitoring of emerging pollutants to advanced isotopic techniques for food and environmental tracing and innovative approaches to assessing ecosystem health. These achievements reflect the dedication and expertise of our researchers.

In addition to environmental research, our department leads in food authenticity, safety, and quality studies. Using state-of-the-art methods, we trace food origins, evaluate contaminant exposure, and investigate sustainable food sources. Stable isotope analysis and studies on the bioavailability of essential and toxic elements provide critical insights that support regulations and consumer well-being.

Equally important is our commitment to mentoring the next generation of scientists. This year, several PhD and master's students successfully defended their theses, adding valuable knowledge across multiple fields and ensuring the continued growth of environmental science.

While this brochure highlights our key achievements, the full scope of our work is reflected in the comprehensive list of scientific publications included. These contributions underscore our department's strong standing in global environmental research.

I am deeply grateful to all our researchers, collaborators, and students for their hard work and dedication. Together, we have laid a strong foundation for continued success.

About us

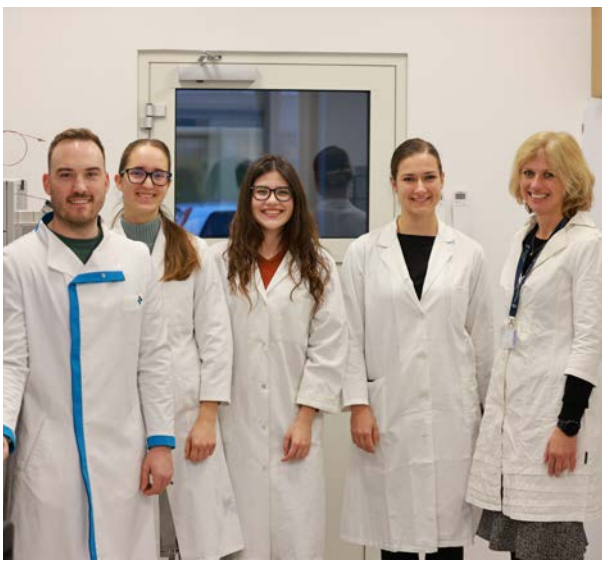
In 2024, the Department of Environmental Sciences (O-2) continued its commitment to addressing pressing environmental challenges and their impact on human health through innovative, multidisciplinary research. Our vision remains focused on integrating cutting-edge science and technology to better understand and manage complex environmental processes and their interactions with human systems. Our research spans environmental analytical chemistry, biogeochemical cycling, microbial systems ecology, environmental health, food safety, and the development of sustainable environmental technologies.

A core focus this year was the **analytical chemistry of environmental and biological systems**, particularly in inorganic analysis and chemical speciation. We advanced research on the environmental impacts of galvanizing activities in Zreče, expanding our analysis of chromium species in environmental samples. Significant progress was made in cancer diagnostics through the analysis of trace elements in biological samples, including the development of new methods for copper speciation in cancer patients. We also enhanced rapid analytical methods for radionuclide detection, critical for environmental safety monitoring.

In **organic analysis**, we developed new sorbents for the extraction of organic pollutants and optimized passive sampling techniques for pharmaceuticals in wastewater. Our research on stable isotope analysis further expanded, particularly in tracing illicit drugs and in food authentication.

Our **metrology** efforts advanced through continued participation in European metrology projects. We refined isotope ratio measurements for elements like cadmium and chromium in seawater and launched the ScreenFood project, focusing on food contaminants from packaging materials. We also contributed to developing new stable isotope reference materials for volatile organic compounds, enhancing global measurement standards.

Research into **nanomaterials** focused on biosensors for mercury detection in aquatic systems and antibacterial textile coatings using CuO and ZnO nanoparticles. In the field of biogeochemistry, we applied stable isotopes to study carbon fluxes, ocean acidification effects, and cave bear paleobiology, providing new insights into climate change indicators and ancient ecosystems.



Our **water cycle** studies included urban hydrology projects in Ljubljana, tracing the origins of the city's drinking water using stable isotopes. We also developed new methodologies in **wastewater-based epidemiology** (WBE) to detect emerging psychoactive substances, applying advanced mass spectrometry techniques.

In **Environment, Food, and Health**, we expanded human biomonitoring programs in collaboration with the National Institute of Public Health, assessing children's exposure to environmental contaminants. Our food research explored insect-based proteins, consumer attitudes toward alternative meats, and the traceability of food products using stable isotopes and elemental analysis. We also continued investigating the reuse of wastewater and sludge in agriculture, assessing contaminant uptake in crops.

The Infrastructure Centers–**CMS**, **ICMIS**, **ELME**, and **MSC-East**–played pivotal roles in research and emergency response. CMS expanded its mass spectrometry applications in environmental and biomedical studies. ICMIS maintained its leadership in ionizing radiation measurements, supporting national and international safety standards. ELME actively responded to environmental incidents and conducted regular field exercises, ensuring readiness for future challenges. **MSC-East** continued its essential role within the European Monitoring and Evaluation Programme (EMEP), focusing on the modeling and monitoring of transboundary air pollution. Its advanced atmospheric models and data analyses have been instrumental in understanding pollutant dispersion, contributing to policy development and improving air quality across Europe.

Our department's excellence is reflected in new EU-funded projects such as **InPlasTwin**, **FutureFoods**, and **SPECTRA**, and through high-impact publications in leading scientific journals. These achievements underscore our dedication to scientific excellence, interdisciplinary collaboration, and applied research that contributes directly to sustainability, human health, and environmental resilience.

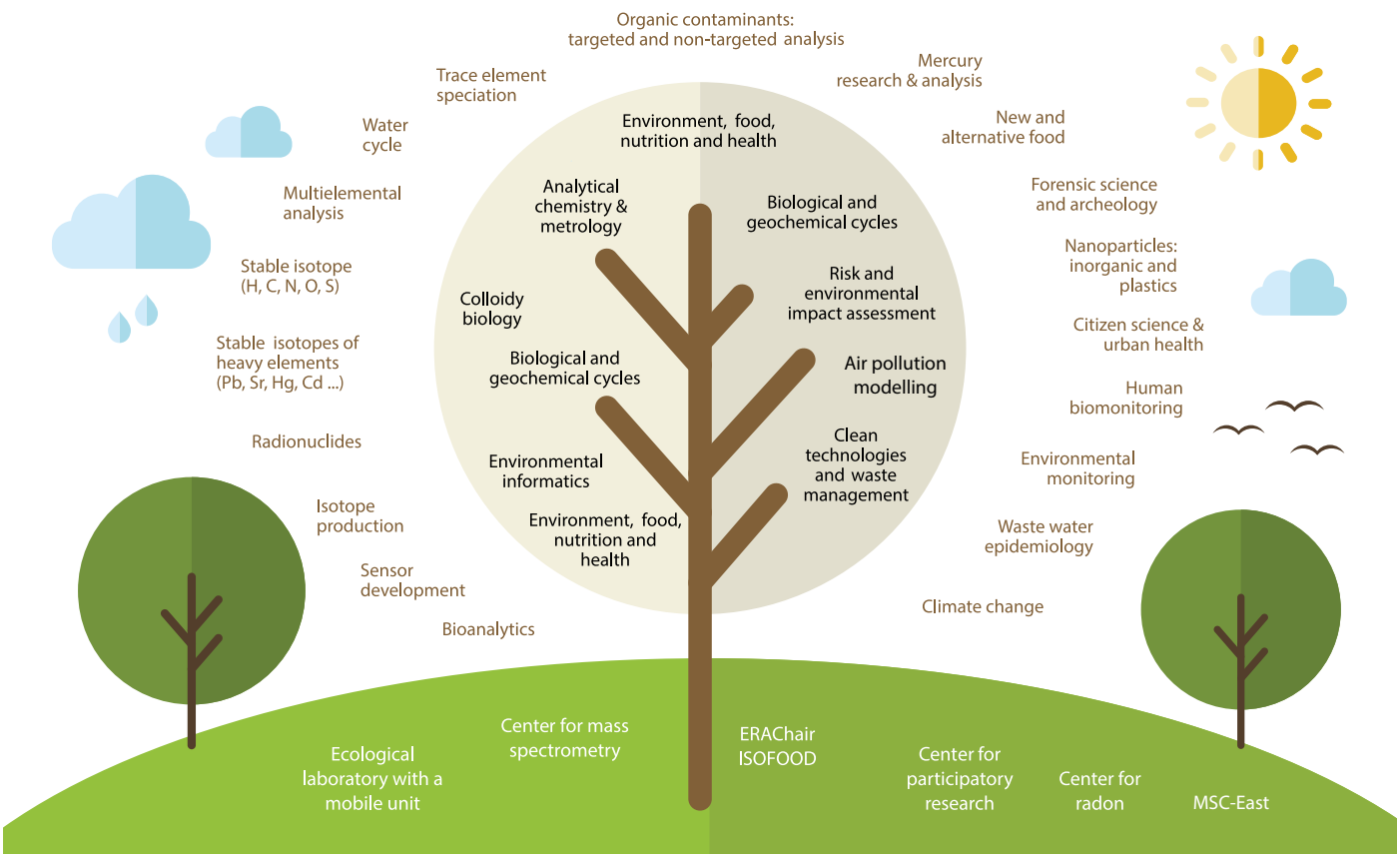
Positioning our research in time and space

UN SDGs:

- Partnerships to achieve the Goal
- Life Below Water
- Clean Water and Sanitation
- Gender Equality
- Life on Land
- Zero Hunger
- Climate Action
- Responsible Consumption and Production
- Sustainable Cities and Communities
- Good Health and Well-beeing
- Industry, Innovation and Infrastructure
- Affordable and Clean Energy
- Quality Education

Strategic goals

- Food safety, security and traceability
- Bring about transformational change in relation to the environment, climate change and health
- Climate change and biodiversity loss – reduce effects on health and the environment
- Improve health impact assessment of environmental factors and promote implementation research
- Cities and communities – promote healthy lives in sustainable and inclusive societies
- Chemical and physical stressors – prevent and eliminate harmful substances exposures to health

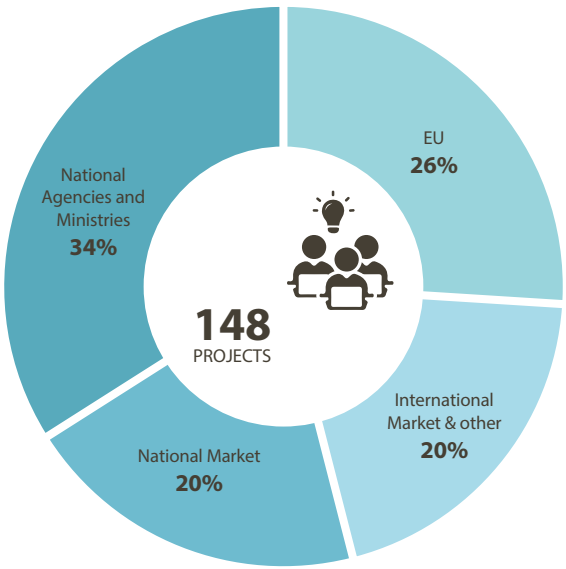


Highlights of 2024

The Department of Environmental Sciences has a long tradition of developing collaborative partnerships with industry. This collaboration helps deliver new products and services, which advances the Slovene economy, improves our quality of life, and brings real-world technologies and management issues into our research laboratories. Building international partnerships are recognized as a necessity for advancing technologies and solving global challenges.

In 2024 the Department was involved in **80** national and **68** international projects, **38** projects were within the EU framework projects.

Total number of projects:	**148**
EU:	**26%**
International Market & Other:	**20%**
National Market:	**20%**
National Agencies and Ministries:	**34%**

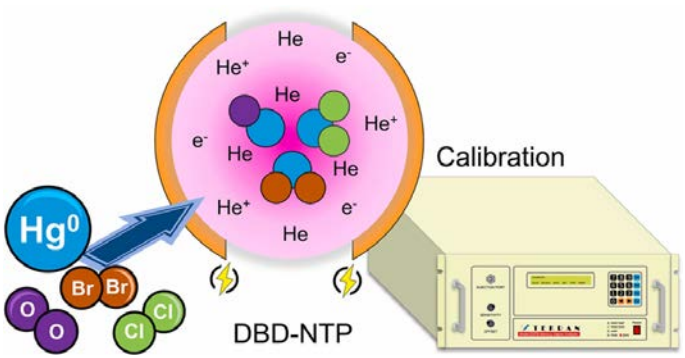


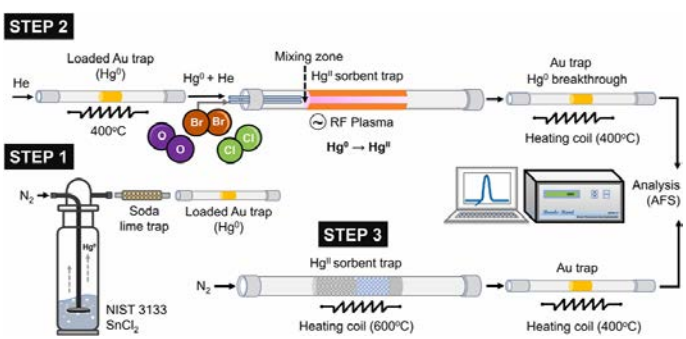
Outstanding Achievements

Advances in traceable calibration of atmospheric mercury

Traditional methods for measuring atmospheric mercury concentrations and the chemical composition of gaseous oxidized mercury (GOM) face challenges, highlighting the need for more accurate and reliable techniques for advancing our understanding of the mercury biogeochemical cycle.

In 2024, we introduced a traceable continuous-flow calibration method for gaseous elemental mercury (GEM) at low ambient concentrations. Tests using a direct mercury analyzer with Zeeman background correction revealed that factory-calibrated devices often underestimate low concentrations. However, calibration using the certified reference material NIST SRM 3133 yielded more accurate results. Additionally, we validated a permeation unit used for GOM calibration, previously tested under field conditions. This system demonstrated high recovery rates for both elemental mercury and $HgBr_2$, verified against an SI-traceable calibration system. Our research has also enhanced a traceable calibration method for measuring GOM in the atmosphere using non-thermal plasma (NTP) oxidation. Results showed that the NTP method provides more accurate and consistent calibration of the detector compared to the standard internal calibration method of the Tekran 2537B analyzer, which tends to underestimate GOM concentrations.





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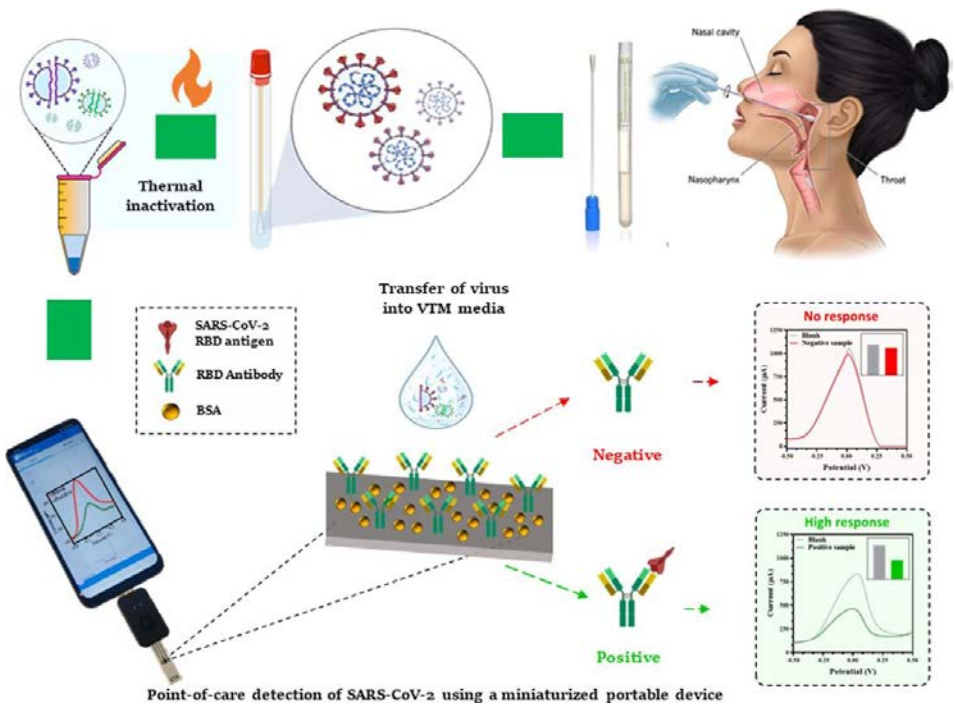
https://doi.org/10.1016/j.aca.2023.342168
https://doi.org/10.5194/amt-17-1217-2024

A new sensor for SARS-CoV-2 virus detecion

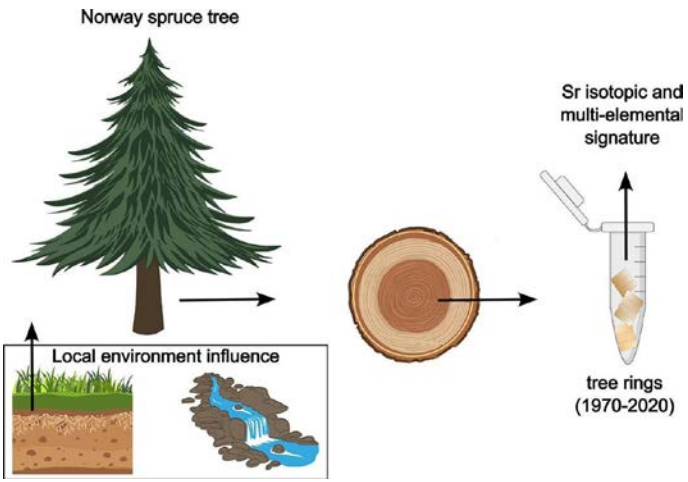
A smartphone-enabled portable device was developed for COVID-19 detection using screen-printed electrodes (SPEs) functionalized with in-house generated antibodies against the SARS-CoV-2 receptor-binding domain. The platform achieved a limit of detection of 0.83 fM and 94% sensitivity in 100 clinical samples compared to RT-PCR, with performance validation against a laboratory-based potentiostat. It successfully recognized the Omicron variant, with no cross-reactivity with MERS or Influenza A H1N1, highlighting its potential for portable point-of-care diagnostics.

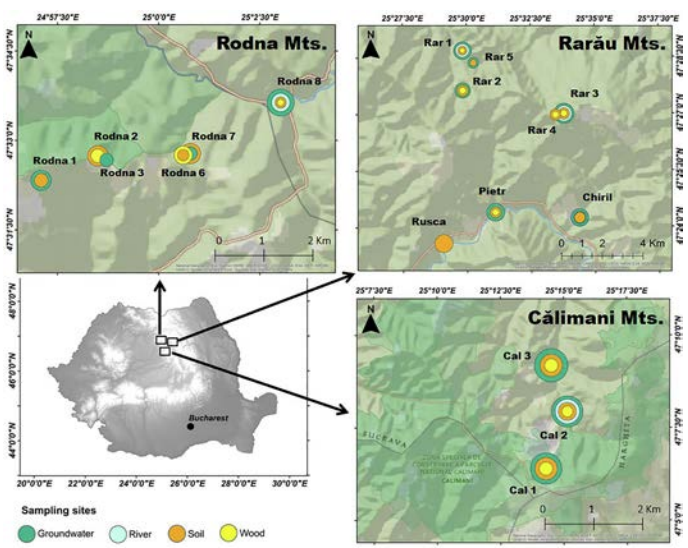


References:
https://doi.org/10.1016/j.bioelechem.2024.108722

Provenance of timber: Sr isotopes as a possible tool

Ensuring efficient wood traceability within procurement chains is essential for establishing sustainable forest management and minimizing environmental damage in countries that produce and export timber. We analysed the potential of using Sr isotope ratios combined with multi-elemental composition to distinguish wood samples from three different geographic origins in the Eastern Carpathians. Sr isotope ratios were consistent across all cores from trees within the same site but varied among sites within the same region. Principal Component Analysis of the Sr isotopic and multi-elemental data successfully differentiated the trees from two out of three regions.

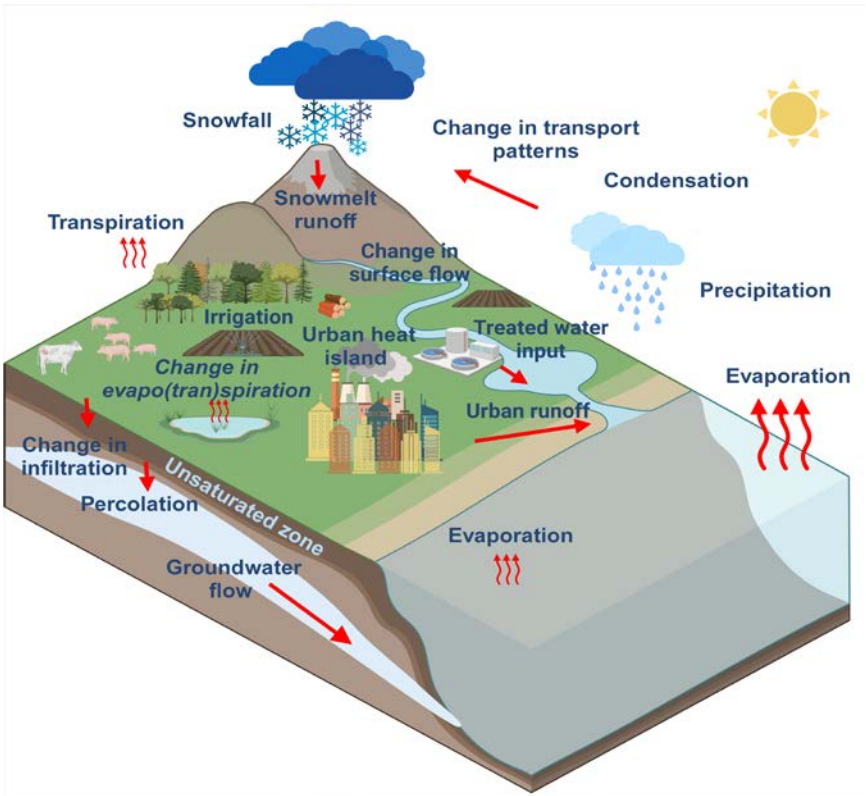




References:
https://doi.org/10.1016/j.scitotenv.2024.176244

Water isotopes in urban hydrology

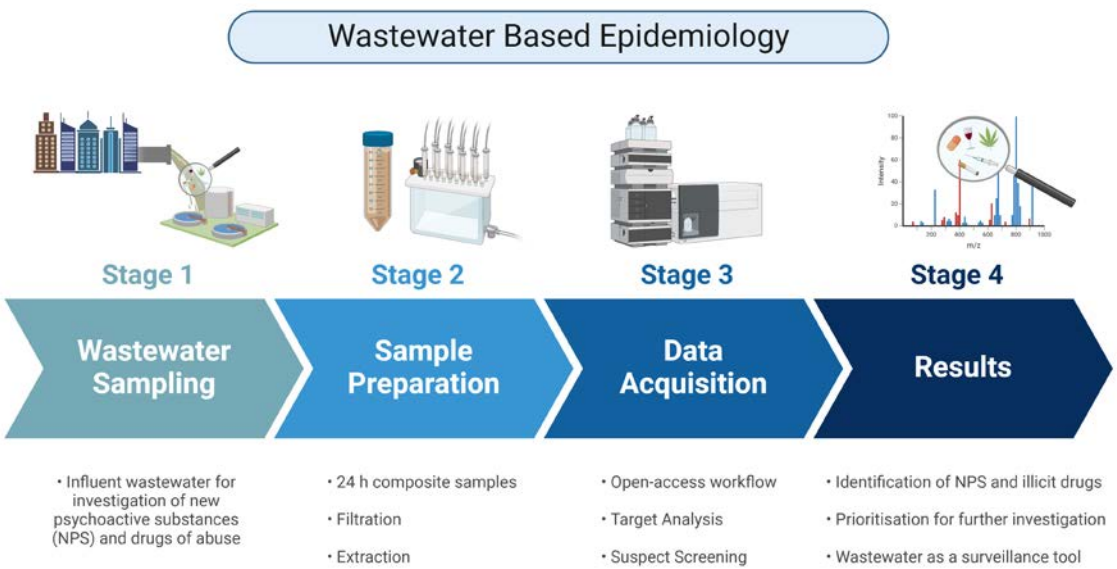
A city-wide study of stable water isotopes (δ2H and δ18O) in precipitation, surface water, and groundwater across the Slovenian capital was undertaken to trace the various sources contributing to the city's drinking water supply. Monthly water isotope composition combined with hydrogeochemical data permitted the identification of contributions of local precipitation and river water to the two main drinking water supply aquifers. A re-examination of the long-term isotope data series revealed mean residence times of groundwater much longer than previously reported. Also, changes in the contributions of surface water and precipitation to groundwater were observed, which indicates a shift of recharge patterns over time.



References:
https://doi.org/10.1016/j.jhydrol.2024.130892

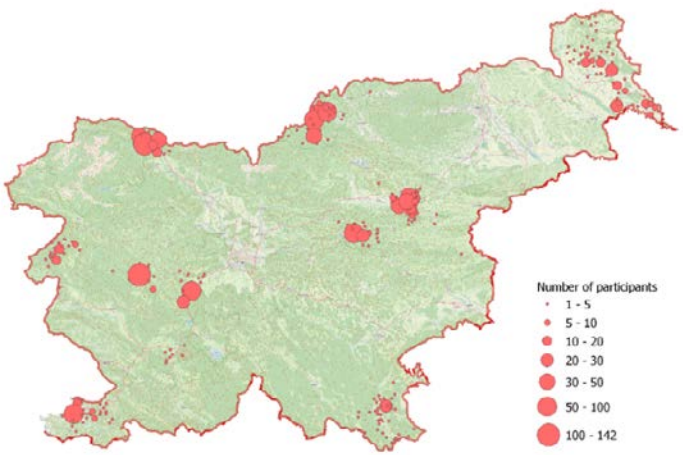
Water based epidemiology

We established an open-access workflow to facilitate the analysis of emerging drugs in wastewater. By combining target analysis of wastewater influent samples and the suspect screening workflows, wastewater-based epidemiology can provide objective and timely insights into the use of new psychoactive substances and drugs of abuse across different countries, including Slovenia.



References:
https://doi.org/10.1016/j.jhazmat.2024.133955
https://doi.org/10.1016/j.watres.2024.121390

Human Biomonitoring



The main goal of the Human Biomonitoring programme, conducted in collaboration with the National Institute of Public Health, is to assess the exposure of children (6-9 years) and adolescents (12-15 years) in Slovenia to environmental chemicals. From 2018 to 2024, we sampled **1845 children** from 9 study areas across Slovenia. In our biobank, more than **50000 aliquots of biological samples** were stored. Currently, biological sample analysis is still underway. The selection of chemical analyses is based on data from previous studies in Slovenia and Europe and includes substances that are of particular concern due to their potential negative impact on health, especially when exposure is higher. We monitor metals, bisphenols, phthalates, brominated flame retardants, parabens, triclosan, pesticides, PFAS, and/or PAHs. We also assess nutritional status with regard to essential elements crucial for normal body functions. Based on the analysis results and questionnaire data on dietary habits, living environment, hobbies, socio-economic status, etc., we will evaluate exposure to selected chemicals in different geographical regions. The exposure assessment will be used for risk assessment for the targeted population, and if a risk is identified, appropriate measures will be proposed.

References:
https://doi.org/10.1016/j.envint.2024.108912
https://doi.org/10.1016/j.ijheh.2023.114315
https://doi.org/10.1016/j.envres.2024.119583

Insects as alternative protein sources

The consumer perceptions in Slovenia was investigated, revealing moderate interest in insect-based foods, especially in non-visible forms. It found that young, educated men and rural residents show greater openness to entomophagy, while economic factors and cultural influences play a crucial role in acceptance.

Consumer attitudes towards plant-based, lab-grown, and insect-based meat alternatives in Slovenia and the UK were compared. Results showed that plant-based options are the most accepted, while health, nutrition, and sensory appeal are the primary drivers of choice.

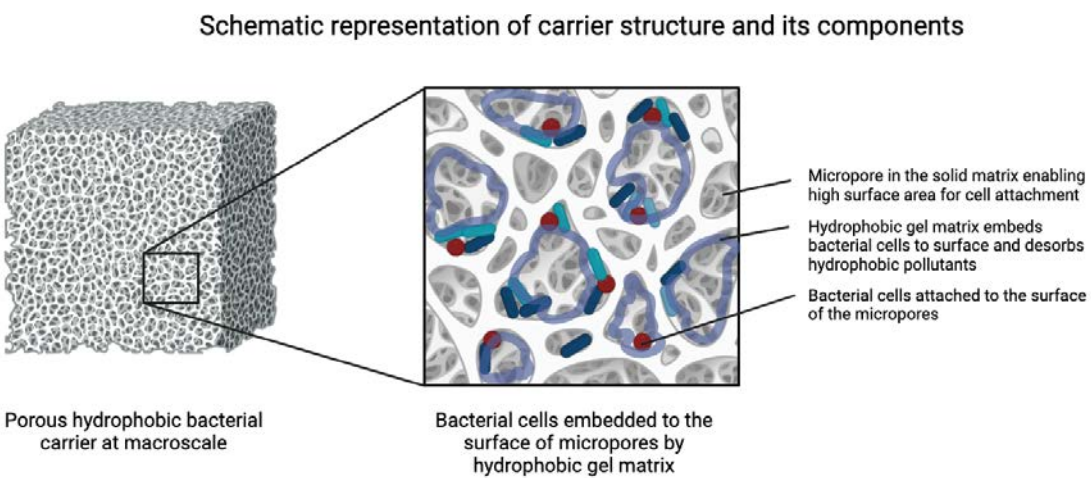
The study investigating the bioaccessibility and bioaccumulation of essential elements in farmed insects focused on selenium fortification. It confirmed the insects' high nutritional value and highlighted the presence of biogenic nanoparticles, including Iron nanoparticles, which affected the bioaccessibility of iron.

The research excellence of our research was recognised internationally, resulting in participation in three new EU funded projects which started in 2024 (AQUASERVE, https://www.aquaserv-ri.eu; FutureFoods, https://www.futurefoodspartnership.eu; SPECTRA, https://spectra-project.eu).

References:
https://doi.org/10.3390/foods13162629
https://doi.org/10.3390/foods13111627
https://doi.org/10.1016/j.foodchem.2024.140229

Colloid Biology

Novel hydrophobic microbial carriers were developed. The new method enables any microbial biomass to be used for the purpose of utilization of hydrophobic compounds via microbial metabolic pathways, embedded in the porous material altered in a way to preserve metabolic activity all while expressing hydrophobic properties to adsorb the pollutants.
A patent was applied at the European patent office.
We are excited to announce the installation of our new super resolution confocal microscope GAIA 2, which expands the possibilities and pushes the boundaries of our research capabilities. During a three-month visit from Thomas Dirk Visser of Delft University of Technology (TU Delft), we conducted research on the controlled coevolution of Lactococcus cremoris strains attached to vaterite microparticles.
The confocal image featured below showcases a 3D reconstruction of bacterial cells (highlighted in red) adhering to the surface of 8 µm-sized particles.



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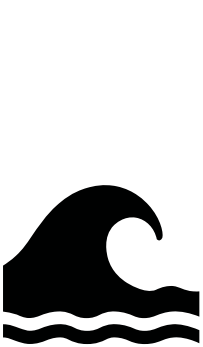
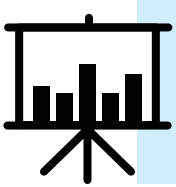
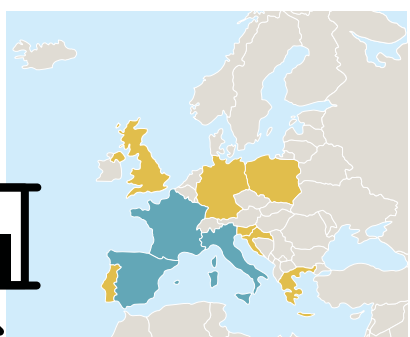
https://doi.org/10.1016/j.jwpe.2024.105525
https://doi.org/10.1016/j.scitotenv.2024.177210

Harmonized databases and innovative data management systems: a key to advancing environmental health

A multi-compartment concentration database for micropollutants in the Danube River Basin Enables consistent data integration across soils, water, and air using PostgreSQL for consistent metadata and evaluability. Supports micropollutants emission inventories and resource allocation for environmental monitoring.
The implementation of open data platforms for exposome analysis transforms the assessment of environmental exposures across European cities centralizing diverse environmental and socio-demographic data to support public health studies, and enhances data accessibility, comparability, and policy-driven decision-making.
Research on indoor radon exposure and the impact of human activities on its behaviour indoors underscores the need for harmonized global radon data and improved measurement protocols, and promotes balancing indoor radon monitoring with laboratory-based research.







References:
https://doi.org/10.1186/s12302-024-00862-4
https://doi.org/10.1038/s41598-024-62924-0
https://doi.org/10.3390/su16062424

Comparability of measurement results

In 2024, we published one new Calibration and Measurement Capability (CMC) in the BIPM KCDB database under Category 5: Water (As in drinking water).

We now have a total of 30 CMCs across five categories.

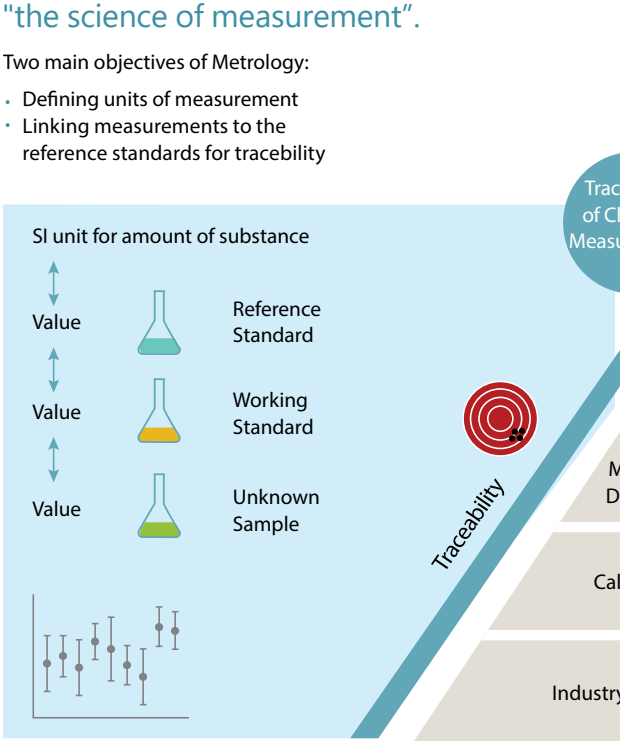
Our CMCs in the BIPM KCDB

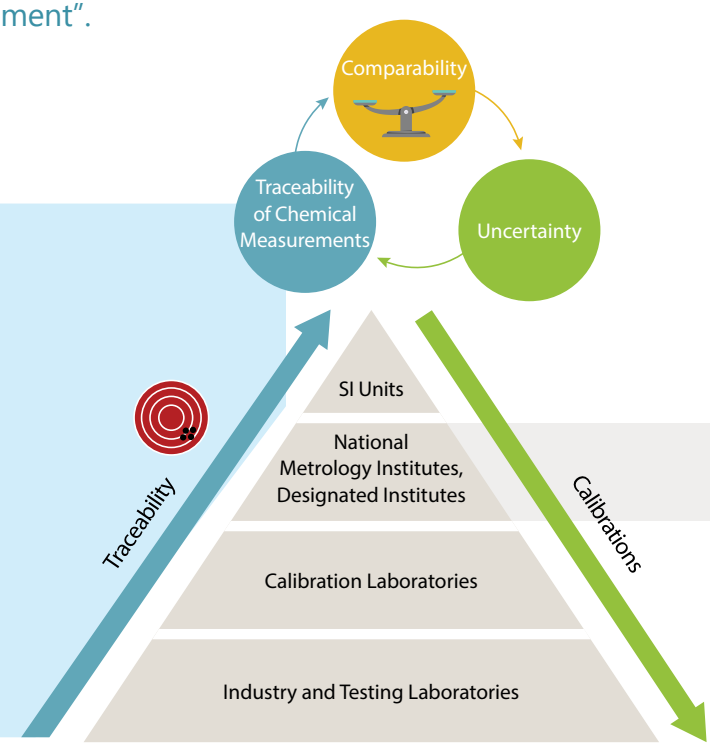
https://doi.org/10.1088/0026-1394/61/1A/08002

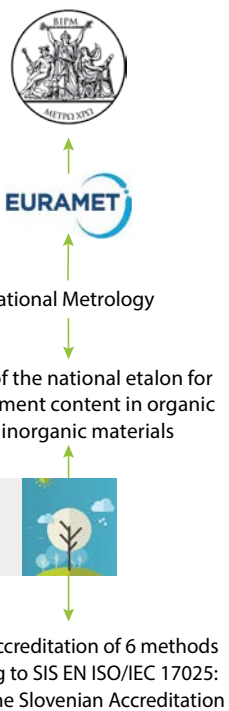
The International Bureau of Weights and Measures (BIPM) defines Metrology as "the science of measurement".

Two main objectives of Metrology:

- Defining units of measurement
- Linking measurements to the reference standards for tracebility







Traditional approach — My 'correct' results; the smaller the '±' the better; no need for traceability

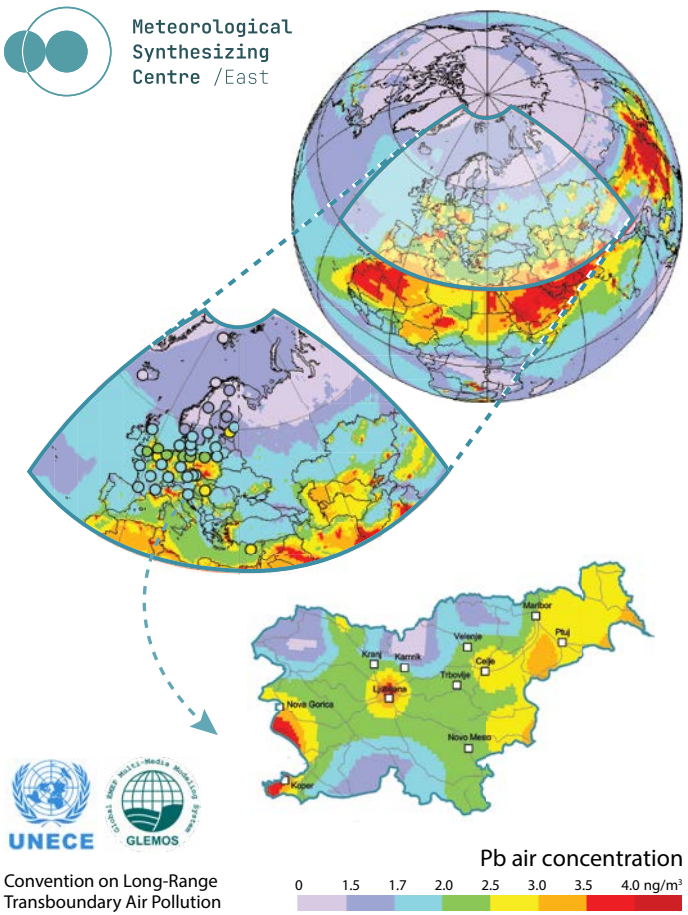
Metrological approach — Establish and demonstrate traceability; standard assessment of uncertainty; 'true' result is theoretical; critical review of imperfect methods

Our Calibration and Measurement Capability (CMC) through key intercomparisons resulted in 25 CMCs in the BIPM Key Comparison Database (KCDB).

BIPM KCDB for CMC's of O2:

Category 5:	Water; (1 CMC)
Category 10:	Biological fluids and materials; (5 CMCs)
Category 11:	Food; (14 CMCs)
Category 13:	Sediments, soils, ores and particulates; (4 CMCs)
Category 14:	Other materials; (2 CMCs)

Air Pollution Modeling for Better Environmental Policy



Computer modeling is an essential tool in understanding and mitigating environmental pollution. By integrating air monitoring data with chemical transport models, we can gain a comprehensive insight into the levels and movement of toxic substances in the atmosphere and other environmental media. These models enable us to track the dispersion pathways of pollutants, assess contamination levels, and inform effective policy actions to reduce environmental harm.

The Meteorological Synthesizing Centre – East (MSC-E, www.msc-east.org), one of the research centres of the European Monitoring and Evaluation Programme (EMEP, www.emep.int), was recently hosted by the Department of Environmental Sciences at the Jožef Stefan Institute (JSI). The Centre is committed to advancing scientific research in support of the UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP, unece.org/environmental-policy-1/air). Through advanced modeling techniques, MSC-E provides critical insights into the transboundary movement of pollutants across Europe, with a focus on toxic metals and persistent organic pollutants (POPs).

The Centre develops state-of-the-art modelling tools, such as the GLEMOS Chemical Transport Model, to assess pollution levels and trends within specific regions and countries, along with evaluations of transboundary pollution on global, regional and local scales. The comprehensive assessments provided by MSC-E serve as valuable tools for policymakers to gauge the effectiveness of pollution control measures

References:
https://doi.org/10.5281/zenodo.14831196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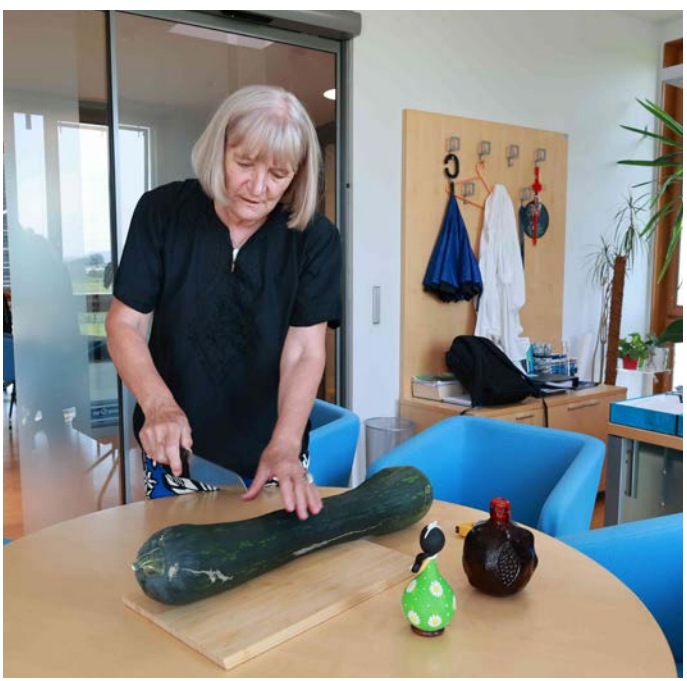


Success Stories

Global Mercury Observation and Training Network - GMOS-Train

Mercury pollution presents a significant risk to the environment and human health, in particular its accumulation in edible fish. The EU-funded 5-year Marie Skłodowska-Curie International Training Network, completed in 2024, helped model mercury's chemical behaviour and fate in land, air, and marine environments to support public health initiatives and make more informed dietary choices possible. Mercury, once released into the environment, spreads through all spheres and environmental compartments, and finally bioaccumulates in fish, sometimes in dangerously high concentrations. GMOS-ITN was primarily established to create a new generation of scientists who would tackle the pertinent issues of the global mercury challenges and to support the goals of the Minamata Convention, by delivering mercury monitoring data and modelling tools to facilitate policy decisions. The network involved the expertise of 15 PhD students from all around the world, who addressed the knowledge gaps on atmospheric, aquatic, and terrestrial mercury dynamics. A particular interest was paid to the mercury transfer from water to biota and within the lower levels of the food chain. Improved mercury measurement techniques and global distribution of case study settings enabled the GMOS-Train to gather comprehensive insights into mercury behaviour in the atmosphere and its conversion from inorganic to toxic organic forms. Fostering collaboration with instrument producers, standardisation bodies, and national and international metrology networks, the measurement infrastructure was enhanced, now ensuring results comparable in time and space. The new knowledge is expected to significantly influence policy decisions and shape international treaties, notably the Minamata Convention.

More: https://projects.research-and-innovation.ec.europa.eu/en/projects/success-stories/all/mercury-rising-scientists-tackling-growing-environmental-threat

The InPlasTwin project: Increasing expertise in micro- and nanoplastics analysis through twinning action

The InPlasTwin project is a 3-year Horizon Europe Twining initiative running from October 2024 to September 2027. Its primary goal is to advance the understanding of the environmental and food-related impacts of microplastic and nanoplastic (MNPs), with a particular emphasis on agriculture. Coordinated by Dr. Janja Vidmar from the Jožef Stefan Institute, the project involves six partners from six countries, aiming to enhance the research capacity of the Jožef Stefan Institute and the Agricultural University of Athens in MNPs analysis through collaboration with renowned European institutions, including the Flemish Institute for Technological Research (Belgium), the Institute of Marine Research (Norway), and the Technical University of Denmark (Denmark). The project will provide access to cutting-edge equipment, training, and knowledge exchange in the extraction, quantification, identification, and characterization of MNPs, as well as plastic additive analysis.

The scientific focus of InPlasTwin is to address the emerging issue of MNP pollution from plastic and biodegradable mulching films used in agriculture. Using strawberries as a model plant, the project will investigate the uptake and potential impact of MNPs on plant growth, development, and fruit quality. Through a combination of field studies, laboratory experiments, and advanced analytical techniques, InPlasTwin will deepen the understanding of MNP formation in agriculture and provide crucial insights into the environmental and health risks associated with MNP pollution from agricultural sources.

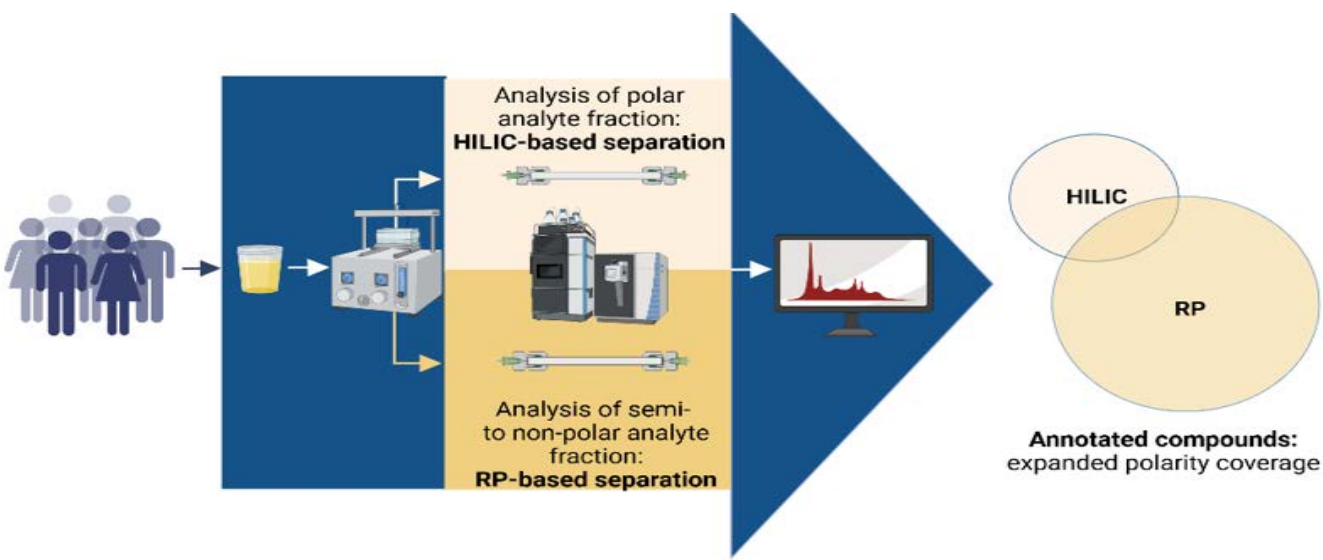
Additionally, InPlasTwin will strengthen the management and administrative capacities of partners from widening countries and promote ethical research practices, while a partnership with FoodScale Hub (Serbia) will further expand the project's impact by raising awareness of plastic pollution in the agri-food sector.

More information about the project's progress and activities can be found at InPlasTwin.

Important Achievements

Partnership for the Assessment of Risks from Chemicals – PARC

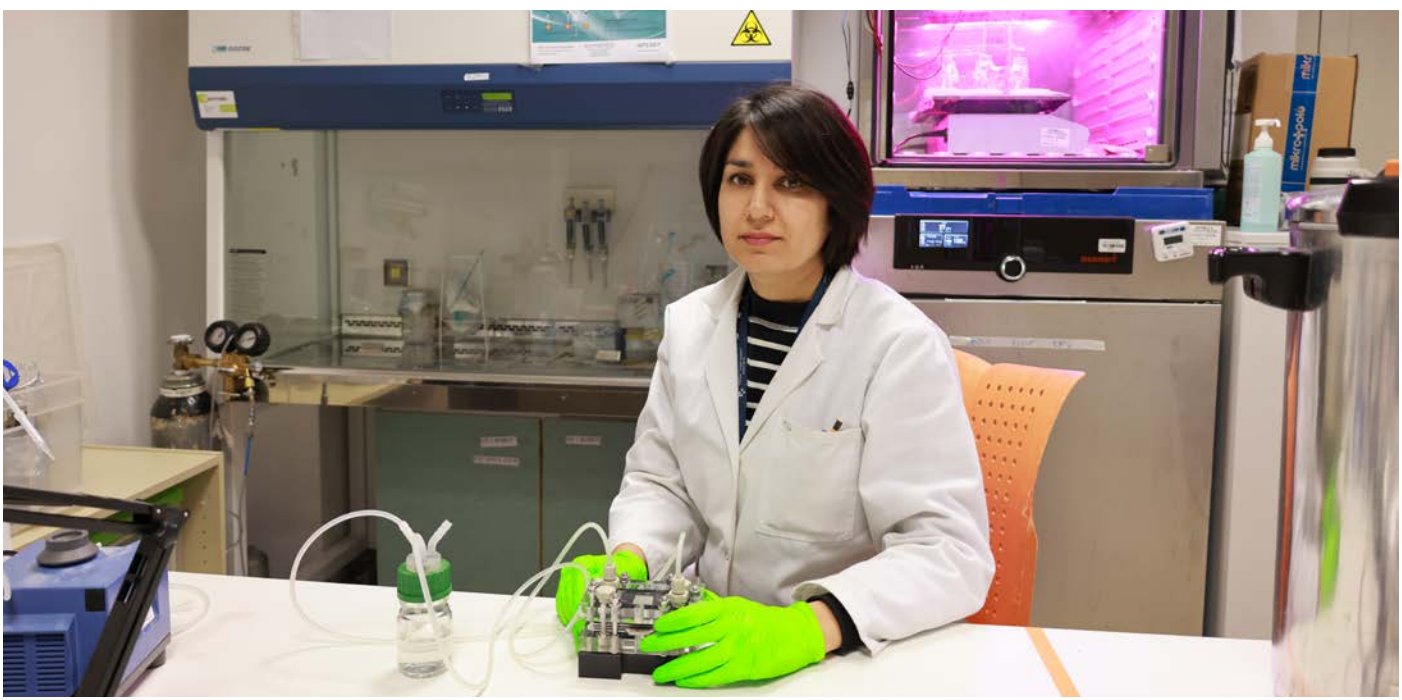
PARC is a European initiative dedicated to advancing chemical risk assessment to better protect human health and the environment. As a part of this initiative, the Department launched a > 2 million € project in May 2024 in collaboration with 22 partners across the EU that will run until 2028. Its primary focus is on exploring alternative and non-conventional human matrices and approaches to expand the coverage of the chemical space. In this frame, we focus on developing protocols and methods for alternative matrices and advancing instrumental analyses using HILIC chromatography within the nontargeted screening framework. As part of this effort, we participated in an interlaboratory study organized by our sister project, 4.3.2.a_H01_Perinatal exposure. We also presented our newly developed methods at the Nordic Metabolomics Society Conference in Turku in August 2024, and successfully developed a multi-residue analysis of hair samples, laying the basis for a nontargeted approach on this non-conventional matrix. Looking ahead, in April 2025, we will host a major meeting that will deepen the synergies between three sister projects dealing with innovative approaches on human matrices. We are proud to lead this important collaborative effort and contribute to advancing the field.



Advancing Hybrid Bio-Photoelectrochemical Systems for Nuclear Waste Management and Sustainable Energy Production

In our MSCA project, BPEC-DW, we successfully developed novel photoactive materials based on BiVO4 and TiO2, integrated with photosynthetic systems (e.g., algae) to create a hybrid bio-photoelectrochemical system. This innovative, energy-efficient approach aims to address nuclear waste management and support sustainable energy production. By combining microbial isotope fractionation with photoelectrochemical water splitting, we are exploring the potential for tritium separation from light water and hydrogen production.

We are also honored to receive the prestigious ERC PERSPECTIVE (former ERC Complementary Scheme) funding to advance novel research at the intersection of semiconductor materials and microbial catalysis. This project aims to overcome the limitations of traditional photocatalysts by leveraging bio-photoelectrocatalytic hybrid systems, enhancing redox reaction selectivity for sustainable solar-driven applications.



Excellent in Science

We are proud of our colleagues whose outstanding research was recognized by the Slovenian Research and Innovation Agency (ARIS) with the annual "Excellent in Science" awards:

Ana Kovačič, **David John Heath**, and **Ester Heath** who contributed to the paper "Degradation and toxicity of bisphenol A and S during cold atmospheric pressure plasma treatment" published in the *Journal of Hazardous Materials*,

https://doi.org/10.1016/j.jhazmat.2023.131478

Bisphenols are widely recognised as toxic compounds that potentially threaten the environment and public health. We used the cold atmospheric pressure plasma (CAP) to remove bisphenol A (BPA) and bisphenol S (BPS) from aqueous systems. To simulate environmental conditions, methanol was added as a radical scavenger. The removal of BPA was much faster than BPS. The characterisation of plasma species showed that adding a radical scavenger affected the formation of reactive oxygen and nitrogen species, resulting in a lower amount of ˙OH-, H2O2, and NO2- but a similar amount of NO3-. In addition, a non-target approach enabled the elucidation of 11 BPA and five BPS transformation products. From this data, transformation pathways were proposed for both compounds, indicating nitrification with further cleavage, demethylation, and carboxylation, and the coupling of smaller bisphenol intermediates. The toxicological characterization of the in vitro HepG2 cell model has shown that the mixture of transformation products formed during CAP is less toxic than BPA and BPS, indicating that CAP is effective in safely degrading bisphenols.

Katja Babič, **Lidija Strojnik**, and **Nives Ogrinc** contribute to the paper "Effect of prolonged cold storage in a vacuum package on the quality of dry-cured ham" published in *Food Packaging and Shelf Life,*

https://doi.org/10.1016/j.fpsl.2024.101257

The paper describes the changes in the quality and aroma (volatile organic compounds) profile of dry-cured ham during extended storage. The findings highlighted that lipid oxidation was the most important process affecting the quality of the ham. The study also revealed that prolonged vacuum storage for up to seven months at refrigeration temperatures does not diminish the quality of the ham but instead improves its homogeneity. A deeper understanding of lipid oxidation during storage will enable manufacturers to develop targeted strategies to extend shelf life, maintain flavor integrity, and ensure consumer satisfaction.

Agneta Annika Runkel, **Anja Stajnko**, **Janja Snoj Tratnik**, **Darja Mazej**, **Milena Horvat**, and **Tina Kosjek** who contributed to the paper "Exposure of children and adolescents from Northeastern Slovenia to per- and polyfluoroalkyl substances" published in *Chemosphere*,

https://doi.org/10.1016/j.chemosphere.2023.138096

Per- and polyfluoroalkyl substances (PFAS) are of high concern for the environment, wildlife, and human health due to their persistence and toxicity. Despite global efforts to limit the exposure of populations, PFAS can be measured at commonly high detection frequencies in human samples. In Slovenia, 57 potentially PFAS-contaminated sites were confirmed or suspected. We determined the concentrations of 12 PFAS in 225 girls and boys (ages 7–10 and 12–15) from Northeastern Slovenia and identified potential sources of exposure. 9 out of 12 analytes were detected at detection frequencies above 30%, with the highest geometric means being observed for PFOS (1.9 ng/mL) and PFOA (1.0 ng/mL). Exposure was determined by the participant's socio-economic status, age, sex, sampling region, public water supply, and the consumption of fish and seafood, cereals, and locally produced fruits, vegetables, and mushrooms. In comparison with other studies, PFAS exposure in our pilot population is low, but as it is the first study on PFAS exposure in Slovenia it will be extended to a nationwide HBM study.

Student awards

- ☆ **Eirini Andreasidou** won 1st place in the SETAC Science Slam Competition at the 35th Annual Meeting of SETAC Europe in Seville, Spain, on May 20, 2024. Her presentation, *"Tomatoes of the Shire: A Fellowship's Quest through the Soil-Plant Continuum,"* earned an impressive 81% of the votes from an audience of nearly 700 attendees.
- ☆ **Adna Alilović** won the Best Student Presentation Award at the 16th International Conference on Mercury as a Global Pollutant (ICMGP) in Cape Town on July 30, 2024. Her research on mercury exposure and selenium-mercury interactions stood out among 68 student contributions, earning recognition at a global event attended by over 350 participants from 54 countries.


Positioning our research
in time and space

Key Events

GMOS-Train and MCHgMAP Workshop: Addressing Challenges in Merfury Dynamics Modelling across Atmosphere, Oceans, and Land

From 9 to 11 October 2024, mercury scientists convened in Portorož, Slovenia, for a collaborative workshop aimed at advancing the understanding of how mercury emissions and releases influence environmental mercury levels. This event brought together two key scientific initiatives: the Global Mercury Observation Training Network (GMOS-Train) and the Multi-Compartment Mercury Modelling and Analysis Project (MCHgMAP).

Dr. Ashu Dastoor from Environment Canada led the MCHgMAP discussions, with the team focusing on refining computer models that simulate mercury dynamics across different environmental compartments. Participants reviewed previous atmospheric and oceanic mercury models and agreed to rerun simulations using updated mercury emission data. These new findings will be presented at the upcoming Open-Ended Scientific Group (OESG) meeting in March 2025, supporting the Minamata Convention's efforts in addressing global mercury pollution.

On the GMOS-Train side, Dr. Milena Horvat from the Jožef Stefan Institute chaired the network's final meeting. GMOS-Train, funded by the European Union, has successfully trained a new generation of PhD students in mercury science, with many already contributing to OESG efforts. Additional researchers volunteered to support the OESG by joining the expert roster.

Representing the Minamata Convention Secretariat, Senior Programme Management Officer Mr. Eisaku Toda chaired a session on mercury emissions, emphasizing the importance of integrating scientific findings into policy frameworks.

The joint workshop highlighted the critical role of collaboration between scientific networks and policy-making bodies in addressing the global challenges posed by mercury pollution.

FoodTraNet Conference

The FoodTraNet Final Conference, held from October 9 to 11, 2024, in Portorož, Slovenia, marked the successful culmination of the FoodTraNet: Advanced Research and Training Network in Food Quality, Safety, and Security (H2020 MSCA-ITN-2020). The conference highlighted the work of Early-Stage Researchers (ESRs), whose contributions have been essential to the success of the FoodTraNet initiative. These ESRs, have been actively engaged in interdisciplinary research aimed at enhancing food safety, security, sustainability, authenticity and traceability, as well as developing innovative technologies in food research.

The conference agenda was organized into three thematic sessions, reflecting the three technical Work Packages (WPs) of the FoodTraNet project. The first session addressed food authenticity and traceability, showcasing advanced methods to verify food origin and prevent fraud. The second session focused on the safety of using treated wastewater in agriculture and the introduction of novel foods. The third session explored cutting-edge technologies, including edible barcodes, sensors and intelligent and active packaging, as well as insights into consumer behavior and how consumers interact with these new developments in food safety and sustainability.

A special session was dedicated to the Industrial Liaison Group (ILG), where ESRs presented their novel technologies and commercialisation strategies. This session coordinated by prof. Michele Suman from Barilla (Italy) offered an opportunity for ESRs

to demonstrate how their research could be adopted to industry. Additionally, the opening session focused on career development, providing ESRs with valuable insights into the next steps in their professional journeys, including academic and industry opportunities, mentorship, and strategies for up-skilling.

The social event featured a joint dinner with participants from the GMOS-Train project, providing an excellent opportunity for networking and sharing experiences between the two projects. During the dinner on Wednesday, a Science Slam was organized, which added an exciting and engaging element to the evening.

Key outcomes of the event included the publication of a Book of Abstracts and recorded presentations available on the VideoLecture platform, ensuring continued access to the knowledge shared during the conference. As the ESRs transition into postdoctoral roles, the conference reinforced the importance of maintaining the network established through the FoodTraNet project, with all participants expressing a shared commitment to continued collaboration and future research initiatives in the field.

PARC training

Within the Partnership for the Assessment of Risks from Chemicals (PARC), we organized an in-person training course, "FAIR Data and Databases," at the Reactor Center from May 22 to 24, 2024. The course was designed for researchers and students working with experimental data on chemical exposure, hazards, and risk assessment, as well as those using existing databases for this purpose. It aimed to strengthen participants' understanding of FAIR data principles–ensuring data is Findable, Accessible, Interoperable, and Reusable–and promote effective data management practices. A total of 26 researchers and students attended, gaining practical insights into applying FAIR principles in their work.

Source: https://www.eu-parc.eu/news/building-capacities/parc-empowers-researchers-fair-data-and-databases-training-ljubljana

Custom Training in Analytical Radiochemistry

We successfully organized a specialized training course in analytical radiochemistry for six participants from Saudi Arabia. The program covered fundamental and advanced techniques, including alpha-particle spectrometry and liquid scintillation counting (LSC) for the precise determination of various radionuclides, such as Po-210, Pb-210, Sr-90, Th isotopes, Ra-226, Pu isotopes, and Am-241. Additionally, we provided hands-on experience with measurement techniques and instrumentation for Rn-222 analysis in different media. This tailored course contributed to enhancing expertise in radiochemical analysis and its applications in environmental and nuclear research.

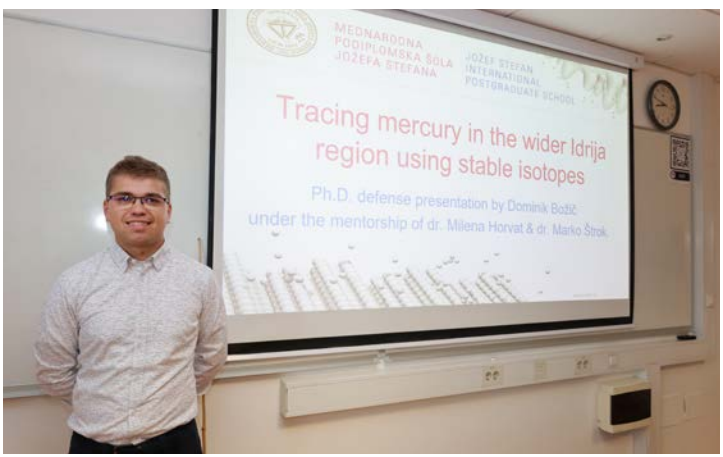
Theses and Academic Mentoring

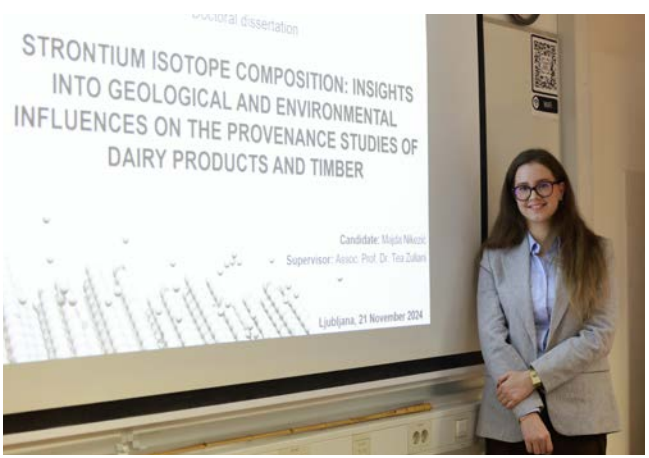
Doctoral Dissertations

- ☆ URANJEK, Gregor. Assessment of Dimethyl Sulphide Odorous Emissions Released During the Underground Coal Extraction in Coal Mine Velenje, doctoral dissertation, Ljubljana 2024
- ☆ ŽAGAR, Klara. Isotopic Fingerprint of Water from Source to Tap, doctoral dissertation, Ljubljana 2024
- ☆ NIKEZIĆ, Majda. Strontium Isotope Composition: Insights into Geological and Environmental Influences on the Provenance Studies of Dairy Products and Timber, doctoral dissertation, Ljubljana 2024
- ☆ BOŽIČ, Dominik. Tracing Mercury in the Wider Idrija Region Using Stable Isotopes, doctoral dissertation, Ljubljana 2024
- ☆ HAMZIĆ GREGORČIČ, Staša. Tracing Origin of Food Using Stable Isotopes of Light and Heavier Elements, doctoral dissertation, Ljubljana 2024
- ☆ SAHAI, Harshit. Micro and Nano Plastic in Agriculture: Interactions with Pesticide Residues and Bioaccumulation in Plants, doctoral dissertation, Ljubljana 2024
- ☆ TORRES-RODRIGUES, Natalia. Marine mercury species dynamics and distribution, doctoral dissertation, Maseille 2024

Master Theses

- ☆ PAŠČINSKI, Mateja. Determination of the Total Concentration of Zinc, Iron, Magnesium, and Calcium in Selected Food Supplements and the Assessment of Their Bioaccessibility in the Digestive Tract, master's thesis, Ljubljana 2024
- ☆ PAJK, Pia. Removal of Bisphenols from Drinking and Waste Water by Photocatalysis and Hydrodynamic Cavitation, master's thesis, Ljubljana 2024
- ☆ ERJAVEC, Nuša. Tracing the Fate of Potentially Toxic Elements in the Wulka River Catchment (Austria), master's thesis, Ljubljana 2024
- ☆ SIMIĆ, Pavle. Analysis of Rosemary (Rosmarinus Officinalis L.) and Bay Leaf (Laurus Nobilis L.) Essential Oils on the Slovenian Market, master's thesis, Ljubljana 2024
- ☆ PRIMOŽIČ, Sabina. Determination of Cinnamon (Cinnamomum spp.) and Paprika Powder (Capsicum Annuum) Authenticity on the Slovenian Market, master's thesis, Ljubljana 2024
- ☆ GORENČIČ, Mišel. Strontium and Magnesium Isotopes in the Karst Aquifer of the Ljubljanica River, master's thesis, Ljubljana 2024
- ☆ PEPELKO, Sara. Mass Spectrometric Quantification of Polyphenol Compounds in the Extracts of Invasive Knotweed Species*, master's thesis, Ljubljana 2024
- ☆ JELENKO, Leja. Monitoring the Isotopic Composition of Carbon in Volatile Organic Compounds during Storage, master's thesis, Ljubljana 2024


MEDNARODNA
PODIPLOMSKA ŠOLA
JOŽEFA STEFANA
JOŽEF STEFAN
INTERNATIONAL
POSTGRADUATE SCHOOL
Tracing mercury in the wider Idrija region using stable isotopes
Ph.D. defense presentation by Dominik Božič
under the mentorship of dr. Milena Horvat & dr. Marko Štrok


STRONTIUM ISOTOPE COMPOSITION: INSIGHTS INTO GEOLOGICAL AND ENVIRONMENTAL INFLUENCES ON THE PROVENANCE STUDIES OF DAIRY PRODUCTS AND TIMBER
Ljubljana, 21 November 2024

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7
MAGISTRANDS
in 2024

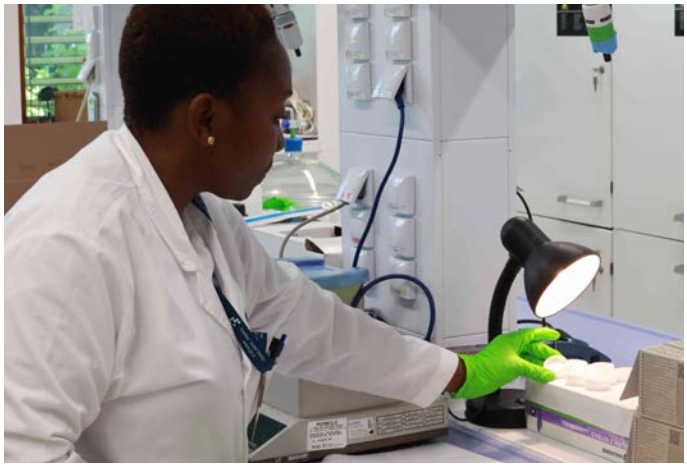
7
DOCTORANDS
in 2024

100
RESEARCH
ARTICLES


BD Vacutainer
Trace Element
K2 EDTA
REF 368381
BK2024F2003-1-2
HBM2024
WB- 6 mL - moder
BK2024F1005-1-2
HBM2024
WB- 6 mL - moder
BK2024M2006-1-2
HBM2024
BK2024F2008-1-2
HBM2024
BK2024F2009-1-2
BK2024F1010-1-2
HBM2024

Research visitors in 2024

1. Ivana Coha, Institut Rudjer Bošković, 1. 1.–31. 12. 2024
2. Sarra Trabelsi, Institut National de Recherche et d'Analyse Physico-Chimique, Arana, Tunisia, 1. 1.–31. 12. 2024
3. Mona Maghsoudlou, Eötvös Loránd University, Iran, 3. 3.–31. 3. 2024
4. Michele Toma, La Sapienza, Rome, Italy, 6. 3.–6. 9. 2024
5. Mariella Van Ginkel, La Sapienza, Rome, Italy, 6. 3.–6. 9. 2024
6. Alberto Soto Canas, University in Burgos, Spain, 15. 4.–15. 7. 2024
7. Omar Ahmed Alsager, Nuclear and Radiological Regulatory Commission, Saudi Arabia, 22. 4.–17. 5. 2024
8. Salman Ali Alammari, Nuclear and Radiological Regulatory Commission, Saudi Arabia, 22. 4.–17. 5. 2024
9. Yousef Jumah Alanazi, Nuclear and Radiological Regulatory Commission, Saudi Arabia, 22. 4.–17. 5. 2024
10. Saud Abdulrahman Aljuwiser, Nuclear and Radiological Regulatory Commission, Saudi Arabia, 22. 4.–17. 5. 2024
11. Abdulaziz Hassan Alshehri, Nuclear and Radiological Regulatory Commission, Saudi Arabia, 22. 4.–17. 5. 2024
12. Razan Jamaan Alghamdi, Nuclear and Radiological Regulatory Commission, Saudi Arabia, 22. 4.–17. 5. 2024
13. Jose Carlos Castilla Alcantara, University in Burgos, Spain, 26. 4.–17. 5. 2024
14. Samuel de Almeida Caldeira, Universidade Federal de Minas Gerais, Brasil, 15.–16. 5. 2024
15. Artak Khachatryan, Hydrometeorology and Monitoring Center SNCO, Armenia, 20.–31. 5. 2024
16. Shahnazaryan Gayane, Hydrometeorology and Monitoring Center SNCO, Armenia, 27.–31. 5. 2024
17. Anahit Aleksandryan, Ministry of Environment, Armenia, 27.–31. 5. 2024
18. Harshit Sahaia, CSIC-EEZA, Almeria, Spain, 24. 6.–31. 7. 2024
19. Alberto Soto Canas, University in Burgos, Spain, 15. 4.–15. 7. 2024
20. Raffaela Ofano, University of Naples, Italy, 2. 9.–31. 12. 2024
21. Thomas Visser, University of Delft, Netherlands, 4. 9.–31. 11. 2024
22. Nayyer Rehman, WRG Europe, Great Britain, 15. 9.–15. 11. 2024
23. Fatma ElZahraa ElSayed, Egyptian Atomic Energy Authority (EAEA), Egypt, 30. 9.–4. 10. 2024
24. Abdullah Othman, Egyptian Atomic Energy Authority (EAEA), Egypt, 30. 9.–4. 10. 2024
25. Hadeel Sami Abuhejleh, Jordan Research and Training Reactor, Jordan, 30. 9.–10. 10. 2024
26. Tukur Muhammad, Centre for Energy Research and Training, Nigeria, 30. 9.–4. 10. 2024
27. Dang Khue Nguyen, Dalat Nuclear Research Institute, Vietnam, 30. 9.–4. 10. 2024
28. Teancum Earl Quist, Idaho National Laboratory, United States of America, 30. 9.–4. 10. 2024
29. Menno Blaauw, Netherlands, 30. 9.–4. 10. 2024
30. Maria Angela de Barros Correia Menezas, Centro de Desenvolvimento da Technologia Nuclear, Brasil, 30. 9.–4. 10. 2024
31. Artur Canella Avelar, Universidade Federal de Minas Gerais Avenida Antonio, Brasil, 30. 9.–4. 10. 2024



Publications in 2024

1. İŞleyen, A., Can, S. Z., Cankur, O., Ari Engin, B., Vogl, J., Horvat, M., Jaćimović, R., Zuliani, T., Fajon, V., Gumus, Z., et al. (2024). Certification of the total element mass fractions in UME EnvCRM 03 soil sample via a joint research project. *Accreditation and Quality Assurance*, 29(4), 293-301. DOI: 10.1007/s00769-024-01597-8.
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9. Leskovar, T., Knific, T., Zupanič-Pajnič, I., Potočnik, D., Črešnar, M. (2024). Potencial interdisciplinarnih raziskav človeških skeletnih posmrtnih ostankov: četverni grob s poznoantičnega grobišča Bled - Pristava. *Arheološki Vestnik*, 75, 323-354. DOI: 10.3986/AV.75.11.
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12. Šlejkovec, Z., van Elteren, J. T., Bergmann, M., Gössler, W. (2024). A glimpse into the nature of particles created during pulsed laser ablation of arsenic compounds in ambient gases. *Atomic Spectroscopy*, 45(1), 9-14. DOI: 10.46770/AS.2023.305.
13. Ramya, P. R., Halder, S., Nagamani, K., Chouhan, R. S., Gandhi, S. (2024). Disposable graphene-oxide screen-printed electrode integrated with portable device for detection of SARS-CoV-2 in clinical samples. *Bioelectrochemistry*, 158, Article 108722, 1-11. DOI: 10.1016/j.bioelechem.2024.108722.
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15. Stajnko, A., Lundh, T., Assarson, E., Åkerberg Krook, E., Broberg, K. (2024). Lead, cadmium, and mercury blood levels in schoolchildren in southern Sweden: Time trends over the last decades. *Chemosphere*, 346, Article 140562, 1-12. DOI: 10.1016/j.chemosphere.2023.140562.
16. Gholizadeh, R., Pavlin, M., Likozar, B., Huš, M. (2024). Why including solvation is paramount: First-principles calculations of electrochemical CO_2 reduction to CO on a Cu electrocatalyst. *ChemPlusChem*, In Press, Article e202400346, 1-18. DOI: 10.1002/cplu.202400346.
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19. Tkalec, Ž., Antignac, J.-P., Bandow, N., Béen, F. M., Belova, L., Bessems, J., Le Bizec, B., Kosjek, T., Roškar, R., Trontelj, J., et al. (2024). Innovative analytical methodologies for characterizing chemical exposure with a view to next-generation risk assessment. *Environment International*, 186, Article 108585, 1-16. DOI: 10.1016/j.envint.2024.108585.

20. Tagne-Fotso, R., Riou, M., Saoudi, A., Zeghnoun, A., Frederiksen, H., Berman, T., Montazeri, P., Kosjek, T., Snoj Tratnik, J., et al. (2024). Exposure to bisphenol A in European women from 2007 to 2014 using human biomonitoring data: The European Joint Programme HBM4EU. *Environment International*, 190, Article 108912, 1-21. DOI: 10.1016/j.envint.2024.108912.

21. Desalegn, A., Schillemans, T., Snoj Tratnik, J., Stajnko, A., Kosjek, T., Tkalec, Ž., Govarts, E., Iszatt, N., et al. (2024). Urinary concentrations of phthalate/DINCH metabolites and body mass index among European children and adolescents in the HBM4EU Aligned Studies: A cross-sectional multi-country study. *Environment International*, 190, Article 108931, 1-13. DOI: 10.1016/j.envint.2024.108931.

22. France Štiglic, A., Stajnko, A., Sešek-Briški, A., Snoj Tratnik, J., Mazej, D., Jerin, A., Skitek, M., Horvat, M., Marc, J., Falnoga, I. (2024). Associations between APOE genotypes, urine 8-isoprostane and blood trace elements in middle-aged mothers (CROME study). *Environment International*, 193, Article 109034, 1-14. DOI: 10.1016/j.envint.2024.109034.

23. Šušmelj, K., Čenčur Curk, B., Kanduč, T., Rožič, B., Verbovšek, T., Vreča, P., Žagar, K., Žvab Rožič, P. (2024). Hydrogeochemical conditions of submarine and terrestrial karst sulfur springs in the Northern Adriatic. *Environmental Earth Sciences*, 83, 1-18. DOI: 10.1007/s12665-024-11476-7.

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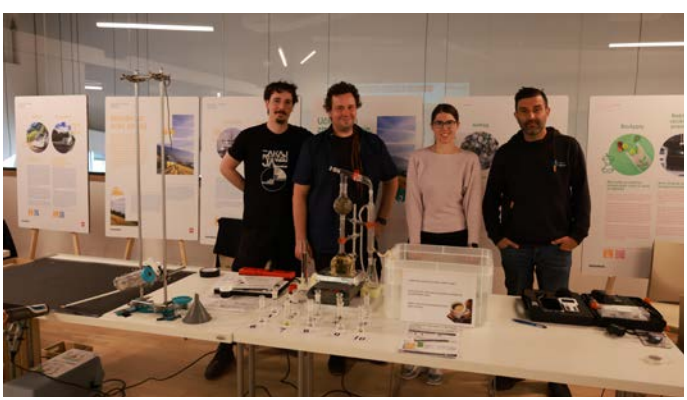


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Department of Environmental Sciences

Outstanding Achievements of 2024

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