6th Swiss Microplastics meeting (MP-CH-VI)

April 4, 2025

Agroscope Zürich-Reckenholz

Aims and Scope of the Meeting:

The main purpose of the meeting is to strengthen our network on all aspects of microplastics, to exchange ideas, challenges and results, find partners for new collaborations, and give early-stage researchers the opportunity to present their work.

Program (brief):

10.00-10.30: Welcome coffee

10.30-11.20: Introduction

11.20-12.30: Session 1 – Analytical Chemistry

12.30-13.40: Lunch break

13.40-15.00: Session 2 – Environmental Exposure

15.00-15.30: Coffee break

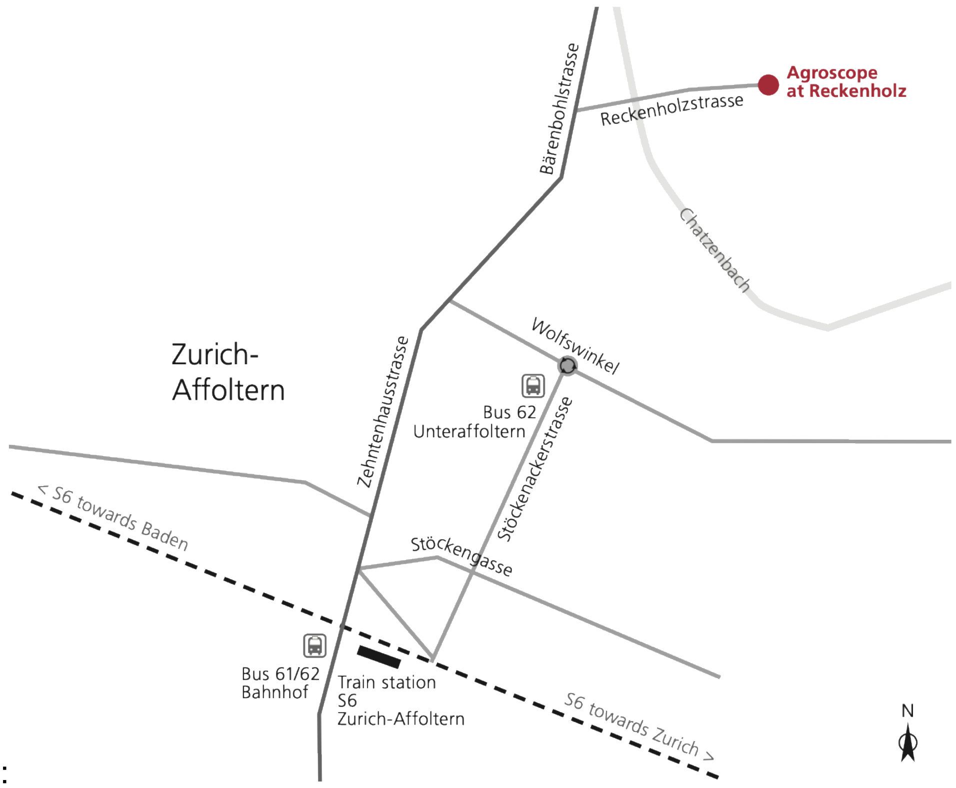
15.30-16.05: Session 3 – Environmental Processes

16.05-16.40: Session 4 – Environmental and Human Health

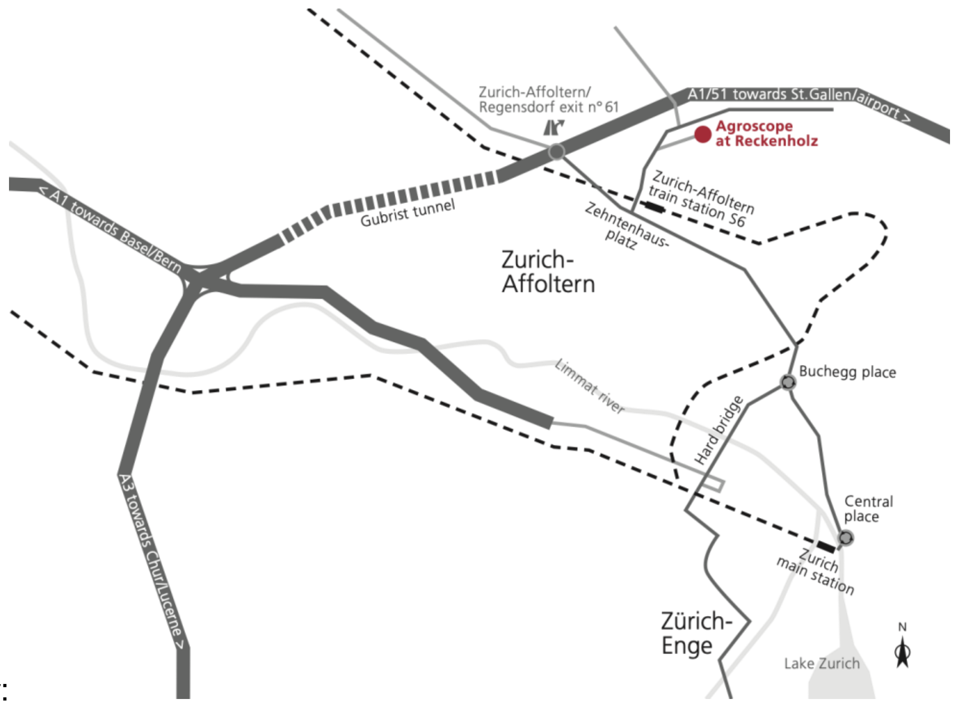
16.40: Wrap-up and Apéro

To stay informed about future events: https://microplastics.ch/

How to get to Agroscope, Reckenholzstrasse 191, 8046 Zürich:



By train:



By car:

Program (detailed):

			10.00-10.30: Welcome coffee	
10.30-11.20: Welcome and Introduction – Moderator: Thomas Bucheli				
1	Jud Khan	C.	(Micro-)plastics in agriculture	Agroscope
2	Bucheli	T.D.	Introduction & practicalities	Agroscope
3	Storck	F.	Microplastics – authorities' perspective. Activities and projects of FOEN and FSVO.	FOEN
11.20-12.30: Session 1 – Analytical Chemistry – Moderator: Ralf Kägi				
4	Moraz	A.	Production, labeling, and applications of micro- and nanoplastic reference and test materials	Agroscope
5	Cusworth	S.J.	Assessment of sampling approaches for representative quantification of microplastics in soil	ETH
6	Haeffner	M.	Detection of nanoplastics in-liquid using SERS tags	University Fribourg
7	Foetisch	A.	Overcome the obstacle of NP analysis – a concept of chemical/microscopic methods combined with artificial intelligence	TU Darmstadt
8	Rahman	A.	Development and application of an analytical method for the determination of tire wear particles in atmospheric deposition	Empa
			12.30-13.40: Lunch break	
13.40-15.00: Session 2 – Environmental Exposure – Moderator: Christoph Hüglin				
9	Zimmermann	E.J.	Release, characterization, and quantification of natural, biobased and synthetic fiber fragments and their Impact on Human Health	Empa
10	Ashta	N.	Quantifying the wet and dry atmospheric deposition of microplastics in Switzerland – early results from a measurement campaign	Empa
11	Kummer	N.	Assessment of Atmospheric Nanoplastics Using Infrared Atomic Force Microscopy (AFM-IR)	Eawag
12	Negrete Velasco	A.	Detection and characterisation of microplastics in the urban water cycle in Geneva, CH	University Geneva
13	Crosset-Perrotin	G.	Assessment of the microplastics loads discharged from Swiss wastewater treatment plants	Eawag
14	Masset	T.	Spatial and temporal distribution of tire-related additives in freshwater ecosystems: insights from a Swiss pilot study	EPFL
15	Grunder	A.	Soil Micro Plastic: microplastic concentrations from MINAGRIS soils	University Berne
			15.00-15.30: Coffee break	
15.30-16.05: Session 3 – Environmental Processes – Moderator: Angélique Moraz				
16	Parrella	F.	Factors impacting resuspension of microplastics from rivers: analysis of burial and shielding effects of sediment beds	ETH
17	Rohling	M.	Incorporation of microplastics into water-stable soil aggregates: dependencies on particle and soil characteristics	ETH
18	Schefer	R.	A Two-Year Incubation Study: Investigating the Vertical Transport of Microplastics in Soil and its Impact on Soil Pore Development	ETH
16.05-16.40: Session 4 – Environmental and Human Health – Moderator: Angélique Moraz				
19	Meissle	M.	Nanoplastics ingestion by springtails: linking exposure to effects through dose-response relationships	Agroscope
20	Eitner	S.	Synthetic versus biobased textile fibers: investigating their impact on human lung health	Empa
21	Ruhstaller	S.	Tiny plastics, big impact? Investigating placental immune responses to micro-/nanoplastics	Empa
16.40: Wrap-up – Moderator: Ralf Kägi				
			16.45: Apéro	

Production, Labeling, and Applications of Micro- and Nanoplastic Reference and Test Materials

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Challenges inherent to the extraction of micro- and nanoplastics (MNPs) from the environment, combined with the limited range of commercially available MNPs, have prompted an increasing number of researchers to generate in-house reference and test MNPs.
The first part of this review provides a comprehensive overview of existing MNP production methods, including top-down and bottom-up fabrication techniques. Strengths and weaknesses of different methods are compared and contrasted, and the potential for optimization and control over MNP properties is discussed. Methods to label and to artificially weather MNPs before, during, or after production, as well as appropriate dispersion protocols for introducing MNPs into different media, are also covered. The second part of this review focuses on how reference and test MNPs have been implemented in different types of studies, categorized as toxicity, uptake, fate, and monitoring. Given the wide range of properties needed to fully define MNPs, we propose a set of essential properties that need to be characterized depending on the study type. Looking forward, we suggest future needs, not only in the creation of reference MNPs, but also in experimental protocols that would help to better understand the behavior and impacts of MNPs.
Overall, this review aims to provide the necessary information to guide researchers in decision-making regarding which reference MNPs are most appropriate to answer their specific research questions and to serve as a framework that will contribute to obtaining reliable, benchmarked data urgently needed to develop consensus on the fate and risk posed by MNPs.

Assessment of Sampling Approaches for Representative Quantification of Microplastics in Soil

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Microplastics (MPs) in soils are highly spatially variable and are dependent on proximity to sources, land-use and natural processes. Quantifying and characterizing MPs in soils is challenging, particularly in terms of accurately capturing the variations of a heterogeneously distributed particulate contaminant, which is the foundation for all future steps in assessing MPs exposure. Current approaches for MPs sampling rarely account for the spatial representativeness of each sample. Using metal-doped MPs to more quickly assess sampling strategies, we produced a reproducible and representative hypothesis-driven sampling framework from which MPs can be quantified. MPs of different morphologies (fragments, fibers) and concentrations (0.01 – 0.1 %) were mixed into different model systems (100 x 100 x 5 cm and 40 x 40 x 30) at distribution patterns mimicking clustered or homogenously polluted systems. We created a multi-factorial experiment to determine the most effective combination of the individual components (sampling design, frequency, sample mass, homogenization and separation techniques, as well as composite aliquot factors) to accurately represent different distributions and concentrations of MPs in soils. Initial results highlight that mass reduction strategies must have > 90% recovery for integration in the sampling framework. Similarly, a higher composite aliquot factor of 5:1 (aliquots:composite) returned higher recover rates than direct analysis of individual samples, for both fragments and fibers. From 0.02 – 0.09 wt.% (MPs/soil), recovery rates of direct digestion were 91.3% ± 10.1%, compared to density separation (85.7% ± 4.5%). However, when two density separation cycles were performed, recovery rates were comparable to direct digestion (94.6% ± 3.1%). The development of this sampling framework is critical for the accurate assessment of MPs in different soil environments, facilitating comparability of data between studies. These approaches provide guidance for MPs monitoring in soil, which is urgently needed for the accurate assessment of MPs exposure in the terrestrial environment.

Detection of nanoplastics in-liquid using SERS tags

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Microplastics (5 mm–100 nm) and nanoplastics (<100 nm) have recently drawn significant attention due to their widespread presence in various consumables and environmental systems. Despite this growing interest, detecting and measuring nanoplastics remains challenging, particularly at low concentrations and small particle sizes typically found in environmental samples.

Surface-enhanced Raman spectroscopy (SERS) has shown promise for achieving the high sensitivity required to detect nanoplastics below the conventional resolution limits of standard Raman spectroscopy (~500 nm), reaching concentrations as low as ng/mL. However, many SERS approaches depend on aggregated plasmonic particles, which can limit reproducibility in biological and environmental applications.

To address this limitation, we applied an indirect detection method commonly used in bioanalytical studies involving SERS tags. By conjugating gold nanostars with a reporter molecule that exhibits a strong Raman signal, we can monitor changes in the reporter's signal in the presence of plastic particles. This approach offers the potential to enhance nanoplastic detection at environmentally relevant concentrations in natural freshwater, marine environments, and other aqueous matrices.

Overcome the obstacle of NP analysis – a concept of chemical/microscopic methods combined with artificial intelligence

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Numerous studies have shown the potential risk that nanoplastic (NP) represents for the living organisms in the different ecosystems. However, the amount and characteristics of NP present in the environment are still unknown in its full extent. Even if several methods have already managed to quantify or characterize environmental NP, none could yet provide a complete characterization over the full nanoscale range combined with a high sample throughput.

The present work addresses the challenge of NP full characterization in soil by testing an innovative combination and alignment of µ Raman spectroscopy (RS), scanning electron microscopy coupled with energy dispersive x-ray spectroscopy (SEM/EDX) and artificial intelligence (AI). The aim is to use SEM/EDX data cross validated by RS to train an AI model to automatically characterize NP in environmental samples.

The method is tested and optimized using sample types of increasing complexity, starting with pure NP, mixed NP, spiked media and, finally, environmental samples. First, NP chemical information is acquired down to a ~500 nm size using RS and NP quantification, size and surface characteristics are obtained using SEM/EDX down to a ~50 nm size. Finally, the dataset acquired with RS and SEM/EDX on >500 nm NP is divided into a training and testing set to build a convolutional neural network (CNN) allowing the differentiation between NP and non-NP particles present in a sample. The aim of this model is then to allow the identification and characterization of <500 nm NP present in a sample using SEM/EDX data and AI.

In case of success, this model would provide for the first time a full characterization of environmental NP with a high sample throughput. This methods combination could then provide a more accurate assessment of the NP pollution in the environment.

Development and application of an analytical method for the determination of tire wear particles in atmospheric deposition

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Tire wear particles (TWPs) constitute a substantial environmental source of microplastics and airborne particulate matter (PM2.5 and PM10). The estimated per capita emission ranges from 0.23 to 4.7 kg/year, with a global average of 0.81 kg/year[1]. Tire wear contributes 5–10% of plastic in the ocean and 3–7% of particulate matter ($PM_{2.5}$), which contributes to the global health burden of air pollution[1]. These TWPs are the main source of anthropogenic Zn (II) and of over 200 toxic organic molecules in the environment[2]. To assess the impact, TWPs need to be measured across different geographical locations and their transport via air and water needs to be investigated. Estimating TWPs is a challenging task because of their variable composition across brands, usage, and age of tire.
In response, we have developed a Py-GCMS method that quantifies all polymer components, not just individual markers. Optimized sample preparation methods reduced interfering compounds in the Py-GCMS analysis. TWP concentrations are determined by estimating the total primary and secondary pyrolysis products of tire rubber. The developed method was applied to quantify TWPs in atmospheric deposition samples collected from several sites in Switzerland. The annual input of TWP into the environment in Switzerland will be estimated based on our measurements in combination with land use data. These results will provide the basis for assessing the environmental risks related to the release of TWP from road traffic emission.

Reference

1 P. J. Kole, A. J. Löhr, F. Van Belleghem and A. Ragas, *Int. J. Environ. Res. Public Health*, 2017, **14**, 1265.

2 C. Pei, S. Hou, Z. Peng, X. Zhang, D. Yin, W. Zhang, Y. Zhang, Z. Cai and S. Zhang, *TrAC Trends Anal. Chem.*, 2025, **182**, 118059.

Release, Characterization, and Quantification of Natural, Biobased and Synthetic Fiber Fragments and their Impact on Human Health

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Released fibers, fibrils and microplastics from textiles are a growing concern due to their potential toxicity and the presence of harmful additives. Unlike synthetic textile fibers, natural and biobased textile fibers have received little attention. While it is true that natural polymers are more biodegradable than synthetic polymers, textile production changes the polymeric structure of natural fibers, making them more resistant to degradation processes. Even though, there is an increasing amount of microplastic studies, comparative data on the properties and the release of fiber fragments from different textiles under real-life use conditions (wear, washing, tumbler drying), and their potential health hazard upon inhalation in the lungs is scarce.

To address these knowledge gaps, our project aims to comprehensively characterize and quantify the fiber fragments released from a range of natural, biobased and synthetic textiles. To mimic natural textile usage, a combination of abrasion and aging will be applied together with washing. In addition, release during drying will be studied with a novel approach utilizing a self-constructed lab dry tumbler allowing well controlled and reproducible conditions. A material repository of natural, biobased and synthetic fabrics was built (so far 23 materials), allowing a systematic approach and enabling future comparative studies. Additionally, *in vitro* toxicity testing using human lung cells will be performed to assess the potential health impacts of the released fiber fragments. Our first results demonstrated higher amounts of released fibers from natural textiles, similar to previous studies, and structural changes following mechanical usage. The construction of the lab dry tumbler is almost finished, completing our experimental setup and allowing the comprehensive characterization with subsequent toxicity tests.

Quantifying the wet and dry atmospheric deposition of microplastics in Switzerland – early results from a measurement campaign

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Atmospheric transport and deposition have recently been described as one of the pathways for the distribution of MPs in the environment. This pathway may be responsible for the detection of MPs in remote locations such as the Arctic and alpine regions.

To understand the importance of this pathway, we have been collecting wet and dry atmospheric deposition samples every four weeks in urban, suburban, rural and remote locations in Switzerland as part of a one-year measurement campaign and quantifying the MPs therein.

So far, we have analyzed just over half a year's worth of samples and therefore present some early results of the wet and dry atmospheric deposition rates, both in terms of particle numbers and mass. Based on these deposition rates, we provide an extrapolation of the total annual deposition of microplastics across Switzerland. We also make a comparison of the atmospheric inputs of MPs to Swiss surface waters with inputs from the effluent of Swiss wastewater treatment plants.

Assessment of Atmospheric Nanoplastics Using Infrared Atomic Force Microscopy (AFM-IR)

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Nanoplastics, particles smaller than 1 micrometer, pose significant environmental and health risks due to their widespread presence and potential for cellular uptake. Traditional methods such as electron, Raman, and infrared microscopy often fail to provide detailed chemical information at the nanoscale. Atomic force microscopy coupled with infrared spectroscopy (AFM-IR) combines the high spatial resolution of AFM with the chemical specificity of infrared spectroscopy, offering a unique approach for characterizing nanoplastics.

This study develops an analytical pipeline for atmospheric nanoplastics, incorporating electrostatic precipitation for environmental sampling and AFM-IR for quantitative chemical analysis of the collected nanoparticles. Standard materials representing common aerosol components, polymer, silica, carbon, and salt nanoparticles, are aerosolized and collected using an electrostatic precipitator. These standards, simulating nanoplastics, mineral dust, soot, and other aerosols, will be used to validate the sampling process and optimize the AFM-IR analysis, determining key analytical figures such as size detection limit, specificity, and dynamic range.

Preliminary results show that AFM-IR is an effective, non-destructive technique for characterizing polymer nanospheres, demonstrating its potential for analyzing nanoplastics in environmental matrices. By providing quantitative chemical data on atmospheric nanoplastics, this work will enhance our understanding of their composition, behavior, and interactions in environmental and biological contexts. These findings can pave the way for the development of complementary analytical techniques and inform in-vitro and in-vivo risk assessments.

Detection and Characterisation of Microplastics in the Urban Water Cycle in Geneva, CH

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This study analyses MPs (>20 µm) across the urban water cycle of the city of Geneva (Switzerland), encompassing raw water sources (groundwater and surface water), drinking water treatment, water supply network, and wastewater treatment. Using a standardized sampling and preparation methodology, MPs concentrations, size distributions, and chemical compositions were determined through Fourier-transform infrared spectroscopy (FTIR). Strict quality assurance measures were implemented to ensure data reliability, in accordance with current MPs analysis guidelines.

Findings indicate that raw water entering Geneva's main conventional drinking water treatment plant (serving approximately 500'000 consumers) exhibited MPs concentrations of 640 ± 292 MPs/m^3, which decreased to 10 ± 6 MPs/m^3 after treatment (including coagulation, sand filtration, ozonation and granular activated carbon filtration), demonstrating a removal efficiency of 97 ± 3% [1]. Geneva groundwater showed low MPs levels, with an average concentration of 8 ± 7 MPs/m^3 [2]. The drinking water supply network (DWSN) was found to increase MPs concentration, with values equal to 27 ± 37 MPs/m^3 in the eastern section and 23 ± 19 MPs/m^3 in the western section. Effluents from three wastewater treatment plants were found to contain an average of 5'829 ± 5'108 MPs/m^3.

References:

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[2] A. Negrete Velasco, A. Ellero, S. Ramseier Gentile, S. Zimmermann, P. Ramaciotti, S. Stoll, Impact of a nanofiltration system on microplastic contamination in Geneva groundwater (Switzerland), Environ. Sci. Pollut. Res. (2024). https://doi.org/10.1007/s11356-024-31940-y.

Assessment of the Microplastics Loads Discharged from Swiss Wastewater Treatment Plants

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Wastewater treatment plants (WWTPs) are known pathways for microplastic particles (MPs) to surface waters, yet the overall contribution of WWTPs for MPs pollution of surface waters remains unclear. During the biological treatment of wastewater, MPs form heteroagglomerates with sludge flocs, leading to similar MP-to-total suspended solids (TSS) ratios in both activated sludge and treated wastewater. Thus, measuring MPs in activated sludge can help estimate MP discharge via treated wastewater. In this study, we, therefore, analyzed MP contents in activated sludge from 52 Swiss WWTPs to assess MP loads released into surface waters.

Activated sludge (~200 mg TSS) was treated with hydrogen peroxide to remove organic matter, followed by density separation with sodium polytungstate to remove the mineral particles. Quality control included spiking with red polyethylene (PE) spheres to determine sample-specific recoveries. Processed samples were filtered onto aluminum oxide filters and analyzed using Focal Plane Array–µ–Fourier Transform Infrared spectroscopy. MPs (equivalent circle diameter (dECD) > 20 µm) were identified via spectral matching with a polymer database (Purency).

MP concentrations in sludge (36 WWTPs analyzed so far) ranged from 100 to 20,000 MPs $gTSS^{-1}$, averaging 5,500 MPs $gTSS^{-1}$. The particle size distribution showed a high abundance of MPs <100 µm and followed a power law distribution ($n(dECD) = \beta \cdot dECD^{-2.26}$, $R^2 = 0.93$). Estimated MP mass ranged from 0.02 to 8.96 mgMPs $gTSS^{-1}$ (average: 0.65 mgMPs $gTSS^{-1}$) and large MPs dominated the mass in spite of their lower abundance. Using average TSS concentration in treated wastewater, WWTP MP discharge was estimated at 1.45×10^{13} MPs $year^{-1}$ (2’394 kgMPs $year^{-1}$) for 36 WWTPs, and 4.04×10^{13} MPs $year^{-1}$ (6’654 kgMPs $year^{-1}$) when extrapolated to the Swiss population. While preliminary, these findings provide a key benchmark for evaluating MP pollution sources.

Spatial and temporal distribution of tire-related additives in freshwater ecosystems: insights from a Swiss pilot study

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Tire and road wear particles (TRWP) are produced during abrasion of tires on road pavement. 61 % of all microplastics entering Lake Geneva (Switzerland) are estimated to originate from tire wear. Field measurements suggest that levels of TRWPs decrease between their emission source and the aquatic environment. Many chemicals are intensively used as vulcanization agents, antioxidants and antiozonants; they can represent several percent of the tire rubber mass. The distribution and fate of TRWPs and associated chemicals in the aquatic environment are still poorly understood as are their potential toxic impacts for aquatic biota. This study aimed (i) to assess the presence and distribution of tire-related additives in water and sediment from alpine/perialpine lakes in Switzerland (ii) to retrace tire-related additives contamination history in sediment cores from Lake Geneva and (iii) to identify the input sources of tire-related additives. Water and sediment from Swiss lakes (n=17), and sediment cores from Lake Geneva (n=2) were collected. Sediment and water were extracted and analysed by UPLC-MS/MS for 15 additives. Our results showed that several additives were present in most perialpine lakes with a predominance of DPG, 6PPD-Q, aniline and benzothiazoles in the ng L^{-1} range. Traces of tire-related additives were detected in high altitude remote lakes highlighting the possibility of atmospheric deposition of TRWPs or gaseous tire-related additives. The concentrations of tire-related additives in sediment cores showed negative correlation with depth. Two main mechanisms likely play a role: a higher road traffic in the catchment of the sampling point in recent years together with a potential degradation of tire- related additives in the most ancient sediment layers. Our results provide important data for a better understanding of tire-related additives fate in freshwater ecosystems and could be used for future risk assessment and mitigation studies.

Soil Micro Plastic: microplastic concentrations from MINAGRIS soils

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In recent years much attention has been brought to microplastic pollution in soils but comparability in results is often lacking. As part of MINAGRIS (MIcro- and NAnoplastics in AGRIcultural Soils), 220+ Soils from 110+ farms across 10 countries in Europe were investigated for MP concentration (particles >88 µm). The study showcases sampling, sample preparation, extraction, and analysis using a predefined harmonized methodology [1]. This big-scale comparison will help to better understand the implications of given preconditions on the determined concentrations. The latter will further be evaluated down the line by comparing it to the qualitative data concerning practices related to the sampled fields acquired from the participating agriculturers. Meticulous quality control was applied across all steps of the analysis process: from sampling and sample preparation to extraction and analysis. In MP research, it is crucial to assess procedural contamination at all times as MPs are ubiquitous in all environmental compartments (most prominently air & water) and can hence greatly distort results. As soil is a heterogeneous matrix and plastic a generally non-soluable material with high chemical and physical differences in itself [2] a high variability was to be expected from the results. To counteract this, replicates of each sample have been processed in two different labs - the variability in the results remains nonetheless high. They show major differences between farms, countries, and cropping systems, but are very much in line with previous findings. Some fields were found to be completely pristine and untouched by plastic while others show concentrations of several thousand particles per kilogram of soil.

To calibrate our results with ecotoxicological findings will be the next important step to determine the severity of the established concentrations for soil, plant, and most importantly human health.

References:
[1] Foetisch, A., Grunder, A., Kuster, B. et al., Microplastic & Nanoplastic, **2024**, 4, **25**.
[2] Koelmans A. et al., Water Research, **2019**, 155, **410-422**.

Factors impacting resuspension of microplastics from rivers: Analysis of Burial and Shielding Effects of Sediment Beds

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Riverine systems can retain considerable amounts microplastics (MPs) through sedimentation, but their resuspension depends on multiple factors. These include particle characteristics and hydrodynamic conditions. The resuspension of natural particles has been studied using various models for bed load transport, such as Shield theory, where the critical shear stress describes the hydrodynamic conditions at which a particle could be resuspended. However, little is known on if MPs behaviour can also be predicted by these standard models due to significant differences in the properties between natural particles and MPs. How specific river morphologies such as bed thickness and grain size impact resuspension is also unexplored, both in the context of 1) shielding/exposure effects exerted by grains on MPs deposited on the sediment surface and 2) MPs resuspension potential when buried within the sediment bed. Here we investigated MPs resuspension using a flume setup across various sediment grain sizes and bed thicknesses under different flow rates. The shielding effect was anticipated to be dependent by the grain size, with larger ones expected to have higher shielding potential than smaller ones. We found that larger grains limited MPs resuspension by changing the bed porosity instead. Large grains allowed MPs to deposit between the pores and cavities, limiting their resuspension. This effect was more pronounced with thicker bed where particles could deposit more in depth. Smaller grains lead to a more compact bed where MPs deposited on the surface were more exposed to the flow shear stress and more easily resuspended. When MPs were buried within the sediment bed, thin bed thickness layers allowed more MPs to resuspend than thicker ones. Collectively, these results provide a better understanding of MPs transport in rivers by assessing the conditions which facilitate particle resuspension in various scenarios.

Incorporation of microplastics into water-stable soil aggregates: dependencies on particle and soil characteristics

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Agricultural practices such as irrigation, mulching, and fertilization contribute to soil pollution by microplastics (MPs). These particles can move both vertically and horizontally, with potential contamination of water sources. While vertical transport has been studied extensively, horizontal transport remains less explored. In soils, MPs interact with other particles, forming aggregates that may alter their transport behavior, especially in water-stable soil aggregates (WSAs). This study investigated the incorporation of MPs into WSAs based on MP and soil properties. Polyethylene terephthalate (PET) and Polylactic acid (PLA) fragments were spiked at 0.2% (wt/wt) into soil sieved to <250 µm. All materials contained rare metals for tracing. MPs were milled to <63 µm, with PET also milled to 125-250 µm. One variant comprised PET (<63 µm) with soil recombined with its mineral fraction 250–2000 µm. Soils were incubated at 60% of their maximum water-holding capacity for two weeks with 2% (wt/wt) glucose to accelerate soil aggregation. After incubation, WSAs were obtained by drop-shattering and subsequent wet-sieved through 1000 and 250 µm meshes. Both incorporated and non-incorporated MPs were quantified by ICP-MS. Comparing different PET sizes revealed the influence of particle size on WSA incorporation, while using different MPs of the same size range highlighted the role of chemical composition. Testing different soil textures with the same MPs provided further insight into soil property influences. At last, testing a concentration range of PET particles will reveal the role of MPs concentration on their incorporation into WSAs.

A Two-Year Incubation Study: Investigating the Vertical Transport of Microplastics in Soil and its Impact on Soil Pore Development

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Plastics are widely used in agriculture to improve productivity and resource efficiency. As they fragment over time, microplastics (MPs) are unintentionally released into soil, raising concerns regarding long-term implications for soil structure and fertility. This study investigates MPs transport and their impact on soil structure evolution through a two-year field experiment. 45 re-packed soil columns were installed with three treatments; indium-doped polyethylene terephthalate fragments or fibers spiked (0.2 wt.%) in the top 2cm and a control with no MPs. Soil pore structure was monitored with X-ray tomography, and MPs' vertical transport was assessed. Both control and MPs-containing samples showed changes in soil structure over time, with shifts towards larger macropores, increases in biopore volume fraction and critical pore diameter. MPs transport was minimal, with nearly all MPs remaining in the top few centimeters of soil and only approximately 1% reaching below 8 cm after two years, regardless of morphology. This experimental design, simulating natural soil conditions, provides realistic MPs transport rates and insights into their impact on soil structure, a key factor in soil ecosystem health. Overall, the findings suggest that MPs have a negligible influence on soil macropore architecture and transport is limited in the short term.

Nanoplastics Ingestion by Springtails: Linking Exposure to Effects Through Dose-Response Relationships

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While many studies have focussed on exposure of aquatic species to nanoplastics (NPs) and respective toxicity, little information is available about their impacts on terrestrial organisms. One problem when assessing ingestion of NPs is the methodological difficulties of NPs identification and quantification. Here, we achieve NPs quantification within soil organisms using Pd-doped NPs, which can be detected in low concentrations via ICP-MS. We assessed toxicity (dose-response relationships) and ingestion/depuration dynamics for the arthropod *Folsomia candida* (Collembola). For the ecotoxicological experiments, springtails were exposed to NPs via spiked feed ranging from 0 to 10,000 mg/kg for a period of 28 days. Weight increase, reproduction, and mortality were assessed. For the toxicokinetics experiments, NPs concentrations in springtails were monitored over 14 days of feeding on spiked feed, followed by another 14 days depuration period. Half-life and bioaccumulation factors were calculated.
NPs were detected in springtails after 28 days exposure when feed contained 400, 2000, or 10,000 mg/kg NPs, while concentrations remained below the limit of detection when feed contained 80 mg/kg NPs. No effects on life-table parameters were observed at any of the tested concentrations. NPs content within springtails increased over time when fed on spiked feed (10,000 mg/kg), reaching a plateau after 7 days exposure. NPs had a half-life of 8.3 days within springtails but were still detected after 14 days depuration period, suggesting longer-term retention of particles within the arthropods. This work demonstrates the utility of Pd-doped NPs in quantifying dose-response relationships and in establishing ingestion/depuration dynamics for soil arthropods. Our results thus contribute to the assessment of risks of NPs to terrestrial ecosystems.

Synthetic versus Biobased Textile Fibers: Investigating their Impact on Human Lung Health

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Microplastic pollution poses a serious threat to both the environment and human health, with the lungs being particularly vulnerable to airborne particles[1]. Smaller fibrils and fiber debris below 5 µm may present a greater health risk than larger fibers, as they can penetrate deeper into the lungs, potentially affecting lung function and interfering with the lung's clearance mechanisms[2].
While the behavior and distribution of microplastics is increasingly studied, there is still limited knowledge about the health effects of inhaled synthetic and biobased polymer fibers. Especially the chronic, long-term impact of environmentally relevant fiber concentrations on lung health remains unclear. Therefore, in this project we aim to understand the long-term impact of airborne synthetic and biobased textile fibers on respiratory health using cell culture models, considering both healthy conditions and those with preexisting respiratory conditions (e.g. asthma and COPD).
To achieve this, we are establishing a material repository by collecting and characterizing unused and aged textiles and fabrics, while also analyzing their potential fiber release under different conditions. These fibers will undergo a systematic toxicological analysis using advanced 3D lung cell culture models that mimic different lung regions relevant to fiber inhalation exposure. Additionally, we will analyze how synthetic and bio-based fibers differ in their modes of action in causing toxicity in vitro, as well as investigate the potential toxic effects of additives within the material. Preliminary data suggest that these additives could exacerbate the health impact in the human lung.
Initial findings demonstrate the successful extraction and sterilization of synthetic and biobased fibers from water. Raman spectroscopy analysis revealed structural changes in abraded material, while scanning electron microscopy will be used to quantify extracted fibers.
These preliminary results provide a solid foundation for further toxicological studies.

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Tiny Plastics, Big Impact?
Investigating Placental Immune Responses to Micro-/Nanoplastics

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Microplastics have been found in every part of the human body and are thus global contaminants of great concern (low degradation rate, fragmentation & potential to take up pathogens). Little is known about how micro-/nanoplastics (MNPs) impacts the health of pregnant women and if these particles can be one of the environmental factors contributing to the increasing prevalence of allergies in newborns [1-2]. Therefore, we are exploiting the health hazards of environmentally relevant MNPs at the maternal-fetal interface with a focus on potential immunomodulatory effects.

To more closely mimic environmentally relevant MNPs, we produced different MNP powders through milling or abrasion of pre-production pellets, consumer plastic products and plastic litter collected from the ocean surface. Initial physicochemical characterization indicated the generation of polydisperse samples in the nano- to micrometer size range. Further size fractionation was performed using a 63 µm sieve to remove particles above the average maximum size of MNPs (~ 50 µm) currently found in human placenta [3-5].

In future studies, we will continue to investigate MNPs interaction with different allergens and assess their uptake, translocation and immunomodulatory effects at the placenta.

Importantly, to achieve results predictive for human pregnancy, we will employ human-based placenta models (e.g. explant cultures or static & dynamic co-culture models) since the placenta is considered the most species-specific organ.

The findings of our study on the potential (immunological) health hazards of MNPs during pregnancy will be important for ensuring the sustainable production and use of plastics and safeguarding the health of pregnant women and unborn children.

This project receives financial support from Eduard Aeberhardt Stiftung, the European Union (EU) URPISE project (grant agreement number – 101156622) and the Swiss State Secretariat for Education, Research and Innovation (SERI).

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