

# Reaching Inside Out

IBP PhD Congress

#12IBPPhD

April 26, 2019  
Vol. 12

**12** amazing talks  
that will change  
your life



**+40** posters  
to charge up  
your scientific ideas

**dozen ways**  
to communicate  
science...

**ETH** zürich

**eawag**  
aquatic research 000



# Welcome!

#12th IBP PhD Congress



**T**his year's PhD Congress is all about our research at the Institute of Biogeochemistry and Pollutant Dynamics (IBP) and how we collaborate and communicate *INSIDE* the very same. Next to promising opportunities within the IBP, *REACHING OUT* might be valuable for some of us to strengthen not only scientific bonds but also to allow for extensive communication beyond our own field. Let us use today to get an insight into the variety of research at the IBP to foster discussions and interactions. ■

April 26. 2019  
Forum Chriesbach  
Eawag, Dübendorf

**Organizing Committee**

Lisa Neu  
Regiane Sanches Natumi  
Samuel Bickel

**Chairwoman and Chairman**

Daniela Rechsteiner  
Philipp Staudacher

# PROGRAM

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## Welcome by Chair People

Daniela Rechsteiner, Philipp Staudacher

## Opening Address

Prof. Dani Or



## Poster Session A & Coffee

## Session 2 - Action & Reaction

### Annika Fiskal

Effects of eutrophication on sedimentary organic carbon cycling in five Swiss lakes

### Benedict Borer

Microgravity promotes anoxic bacterial hotspots in unsaturated porous media

### Davide Ciccarese

Jackpot events prevent ecosystem collapse in the face of environmental fluctuation

08:30

## Registration & Coffee

09:00



09:20

## Session 1 - Tracing the Truth

### Taylor Nelson

Using stable carbon isotopes to assess polyester biodegradation in soils

### Anne-Marie Wefing

Tracing Atlantic waters in the Fram strait using  $^{129}\text{I}$  and  $^{236}\text{U}$

### Jonas Mechelke

Tracing organic pollutants across the water-sediment interface using different analytical methods

10:20

11:30



12:30

## Lunch

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## Session 3 - I came, I saw, I sorbed

13:40

**Emanuel Müller**

Reactivity between dimethyl sulfide and hypobromous acid and its relevance for the environment

**Natacha van Groeningen**

Influence of Mn(II) on the sorption of Cd(II) to clay minerals

**Silvan Wick**

Thallium sorption onto birnessite



14:40

**Poster Session B & Coffee**

15:50

**Session 4 - Reaching Inside Out**

**Elisa Calamita**

60 years of Kariba Dam: Implications for downstream water quality

**Bogdan Caradima**

Inferring stream invertebrate responses to environmental conditions under various biomonitoring designs

**Jangwoo Lee**

The fate of antibiotic resistomes after being discharged from wastewater treatment plants



**Closing Speech & Acknowledgments**

16:50

17:00

**Apéro & Awards**

**Dinner & After Hour Party**

18:00



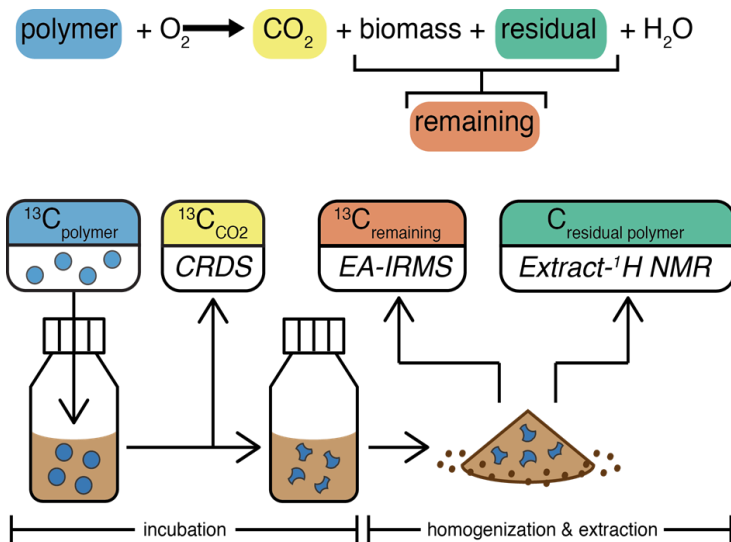
# PRESENTATIONS

Taylor Nelson

Environmental Chemistry | ETH

## Using stable carbon isotopes to assess polyester biodegradation in soils

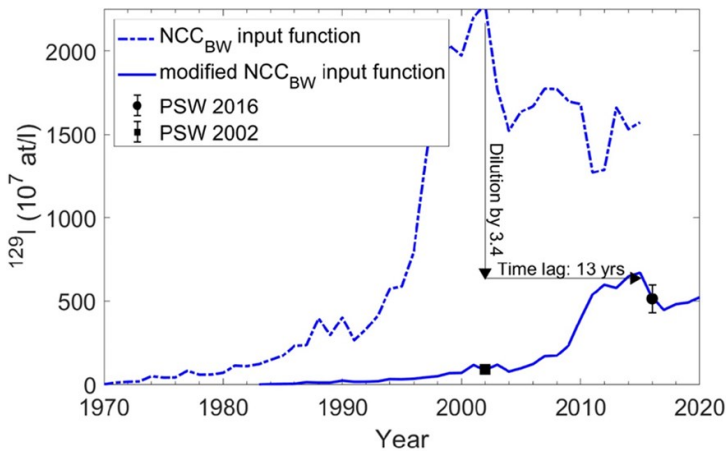
The use of biodegradable polymers in agricultural applications promises to help overcome the accumulation of conventional, persistent plastics in soils; however, polymer biodegradation in soils remains poorly understood due to analytical challenges in studying this process. I will present a novel stable carbon isotope labeling approach that enables tracking of polymer carbon during biodegradation in soils. Applied to soil incubations of the polyester poly (butylene succinate) (PBS), the labeling not only allows continuously determining PBS mineralization to  $^{13}\text{CO}_2$ , but also to close mass balances on added  $^{13}\text{C}$  by quantifying  $^{13}\text{C}$  remaining in the soils. Modeling of the biodegradation data emphasizes the importance of quantifying remnant PBS in soils. The presented approach helps identify possible limitations on polymer biodegradation in soils.



Novel analytical approach for tracking biodegradable polymer carbon into different carbon pools during biodegradation in soil.

## Tracing atlantic waters in the Fram Strait using $^{129}\text{I}$ and $^{236}\text{U}$

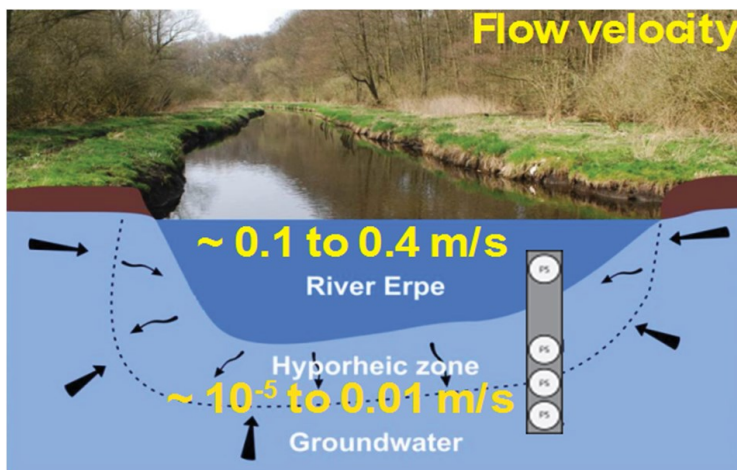
The long-lived artificial radionuclides  $^{129}\text{I}$  and  $^{236}\text{U}$  are known to be suitable tracers to study circulation patterns in the Nordic Seas and the Arctic Ocean due to their locally and timely constrained release by the two European nuclear reprocessing plants in Sellafield and La Hague. Seawater samples collected along a transect across the Fram Strait in 2016 revealed a significant influence of the Norwegian Coastal Current (NCC) in the surface waters outflowing the Arctic Ocean. Using a recently defined input function for  $^{129}\text{I}$  and  $^{236}\text{U}$  entering the Arctic Ocean in the NCC, surface water transit times through the Arctic to the Fram Strait were estimated to be around 12 - 19 years.



Estimation of transit times in the outflowing polar surface waters (PSW) in the Fram Strait.

## Tracing organic pollutants across the water-sediment interface using different analytical methods

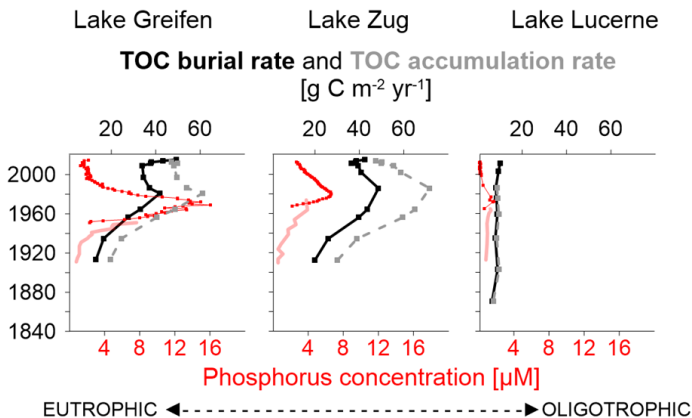
Rivers are no isolated pipes but can have multiple vertical and lateral flow paths that link them to the surrounding landscape. These links create hyporheic zones (HZ) that offer an abundance of sorption sites and excellent conditions for biotransformation. Still, only few studies have focused on the fate of organic pollutants in HZ and its contribution to the self-purification of rivers. In the context of the European training network HypoTRAIN, we developed, validated and partly applied different analytical methods (passive sampling, enantiomeric fractionation, improved water sample preparation, mass spectrometry workflows) at a river and in mesocosms to trace the attenuation of organic pollutants in the HZ. Advantages and limitations of the different methods will be presented with some illustrative examples.



Passive sampling of polar organic pollutants across the water-sediment interface of river Erpe in Berlin.

## Effects of eutrophication on sedimentary organic carbon cycling in five Swiss lakes

Increased phosphorus (P) concentrations in lake water due to anthropogenic inputs can stimulate primary production and lead to oxygen depletion due to enhanced organic matter degradation. Yet, the effects on total organic carbon (TOC) accumulation and microbial respiration in underlying sediments are not well known. We study these effects using sedimentary records of five Swiss lakes covering the last 180 years. Our results show that sediments from lakes that experienced strongly elevated P concentrations have higher TOC accumulation, total respiration, and methanogenesis rates, but the zonation of redox reactions or microbial cell numbers are not significantly affected. Furthermore, despite recent decreases in P concentrations and artificial aeration, TOC accumulation remains high, perhaps due to recycling of sedimentary P to overlying water.

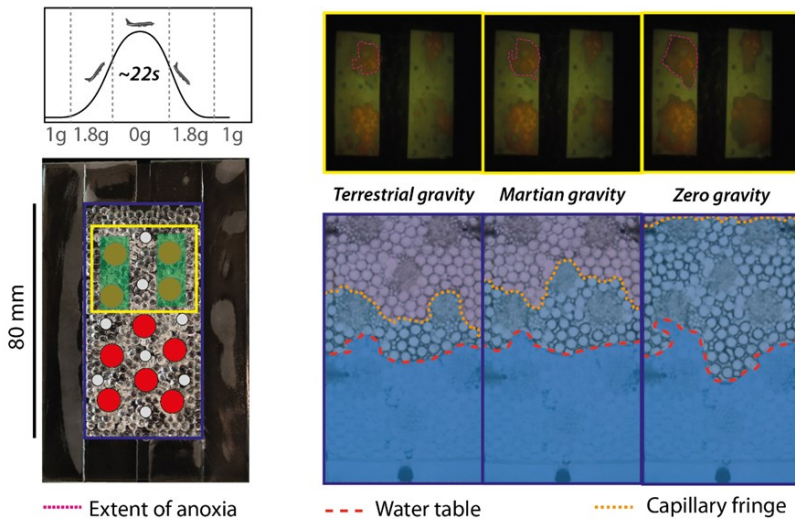


TOC burial rates (black solid lines), reconstructed TOC accumulation rates (dashed grey lines), measured water column total P concentrations (dark red dotted lines), and reconstructed water column total P concentrations (pale red solid lines) all plotted against sediment age at various lakes and lake stations. TOC burial rates are based on the amount of TOC that is currently present in sediments of different ages. Reconstructed TOC accumulation rates are corresponding estimates of the amount of TOC that was accumulating at the sediment surface at the time that each sediment layer was located at the sediment surface.



## Microgravity promotes anoxic bacterial hotspots in unsaturated porous media

Human endeavours into deep space exploration and establishing colonies on nearby planets would invariably involve plant-based bio regenerative life support. Growing plants and their biomes in porous media under different gravitational fields may present new challenges due to capillary dominance of liquid distribution and related gas supply restrictions to roots and microorganism. We provide direct evidence that liquid reconfiguration under reduced gravity conditions promote bacterially mediated anoxic hot spots in unsaturated porous media. Experiments using sintered glass beads inoculated with selected bacterial species exhibited systematic onset of anoxic conditions during reduced gravity periods. Enhanced anoxic conditions in growth media could affect  $N_2O$  and  $CH_4$  emissions to the cabin atmosphere, but offer favourable conditions for detoxifying Mars regolith through bioremediation of perchlorate.



Microcosm, aqueous phase distribution and oxygen optode measurements during 3<sup>rd</sup> Swiss Parabolic Flight campaign.

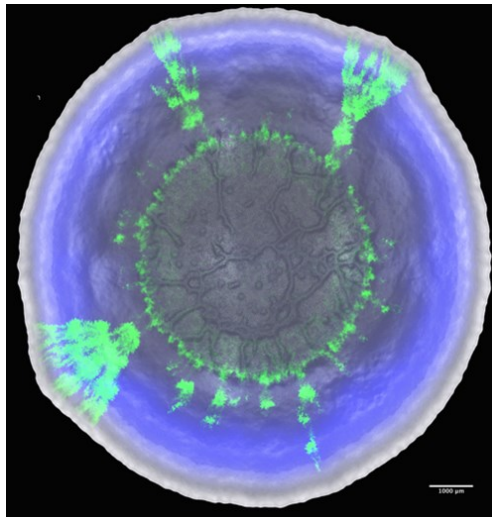
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Davide Ciccarese

Environmental Microbiology UMIK | EAWAG

## Jackpot events prevent ecosystem collapse in the face of environmental fluctuation

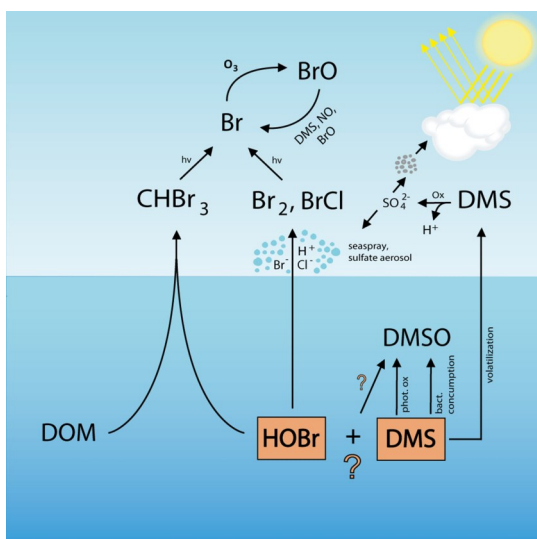
Microbial communities face temporal fluctuations in their local environmental conditions. These changes in local environmental conditions can affect the spatial self-organization of microbial communities. Spatial self-organization can have profound effects on the metabolic processes, ecology, and evolution of microbial communities. Our goal is to address the following two questions. How do temporal fluctuations in environmental conditions affect spatial self-organization? Do these temporal fluctuations affect the long-term stability and functioning of microbial communities? We addressed these questions using a cross-feeding community composed of two strains of the bacterium *Pseudomonas stutzeri*. We found that fluctuations between environments that promote mutualism or competition do indeed reduce the stability of the microbial community as a whole as a result of the strength of the mutualistic interaction.



Confocal laser scanning image of a bacterial colony after 350 h of expansion under fluctuating environment.

## Reactivity between dimethylsulfide and hypobromous acid and its relevance for the environment

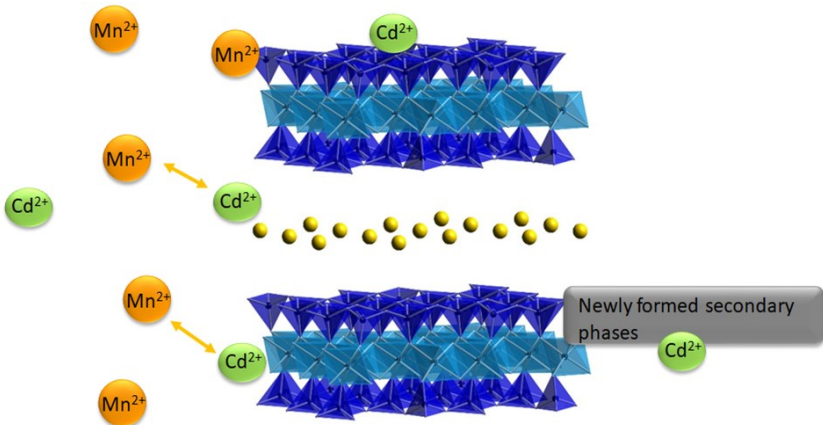
Previously, we reported high reactivity between the climate-active compound dimethylsulfide (DMS) and the strong oxidant hypobromous acid (HOBr), which are both produced by marine algae. This high reactivity might have two consequences: (i) HOBr may present a sink for marine DMS and (ii) this reaction may compete with the reaction between HOBr and dissolved organic matter, which results in the ozone degrading compound bromoform. In a combined experimental and modeling approach we showed that HOBr is indeed an important sink for DMS. Furthermore, in batch and reactor experiments, performed at environmentally relevant [DMS]:[DOM] ratios, we demonstrated that the reaction between DMS and HOBr leads to reduced bromoform formation. The reaction between HOBr and DMS seems thus relevant in marine waters.



The reaction between HOBr and DMS potentially links the marine Br and S cycle.

## Influence of Mn(II) on the sorption of Cd(II) to clay minerals

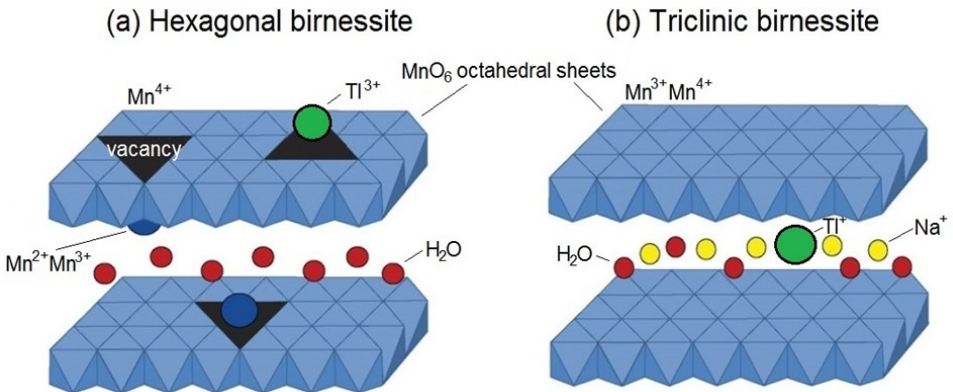
Cadmium is one of the main contaminant in rice paddy soils. Water-saturation of paddy soils can cause elevated dissolved concentrations of  $Mn^{2+}$  as a result of reductive dissolution of Mn(IV,III)-(oxyhydr)oxides. High concentrations of  $Mn^{2+}$  are expected to trigger a mobilization of trace elements (e.g.,  $Zn^{2+}$  and  $Cd^{2+}$ ) due to competition for cation adsorption to mineral surfaces. Since clay minerals are considered major sorbent phases for cations in anoxic environments, our objective was to investigate how  $Mn^{2+}$  influences  $Cd^{2+}$  sorption onto two clay minerals. It was found that cadmium mobility and bioavailability in soils under reducing conditions can be affected by elevated  $Mn^{2+}$  concentration through competitive sorption and concomitantly by the formation of new secondary phases able to incorporate or sorb Cd.



$Mn^{2+}$  competing for sorption with  $Cd^{2+}$  onto a montmorillonite and possible formation of new secondary phases with incorporation or sorption into secondary phases.

## Thallium sorption onto birnessite

Thallium (Tl) is a highly toxic trace element and may pose serious threat to human health. In the environment, Tl commonly occurs as monovalent  $Tl^I$  and, to a lesser extent, as trivalent  $Tl^{III}$ . Birnessites are important sorbents for Tl in soils. It has been shown that hexagonal birnessite can oxidatively sequester  $Tl^{III}$ , whereas triclinic birnessite binds  $Tl^I$  without oxidation. Using a combination of batch sorption experiments and X-ray absorption spectroscopy, we studied the mode and extent of Tl sorption onto synthetic  $\delta\text{-MnO}_2$  and triclinic birnessite. Our results provide insights into variations in the mode of Tl uptake by Mn-oxides, and serve as a basis for a better understanding of the impact of Mn-oxides on the mobility of Tl in soils.



Thallium uptake mechanisms by (a) hexagonal (lower crystalline analogue:  $\delta\text{-MnO}_2$ ) and (b) triclinic birnessite.

## 60 years of Kariba Dam: implications for downstream water quality

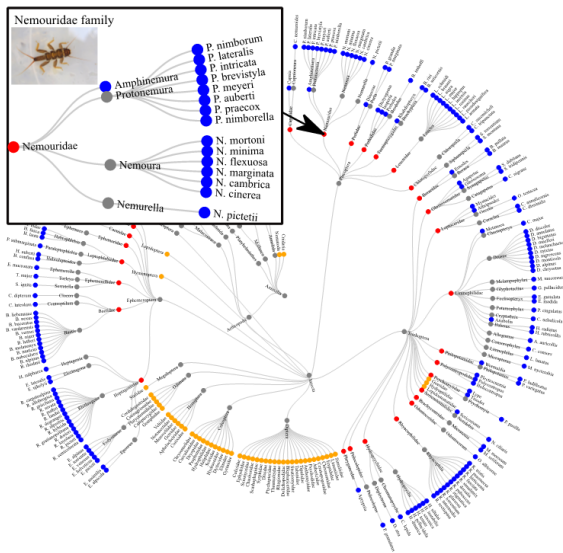
The fast growing African population triggers a rising demand of water, food and energy. Such needs lead to major anthropogenic pressures on African River systems. Among others, the ongoing boom of dam constructions will change water quantity and quality. In this study, we assess the water quality alteration by large dams in tropical regions and we use Lake Kariba as a test case. We aggregated a unified database of observed lake profiles of water temperature and dissolved oxygen for the sixty years of Lake Kariba. Moreover, we produced frequency maps to describe the interannual variation of water temperature and dissolved oxygen at each lake depth. Finally, through a modelling approach, we quantify the impact of the reservoir on downstream water temperature and dissolved oxygen concentrations.



Kariba Dam located along the Zambezi River at the border between Zambia and Zimbabwe.

## Inferring stream invertebrate responses to environmental conditions under various biomonitoring designs

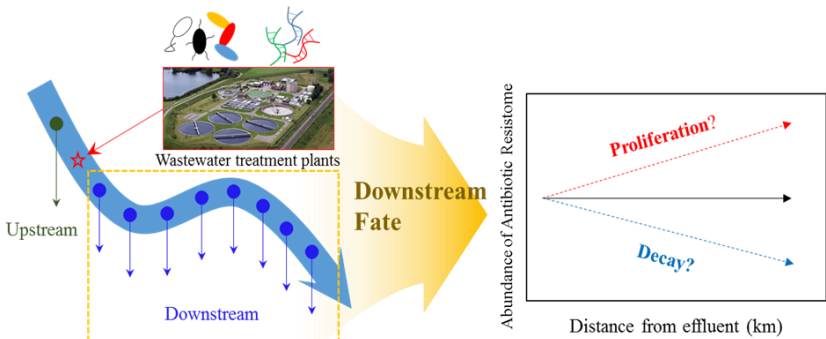
Our ability to infer anthropogenic impacts from biomonitoring data of stream invertebrates depends on key aspects of biomonitoring design, including the taxonomic resolution, sampling locations, and sampling frequency. In this study, we prepare four datasets from Swiss federal and cantonal biomonitoring programs that differ in these key aspects of design. Using a multi-species distribution model, we analyze how differences among the datasets affect our ability to quantify the effect and relative importance of selected natural and anthropogenic environmental conditions, and to predict distributions of taxa. We show that multi-species models can contribute to the selection of specific taxa for identification at higher taxonomic resolutions, potentially facilitating the standardization and combination of multiple biomonitoring datasets at mixed taxonomic resolutions.



The taxonomy of stream invertebrate taxa in the Swiss Biodiversity Monitoring program, with the stonefly family Nemouridae highlighted. Identifying taxa at higher taxonomic resolutions is costly and technically difficult, but can reveal more diverse and significant responses to environmental conditions.

## The fate of antibiotic resistomes after being discharged from wastewater treatment plants

Since its introduction to human medicine, the consumption of antibiotics has increased rapidly, and the bacterial resistance has been developed accordingly. Wastewater treatment plants (WWTPs) have been indicated as major routes for discharging antibiotic resistomes. In this study, the impact of two Swiss WWTPs on their receiving rivers and the downstream fate of antibiotic resistomes were investigated. Antibiotic resistant bacteria were analyzed using heterotrophic plate counts, and resistance genes were measured by quantitative PCR. Antibiotic resistant bacteria and genes decreased rapidly within 2.0 – 2.5 km downstream distance, but some genes increased in the further downstream for certain campaigns. The detailed results will be discussed during the congress, and further investigated after analyzing flow cytometry, 16S rRNA amplicon-, and metagenome sequencing data.



Antibiotic resistant bacteria and genes downstream a wastewater treatment plant.



# POSTER SESSION A

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- A01 **Kathrin Baumann**  
Nitrogen turnover and microbial communities in lake sediments
- A02 **Sami Ben Said**  
A spatially organized microbial consortium for the conversion of cellulose to methane
- A03 **Charlotte Bopp**  
Using isotope effects to understand enzymatic oxygenation kinetics
- A04 **Mattia Cerri**  
Quantitative kinetics of polyester hydrolysis by simultaneous detection of embedded fluorogenic markers
- A05 **Alma Dal Co**  
Short-range interactions govern cellular dynamics in microbial multi-genotype systems
- A06 **Francisca De Bruijn**  
Monitoring of agricultural derived natural estrogens in Swiss surface waters
- A07 **Werner Leonardo Desiante**  
Biotransformation linked to the adaptation history of stream biofilms
- A08 **Flora Desmet**  
Ocean acidification extreme events in the California Current System
- A09 **Deniz Disa**  
Spatio-temporal variabilities in coral reef biogeochemistry
- A10 **Tomy Doda**  
Density currents induced by differential cooling in lakes: field observations
- A11 **Barbara Günthardt**  
Suspect screening for phytotoxins – occurrence of natural toxins in surface waters
- A12 **Surya Gupta**  
Using vegetation attributes to represent soil structure effects in pedotransfer functions

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- A13 **Xingguo Han**  
Eutrophication and organic matter sources control microbial communities in lake sediments
- A14 **Kevin Hoffmann**  
Environmental conditions controlling the behaviour of metal sulfide nanoparticles
- A15 **Urs Hofmann Elizondo**  
Marine biomes based on global species occurrence projections
- A16 **Edith Horstmann**  
Noble gas analysis of black smoker sediments
- A17 **Joanna Houska**  
An unresolved puzzle: linking oxidation by-products in the water matrix to their precursors
- A18 **Andrea Mancini**  
The fate of iron in cementitious environments
- A19 **Xingyu Liu**  
Sampling of labile As(III) in Chinese paddy rice soils using DGT technique

# POSTER SESSION B

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- B01 **Karin Kiefer**  
Broad groundwater screening reveals new pesticide transformation products
- B02 **Hannah Kleyer**  
Trends in bacterial community stability-diversity under hydration cycles
- B03 **Eike Köhn**  
Oxygen extreme events in the Eastern Tropical Pacific
- B04 **Alexandra Lightfoot**  
The role of gases in an arsenic contaminated aquifer
- B05 **Domitille Louchard**  
Phytoplankton community structure and carbon export in the Amazon River plume
- B06 **Yinyin Ma**  
Evolvability of spatial self-organization during microbial range expansion
- B07 **Marie-Sophie Maier**  
Carbon cycling in different aquatic compartments of the Danube Delta
- B08 **Karin MacKevett**  
Effects of organic matter quality on arsenic (im)mobilisation
- B09 **Alessandro Manfrin**  
Substituent effect on the direct photodegradation of benzotrifluorides
- B10 **Rachele Ossola**  
Understanding sulfate production from photosensitized degradation of cysteine
- B11 **Carla Perez Mon**  
Impact of temperatures and carbon and nutrients' increase on High-Arctic microbial communities
- B12 **Vanessa Povo**  
Drivers of metabolism-dependent growth strategy transitions in microbial collectives

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- B13 **Daniela Rechsteiner**  
Determination of natural estrogens in Swiss cattle and pig manure
- B14 **Damiano Righetti**  
Global patterns of phytoplankton diversity
- B15 **Lena Schinkel**  
POPs in microplastics in the South Atlantic gyre and their environmental risks
- B16 **Carina Schönsee**  
Using column chromatography to assess natural toxin mobility in the aquatic environment
- B17 **Katharina Sodnikar**  
Fate of double-stranded ribonucleic acid (dsRNA) plant incorporated protectants (PIPs) in agricultural soils
- B18 **Pascal Wiesli**  
Off-flavour control in land-based salmon production
- B19 **Lin Boynton**  
The effect of solution chemistry on DNA adsorption to soil minerals

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