Programme

Rivers connect climatic regions and supply drier lowlands with freshwater. They connect landscapes, supply and store sediments and provide lifelines for people, nature and goods. Yet, the governance and management of these lifelines is challenged by global change. Climate change alters hydrological processes and sediment cascades, legacy and emerging pollutants deteriorate water quality along whole river networks and limit water use. But also, human influences like dams, reservoirs, or water abstraction disconnect rivers with negative impacts on environmental flows. All this increases use conflicts and resource competition. Unfortunately, current monitoring, analyses and modelling often neglect river connectivity highlighting the need for sustainable solutions.

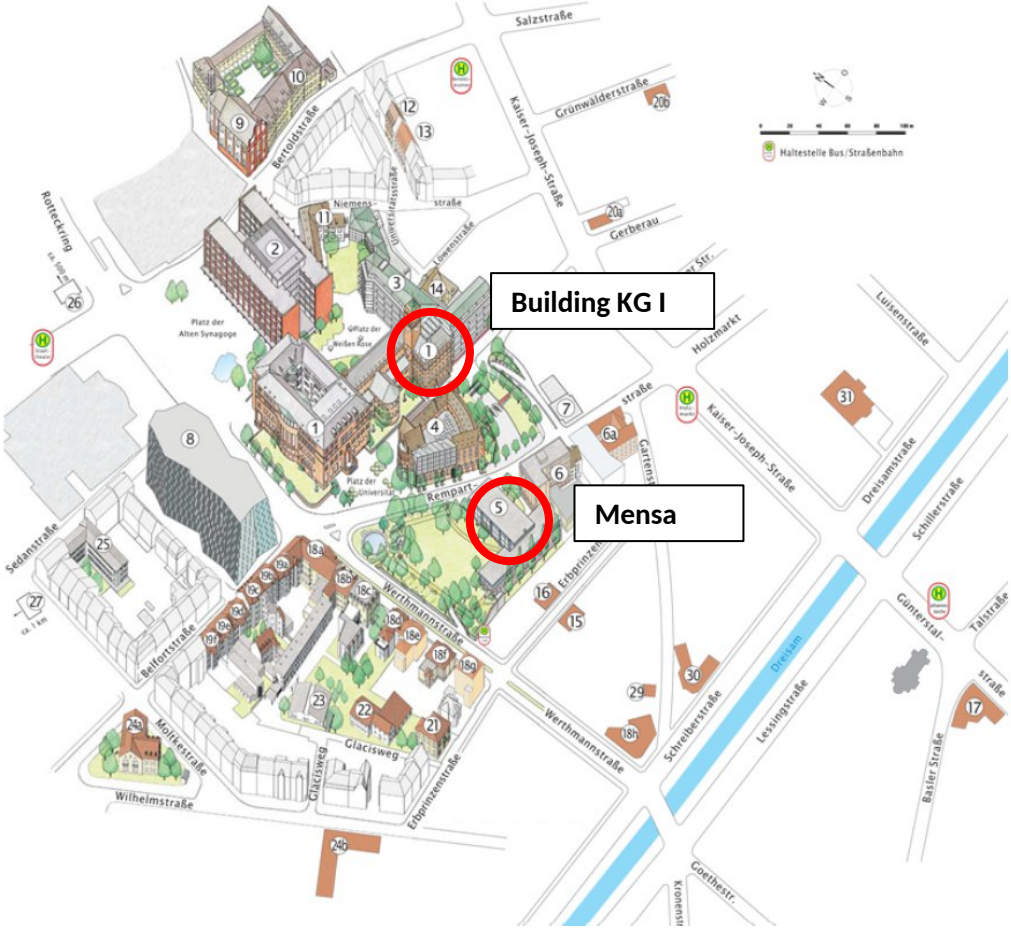
The 13th Water Research Horizon Conference will bring together national and international researchers, practitioners and policy-makers with diverse backgrounds. Participants will engage in a multilateral and multidisciplinary exchange about the role of research in addressing the challenges of river links.

jointly organized by

universität freiburg

Water Science Alliance e.V.
Deutsche Allianz Wasserforschung

The conference venue – Freiburg University



Tuesday, 26. September 2023		
8:30	**Registration**	
9:00	**Opening & Welcome Address (chairs WSA and local organization committee)**	
9:30	**Keynote** ***Christiane Zarfl**, Tübingen University (DE)* Disconnected rivers - rivers under pressure from infrastructure and pollution	
10:15	**Coffee Break**	
	Session: "Water connecting Biodiversity" Chair: Florian Leese, University of Duisburg-Essen (DE)	**Session: "Water connecting Climates"** Chair: Kerstin Stahl, University of Freiburg (DE)
10:45	***Hans-Peter Grossart**, IGB Berlin (DE)* Connectivity – an often overlooked factor of aquatic biodiversity	***Arthur Lutz & W. Immerzeel**, Utrecht University* (NL) Connecting climate, water and people in high mountain Asia
11:15	***Kristy Deiner**, ETH Zürich (CH)* Transport and degradation rates of eDNA in rivers predict hot spots for eDNA monitoring in landscapes	***Sergio Vincente-Serrano**, Instituto Pirenaico de Ecologia (ES)* Water availability challenges in Spain: complex land management processes and water demands in a climate change scenario
11:45	***Benjamin M. Kraemer**, Freiburg University (DE)* Global drivers of lake dead zone formation at the mouths of major rivers	***Marit van Tiel**, ETH Zurich (CH)* Linking upstream meltwater contributions to downstream low flows in the Rhine basin
12:00	***Marie-Thérése Werner**, University of Duisburg-Essen (DE)* Genetic isolation of a keystone invertebrate species in headwater streams	***Uwe Spank**, TU Dresden (DE)* Challenges to correctly quantify momentum, mass and energy fluxes between extensive water surfaces and the atmosphere
12:15	Discussion	Discussion
12:30	**Lunch Break (Menu)**	
	Session: "Water connecting People" Chair: Jörg Seegert, TU Dresden (DE)	**Session: "Water connecting Health"** Chair: Martina Flörke, Ruhr University Bochum (DE)
13:30	***Ines Dombrowsky**, German Institute of Development and Sustainability – IDOS, Bonn* Multidisciplinary perspectives on conflict and cooperation of transboundary rivers	***Julia Derx**, Technical University Wien (AT)* Genetic microbial source tracking support drinking water infection risk modeling in a riverine wetland
14:00	***Claudia Pahl-Wostl**, Osnabrück University (DE)* How to meet the coordination challenge in dealing with complex water governance problems	***Andreas Fath**, Furtwangen University (DE)* Swimming rivers as research projects to convince policy makers
14:30	***Nora Schütze**, Kassel University (DE)* Challenges and opportunities for governing the water-energy-food-ecosystem nexus	***Wiltrud Terlau**, Bonn-Rhein-Sieg University (DE)* The importance of water bodies in parks promoting on health in cities, Sao Paulo
14:45		***Emmanuel O. Akindele**, IGB Berlin (DE)* Gold mining impairs the biological water quality of a culturally important river and UNESCO World Heritage site in Nigeria
15:00	Discussion	Discussion
15:15	**Coffee Break**	
15:30	**Poster Session**	
16:00		**General Assembly Water Science Alliance e.V.**
17:00	**Award Ceremony: Ritter Foundation "Water Monitoring Award 2023"**	
18:00 – 22:00	**Get-together (Mediterranean Finger-Food, Wine, Beer & other Drinks) at AOK Forum (see map)**	

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Wednesday, 27. September 2023			
8:30	**Registration**		
9:00	**Keynote** ***Susanne Schmeier**, IHE Delft Institute for Water Education (NL)* Enhancing sustainability in the management of rivers, lakes and aquifers - the role of cooperation across sectors, actors and countries		
9:45	**Coffee Break**		
	Session "Water connecting Landscapes" Chair: Markus Weiler, Freiburg University (DE)	**Session: "People (dis)connecting Water"** Chair: Peter Krebs, TU Dresden (DE)	
10:15	***Simone Bizzi**, University of Padova (IT)* Building evidence of river geomorphic processes in a data-rich era	***Bernhard Lehner**, McGill University (CA)* Global effects of dams and reservoirs on free-flowing rivers: status, challenges and opportunities	
10:45	***Sergiy Vorogushyn**, GFZ Potsdam (DE)* Interplay of river networks and floodplains from the flood risk perspective	***Johannes Weinig,** Hochschule Bielefeld University of Applied Sciences and Art (DE)* Harmless for the river - with a close cycle of urban water	
11:00		***Jens Lange**, Freiburg University (DE)* Benefits of floating photovoltaic power plants on the Aswan high dam reservoir	
11:15	***Günter Müller-Czygan**, Hof University (DE)* Change of perspective – How rivers are effectively incorporated into sponge concepts using multi-level analysis	***Max Gustav Rudolph**, TU Dresden (DE)* The importance of uncertainty quantification in water resources management and system understanding with applications to groundwater systems	
11:30	***Carolin Winter**, Freiburg University (DE)* Large-scale evidence against nitrate source limitation during high-magnitude events and systematic divergence between long-term and event-scale export patterns	***Rebecca Peters**, Tübingen University (DE)* Towards a renewable electricity mix that prevents the increasing fragmentation of African rivers	
11:45	Discussion	Discussion	
12:00	**Lunch Break (Menu)**		
13:00	**Workshops**		
	1. Water governance workshop Inter- & transdisciplinarity in research is required for many project calls in the project designs. How can we improve successful collaborations among disciplines towards research for good water governance? Hosts: Kerstin Stahl & Nora Schütze	**2. Research data workshop** Research on river links also requires linked research datasets: How can we combine existing datasets to generate added value for data analysis and modelling in water science. Hosts: Markus Weiler & Ralf Loritz in cooperation with NFDI4Earth	**3. Hydrology meets Biodiversity** The knowns and unknowns of flow connectivity in catchments: How can interdisciplinary dialogue enhance our understanding of flow processes, biodiversity change and how these influence each other? Hosts: Florian Leese, Yvonne Schadewell, Peter Chifflard (DFG Research Unit 5288)
14:30	**Outcomes of workshops and next steps (Workshop 1-3 hosts)**		
15:00	**Conference closing remarks (Chairs WSA)**		
15:15	**Field trip to two research projects close to Freiburg**		
	DFG Research Unit 5288: Fast and Invisible: Conquering Subsurface Stormflow through an Interdisciplinary Multi-Site Approach. StressRes: Monitoring and Modelling System for the Assessment of Stress on groundwater resources and public water supply		
17:40	**Return from field trip (train station)**		

Lecture Halls/Rooms	Building
Aula	KG I
1199	KG I
1108	KG I
Prometheushalle	KG I
Mensa Rempartstrasse	Link

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Keynotes ----------

26.9.2023: Christiane Zarfl

Environmental Systems Analysis at University Tübingen (DE)

Disconnected rivers - rivers under pressure from infrastructure and pollution

27.9.2023: Susanne Schmeier

Water Law and Diplomacy at IHE Delft (NL)

Enhancing sustainability in the management of rivers, lakes and aquifers - The role of cooperation across sectors, actors and countries

Water connecting Biodiversity ----------

Rivers are integral connecting elements of biodiversity and ecosystems. However, due to anthropogenic activities they are increasingly disconnected. This session features contributions about these connections and their potential severe consequences for nature and humanity.

- **Hans-Peter Grossart,** IGB Berlin (DE)

  Connectivity - an often overlooked factor of aquatic biodiversity

- **Kristy Deiner,** ETH Zürich (CH)

  Transport and degradation rates of eDNA in rivers predict hot spots for eDNA monitoring in landscapes

Benjamin M. Kraemer, Freiburg University (DE)
Global drivers of lake dead zone formation at the mouths of major rivers
Dead zones are commonly associated with marine coastal areas where rivers deposit excessive nutrients leading to local anoxia sometimes stretching for hundreds of kilometers. Marine dead zones are well-recognized for their adverse effects on ecosystems, fisheries, and coastal communities. But in contrast, the global extent and drivers of dead zone formation near inflowing rivers to the world's lakes remains uncertain despite the importance of lakes for drinking water supplies, recreation, and biodiversity. Here, I used 742 million chlorophyll-a (chl-a) estimates merged over 6 satellite sensors (daily, 1 to 4 km resolution) to detect dead zones at the mouths of major inflowing rivers in more than 100 large lakes and asses their changes from 1997 to 2020. Dead zones were present in lakes across geographic and climatic gradients and were associated with a combination of urban and agricultural activities in lake watersheds. Dead zones expanded in some lakes even as water quality offshore improved. This spatiotemporal complexity demonstrates the value of moderate resolution mapping of lake dead zones to inform water management decision-making and to determine the local ecological consequences of human activity.

Marie-Thérése Werner, University of Duisburg-Essen (DE)
Genetic isolation of a keystone invertebrate species in headwater streams
Freshwater ecosystems incur a strong decline in both, species diversity and genetic diversity. In a previous study by Weigand et al. (2020), the genetic population structure of Gammarus fossarum was

investigated to identify potential cryptic species in the Kinzig catchment and inform about connectivity and population demography. They reported high genetic diversity together with a prominent small-scale pattern with endemic haplotypes in headwaters and found indications for a potential new cryptic species (clade RMO) based on mitochondrial COI data. However, it remained unclear if the G. fossarum species complex inhabits a new cryptic species and if the headwater populations are isolated, which can only be clarified by using nuclear markers. Therefore, we reinvestigated the population structure of G. fossarum in the headwaters based on 300 specimens from 15 sites with genome-wide SNP data derived from ddRADseq. We aimed to analyze changes in the population structure, test if the RMO clade represents a cryptic species, and verify if headwater populations are isolated. Like the previous study we found high genetic diversity and a prominent small-scale pattern with endemic haplotypes. Since we did not find any specimens of the RMO clade, it was not possible to verify the species status. However, the nuclear data confirmed the strong isolation of populations, revealing 13 genomic clusters along the 15 sites. These results show that populations of G. fossarum can be highly isolated despite being highly abundant in many streams, underlining the importance of including genetic diversity to derive estimates of population and river connectivity.

Water connecting Climates ----------

Rivers link climatically different regions. This session features topics such as cold region (cryosphere) mountain headwater contributions to lowland regions, wet-to-dry climate controls of exotic rivers, precipitation contributions from different source areas, and research on disparate compensating or exacerbating hydroclimatic changes.

- **Walter Immerzeel**, Utrecht University (NL)

Connecting climate, water and people in high mountain Asia

- **Sergio Vincente-Serrano**, Instituto Pirenaico de Ecologia (ES)

Water availability challenges in Spain: complex land management processes and water demands in a climate change scenario

Marit van Tiel, ETH Zurich (CH)
Linking upstream meltwater contributions to downstream low flows in the Rhine basin
Meltwater, specifically glacier meltwater, is an important source of water during droughts. Meteorological droughts, including a lack of snow, combined with heatwaves, cause high glacier melt rates which can alleviate low flows further downstream. Here we analyzed these processes at the scale of a large river basin, the European River Rhine basin, using a modelling framework. All glacierized headwater catchments (n=66) were modelled using the HBV-light model and the resulting streamflow simulations were input into the hydrological model LARSIM that was used in the rest of the basin. We analyzed streamflow and its components, snow, ice and rain contributions for 10 low flow periods between 1974 and 2019, such as in 1976, 2003, 2015 and 2018. During these periods, rainfall contributions were usually lower than normal, snow amounts varied, and ice melt contributions were often higher than normal. Snowmelt provided the highest contributions during low flow situations in the Rhine basin. At a daily scale, ice melt contributions during low flows were still significant, up to around 15%, even far downstream. However, diminishing glaciers threaten this meltwater supply. In so called stress-test scenarios, we analyzed the changes in streamflow for situations where the meteorological conditions of selected low periods (1976, 2003, 2018) would occur again at different moments in the future. The simulations show that summer streamflow during already critical drought years, would decline between 5-25% downstream and 30-70% upstream, depending on low flow year and near or far future conditions. Durations of extreme low flow situations may double. The results

highlight the importance of cryospheric changes for downstream low flow situations in a changing climate.

Uwe Spank, TU Dresden (DE)
Challenges to correctly quantify momentum, mass and energy fluxes between extensive water surfaces and the atmosphere
The quantification of momentum, mass, and energy exchange between inland waters and the atmosphere has always been of great importance for a sustainable management of water quantity and quality. The importance to correctly determine these fluxes becomes even higher considering the new challenges caused by climate change and the growing world population. The use of floating eddy covariance (EC) measurement systems in combination with in situ limnological measurements is an appropriate method to observe momentum, gas, and energy fluxes as well as the related meteorological and limnological driver variables from extensive inland waters such as lakes and reservoirs. This approach provides continuous data in high temporal resolution, which are representative for the offshore conditions. We operated such a measurement system for five seasons from ice off in spring until the beginning of winter after autumn overturn on two reservoirs of contrasting limnic conditions in Germany. Our data reveal that many standard assumption and guidelines need to be revised. For example, the evaporation in the center of the reservoirs was significantly lower than expected and was only about half of typical model estimates. Measurement errors and other methodological reasoned uncertainties can be ruled out as the sole causes. Rather, spatial differences and interferences with surrounding terrestrial sites at the shoreline lead to considerable spatial differences. In similar way, high spatial variations in other limnic and meteorological variables were detected, making each inland water a unique and complex system. Nevertheless, it was possible to determine functional relationships that allow our results to be transferred to other waters.

Water connecting People ----------

Many industries and sectors are dependent on water use and water bodies - both nationally and internationally. Scarce water resources and pollution represent potential for conflict, but can also open up opportunities for cooperation. This session features research on the governance and management aspects involved.

- **Ines Dombrowsky,** German Institute of Development and Sustainability (DE)

Multidisciplinary Perspectives on Conflict and Cooperation of Transboundary Rivers

- **Claudia Pahl-Wostl,** Osnabrück University (DE)

How to meet the coordination challenge in dealing with complex water governance problems

- **Nora Schütz,** Kassel University (DE)

Challenges and opportunities for governing the water-energy-food-ecosystem nexus

Water connecting Health ----------

Access to clean and safe drinking water is crucial for public health, as polluted water can cause severe illness and even death. In this context, water quantity and quality are closely related to human health. This session features research from different exposure pathways such as drinking, bathing, irrigation of crops like vegetables, rice, or the consumption of contaminated fish and shellfish to a better management of water resources that may help to reduce the transmission of pollutants to make water bodies safe for domestic, economic, and recreational uses.

- **Julia Derx,** TU Wien (AU)

Genetic microbial source tracking support drinking water infection risk modeling in a riverine wetland

- **Andreas Fath,** Furtwangen University (DE)

Swimming rivers as research projects to convince policy makers

Wiltrud Terlau, Bonn-Rhein-Sieg University (DE)
The importance of water bodies in parks promoting on health in cities, Sao Paulo
The One Health approach recognizes that the health of humans, animals, and the environment is intrinsically connected, and therefore effective and sustainable interventions should consider the three dimensions simultaneously. Green infrastructure has been increasingly associated with benefits to human physical and mental health, biodiversity conservation, and climate change mitigation, making it a strategic One Health intervention that addresses the three dimensions of health in cities. Urban green spaces, such as parks, are the most used green infrastructure component and are usually freely accessible by the population. However, as park quality may vary a lot within and between cities, it is necessary to understand which characteristics are important so that these spaces actually provide the benefits expected from them. In this study, we investigated which park characteristics were associated with better outcomes for users' mental health and for wildlife support. One of the main findings was the synergistic effect of the presence of water bodies in urban parks contributing to both psychological restoration of park users and support to biodiversity (bird species). Moreover, not only the presence of water was important, but also its accessibility and quality. Better potential for psychological restoration was associated with water bodies that were (physically/visually/acoustically) accessible by park users and of natural aspect. The naturalness of the water body was also associated with higher richness in bird assemblages. We conclude that water should be prioritized in urban park design to maximize the benefits for people and animals, ultimately promoting One Health in cities.

Water connecting Landscapes ----------

Water erodes and deposits sediments and nutrients, among other biotic and abiotic matter exchanges in the landscape. The session deals with the interaction of water with landscape features that control and shape such links as well as with observed, modeled and predicted changes.

- **Simone Bizzi,** University of Padova (IT)

Building evidence of river geomorphic processes in a data rich era

- **Sergiy Vorogushyn,** GFZ Potsdam (DE)

Interplay of river networks and floodplains from the flood risk perspective

Günter Müller-Czygan, Hof University (DE)

Change of perspective – How rivers are effectively incorporated into sponge concepts using multi-level analysis

The increase in weather extremes requires a more cross-system engineering in the field of urban water management than has been the case so far. The separation between drinking water and wastewater or hydraulic engineering and river water management must increasingly be replaced by an interdisciplinary engineering approach. In urban areas, transport and landscape planners as well as architects and infrastructure specialists, and in rural areas agriculture and forestry, must also be involved in a joint planning and implementation process to enable sustainable water management. Increasingly, the sponge city concept is seen as a key measure for dealing with the two weather extremes of heavy rain and drought. However, not many of these concepts go beyond the urban perspective to include agriculture, forestry and rivers in a holistic approach. Sponge considerations are often made spatially very limited, e.g. to a building or a neighborhood, and reduce the activities to the hazard-free drainage of heavy rain. But especially in the transition area between city and countryside, the natural systems of forest, landscape and river play an important role so that the sponge principle can achieve its full effect for both weather extremes. At the Hof University of Applied Sciences, a method has been developed with the multi-level analysis, which allows a complex consideration of the different objectives and disciplines with simultaneous spatial allocation. Examples will be given to show how the multi-level analysis can be used for a holistic consideration of the sponge concept, especially for the integration of rivers.

Carolin Winter, Freiburg University (DE)

Large-scale evidence against nitrate source limitation during high-magnitude events and systematic divergence between long-term and event-scale export patterns

Excessive application of nitrogen to our landscapes and its hydrologic transport along catchment flow paths towards the river network and further into downstream receiving waters threaten drinking water quality and aquatic ecosystem health. Nitrogen storage and release at the catchment scale are shaped by mechanisms that operate at different temporal scales. Still, most of our understanding of catchment internal processes is based on low-frequency nitrate concentration data, bearing the risk of overseeing important processes and export peaks. Studies analyzing high-frequency nitrate concentrations in rivers revealed the disproportionate role of storm events for nitrate export and an apparent divergence between long-term and event-scale nitrate export patterns. However, these studies are restricted to a small number of catchments, while large-scale evidence that is more generalizable is still missing. To test the hypothesis that nitrate export patterns systematically diverge between event and inter-annual scales, we evaluated time series of high-frequency observations of nitrate concentrations and discharge from 28 catchments and across 3480 discrete storm events. We observed consistent and often drastic divergence between long-term and event-specific export patterns, with average event patterns consistently closer to chemostatic export. Variability in export patterns across events consistently decreased with event magnitude and yielded compelling evidence against source limitation during high-magnitude events. Multi-catchment high-frequency data revealed novel aspects of catchment functioning, including complementary controls on long-term and event-scale nitrate export patterns. Our work underlines the crucial role of time-scale-specific mechanisms for efficiently managing nitrate storage and release at the catchment scale.

Water (dis)connecting People ----------

People have disconnected free-flowing water by dams and reservoirs, but also through alterations by river training, abstractions and other human influences. This session features research that investigates trends and positive or negative effects - including but not limited to e.g. increases in water quantity for (drinking) water supply, effective flood protection (and limits to it), disturbance of aquatic ecosystems, sediment transport or water quality and explores management and governance options.

- **Bernhard Lehner,** McGill University (CA)

  Global effects of dams and reservoirs on free-flowing rivers: status, challenges, and opportunities

Johannes Weinig, Hochschule Bielefeld University of Applied Sciences and Art (DE)
Harmless for the river - with a close cycle of urban water
The anthropogenic (damaging) flow of water must be interrupted, as called for in particular by the United Nations Sustainable Development Goals (SDGs) with SDG 6 (Water) and SDG 14/15 (Life below water/on land. From groundwater to use in the settlement area, we then need a high-quality barrier or connection to the aquatic environment (River Links). The treated water must be free of pollutants so that we can release it back into the water cycle respectively into the river without causing ecological damage or/and re-use it in the settlement area. This is not only a technological question in the sense of which process technology is appropriate for this advanced (fourth) treatment stage. Economic incentives for the reduction of water pollution or for more advanced wastewater treatment must be developed. A polluter-pays allocation of the costs for this wastewater treatment is necessary. For example, waterborne external costs in the production of pharmaceuticals and the costs of eliminating residual pharmaceuticals and metabolites, (micro)plastics and other trace substances can be financially priced into the costs of the polluters. Just as air pollution is sanctioned, CO 2 emissions are monetized, water pollution can also be charged financially (more). Cost allocation models exist like the European CO 2 Emissions Trading System, the German Immission Control Act, or the Wastewater Levy Act. Also greater awareness is required via Education for Sustainable Development. Cooperation of all relevant actors and interdisciplinary frameworks for technological options, economic incentive systems, ecological standards and social acceptance for a harmless (water) flow must take place.

Jens Lange, Freiburg University (DE)
Benefits of floating photovoltaic power plants on the Aswan high dam reservoir
In recent decades, the construction of various hydropower dams has resulted in the formation of large water reservoirs. Particularly in arid regions, these reservoirs are subject to considerable evaporation. As a benefit, Floating Photovoltaic (FPV) can contribute to minimizing evaporation loss while generating renewable energy at the same time. In the present case study, we simulate the reduction of evaporation loss due to FPV by applying the hydrodynamic General Lake Model together with the yield simulation model Zenit to one of the largest manmade reservoirs in the world, the Aswan High Dam Reservoir (Lake Nasser and Lake Nubia). We estimate a 49.7% reduction of evaporation at 90% FPV occupancy and water savings of up to 5.9 billion cubic meters per year. We analyze possible ways to use the saved water, such as additional hydropower at the Aswan High Dam, filling up the Toshka Lakes, or agricultural irrigation in the New Valley Project. The use of FPV water savings for agricultural irrigation appeared to be most efficient. Results from the yield simulation suggest that a FPV coverage of 10% could minimize Egypt´s dependence on natural gas for electricity supply from 85% to 1%.

Max Gustav Rudolph, TU Dresden (DE)

The importance of uncertainty quantification in water resources management and system understanding with applications to groundwater systems

Water resources need to be managed sustainably, especially under the impact of climate change and its associated challenges and uncertainties. Quantifying the uncertainty of model simulations and predictions is therefore needed to make informed management decisions and to assess risks. Groundwater systems, as a vital source of freshwater, usually require complex spatially distributed numerical models to address such management problems. However, associated inverse problems are often severely ill-posed, leading to equifinality and uncertainty. Reducing prediction uncertainty for groundwater models is therefore a pivotal challenge of water resources management. However, quantifying simulation uncertainties remains challenging due to the high computational costs of distributed groundwater models.nBesides hydraulic data, we use alternative data-types, such as environmental tracers, to reduce groundwater model uncertainty and to more accurately simulate processes such as river-aquifer interaction. We developed and apply state-of-the-art approaches of sampling-based Bayesian inversion, allowing for a rigorous quantification of uncertainties with substantially reduced computational cost. In these approaches, multiple spatial model resolutions are used synergetically to make inferences for the high-fidelity model. While the benefit of using environmental tracer data to reduce model uncertainty has previously been quantified using simplified approaches, our approach allows for a more rigorous assessment while still being computationally efficient. The statistical inversion framework furthermore enables the optimal design of future observation points. Our cost-efficient uncertainty quantification approach is applicable to any PDE-based model, harbouring the potential for substantial computational savings for statistical inversion with complex models.

Rebecca Peters, Tübingen University (DE)

Towards a renewable electricity mix that prevents the increasing fragmentation of African rivers

In Africa, the mitigation of climate change for a growing population and developing economies requires a bold shift to renewable energy (RE) resources. To “ensure access to affordable, reliable, sustainable, and modern energy” (SDG 7) for almost half of the African human population that currently lacks access, national and global efforts promote the construction of hydro-, wind, and solar power plants. Declining costs for solar photovoltaics (90% since 2009) and wind turbines (57% since 2010) fueled their construction including hybrid forms such as floating photovoltaics on existing hydropower reservoirs. Still, 65% of the proposed RE capacity in Africa remains hydropower, despite confirmed ecological, socioeconomic, and political ramifications on different spatiotemporal scales. Across the whole continent, 672 proposed hydropower plants (HPPs) disturb river systems and threaten freshwater biodiversity. While literature suggests that a RE transition in Africa is potentially feasible, it lacks spatially explicit studies on how this transition could avoid additional hydropower construction and, therefore, further river fragmentation. Thus, the aims of this study were to (1) assess potential river fragmentation from proposed HPPs, (2) calculate if proposed HPPs could be replaced by solar and wind power when their potential is fully exploited, and to analyse to which degree (3) the use of existing reservoirs for floating photovoltaics and (4) the minimization of plant failure can increase the renewable electricity generation. This study provides quantitative, data-based, and spatially explicit scenarios on the implementation of a RE mix that could relieve the dam building pressure on African rivers.

Poster Presentations

Water connecting Biodiversity -

Philipp M. Rehsen
University of Duisburg-Essen, Aquatic Ecosystem Research (DE)
Applying image-based approaches for biomass and biodiversity assessment of macroinvertebrates

Biodiversity loss is proceeding at an alarming pace. To counteract it, we need quick and reliable tools to identify and monitor taxa of interest, particularly in the most vulnerable environments like freshwater ecosystems where extinction rates are extremely high. However, reliable species identification poses a major challenge for swift bioassessment and monitoring of biological quality elements such as macroinvertebrates, fish and diatoms as proposed in the Water Framework Directive. The current standard identification procedures rely mostly on morphological identification, which requires substantial time and taxonomic expertise. As an alternative, recent advances in machine learning enable reliable species identification by high-accuracy image classification. However, automated image-based approaches remain understudied for identifying species in biodiversity research. In our upcoming project, we plan to test image-based morphological identification and biomass estimation of stream macroinvertebrates, including multiple keystone species, using the semi-automated imaging device BIODISCOVER. We intend to use extensive material from a recent outdoor field experiment, where we tested the impact of multiple stressors on macroinvertebrate communities. The first results indicate that semi-automated imaging can help to train deep learning networks for accurate species identification, while also providing information on species' biomass. Cross-validated with high-throughput species identification via DNA metabarcoding, the proposed interdisciplinary approach provides a promising solution for rapid and reliable species identification while providing detailed information about community composition.

Kamil Hupalo
University of Duisburg-Essen, Aquatic Ecosystem Research (DE)
ADAPT - Upcoming project on the role of rapid evolutionary adaptation in altering the response to multiple stressors in a changing environment

Rapid climate change and anthropogenic activities introduced a multitude of environmental stressors that have profoundly impacted global freshwater biodiversity. These stressors often interact in unforeseen ways, making it challenging to accurately predict biodiversity responses. The sensitivity of organisms to stressors, resulting from evolutionary adaptations, plays a vital role in their combined stress response. Prior exposure to stressors can further complicate our understanding of the effects of introducing novel or reducing established stressors in an ecosystem.Thus, our upcoming project aims to assess the role of rapid evolutionary adaptation on the stress responses of freshwater organisms, particularly focusing on Gammarus pulex, an aquatic keystone species. We will investigate stress responses in G. pulex populations adapted to elevated pesticide levels, as they offer valuable insights into the sensitivity of organisms to specific stressors.To achieve our objectives, we will conduct a series of indoor experiments including combinations of stressors G. pulex populations are adapted to (pesticide) and additional environmental stressors related to the changing environment. We will evaluate a set of functional, behavioral, and physiological endpoints. Additionally, high-resolution morphometrics and genomics will be employed to explore eco-evolutionary signatures of adaptation.This research aims to provide novel insights into ecological responses to multiple environmental stressors, considering the importance of organisms' evolutionary adaptation. The findings of this project will be of value to policymakers, environmentalists, and researchers seeking

solutions to safeguard global freshwater biodiversity by aiding in development of effective conservation and management strategies in the face of rapidly changing conditions.

Water connecting Climates -

Amber van Hamel
WSL Institute for Snow and Avalanche Research SLF, Hydrology & Climate Impacts in Mountain Regions (CH)

Trends in extreme water temperatures in mountain regions

Human-induced warming, accompanied by more frequent extreme weather phenomena such as heat waves and prolonged drought, can result in extreme river water temperatures. Since water temperature is one of the main variables regulating physical, chemical and biological processes in streams, extreme water temperatures potentially result in severe impacts on the survival of aquatic ecosystems. Despite the importance of extreme water temperatures, current research has mainly focussed on changes in mean water temperature. As there is little research on water temperature extremes, this project aims to improve our understanding of the temporal changes and processes influencing the occurrence of water temperature extremes in mountain rivers in the Alps. To gain insights into the temporal variability of water temperature extremes, we compare 30-year data series of water temperature in 18 catchments in the Alps. We apply trend analyses to extract information about the long-term trends and seasonal variability of these extremes. Preliminary results show that extreme water temperatures, i.e. water temperatures exceeding a locally varying threshold, have increased faster over the summer period 1991-2021 than mean water temperatures. Although the most severe extreme events can be mainly found at low elevations, the number of extreme events has increased over time at all elevations, with the strongest increase for catchments at high elevations. These trends in extreme water temperatures show that aquatice ecosystems in mountain rivers are expected to be more affected by extreme water temperatures towards the future.

Gregor Joren Janzing
WSL Institute for Snow and Avalanche Research SLF, Hydrology & Climate Impacts in Mountain Regions (CH)

Streamflow simulations in the Alps profit from improved snow and glacier routines

Large-scale hydrological models that exceed national boundaries are needed to study spatial patterns in streamflow in Alpine regions. However, large-scale hydrological models do not always capture cryospheric processes well, which can affect simulations of discharge in Alpine regions. Here, we present an improved snow and glacier routine for the PCR-GLOBWB 2.0 global hydrological model and study its effects on simulations of discharge over the Alps. We set up the PCR-GLOBWB 2.0 model over the Alps at a resolution of 30 arcsec (~1km). The existing model uses a constant degree-day factor to simulate snowmelt and does not explicitly represent glaciers. First, we implemented different extensions of the snowmelt module by varying the degree-day factor with the season and with snow albedo. Second, we added a new glacier component to the model. We calibrated the model against datasets of snow cover, glacier mass balances and discharge over Switzerland. Our preliminary results show a limited improvement of discharge simulations through the new snowmelt routine. The glacier routine leads to clear increases in performance for glacierized catchments. Furthermore, the new snow and glacier modules prevent the unrealistic snow accumulation across multiple seasons in PCR-GLOBWB 2.0. Our future work will focus on the effect of cryospheric processes on historical floods and droughts by running the model over the larger Alpine domain.

Water connecting People -

Mirjam Scheller
Zürich University, Department of Geography (CH)
CrowdWater: Connecting citizens, science, and disconnected streams

Half of the global river network is known to dry up from time to time. However, these so-called temporary streams are not represented well in traditional gauging networks. One reason for this is that measurement devices have trouble detecting zero flows. In the last years new approaches have been developed such as low-cost sensors and the collection of data by citizen science. The latter is used in the CrowdWater project. Citizens can collect observations about the state of temporary streams with the help of a smartphone app since 2017. By a visual approach, the flow state of the stream is assessed to be one of the following six classes: dry streambed, wet/damp streambed, isolated pools, standing water, trickling water, and flowing. Citizen scientists have observed 2500 temporary streams an average of over twelve times globally (25.08.2023). In a survey in 2022, we interviewed more than 1200 citizens and found that they agreed in their observations of a stream being flowing or not. During conversations with participants, we experienced that the randomly selected participants showed a high interest in the protection of temporary streams and other environmental topics. They also shared concerns about the impacts of climate change and human actions.

Christian Fischer
Water Science Policy
arteries.blue

Climate change, water scarcity, pollution and land use change are among the threats to the world´s rivers and those who rely upon them. An inability to access water threatens the security, stability and environmental sustainability of all nations, especially in the Global South. By 2025, two-thirds of the global population may face water shortages. As the resource becomes increasingly scarce, the need for states to find ways to resolve conflict and find cooperation grows. From source to sea, arteries.blue tells data-driven river stories. The project uses a mix of interactive data, graphics, articles from academic researchers and photostories from journalists to communicate the challenges, opportunities, and beauty of some of Earth's most vital lifelines.

Water connecting Landscapes -

Mohsen Dehghani Darmian; Britta Schmalz
TU Darmstadt, Engineering Hydrology and Water Management (DE)
Prediction of longitudinal dispersion coefficient in natural rivers using genetic programming algorithm

The accurate simulation of water quality management tools depends on the precise estimation of the longitudinal dispersion coefficient (LDC). In previous research, LDC equations were presented in two ways: ignoring or considering river sinuosity. In this regard, two separate experimental datasets from 56 and 24 different rivers worldwide are investigated in this study to present novel equations for LDC prediction using genetic programming (GP). Significant improvements in this study´s LDC equations precision are obtained compared to the best values of the indicators in previous investigations

considering related statistical measures: R2 (Determination Coefficient), OI (Overall Index), NSE (Nash-Sutcliffe Efficiency), WI (Willmott's Index of Agreement), RMSE (Root Mean Square Error), and MAE (Mean Absolute Error). Furthermore, this research introduces and applies the mean normalized statistical index (MNSI) as a new estimate of the efficiency of mathematical equations. Finally, with this research presented and previous LDCs, a sensitivity analysis is carried out by applying the analytical solution of pollution propagation to a river´s assimilation capacity determination.

Yvonne Schadewell
University of Duisburg-Essen, Aquatic Ecosystem Research (DE)
Environmental DNA as a tracer for Subsurface Stormflow formation

Extreme rainfall events are likely to increase in intensity and frequency due to climatic changes and the forecast of flooding events will become more important in the following decades. The flow properties of rainwater in the subsurface play a critical role in the flood formation process, but the underlying mechanism of this subsurface stormflow (SSF) formation has not been fully understood so far because it is only invasively measurable with high financial and personal efforts with current methods. In our project, we explore the viability of environmental DNA (eDNA) as a tracer for subsurface flow paths and SSF formation. We characterised 3 trenched hillslopes in each of our 4 catchments in Germany and Austria with Tree of Life (ToL) metabarcoding. In parallel, organic carbon and isotope measurements were performed and will be used in combination with diversity patterns to trace subsurface flow pathways and related subsurface hillslope–stream connectivity. To trace back the source of SSF forced water masses we are going to use artificial DNA tracer, injected in various positions in the hill slope and measure the signals at the trench outflows as well as in the streams. The aim is to understand how eDNA diversity patterns can inform, as a non-invasive tracer, about subsurface flow pathways.

Alessandra Musso
Friedrich-Alexander University Erlangen, Applied Geology (DE)
Investigations of artificial streams with iron addition: effects on the carbon and oxygen cycle

Formations of iron oxides (FeOx) from iron-rich groundwater have become a growing concern in headwater streams. Starting dissolved oxygen (DO) contents in water are low due to its low solubility, and the formation of FeOx further lowers this important parameter in stream waters. Moreover, FeOx also clog up the pore space in stream bed sediments and can thus lead to cause dangerously low DO levels for benthic organisms. However, effects on the aqueous carbon cycle of both free and sedimentary water have hardly been investigated to date. We present first insights from a flume experiment that investigated effects of an added iron solution (0.1mmol L-1 Fe(II)Cl2) to artificial streams with fine (5% sand content) and coarse sediment (35% sand content). We measured concentrations of dissolved organic and inorganic carbon (DOC and DIC), dissolved oxygen (DO) as well as their isotope ratios (expressed as d-notations in ‰) in both the surface and sediment waters. Average DOC contents rose by 7% in both surface and sediment with iron additions, while DIC contents rose by 33% and 30% in the surface and sediment waters, respectively. Most pronounced changes in the d13CDIC values were observed in sediment waters with average decreases from -10.0 ‰ to -11.5 ‰ after iron addition. Values of d13CDOC increased from -28.1 ‰ to -27.5 ‰ in surface waters and from 28.2 ‰ to 27.9 ‰ in sediment waters. Further differences between fine