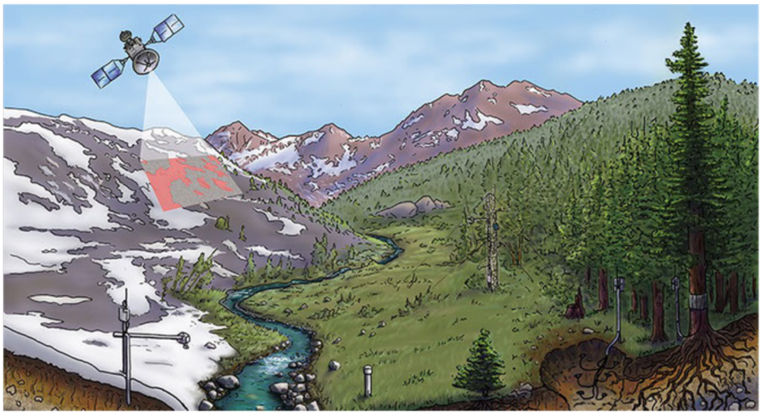
Zhydro 2023



An illustration of a critical zone observatory

www.zhydro.ch

ZHydro is a celebration of current hydrological research in Zürich. It is an annual day-long meeting in November of hydrologists working at the various departments and institutes in the Zürich area – mostly groups at ETH Zürich, University of Zürich, EAWAG and WSL. It is aimed mainly at PhD students and Postdocs, and in particular at new incoming scientists, who present their current research and network with peers. ZHydro is organized on a rotational basis by one of the participating chairs. In case of questions, please contact one of the organizers.

WHEN: 1 November 2023 (Wednesday) from 8:30-17:00

WHERE: ETH Zentrum, MM C 78.1 (Alumni Pavillon) next to top station of Polybahn

FORM: 16 talks (10 & 20 mins), 14 posters

PLEASE REGISTER HERE:
https://nuudel.ch/vfHyXjFiO5jbhopV

ZHydro Contacts

Organizers of 2023:
Swiss Federal Research Institute WSL
Mountain Hydrology and Mass Movements
Manfred Stähli manfred.staehli@wsl.ch
Annie Chang annie.chang@wsl.ch

Main Contact:
Peter Lehmann peter.lehmann@env.ethz.ch
Physics of Soil and Terrestrial Ecosystems, ETH Zurich

www.zhydro.ch

ZHydro 2023 SCHEDULE
1 November 2023, Alumni Pavillon, ETH Zürich

(orange)	10+5 mins
(blue)	20+5 mins

	Introduction	
08:30	Welcome address	Annie Chang
	Session 1	
08:35	Global potential groundwater recharge in response to climate variability and teleconnection	Christian Moeck (EAWAG)
08:50	Why are there so few treaties over internationally shared aquifers?	Marc Muller (EAWAG)
09:05	Inundation dynamics in floodplain forests in southeastern Brazil	Aline Meyer Oliveira (UZH)
09:30	Data availability and model complexity: modeling pluvial floods in data-scarce areas	Fabrizia Fappiano (EAWAG)
09:45	**POSTER HEADLINES**	
09:50-10:30	**Coffee break (Posters)**	
	Session 2	
10:30	Enhancing sub-seasonal drought predictions in the European Alpine space using EFAS forecasts	Annie Chang (WSL)
10:55	Extreme water temperatures in mountain rivers	Amber van Hamel (SLF)
11:10	Effect of soil water dynamics on tree water use: The example of oak in the Valais	Julian Schoch (ETH)
11:25	Statistical emulation of soil moisture from climate models using MESMER-X	Yann Quilcaille (ETH)
11:50	Groundwater's fingerprint in stream network branching angles	Elham Freund (UZH)
12:05	Can I have your signature? Model evaluation using groundwater signatures	Raoul Collenteur (EAWAG)
12:20-13:30	**Lunch break (Poster viewing possible), *independent***	
	Session 3	
13:30	Comparison of high-resolution climate reanalyses datasets for hydro-climatic impact studies	Raul Wood (SLF)
13:45	A unified database for water-related modelling in Switzerland	Marvin Höeg (EAWAG)
14:00	High resolution, open-source sensors and their applications in Alpine rivers	Jessica Droujko (ETH)
14:25	Hysteretic soil moisture dynamics disentangled by Artificial Intelligence	Nedal Aqel (ETH)
14:40	Isotopic evidence for seasonal water sources in tree xylem and forest soils	Marius Floriancic (ETH)
14:55	Is soil the soul of hydrology?	Fabrizio Fenicia (EAWAG)
15:10	OUTLOOK 2024 and closing of the general presentations	
15:15-15:25	**Short break**	
	Session 4: Farewell honors Christoph Schär & James Kirchner	
15:25	Introduction	Manfred Stähli
15:30	Some personal reflections about the development of hydrology in the context of climate change	Christoph Schär
15:50	Instructive surprises in the hydrological functioning of landscapes	James Kirchner
16:10	Closing	Manfred Stähli
16:15	**Apero**	

ZHydro 2023 POSTERS

1	Myriam Benkirane (EAWAG)	Analyzing stream network dynamics in a Swiss Alpine catchment
2	Harsh Beria (ETH)	Explaining drought paradox in the European Alps using remote sensing, stable water isotopes and plant growth models
3	Bianca Biess (ETH)	Assessing global and regional trends in spatially co-occurring hot or wet events under climate change
4	Andrea Carminati (ETH)	Evapotranspiration is controlled by the soil hydraulic properties: a successful case of upscaling
5	Yasser Haddad (ETH)	Dry me a river: investigating climate impacts on hydropower and energy systems planning in Switzerland
6	Joren Janzing (SLF)	Streamflow simulations in the Alps profit from improved snow and glacier routines
7	Eleni Kritidou (UZH)	Uncertainty evaluation of simulated extreme floods in Switzerland: An experiment based on weather generator changes
8	Marie-Sophie Maier (EAWAG)	Hydrology – the secret driver of CO2 and CH4 emissions from the Danube Delta freshwater system, Romania
9	Thiago Nascimento (EAWAG)	An Integrated Database of Hydro-meteorological and Landscape Descriptors for a large sample of European River Catchments
10	Nicolas Harrington Ruiz (ETH)	Distributional Predictions of Rain-Runoff using LSTMs trained with the Energy Score
11	Mirjam Scheller (UZH)	CrowdWater: Connecting citizens, science, and disconnected streams
12	Maurus Villiger (ETH)	Comparison of Water Extraction Techniques and Isotope Analyzing Methods to Study Tree Water Uptake Patterns at the Long-Term Drought Monitoring Site, Pfynwald – Study Outlook
13	Mosisa Wakjira (ETH)	Climate change impacts on cropland suitability in the tropics: An example from Ethiopia
14	Bowen Yu (ETH, Wuhan University)	Study on the change of habitat suitability of four major Chinese carps under human impact

ORAL PRESENTATIONS ABSTRACTS
IN ALPHABETICAL ORDER

Hysteretic soil moisture dynamics disentangled by Artificial Intelligence

Nedal Aqel (nedal.aqel@usys.ethz.ch)
Physics of Soils and Terrestrial Ecosystems, D-USYS, ETH Zürich, Zürich

The relationship between water content and water potential controls the soil water distribution and rainfall partitioning. Despite evidence of a highly hysteretic relationship under field conditions, it is typically modelled as non-ambiguous function, resulting in systematic errors in the prediction of seasonal soil water dynamics. This research involves the application of artificial intelligence (a method denoted as autoencoder), to categorize the intricate patterns of soil moisture fluctuations, shedding light on the underlying dynamics of the soil water retention curves. In a next step, Artificial neural networks are employed, using this categorization to forecast dynamic soil water potential, offering valuable insights into soil behavior under varying environmental conditions. This dual approach, combining classification and prediction through artificial intelligence, presents a promising avenue for advancing our understanding of soil moisture dynamics. It also holds the potential to inform agricultural and environmental management practices, leading to more sustainable land use and resource conservation.

Enhancing sub-seasonal drought predictions in the European Alpine space using EFAS forecasts

Annie Chang (annie.chang@wsl.ch)
Mountain Hydrology and Mass Movements, WSL, Birmensdorf

The European Flood Awareness System (EFAS) has been instrumental in providing flood risk assessments across Europe with up to 15 days of lead time since 2012. Expanding its capabilities, EFAS started generating long-range hydrological outlooks for sub-seasonal to seasonal horizons. This research investigates the integration of the 46-day sub-seasonal EFAS forecasts into a hybrid forecasting system for more than 120 Alpine catchments. To enhance low-flow predictions and understand their spatio-temporal evolution, we employ the Temporal Fusion Transformer (TFT), a machine learning algorithm. Our aim is to shed light on EFAS's role in sub-seasonal hydrological drought predictions, especially in challenging regions such as the European Alps These findings will contribute to evaluating EFAS's potential for early warnings and support decision-making in regional and local water resource management efforts.

Can I have your signature? Model evaluation using groundwater signatures

Raoul Collenteur (raoul.collenteur@eawag.ch)
Department Water Resources & Drinking Water (W+T), Eawag, Dübendorf

Solving groundwater problems often involves the evaluation and selection of models from competing alternatives. The traditional approach is to use goodness-of-fit metrics and information criteria for this purpose. A critique of this is that these methods are not adapted to the purpose of modeling and the characteristics of hydrological time series. Groundwater signatures are aggregate statistics that can be used to quantify the behavior of groundwater hydrographs. In this presentation we will share and discuss our idea to evaluate models using groundwater signatures, and some early results from initial tries. The main question here is if and how we can use signatures to improve groundwater model evaluation and selection.

High resolution, open-source sensors and their applications in Alpine rivers

Jessica Droujko (droujko@ifu.baug.ethz.ch)
Institute of Environmental Engineering, D-BAUG, ETH Zürich, Zürich

The transportation of fine sediment within river systems plays a crucial role in influencing catchment nutrient fluxes, global biogeochemical cycles, and pollution levels in riverine ecosystems. However, the monitoring of suspended sediment in rivers using current sensors poses significant challenges and is expensive.To meet these challenges, we have developed an open-source and low-cost multiparameter sonde. We conducted two proof-of-concept studies using the low-cost sensor. The first was measuring the glacial ablation of the Rhonegletscher and the second was applying a network of these sensors on the Spöl river in Switzerland during an experimental flood (in 2021 and 2023). The collected data reveal sudden sediment concentration pulsing as the discharge increases steadily throughout the day. The highest concentration of sediment is much larger than would be expected and appeared with the onset of the flood and again with the peak discharge. This study demonstrates the high potential and applications of such sensors.

Groundwater's fingerprint in stream network branching angles

Elham Freund (elham.freund@geo.uzh.ch)
Department of Geography, University of Zurich, Zurich

Branching river networks are prominent features of the Earth's surface, but the mechanisms that create branching river networks patterns remain elusive. Recent studies have suggested that climate, tectonics, and lithology may control both longitudinal profiles of channel incision and the planform geometry of stream networks. Here we show, by analyzing almost 1 million river junctions and over 4.2 million groundwater wells across the contiguous United States, that stream network branching angles vary systematically with the degree to which streams lose water to, or gain water from, nearby groundwater aquifers. Streams whose surfaces lie above nearby groundwater levels, and thus are likely to be losing flow to underlying aquifers, tend to have narrower branching angles than streams that lie below nearby groundwater levels, and thus are likely to gain flow from groundwater. This systematic relationship persists across several stream orders, and across a wide range in channel gradients.

Isotopic evidence for seasonal water sources in tree xylem and forest soils

Marius Floriancic (floriancic@ifu.baug.ethz.ch)
Institute of Environmental Engineering, D-BAUG, ETH Zürich, Zürich
Institute of Terrestrial Ecosystems, U-SYS, ETH Zürich, Zürich

Forest trees greatly influence both the routing of water downward into the subsurface and the re-routing of water upward through water uptake and transpiration. To reveal how the subsurface soil water pools used by trees change across seasons, we analyzed two years of stable isotope ratios of precipitation, soil water from different depths (using both bulk sampling and suction-cup lysimeters), and xylem in a mixed beech and spruce forest. Precipitation as well as mobile and bulk soil waters all showed a distinct seasonal signature; the seasonal amplitude decreased with depth, and mobile soil waters varied less than bulk soil waters. Beech and spruce trees had different isotope ratios suggesting use of different water sources, and these differences were larger under dry antecedent conditions than wet antecedent conditions. Despite these differences, both species predominantly transpired waters with a winter-precipitation isotopic signature throughout the summer. Over most of the sampling dates, the fraction of recent precipitation (i.e., from the preceding 30 days) in xylem water was low, despite both species typically demonstrating use of both shallow and deeper soil waters. These results provide evidence that the soil water storages used by these trees are largely filled in winter and bypassed by recent precipitation, implying long residence times.

Data availability and model complexity: modelling pluvial floods in data scarce contexts

Fabrizia Fappiano (fabrizia.fappiano@eawag.ch)
Department of Urban Water Management, Eawag, Dübendorf

Pluvial floods have, in recent years, become a significant threat to the economic, environmental, and social assets of many areas globally. Despite this, pluvial flooding risk quantification remains a challenge in both research and practice. Especially in data scarce peri-urban regions, methods to assess and manage pluvial floods are often not specific enough to inform decision makers.

As part of my PhD, I carried out an exploratory analysis to define the minimum model and data requirements to quantify pluvial flood hazard. I tested various model complexity-data resolution combinations for two rainfall events, and then compared the obtained results with a benchmark flood map. Findings show that simple models might accurately represent pluvial floods, given that the input data is of high resolution.

Is soil the soul of hydrology?

Fabrizio Fenicia (fabrizio.fenicia@eawag.ch)
Department of Systems Analysis, Integrated Assessment and Modelling, Eawag, Dübendorf

A fundamental premise in hydrology is that soil hydraulic properties hold the key to governing hydrological processes at the catchment scale. This presentation challenges this conventional assumption by asserting that it is, in fact, hydrological processes, intricately interwoven with the ecosystem, that primarily shape soil properties. This paradigm shift implies that hydrological models on a catchment scale can effectively simulate hydrological processes without necessitating an explicit focus on soil properties, while still adhering to their physical underpinnings.

A unified database for water-related modelling in Switzerland

Marvin Höge (marvin.hoege@eawag.ch)
Department of Systems Analysis, Integrated Assessment and Modelling, Eawag, Dübendorf

This presentation will provide an overview of ongoing initiatives aimed at consolidating hydrological datasets in Switzerland, encompassing the Camels-CH (Catchment Attributes and MEteorology for large-sample Studies - Switzerland) dataset and more. Additionally, it will outline the current undertakings within our research group to establish Europe-wide hydrological databases that both enhance and expand upon the existing resources.

Global potential groundwater recharge in response to climate variability and teleconnection

Christian Moeck (christian.moeck@eawag.ch)
Department Water Resources & Drinking Water (W+T), Eawag, Dübendorf

Periodic climate variability can significantly impact groundwater, and the ability to predict groundwater variability in space and time is critical for effective water resource management. This study presents a global assessment of the impact of climate variability and climate teleconnections on groundwater recharge and groundwater levels using an analytical solution derived from the Richards equation. The propagation of climate variability through the unsaturated zone by considering global-scale climate variability consistent with climate teleconnections such as the Pacific-North American Oscillation (PNA) and the El Niño/Southern Oscillation (ENSO) is evaluated, and it is shown when and where climate teleconnections are expected to affect groundwater levels. The results demonstrate the dampening effect of surface infiltration variability with depth in the vadose zone. Guidance for predicting long-term groundwater levels and highlighting the importance of climate teleconnections in groundwater management is provided.

Why are there so few treaties over internationally shared aquifers?

Marc Müller (marc.mueller@eawag.ch)
Department of Systems Analysis, Integrated Assessment and Modelling, Eawag, Dübendorf

More than 500 aquifers are shared internationally and yet less than 10 international agreements currently exist to manage them. This lack of regulation is peculiar given the common-pool nature of groundwater, where pumping cost externalities often set the conditions for a pumping race phenomenon that has long been known to accelerates the depletion of shared aquifers. I will present recent work combining game theory and groundwater modelling to investigate the emergence of some of the few international groundwater treaties that do exist and present preliminary results of a global assessment seeking to evaluate the need and opportunity for such treaties in transboundary aquifers worldwide.

Inundation dynamics in floodplain forests in southeastern Brazil

Aline Meyer Oliveira (aline.meyer@geo.uzh.ch)
Department of Geography, University of Zurich, Zurich

The vegetation distribution in floodplain forests is strongly related to the flood regime, but it remains unclear how much the vegetation depends on the flood pulse. This hinders our ability to determine how changes in the hydrological regime, due to climate- and land use- change, impacts floodplain vegetation. Therefore, as part of the WatForFun project, we monitored the water level regime and vegetation composition along a vegetation and geomorphic gradient for six floodplain forest sites in southeastern Brazil. We used the surface and groundwater level data to investigate the main flood mechanisms (i.e., “flood pulse” vs. “flow pulse” vs. rainfall) for each of these sites. We determined the water sources used by the vegetation by analyzing the isotopic composition of xylem water and all potential sources (e.g., river water, groundwater). In this presentation, we will describe the WatForFun project and present the initial results from this study.

Statistical emulation of soil moisture from climate models using MESMER-X

Yann Quilcaille (yann.quilcaille@env.ethz.ch)
Institute for Atmospheric and Climate Science, D-USYS, ETH Zürich, Zürich

Climate change will affect the frequencies and intensities of droughts, which could endanger ecosystems, food security and hinder nature-based solutions to mitigate climate change. Assessing such interplays requires a tool faster than Earth System Models (ESMs) to accelerate the exploration of scenarios and allow the integration of climate information into other models. Here, we present the statistical emulator MESMER-X, providing spatially resolved fields of various climate variables, including the annual mean total soil moisture and the annual minimum of the monthly mean total soil moisture. MESMER-X reproduces the statistical properties of each ESM using conditional distributions, while auto-regressive processes with spatially correlated innovations mimic the temporal and spatial properties. Emulating a scenario over 1000 realizations representative of the natural variability takes less than 10 minutes, shown here with good performances. This framework allows various distributions, non-linear evolutions, and lagged effects, thus may be extended to other variables in the future.

Effect of soil water dynamics on tree water use: The example of oak in the Valais

Julian Schoch (julian.schoch@usys.ethz.ch)
Physics of Soils and Terrestrial Ecosystems, D-USYS, ETH Zürich, Zürich

Understanding mechanisms regulating transpiration rates is essential for quantifying water fluxes in terrestrial ecosystems and their influence on the global hydrological system. Forest systems are a major contributor to terrestrial water fluxes and predicting transpiration response to soil drying is becoming increasingly relevant in the context of climate change. To reveal the mechanisms controlling transpiration during severe droughts, two sites in the Valais with iden-tical tree species (Quercus pubescens) but different soil texture and gravel content were instru-mented. The results indicate that root distribution and leaf area adapted to the different hydraulic properties of the soil. To better explore this adaptation, we used electrical resistivity tomogra-phy (ERT). The technique provides spatial information on the heterogeneity of water distribu-tion and soil drying, which explains the different onset of water stress at the two sites and the impacts on tree water use regulations.

Extreme water temperatures in mountain rivers

Amber van Hamel (amber.vanhamel@slf.ch)
Hydrology & Climate Impacts in Mountain Regions, SLF, Davos

Mountain rivers are particularly sensitive to climate change, while they provide a unique set of habitat conditions within river networks. In the future, mountain river ecosystems are expected to be stressed by more frequent extreme weather events, such as heat waves and prolonged droughts, which can cause extreme water temperatures. Despite the potential impacts of extreme water temperatures, our understanding of the occurrence and changes of extreme water temperatures in mountain rivers remains limited. Therefore, we analyse the temporal changes and spatial variability in the occurrence of extreme water temperatures in mountain rivers, as well as the main driving processes behind these extremes. Preliminary results show that the observed changes in extremes behave differently from changes in the mean, which underlines the importance of studying water temperature extremes.

Comparison of high-resolution climate reanalyses datasets for hydro-climatic impact studies

Raul Wood (raul.wood@slf.ch)
Hydrology & Climate Impacts in Mountain Regions, SLF, Davos, Switzerland

When studying or modelling hydro-climatic impacts, high quality and multivariate meteorological information is needed. However, study regions often extend across borders, multiple regions are compared with partly scarce observational coverage, or multivariate meteorological information is required which is often not measured at the specific site. Hence, spatio-temporally consistent meteorological datasets are needed. New generations of high-resolution reanalysis products with continental or global coverage are available that offer a wide range of land surface variables. However, the fit-for-purpose of these datasets for hydro-climatic impact studies needs to be tested. Here, we present a comparison of multiple high-resolution reanalysis datasets (ERA5(-land), CERRA(-land), and CHELSA) and the MeteoSwiss gridded observational product. General climatological features, as well as spatial and temporal correlation is analyzed and compared. Lastly, the datasets are compared for spatial and temporal consistency of multiple observed hydro-climatological extreme events (Drought 2018, Flood 2005, and Heatwave 2003/2018) over Switzerland.

POSTER ABSTRACTS
IN ALPHABETICAL ORDER

Analyzing stream network dynamics in a Swiss Alpine catchment

Myriam Benkirane (myriam.benkirane@eawag.ch)
Department of Water Resources and Drinking Water (W+T), Eawag, Dübendorf
Department of Civil, Building and Environmental Engineering - ICEA, Padua, Italy

This research delves into the impact of stream network dynamics on watershed behavior and ecosystem services, employing diverse methodologies within the context of the Rietholzbach basin, a modest Swiss watershed spanning 3.31 Km^2. Mapping stream networks across varying moisture conditions unveiled substantial temporal and spatial variations in flow paths and distribution patterns. Extensive field surveys conducted from 2020 to 2023, with varying temporal resolutions, facilitated the analysis of stream network wetness.

Statistical models were effectively employed to investigate network dynamics across different time scales. Overcoming the challenge of monitoring temporary streams was addressed through the deployment of EXO sensors and camera traps, offering valuable insights into hydrological diversity and active channel dynamics in these areas. The results reveal that approximately 87% of the river network is permanent, while the remaining 13% is temporary, strongly influenced by preceding precipitation during wet seasons.

This study presents significant opportunities to advance understanding of the spatiotemporal dynamics of active channels in temporary streams, with potential implications for hydrological modeling and improved watershed management in Alpine regions.

Explaining drought paradox in the European Alps using remote sensing, stable water isotopes and plant growth models

Harsh Beria (harsh.beria@usys.ethz.ch)
Institute of Terrestrial Ecosystems, D-USYS, ETH Zürich, Zürich

The concept of “drought paradox” was popularized by the 2003 European drought, which was one of the longest and hottest rainless periods in recorded history. In the 2003 drought, using a distributed hydrological model, it was shown that precipitation deficits reduced streamflow without significantly impacting vegetation in the high Alps. This however has not been shown using any observational datasets such as remote sensing estimates of plant growth or flux tower measurements.

In this presentation, we quantify changes in Alpine vegetation during major droughts of the 21st century (2003, 2018 and 2022) using remotely sensed Solar-Induced Fluorescence (SIF) measurements and Net Primary Productivity estimates from a sophisticated tree growth model (3-PG forest ecosystem model). We show a strong elevational gradient in photosynthetic activity in Alpine vegetation during droughts, where high elevation vegetation exhibits increased transpiration, compared to much lower transpiration observed in lower-elevation vegetation. We explain this by quantifying the seasonal origins of waters being used by Alpine trees, using stable water isotope measurements collected across Switzerland. Using these results, we propose a theoretical framework that explains the “drought paradox” phenomenon in the Alps.

Assessing global and regional trends in spatially co-occurring hot or wet events under climate change

Bianca Biess (bianca.biess@env.ethz.ch)
Institute for Atmospheric and Climate Science, D-USYS, ETH Zürich, Zürich

Recent years were characterized by spatially co-occurring hot and wet extremes around the globe, raising questions about the contribution of human-induced global warming to the changing likelihoods of such extreme years. We assess observed trends in land area affected by extreme events in the context of Earth System Model (ESM) simulations for present-day and early-industrial climate conditions. To account for observational data uncertainty, we compare reanalysis and station-based products. Globally, only ESM simulations considering human-induced changes in the composition of the atmosphere can capture trends in co- occurring hot or wet events observed across all data sources. At the regional scale, spatially co-occurring hot extremes exhibit consistent trends among observational products, largely attributable to human climate influence. Trends in spatially co-occurring precipitation extremes show regional disparities, underscoring the importance of a multi-dataset approach to mitigate observational product dependencies. Despite uncertainties, robust detection and attribution results emerge for many regions.

Evapotranspiration is controlled by the soil hydraulic properties: a successful case of upscaling

Andrea Carminati (andrea.carminati@usys.ethz.ch)
Physics of Soils and Terrestrial Ecosystems, D-USYS, ETH Zürich, Zürich

Applying small-scale flow equations and hydraulic properties to simulate water fluxes at larger scale has challenges and large uncertainties. Whereas such upscaling has not been successful for water infiltration and discharge, upscaling works well for evapotranspiration. Evapotranspiration switches from being energy to water limitations at critical soil water thresholds when water flow through the soil matrix limits the atmospheric water demand. These thresholds are controlled by the soil hydraulic conductivity and are soil texture dependent. A small scale model of transpiration predicts well observed soil thresholds at the ecosystem scale, demonstrating the dominant role of matrix flow in soil drying.

Dry me a river: investigating climate impacts on hydropower and energy systems planning in Switzerland

Yasser Haddad (yasser.haddad@env.ethz.ch)
Institute for Atmospheric and Climate Science, D-USYS, ETH Zürich, Zürich

Clean and renewable energy systems are at the heart of climate change mitigation strategies and their deployment is increasing rapidly throughout the world. Nevertheless, it is important to acknowledge that climate change itself threatens the future supply of clean energy. In this project, we aim to understand how climate impacts on hydropower production affect energy systems planning in Switzerland. To accomplish this, we convert climate-impacted hydropower production timeseries into a suitable input for Nexus-e, an interconnected energy systems modeling framework. This enables us to model the investments in new renewable energy infrastructures. Our early findings underscore the strong impact of changes in hydropower generation on investments in renewable energy in Switzerland. Notably, an increase in wind turbines is needed to meet energy demand.

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

Gregor Joren Janzing (joren.janzing@slf.ch)
Hydrology & Climate Impacts in Mountain Regions, SLF, Davos

Large-scale hydrological models do not always capture cryospheric processes well, which can affect discharge simulations 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 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. We tested different extensions of the snowmelt module by varying the degree-day factor with the season and with snow albedo. Furthermore, we implemented a new glacier component.

Our preliminary results show some improvement of discharge simulations through the new snowmelt and glacier routines, with the strongest performance increases in glacierized catchments. Our future work will study the role of cryospheric processes during historical floods and droughts over the larger Alpine domain.

Uncertainty evaluation of simulated extreme floods in Switzerland: An experiment based on weather generator changes

Eleni Kritidou (eleni.kritidou@geo.uzh.ch)
Department of Geography, University of Zurich, Zurich

Reliable flood estimates are a prerequisite for flood management and prevention. Traditionally, floods and their impacts have been studied through statistical techniques based on historical observations. However, important limitations stem from the relatively short available streamflow records. Here, we use an approach based on a hydrometeorological modeling chain with long continuous simulations for several catchments in Switzerland. The modeling chain consists of a multi-site stochastic weather generator, a bucket-type hydrological model HBV, and a hydraulic model (RS Minerve). The aim is to explore the robustness of the simulated extreme floods by applying two experiments based on changes to the precipitation time series of the weather generator. The results shed light on the sensitivity of certain catchments to precipitation changes and the uncertainties of the flood estimates.

Hydrology – the secret driver of CO2 and CH4 emissions from the Danube Delta freshwater system, Romania

Marie-Sophie Maier (marie-sophie.maier@eawag.ch)
Department Water Resources & Drinking Water (W+T), Eawag, Dübendorf

The greenhouse gases carbon dioxide (CO2) and methane (CH4) are products of organic matter degradation and as such released from inland waters to the atmosphere. Globally, this process is estimated to be in the same order of magnitude as the terrestrial carbon sink. However, this estimate is based on data lacking temporal/spatial resolution and underrepresenting river deltas. We therefore studied the greenhouse gas dynamics in the Danube Delta (Romania), Europe's second largest and most pristine river delta. Consisting of the main branches of the Danube River, small connecting channels, flow-through lakes and vast wetland areas, the delta's hydrology is difficult to disentangle or model. Investigating dissolved gas concentrations and water quality parameters with a high temporal and spatial resolution, we were able to show that the hydrologic conditions in the main branches are the key driver of greenhouse gas hotspots and hot moments in the delta.

An Integrated Database of Hydro-meteorological and Landscape Descriptors for a large sample of European River Catchments

Thiago Nascimento (thiago.nascimento@eawag.ch)
Department of Systems Analysis, Integrated Assessment and Modelling, Eawag, Dübendorf

This study presents an integrated database containing comprehensive hydro-meteorological and landscape descriptors for a substantial number of European river catchments. The database offers a valuable resource for research, analysis, and decision-making in the field of hydrology, providing essential data to enhance our understanding of river catchment dynamics across Europe.

Distributional Predictions of Rain-Runoff using LSTMs trained with the Energy Score

Nicolas Harrington Ruiz (nharrington@student.ethz.ch)
Institute for Atmospheric and Climate Science, D-USYS, ETH Zürich, Zürich

Modelling in Hydrology has been transformed through the introduction of machine learning methods, particularly the use of Long Short-Term Memory (LSTM) Neural Networks to predict runoff. Our work takes the LSTM and optimizes the Energy Score in order to create a model that can give distributional predictions to quantify uncertainty for runoff predictions. The Energy Score uses random noise that is concatenated to the observed temperature and precipitation data to fit the appropriate distribution to the runoff data. This approach avoids the need to train over ensemble members to capture distributional information. Single and multiple catchment examples of prediction and assessment are provided by analyzing seepage at the Rietholzbach Research Station lysimeter and Swiss-wide runoff data from 87 catchments not exhibiting human control from the Hydrological Atlas of Switzerland.

CrowdWater: Connecting citizens, science, and disconnected streams

Mirjam Scheller (mirjam.scheller@geo.uzh.ch)
Department of Geography, University of Zurich, Zurich

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 (10.10.2023). 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.

Comparison of Water Extraction Techniques and Isotope Analyzing Methods to Study Tree Water Uptake Patterns at the Long-Term Drought Monitoring Site, Pfynwald – Study Outlook

Maurus Villiger (maurusnathanael.villiger@uzh.ch)
Department of Geography, University of Zurich, Zurich

Do the methods used to extract and analyze tree water for isotopes play a role in drawing conclusions on the tree water uptake pattern? The information presented will give an outlook and first insights on how comparable the isotopic compositions of water extracted trough cryogenic vacuum distillation, pressure chamber or in-situ vapor equilibrium probes are.

Climate change impacts on cropland suitability in the tropics: An example from Ethiopia

Mosisa Wakjira (wakjira@ifu.baug.ethz.ch
Institute of Environmental Engineering, D-BAUG, ETH Zürich, Zürich

Crops, like humans and other species, adapt to dynamic environmental conditions by adjusting their yields, and/or by migrating to favorable agroecologies. While climate, soil, topography, and socioeconomy influence crop habitats, climate change causes long-term changes in cropland suitability (CLS). In this work, we examined how changing climatic conditions alter the future CLS in tropical agroecologies, such as those in Ethiopia. We developed a mathematical modeling framework that combines crop yield data with climatic (rainfall and temperature) and soil (texture, pH, and organic carbon) to estimate the CLS index under the present and future climates. We show that the suitable croplands of the major crops like maize and wheat are expected to undergo significant altitudinal shifts and contractions in area in the future. Whether these changes are dominantly driven by rainfall or temperature depends on specific climatic characteristics and altitudinal locations. See you at the ZHydro poster for the details.

Study on the change of habitat suitability of four major Chinese carps under human impact

Bowen Yu (yubowen5@126.com)
ETH, Zurich
Wuhan University, China

Human impacts like dam impoundment change flow regime, as well as morphology conditions in the downstream reaches. The habitat simulation model is employed to detect human influence on fish spawning. The results find out that, not only the discharge, but also the change of daily discharge is important for fish spawning activities. River morphology also plays an important role for fish habitat. From the model, optimal discharge range can be decided for dam operation