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Panta Rhei Symposium

Abstracts

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Flashlight Talk

Abstract Title Developments in transdisciplinary water research during the Panta Rhei scientific decade

Authors Tobias Krueger, Britta Hoellermann, Leon Hermans, Thomas Thaler and the 'transdisciplinarity' working group

Affiliations

Abstract

At the beginning of the Panta Rhei scientific decade, the 'transdisciplinarity' working group outlined a vision for critical interdisciplinary and participatory water research (Krueger et al., 2016). With the Panta Rhei decade coming to end, it is now time to take stock of how the field of transdisciplinary water research has developed over the past 10 years, within and without Panta Rhei. We will synthesise lessons from the wider literature and our special issue in HESS (Thaler et al., 2020) as well as reflecting on the community discussions taking place in our annual session at EGU and other conference settings. We will conclude with lessons for future water research that aims to be both critical and participatory.

References

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Flashlight Talk

Abstract Title Addressing dynamics in human-water systems with a tightly coupled modeling approach: Experiences from the Western Ghats, India

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Abstract

Land use and climate change affect water resources worldwide. In regions with a seasonally limited water availability, these impacts exacerbate seasonal water scarcity. This is the case in the Mula and Mutha Rivers catchment upstream of Pune in the Indian Western Ghats. Strong urbanization during the recent decades exerts pressure on land including agricultural lands. Moreover, in dry years irrigation water resources for agriculture are limited. To analyze how this interplay of pressures affects agriculture we use an integrated modeling approach for land and water resources. To this end, the hydrologic model SWAT (Soil and Water Assessment Tool) is tightly coupled with the land use model CLUE-s (Conversion of Land Use and its Effects at small regional extent). Dynamics in human-water systems are modeled for a scenario of further urbanization and agricultural intensification as well as cropland abandonment based on high water stress. The scenario analysis revealed that climate variability and land use pressure had an effect on the timing of potential cropland abandonment and the consecutive use of temporarily abandoned cropland areas. From the 12.2 km² that have been abandoned during the 20-year scenario period, only 51% were permanently abandoned. Due to climate variability and pressure on land 26% have been recultivated, 18% have been converted to urban areas, and 5% have been regrown to shrubland. Abandonment was mostly found in the lower part of the catchment, as the increase of cropland upstream decreased the available water for irrigation in the downstream. The coupled modeling approach depicts dynamics in human-water systems and allows for deriving recommendations for climate resilient land use and land management. Moreover, the developed model can be enhanced with further modules that make use of the feedbacks between land use and hydrologic change.

Flashlight Talk

Abstract Title Drought-impacted communities in social-ecological systems: exploration of different system states in Northeast Brazil

Authors S. Kchouk (1), G. Ribeiro Neto (1), L. A. Melsen (1), L. Cavalcante (1), D. W. Walker (1) R. Gondim (2), and P. R. van Oel (1)

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Abstract

Our study applies 'Social-Ecological Systems (SES)' concepts to analyse why and how events happening across spatial, jurisdictional and temporal scales and levels influence droughts and their impacts in rural communities. To trace the evolution of droughts and their impacts on the livelihood system, we conducted a drought diagnosis in the rural community of Riacho da Cruz in the Banabuiú basin in the semi-arid Northeast of Brazil. We analysed how the livelihood of this community reacted differently to drought events and why the impacts of previous drought events either contributed to the adaptation of the livelihood system or its collapse. SES theory helped us posit that it is the collective capacity of stakeholders (nested across the levels of the different spatial, temporal and decisional scales of drought management) to manage their resilience to drought, that determines whether the considered system adapts, collapses or shifts into a new stable state, in response to drought. Monitoring these factors that influence drought resilience could enable the development of drought(-impact) indices that account for the spatial-temporal complexities of drought.

Flashlight Talk

Abstract Title Characteristics of future compound drought and heatwave in Europe

Authors Samuel J. Sutanto (1), Merve Gülveren (1), Rutger Dankers (2), Confidence Duku (2), Spyridon Paparrizos (1)

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Abstract

Human and economic losses caused by natural hazards have continued to rise around the world due to climate change. Drought as one of the weather-related natural disasters highly contributes to these losses. The impacts of drought are further intensified when heatwaves occur simultaneously at the same place (compound drought and heatwave, CDH). The occurrences of these hazards in isolation and as a compound will be higher in the future due to the increase in temperature in a warming world. The objective of the study is to predict the future characteristics of drought, heatwaves, and CDH events, such as the total number of events, average duration, and frequency, using different Shared Socioeconomic Pathway (SSP) scenarios in Europe (SSP1-2.6 and SSP5-8.5). Drought was analyzed using the Standardized Soil Moisture Index and the heatwave was identified using the daily threshold method with the 90th percentile. The temperature and soil moisture data were simulated using the MRI-ESM2-0 model from 1950 to 2014 for the historical period and from 2015 to 2100 for the future period. Results show that heatwave events will increase more than triple in southern and eastern Europe and less than double in northern and western Europe based on the SSP5-8.5. The average duration of heatwaves is 1-2 days longer, with the frequency of events two to three times higher than in the historical period. Similarly, the number of drought events is higher in many parts of Europe compared to the past except in northern Europe, with an average duration of a few days longer and a frequency of 0.2 higher than in the historical period. The increase of future drought and heatwave events in these regions also triggers a higher number of CDH events up to two times higher in the south, with a frequency of two times higher. For the average duration of CDH, the longest average CDH duration is seen in eastern and southern Europe (up to 1.6 months). The study suggests that stakeholders in the CDH hotspot regions should be well prepared for the occurrences of future drought and heatwaves as singly and as a compound that will be 2-3 times higher with a longer duration and higher frequency.

Flashlight Talk

Abstract Title Need for systemic European-wide drought management: A holistic overview of the 2022 European drought

Authors Riccardo Biella (1) (2), Anastasiya Shyrokaya (1) (2), Monica Ionita (3) (4) (5), Ilias Pechlivanidis (6), Jean-Philippe Vidal (7), Anne van Loon (8), Alessia Matanó (8), Samuel Sutanto (9), Lucy Barker (10), Sigrid J. Bakke (11), Faranak Tootoonchi (12), Claudia Teutschbein (2), Marthe Wens (13), Sandra Hauswirth (14), Elena Ridolfi (15), Fabio Russo (15), Patricia Trambauer (16), Viorica Nagavciuc (3) (4), Shreedhar Maskey (17), Serena Ceola (18), Roshanak Tootoonchi (19), Benedetta Moccia (15), Raed Hamed (8), Tirthankar Roy (20), Elin Stenfors (1) (2), Marit van Tiel (21) (22)

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Abstract

Over the span of just five years, Europe has been hit by two major drought events; the 2018-2019 drought, and 2022 drought which is still ongoing in parts of Europe. In particular, the latter has been reported by the media as being the worst drought hitting the continent in 500 years. Nonetheless, Europe is still largely unprepared to manage severe, spatially-large and recurring drought events, and European-wide drought management schemes are in their infancy. Here, we present insights into the drivers, impact, and management measures enacted during the 2022 drought and how drought-sensitive sectors are adapting to the increase in frequency and severity of droughts on the continent.

The study combines an analysis of hydro-meteorological indices, as a proxy for hazard severity, with a survey of decision makers on the impacts and management of droughts, with a focus on the 2022 event. The results are expected to reveal the diversity of responses and the challenges faced by various drought-affected sectors across several European countries. Overall, this study underscores the urgent need for regional coordination in drought management, particularly in transboundary basins, as well as a holistic intersectoral understanding of drought risk that goes beyond sectorial silo thinking

Flashlight Talk

Abstract Title A bottom-up approach to drought resilience

Authors Doris Wendt (1), Gemma Coxon (2), Francesca Pianosi (3)

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Abstract

Preparing for extreme drought conditions is complicated by the episodic nature of droughts, but also by our limited understanding of water systems particularly during droughts. In this, models can be useful tools to simulate a range of plausible to low likelihood drought conditions. Water managers and regulators can use these simulations to make plans and consider consequences for both normal and extreme drought events. Critical in this is the water system resilience to extreme drought conditions and which management decisions increase/decrease drought resilience. Determining the resilience of a certain water system to extreme drought events is highly complex, due to the variable availability of water resources, uncertainty of driving climate data and representation of water resources operations in a model.

In this piece of exploratory research, we apply a bottom-up approach to explore the impact of extreme droughts on domestic water use and environmental water demand, which may compete during droughts. The bottom-up approach consists of a range of tests that examine how robust water supply is under different climatological conditions, including uncertainty of driving input data and parameter uncertainty. We used a tested and calibrated socio-hydrological model for a selected number of catchments in the UK, based on availability of multiple water sources in a catchment, i.e. reservoirs, rivers, groundwater.

The analysis shows under which climate conditions current strategies are confidently meeting both anthropogenic and environmental water supply. Extreme conditions reveal increasing competing interests, threatening the system resilience. Crucial to this is the impact of management decisions that can increase resilience to extreme droughts. Mapping the associated (un)certainty of short-term and long-term management strategies shows that a bottom-up approach can support robust decision-making to increase the resilience of water supply systems in a changing environment.

Flashlight Talk

Abstract Title The need to integrate disaster risk reduction strategies

Authors Philip J. Ward (1)

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Abstract

The last decades have seen a shift in emphasis from managing natural hazards to managing risk. However, the majority of natural-hazard risk research still focuses on single hazards. Internationally, there are many calls for more attention for multi-hazards and multi-risks, from global agreements like the Sendai Framework for Disaster Risk Reduction, right down to local levels at which day-to-day risk management decisions are taken. Hence, the concept of multi-hazard and multi-risk assessment and management have taken centre stage in recent years. In this contribution, we present recent work towards examining disaster risk from a more integrated, multi-risk perspective.

Firstly, we present key findings from a collaborative effort between the International Association of Hydrological Sciences (IAHS) Panta Rhei Working Groups on 'Changes in Flood Risk' and 'Drought in the Anthropocene', examining interactions between flood and drought risk management. We show examples of: (a) how flood or drought DRR measures can have (unintended) positive or negative impacts on risk of the opposite hazard; and (b) how flood or drought DRR measures can be negatively impacted by the opposite hazard. We focus on dikes and levees, dams, stormwater control and upstream measures, subsurface storage, migration, agricultural practices, and vulnerability and preparedness. We identify key challenges for moving towards a more holistic risk management approach.

Secondly, we present new insights on new methods for understanding, assessing, and managing flood risk from across the MYRIAD-EU project (Multi-hazard and sYstemic framework for enhancing Risk-Informed mAnagement and Decision-making in the EU). The overall aim of MYRIAD-EU is that by its completion, policymakers, decision makers, and practitioners will be able to develop forward-looking DRM pathways that assess tradeoffs and synergies of various strategies across sectors, hazards, and spatial scales. Key tools that will be covered include the: Disaster Risk Gateway, a WIKI-style platform for sharing understanding on multi-hazard and multi-risk management; a first-ever global scale multi-hazard database, and a new approach for designing forward-looking dynamic adaptive pathways for multi-risk management, the so-called DAPP-MR approach.

The research presentation reflects collaborative efforts across the MYRIAD-EU consortium and Panta Rhei Working Groups.

Poster

Abstract Title Pooling complex socio-economic drought impact patterns from participatory modeling

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Abstract

The impacts of droughts extend beyond the bio-physical realm to social, economic, and environmental spheres, affecting a wide range of stakeholders and sectors. These impacts result from complex and interconnected systems that involve cascading and compounding effects. Also, existing and future drivers, vulnerabilities, and mitigation measures can lead to unintended consequences, making it imperative to take a holistic approach to evaluate their influence. Specifically, it is essential to consider the impacts on all sectors as opposed to analyses focusing on individual sectors, as this can lead to maladaptation and spillover effects.

Participatory modeling and causal loop diagrams have been gaining popularity for modeling holistic perspectives of the socioeconomic impacts of hydrological extremes. Here, research investigates the connectivity of diverse variables and highlights the relevance of such integrated approaches to drought management and mitigation. Nevertheless, to the best of our knowledge, no study has used mental models to pool knowledge from diverse stakeholders across different socio-economic sectors. However, research has shown that groups can collectively achieve an augmented cognitive capability that enables them to effectively understand complex systems. Therefore, incorporating mental models to gather knowledge from a broad range of stakeholders could improve our understanding of human-water systems.

We employ a participatory modeling approach based on causal loop diagrams to investigate the complex patterns of socio-economic drought impacts.

In particular, we investigate (i) what impacts, causes, and (potential) mitigation measures stakeholders consider relevant; (ii) how complex patterns arise from the interconnections of these elements when combining stakeholder knowledge; (iii) what effect selected mitigation measures or vulnerabilities impose on the modeled system? Our research founds on a case study in the German federal state of Thuringia. The region has recently experienced drought impacts across multiple sectors and is expected to experience increasing drought severity in the future. We conducted 21 interviews with stakeholders representing different knowledge pools and sectors. During the interviews, stakeholders developed individual causal loop diagrams, incorporating drought impacts, causes, mitigation measures, and vulnerabilities. Then, the models were aggregated and analyzed using different network-theory-based measures. Within a consequent group workshop, we validate the model with key stakeholders. Also, a set of relevant scenarios (related to impacts, causes, and mitigation measures) were interactively derived.

Preliminary results highlight how complex patterns connecting the socioeconomic drought impacts emerge by integrating all affected sectors. We find high connectivity among the different sectors and within each individual sector. Specifically, this leads to feedback patterns that require a holistic perspective to be understood. Similarly, the analyzed mitigation measures impose effects across multiple sectors. The resulting insights on the system's complexity and potential effects are of direct use for policy-makers for informing future strategies for coping with water scarcity.

Poster

Abstract Title Drought legacies from different perspectives

Authors Anne F. Van Loon (1), Marthe L.K. Wens (1), Riccardo Biella (2), Sarra Kchouk (3), Johanna K. L. Koehler (1,4), Anastasiya Shyrokaya (2), Camila Alvarez-Garreton (5), Elena Ridolfi (6), Micha Werner (7), Marlies H. Barendrecht (1), Juan P. Boisier (5,8), Louise Cavalcante (9), Franciska T. de Vries (10), Giuliano Di Baldassarre (2), Yiheng Du (11), Mauricio Galleguillos (5,12), René Garreaud (5,8), Khalid E.A. Hassaballah (13), Monica Ionita (14), Sina Khatami (2,15), Elizabeth A. Koebele (16), Charles H. Luce (17), Johanna Mård (2), Shreedhar Maskey (7), Alessia Matanó (1), Heidi D. Mendoza (1), Viorica Nagavciuc (14,18), Ilias G. Pechlivanidis (11),, Germano Ribeiro Neto (3), Tirthankar Roy (19), Ileen N. Streefkerk (1), Claudia Teutschbein (2), Faranak Tootoonchi (20), Roshanak Tootoonchi (21), Patricia Trambauer (22), Minchao Wu (23,24)

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Abstract

Droughts are often long lasting without a sharp start and end. Their impacts cascade across sectors and recovery can take very long — if at all. Our current perception of droughts and their impacts is often event oriented. In this presentation, we advocate for changing this perspective and viewing droughts as hydro-social continuums. We argue that understanding drought impacts requires looking

beyond the drought period itself, and taking into account the drought history (what happened before) and legacy (what happens afterwards). Both physical (e.g. groundwater, vegetation) and social systems (e.g. people, governance) have memory, which means that previous dry periods, but also the wet periods in between, influence how the drought risk manifests itself. Aspects like antecedent conditions, recovery, variability, dynamics, speed of development, resilience, etc. are important for understanding the drought continuum in time. In this presentation, we look at the drought continuum from different perspectives, including hydrology, social science, and ecology. For these different perspectives, we describe the temporal variability and memory / resilience aspects.

The memory in the hydrological system depends on many dynamic linkages between physical and anthropogenic characteristics. For example, storage of water in snow and groundwater determines the delays in the system. We present a conceptual framework focusing on how these characteristics and processes interact, including their superposition, dampening, and feedbacks.

Ecosystems experience a slow emergence of drought consequences that may presage a tipping point in ecosystem functioning in the years after the drought. Impacts vary across timescales, depending on vegetation types, soil type, historical climate. They are exacerbated during compound events. Recovery of vegetation can be slow, especially when there was wide-spread mortality.

At the social level, people and communities can retain the memory of previous droughts through cultural practices, collective experiences, and institutional arrangements. Measures undertaken to address a drought event can increase or decrease, in space and time, the likelihood of impact by the ongoing or future droughts. Measures can be prospective (e.g. education, installation of irrigation system), proactive (e.g.: drought resistant seeds), reactive (e.g. water management/conservation), coping (e.g.: selling livestock and assets), or recovery (prospective measures again). From the examples we studied, typologies of dynamic drought vulnerability emerge.

Governance is triggered by events, but changes are slow. Siloing of governance across scales and sectors undermines our ability to manage drought as a continuum – drought is not an exceptional event. We look at polycentric governance with formal and informal systems across scales. We discuss the key research questions: 1) How does memory of drought affect governance systems?; 2) How do risk perceptions of drought influence institutional responses?; 3) How are inequalities being mitigated in governing drought?

There are several avenues to apply these concepts in practice, ranging from simple to complex. For example, the time range used to identify or manage a drought can be expanded or drought antecedent conditions can be explicitly taken into account. More radically, the entire drought continuum can be considered, for example by using storylines or narratives that link events or processes in time. Also future governance systems should be more adaptive and resilient.

Poster

Abstract Title Assessing the impacts of human-water interactions on hydrological drought using a coupled surface-subsurface model

Authors Yanchen Zheng (1)(2), Gemma Coxon (1), Mostaquimur Rahman (2), Saskia Salwey (1), Doris Wendt (1)(2), Ross Woods (2)

Affiliations (1) School of Geographical Sciences, University of Bristol, (2) Department of Civil Engineering, University of Bristol

Abstract

Hydrological drought exerts serious impacts on public water supply, industrial and agricultural water use and ecological systems. However, the occurrence of hydrological drought is difficult to identify and quantify. Here we focus on hydrological drought, which is a deficit in streamflow and groundwater level. Hydrological droughts are complex phenomena that occur across multiple spatial and temporal scales driven by water and energy fluxes between the atmosphere, land surface, sub-surface, and water infrastructures. These interactions are especially challenging to capture in groundwater-dominated catchments where inter-catchment groundwater flow through subsurface flow pathways, groundwater abstractions and complex management schemes (such as low flow alleviation schemes) are often poorly quantified or not represented in hydrological models. Therefore, developing integrated modelling frameworks for simulating the interactions between surface water, groundwater and human influences is needed and necessary for accurate identification of hydrological drought in these regions.

DECIPHeR is a flexible hydrological modelling framework, which has been applied across Great Britain and exhibited good performance across a large sample of catchments with diverse catchment characteristics. Yet, poorer performance in groundwater-dominated catchments is notable, indicating the representation of groundwater dynamics and surface-subsurface water interactions needs improvements. Hence, in this work, we aim to couple DECIPHeR and a national scale groundwater model. To quantify human influences, we will apply the model with observational hydro-meteorological, groundwater data, a unique dataset of spatially explicit, time-varying abstractions and discharges. Baseline model runs (with no human-water interactions) will be compared to simulations with human-water interactions to establish where/when simulating human-water interactions is vital for accurate drought quantifications. The influence of groundwater abstractions and water policies on hydrological drought can be assessed by these coupled models to support water supply and demand management across Great Britain.

Poster

Abstract Title Assessing the impact of temporal resolution on estimates of rainfall erosivity in semi-arid region

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Abstract

Rainfall erosivity is a measure of the capacity of rainfall to cause soil erosion. Estimating this parameter requires high-resolution rainfall data, which are not available everywhere in the world. This index can also be estimated from Intensity-Duration-Frequency (IDF) curves, which represent the relationship between rainfall intensity, duration, and frequency. However, the accuracy of this estimation may vary depending on the characteristics of the precipitation and the region under study.

A comparison study of erosivity estimation using real data and IDF curves was conducted to evaluate the accuracy of these two estimation methods. The study was conducted on the K'sob watershed located in northeastern Algeria using fine rainfall data. The results showed that using IDF curves to estimate erosivity was often less accurate than using real data. Although IDF curves are often used to estimate erosivity, the use of real data is preferable for a more accurate estimation, especially in regions where precipitation characteristics vary considerably.

Poster

Abstract Title Unveiling Water Allocation Dynamics: A Text Analysis of 25 Years of Stakeholder Meetings

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Helmholtz Centre for Environmental Research (2)

Abstract

Water management in regions characterized by high climate variability and frequent extreme weather events presents significant challenges for policymakers. Participatory approaches have become common to facilitate water allocation and collaborative decision-making in such areas. However, evaluating the effectiveness of these governance methods is complex, primarily due to the lack of structured, long-term records documenting decision-making processes. To address this critical knowledge gap, we propose a novel methodology that leverages text data extracted from minutes of water basin committee meetings. Our methodology is tested using the minutes of 1100 meetings held between 1997 and 2021 across twelve basin committees in Ceará, Brazil, a region known for its extensive history of droughts that have greatly impacted water policies and politics.

To identify conflicts and management issues discussed during these meetings, our approach employs a three-step topic modeling framework: (1) sentence embedding using SBERT, (2) dimensionality reduction, and (3) sentence clustering. By quantifying the frequency of each topic within each committee over time and normalizing it against the annual document count, we unveil recurring topics. Noteworthy subjects that emerged through our analysis include 'organic farming,' 'fish mortality in reservoirs,' and 'structural problems in water infrastructure.' Particularly interesting is the stakeholders' heightened concern for urban water supply over agricultural demand during droughts.

Furthermore, we identify the key actors participating in and influencing these meetings by using named entity recognition and dependency parsing. Network graphs constructed based on actor co-occurrence in meeting minutes reveal the centrality of governmental representatives in the discussions across all water basins, despite the presence of non-governmental institutions and local users in the river basin committees.

In conclusion, our proposed approach harnesses existing text data to uncover spatio-temporal patterns related to water allocation. This study opens new avenues for advancing the field of water management by using text-based analysis.

Poster

Abstract Title : Developing Drought Indicators for Assessing Multi-Sectoral Impacts in Complex Water Systems

Authors: Alvar Escriva Bourte

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Abstract

California's water storage and conveyance infrastructure—called the "water grid"—serves as a hedge against droughts. However, water operations—and more broadly the role of humans in reshaping drought risk and socio-environmental impacts—are usually not considered in characterizing drought status. The overall goal this project is to develop a framework for linking drought hazard indicators with sector-specific impacts in highly managed water storage and conveyance systems, such as those of the American West. To achieve this goal we have developed sector-specific drought hazard indicators for California that take into account water availability considering the built infrastructure, and management operations from both local and more distant water sources. After obtaining drought hazard indicators, we show case studies developing drought impact risk profiles for four sectors—agriculture, cities, small communities, and the environment—that reflect the capacity of these different sectors to respond and adapt to drought conditions.
One of the most innovative parts of this project is the co-development of decision support tools. Working with five different stakeholder advisory groups—science, agriculture, cities, small communities and environment—we are identifying the usefulness of the indicators, and thresholds and triggers that can be tailored for local, state, and federal drought response.
To conclude we will discuss the benefits and challenges of the current methodology, including data availability, the challenges associated with non-stationarity, and the co-development process with stakeholders.

Flashlight Talk

Abstract Title System archetypes for characterizing the dynamics and co-evolution of human-water systems

Authors Sina Khatami (1,2), Giuliano Di Baldassarre (1), Yongping Wei (3), Marlies Barendrecht (4), James (Jay) Famiglietti (5), Xu Li (5), Pieter van Oel (6), Jimmy O'Keeffe (7), Elisa Savelli (1), and Nura Jafar Shanono (8)

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Abstract

System thinking and archetypes are widely used to structure and analyze complex systems, and address the wicked problems within (and beyond) domains of biodiversity, agriculture, sustainable development, and natural resources management. In this presentation, we describe the co-evolutionary human-water system taking the system archetype approach. We introduce archetypes of fixes that fail, limits to growth, success of the successful, and escalation. The system archetypes can be used as both diagnostic and prescriptive tools to assist the decisionmakers in capturing recurrent feedback structures in the coevolutionary human-water systems and the intended and unintended consequences they result in and developing strategies to effectively cope with them. We use archetypes to describe and categorize emergent socio-hydrological phenomena; including safe-development paradox, water governance crisis, over-ambitious development, technological advances as panacea, tragedy of the commons (an archetype itself, here discussed as a multi-agent, i.e. multi-loop, extension of limits to growths), urbanization, agricultural development, groundwater depletion, and water conflicts. In doing so, we analyze several real-world examples of human-water interactions from major river basins across the globe. The four main take-home messages that we highlight using these examples are: 1) Archetypes are generic recurring patterns of behavior or system structures that could be seen as building blocks of complex systems. 2) Archetypes are neither bad nor good, but diagnostic systemic tools. 3) A given phenomenon may be explained using different archetypes depending on the viewpoint. 4) Multiple archetypes may occur simultaneously.

Flashlight Talk

Abstract Title Characterization of compound flood events in the Mediterranean Spanish Coast in basis to their remarkability

Authors María Carmen Llasat, Montserrat Llasat-Botija, Laura Esbrí, Erika Pardo, Raül Marcos

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Abstract

The Western Mediterranean is usually affected by flash floods associated to heavy convective precipitation, and it is very likely to significantly increase under climate change. One of the intrinsic characteristics of flooding in coastal areas is that it can be induced by different climatic drivers such as storm surge, rainfall, and/or river flow, each of which may act individually but are often interconnected. Thus, although risk assessments in coastal zones usually consider the impact of sea hazards and climate drivers individually, they should instead be considered as the result of compounding events (Hao et al., 2018; Ward et al., 2018).

Although the research focused on compound events is relatively recent, Spain has been affected by severe connected, preconditioned and compound events along its history. The case of the "Superstorm" produced in November 2001 is an example of connected events. It gave place to a severe windstorm and sea-storm that destroyed about the half of the trees in the Balearic Islands and took away a large part of the beaches of Catalonia. An example of preconditioned event was the floods of October 1994. The drought and high temperatures favored the serious forest fires occurred in Catalonia and the Valencian Community that same summer. The strong erosion and the large amount of dead wood enhanced the autumn floods and their destructive power. The catastrophic Gloria case that affected the Catalan coast in January 2020 is a clear example of spatial multivariable compound event, where heavy rainfalls, snow storms, windstorms and sea storms were concentrated between two days ravaging the Catalan coast, while the catastrophic floods that affected simultaneously Murcia, Valencia and Andalusia is an example of spatial compound event.

This work focuses on the identification and characterization of compound and connected flood events that have affected the municipalities of the Mediterranean Spanish Coast between 1980 and 2020. The selection has been made following a bottom-up approach, considering the impacts, vulnerability, exposure, and coping capacity. An index that integrates those indicators, named remarkability index (RI), has been defined, following the terminology developed by other authors, though commonly referred to one individual risk (i.e.: Boudou, 2015). To do this, information from AEMET (the Spanish Meteorological Service), the Spanish Civil Protection, the "Consorcio de Compensación de Seguros" (the statal Spanish Insurance company), as well as the PRESSGAMA and INUNGAMA databases have been used. A search on the most optimal and applicable classification, considering direct damage (i.e.: casualties), impact to critical infrastructure (i.e.: airports), impact to coastal ecosystems (i.e.: death of fishes), financial compensation (i.e.: insurance compensation) and cascade effects (i.e.: gas explosions) has been carried out. Indirect impacts such as the losses in working hours are not taken into consideration due to their non-comparable and hardly available nature. Based on the selected variables, a multivariate Impact Index (II) has also been designed. In the study of some specific cases, like the flood event recorded in October 2019, the Early Warning and emergency management have also been included.

Flashlight Talk

Abstract Title Hourly hydrological simulation of historical and future flood events in Western Germany

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Abstract

The July 2021 flood in Western Germany was one of the most severe flood events. It has resulted in a large number of death toll and vast economic damage. The BMBF-funded joint project KAHR (https://hochwasser-kahr.de) deals with the effects of this flood and develops scientific knowledge to support the reconstruction process in flood-prone area in Western Germany. To analyze how the extreme floods generated in the past and how the propagation processes may change under future climate conditions in these small catchments, there is a need for small-scale flood modelling with finer spatial-temporal resolutions. Here, we apply the mesoscale hydrological model mHM at hourly resolution for the three flood prone catchments of Ahr, Erft, and Rur. We are able to accurately capture the dynamics of the extreme flood events for the recent period including the flood in 2021. To assess the present and future flood risk, a regional weather generator and a disaggregation procedure are applied to generate 10,000 years of synthetic hourly meteorological data. Based on the derived simulated floods, we can investigate the spatiotemporal patterns of extreme weather and associated meteorological and hydrological conditions that could lead to similar or more significant flood events.

Flashlight Talk

Abstract Title Heavy tails of flood peak distribution – controls along the flood process cascade

Authors Elena Macdonald1, Bruno Merz1,2, Björn Guse1, Viet Dung Nguyen1, Xiaoxiang Guan1, and Sergiy Vorogushyn1

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Abstract

Observed time series of precipitation and streamflow often show heavy tail behaviour. This means that the occurrence probability of extreme events is higher than for distributions with an exponentially receding tail. By neglecting heavy tail behaviour we might therefore underestimate rarely observed, high-impact events. To achieve more robust estimations of upper tail behaviour, using long time series and improving the understanding of the relevant process controls are ways forward. Better understanding of the process controls also helps with analysing potential future changes in tail behaviour. Here, a conceptual rainfall-runoff model is used to analyse how precipitation and runoff generation characteristics affect the upper tail of flood peak distributions. Long, synthetic precipitation time series with different tail behaviour are produced by a stochastic weather generator and subsequently used as input for a rainfall-runoff model. In addition, catchment characteristics linked to a threshold process in the runoff generation are varied between model runs. The upper tail behaviour of the simulated discharge time series is characterized with the shape parameter of the generalized extreme value distribution (GEV).

Our analysis shows that the rainfall distributions asymptotically govern the flood peak distributions above a certain, catchment-specific return period. Below this return period, threshold processes in the runoff generation lead to heavier tails of flood peak distributions. We conclude that, for return periods that are mostly of interest to flood risk management, runoff generation is often a more pronounced control of flood heavy tails than precipitation.

Flashlight Talk

Abstract Title Assessing flood socioeconomic impacts through text-mining

Authors Mariana Madruga de Brito (1), Jan Sodoge (1,2), Heidi Kreibich (3), Christian Kuhlicke (1,2)

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Abstract

Floods, already among the most prevalent disasters, are estimated to become more severe in several regions. During these events, the media widely disseminates information on flood consequences. Here we demonstrate how newspaper data can be instrumental in the near-real-time monitoring of flood impacts. Using natural language processing on 26,000 newspaper articles, we estimate the socioeconomic consequences of the July 2021 floods in Germany. Our national depiction of flood impact estimates indicates that a broad range of socioeconomic sectors (e.g. industry, mental health and water supply) were affected concomitantly. Furthermore, while the Ahr Valley was the most damaged region, minor flood events were widespread across Germany. Validation results showed that news reporting on flood impacts strongly correlates with observed flood levels and estimated losses. Moreover, we obtained an average accuracy of 98% for extracting the impacts from the text when evaluated on a human-annotated dataset. These results indicate that the automatic processing of news media can be successfully used to accurately infer flood consequences.

Flashlight Talk

Abstract Title How does the local context influence flood impacts?

Authors Daniela Rodriguez Castro (1), Solène Roucour (1), Mario Cools (1), Christophe Dessers (1), Pierre Archambeau (1), Sébastien Erpicum (1), Michel Pirotton (1), Jacques Teller (1), Anna Rita Scorzini (2), Daniela Molinari (3) and Benjamin Dewals (1).

Affiliations (1) Univeristy of Liège, (2) University of L'Aquila, (3) Politecnico di Milano

Abstract

Flood hazard and vulnerability depend on factors spanning multiple scales, from the object level (e.g., building exposure, private precautionary measures) to the regional scale (e.g., climatic conditions, construction standards). In micro-scale flood impact assessment, the regional factors are generally reflected in the choice and parametrization of a particular damage model, whereas the object-level factors are reflected in the model input data. This study explores the influence of factors acting at an intermediate scale, referred to as the "local context". Examples of such factors include the degrees of surprise and overwhelming at the municipality level.

The Vesdre catchment in Belgium was considered as a case study. It was severely affected by the 2021 summer floods in northwest Europe. We focus on six municipalities in this catchment, which are assumed to be in the same "regional context" (same climate, similar landscape, similar macro-economic characteristics). In these six municipalities, field interviews have been conducted to collect information on hazard characteristics (e.g., inundation depth, flood duration), building vulnerability features (e.g., construction type), coping capacity (early-warning, precautionary measures) as well as flood impacts (types of building damages and monetary losses). The respondents are about 300 private households, roughly half of whom have provided data on monetary losses.

We used logistic regression to classify the monetary losses induced by damage to the building and content. Results show that the building footprint area, the inundation depth, and the municipality are important determinants of monetary losses (area under the ROC curve above 0.84). The municipality's significant influence hints at the local context's possible role in worsening or alleviating flood impacts. Though, the municipality being a significant determinant of monetary losses does not reveal the underlying causal link. Therefore, we are currently exploring the influence of variables characterizing the local context. These variables include proxies for the degree of surprise and the degree of overwhelming of the communities. The former is evaluated as the ratio of the number of affected buildings in a municipality to the number of buildings situated in a flood hazard area in the same municipality, while the latter is taken as the ratio of the number of affected buildings in a municipality to the total number of buildings in the same municipality. Results will be presented and discussed at the symposium.

Flashlight Talk

Abstract Title Trends in flood impacts in Europe, 1870-2020: preliminary results from HANZE v2 database

Authors Dominik Paprotny (1), Belinda Rhein (1,2), Simon Treu (1), Alois Tilloy (3), Michalis I. Vousdoukas (3), Luc Feyen (3), Heidi Kreibich (4), Matthias Mengel (1)

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Abstract

Assessing long-term trends in flood losses and attributing them to climatic and socio-economic changes requires comprehensive and systematic collection of historical information. Here, we present an major revision and update of HANZE database of past damaging floods (riverine, pluvial, coastal and compound) in 42 European countries since 1870. More than 2000 events characterized by at least one impact statistic (area inundated, fatalities, persons affected or economic loss) are included. The spatial footprint of affected areas is consistently recorded using European Union's Nomenclature of Territorial Units for Statistics. Daily dates, information on causes of the event and full bibliography of each record supplement the dataset. The dataset is a fundamental part of project FloodDrivers, aimed at attributing past flood losses to environmental and economic factors. Therefore, it is designed to be complimentary to HANZE-Exposure, which is a high-resolution model of historical exposure changes (such as population and asset value). It is further being supplemented by hydrological and hydrodynamic modelling to provide consistent data on the event's exact location, intensity and return periods. Using historical impact data in relation to potential losses during each events will enable reconstructing long-term changes, and detecting socio-economic drivers, of vulnerability. The presentation will discuss the observed trends and variability in unadjusted and exposure-adjusted flood events between 1870 and 2020. It will further explain how hazard and vulnerability will be quantified to achieve a full decomposition of the drivers of flood losses in Europe (limited, due to availability of high-resolution climate reanalysis, to events since 1950).

Flashlight Talk

Abstract Title To Adapt or Mal-Adapt? Taking a collaborative lens to look beyond the human-flood system for sustainable and resilient flood risk management in Ghana

Authors Britta Höllermann (1), Joshua Ntajal (2), Adrian Almoradie (2), Mariele Evers (2)

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Abstract

River and heavy rain flooding increasingly affect Ghana's flooding hot spots in the metropolitan areas of Accra and Kumasi, and the rural North in the White Volta catchment. The interplay of impacts of climate extremes, urbanization and land use planning creates a complex web of pressures, where policy-makers, water resources managers, disaster managers, local community leaders, and flood-prone residents need to navigate in order to reduce the general or personal flood risk and vulnerability or to sustain their livelihoods. Currently, reactive rather than preventive approaches and a web of socio-cultural and -political factors hinder sustainable flood risk management. Thus, understanding the complexity of flooding, flood prevention and social dynamics, a broader perspective on human-flood interaction is necessary. Participatory and collaborative research enables such a broad perspective. In this study a participatory mixed-method approach including participatory mapping, collaborative scenario development workshops, and focus group discussions is employed to identify which adaptation measures and for whom those may foster transformative and holistic instead of incremental and project-focussed change. As our Ghanaian example shows, there is not only one feedback mechanism between society and the environment, but many. These are depending on the group of actors, the characteristics of their environment, their room of action and agency. Thus, policies and adaptation measures intended to reduce flood risk and vulnerability, may have different effects and initiate feedbacks which potentially foster shifting of vulnerabilities, rebounding vulnerabilities and/or eroding sustainable development. The collaborative approach allows to discover this risk for maladaptation, to sensitize decision-makers for place- and group-sensitivities, and to develop more interlinked measures and institutional arrangements. In this talk we will present how the iterative collaborative process enabled the stakeholders to shift their thinking from project-focussed to more transformative measures. Finally, we will discuss the necessity to go beyond the water sector and the environmental issue itself in order to create flood resilience and avoid maladaptation.

Flashlight Talk

Abstract Title The Emergence of Lost Rivers in Tokyo: An Urban Socio-Hydrological Phenomenon and Processes

Authors Shinichiro Nakamura (1), Etsuko Shimomoto (2), Taikan Oki (3)

Affiliations (1) Nagoya University, (2) Nihon Fukushi University, (3) The Unibersity of Tokyo

Abstract

Rapid urbanization has degraded the water environment in cities. As a consequence of the process of human-water interaction in mega cities, "lost rivers" have emerged, in which rivers have been lost due to reclamation or concrete covers. The phenomenon of lost rivers has been reported in major cities such as London, Paris, Zurich, Bangkok and other cities. These cities have also experienced difficulties in restoring rivers once lost. The lost river‘s phenomena is the ultimate and irreversible point of arrival of the process of human-water interaction in cities.

In the early modern era, Tokyo was a water city, with rivers and canals running the length and breadth of the city, connecting its commercial centers. However, Tokyo has become an Asian mega-city through the modernization of the past 150 years and its rapid economic growth after World War II. And now Tokyo's rivers have disappeared, having been filled in or turned into concrete sewers. We showed the process of Tokyo's lost rivers over the past 150 years by analyzing historical government documents and developing original historical spatial data on the lost rivers.

The analysis of the historical documents indicated a process or stages of human-water interaction in the city: 1) water pollution due to urban industrialization, 2) increased water demand and wastewater discharge due to rapid population growth, 3) degradation of water quality and intensification of flooding, 4) artificialization of rivers, improvement of water quality through the development of sewage systems, and 5) revival of urban rivers. And the historical spatial data show that the river has decreased in each of these processes. In particular, the rivers were rapidly lost before and after large-scale events such as the reconstruction from the Great Kanto Earthquake in 1923 and the urban development for the Tokyo Olympics in 1964. These results indicate that the lost river phenomenon has emerged as a result of complex interactions between water, society, and technology including infrastructure, in the city.

Flashlight Talk

Abstract Title Human-water relations along the Panke River in Berlin-Brandenburg

Authors Franziska Frankenfeld and Rasmus Rehwald, Students of the 'Social Hydrology' class 2023 (1)

Affiliations (1) Humboldt-Universität zu Berlin

Abstract

Running from rural Brandenburg to central Berlin, the Panke River is witness to many of the human-water relationships one might encounter in and around a big city like Berlin. This includes traces of a turbulent history as well as imaginaries for a future increasingly affected by climate change. In this presentation, students from the 'Social Hydrology' class 2023 at Humboldt-Universität zu Berlin will present their findings from having studied these human-water relations in an interdisciplinary project seminar over the spring and early summer. They will present empirical results ranging from secondary quantitative data or text analysis to primary data collection (qualitative or quantitative) to modelling. The students will also reflect of an innovative teaching format that begins by walking the entire course of the Panke and let the river guide the research questions that are subsequently embedded in theoretical frameworks such as the hydrosocial cycle, hydrosocial territorialisation and socio-hydrology.

Poster

Abstract Title Nine centuries streamflow reconstruction for the Po River

Authors Rui Guo (1), Hung T. T. Nguyen (2), Stefano Galelli (2) (3), Serena Ceola (1), Alberto Montanari (1)

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Abstract

The Po River, the longest watercourse in Italy, suffered the worst drought for 70 years in 2022. Extreme events such as this severe drought, which caused great economic losses, are projected to occur more frequently under climate change. Relative short instrumental streamflow records limit our understanding of the long-term variability in streamflows, while considering past climatic data could effectively improve future water resources management. Tree rings provide key information to this aim. Using information derived from tree rings, we reconstruct the annual streamflow of Po river over the past nine centuries under a climate-informed framework. To alleviate the uncertainty arising from the tree rings' information, our results are generated by an ensemble method which can better describe the uncertainty range of the reconstructed history. We show that both megadroughts and megafloods have occurred along the Po River in the past centuries. Our findings help to gain a deeper understanding of multicentennial streamflow variability of Po river, thus providing essential technical indications for designing adaptation strategies under climate change.

Poster

Abstract Title Global sensitivity of inundation extent and population exposure to flood magnitude

Authors Laura Devitt (1), Jeffrey Neal (1), Gemma Coxon (1), James Savage (2), Thorsten Wagener (3)

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Abstract

Assessments of potential future flood hazards under climate change using model cascades are subject to large uncertainties, severely limiting our ability to make robust decisions. The mitigation of impacts of disastrous flood events requires the development of complementary approaches to risk management that can identify exposure of populations and assets across a range of plausible events to derive actionable information under large uncertainty. Therefore, here we provide a high-resolution stress test of the global river network and quantify the sensitivity of inundated areas and population exposure to varying flood event magnitudes for 1.2 million river reaches for the first time. Our analysis reveals regional differences in settlement patterns with respect to flood hazard. We find clear settlement patterns in which floodplains that are most sensitive to flooding from frequent, low magnitudes events have evenly distributed exposure across hazard zones, which suggests that people have found ways to adapt to this risk. In contrast, floodplains most sensitive to extreme magnitudes events have tendency for populations to be most densely settled in these rarely flooded zones, being in significant danger from potentially increasing hazard magnitudes.

Poster

Abstract Title The Potential of Machine Learning Approaches in Flood Loss Modeling: A Case Study of Ho Chi Minh City, Vietnam

Authors Kasra Rafiezadeh Shahi1, Nivedita Sairam1, Lukas Schoppa1,2, Le Thanh Sang 3, Do Ly Hoai Tan 3, and Heidi Kreibich1

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Abstract

Ho Chi Minh City (HCMC) is the most populous coastal metropolis in Vietnam. Due to increasing economic growth, HCMC is expected to become the economic hub of Southeast Asia by 2030. Therefore, such a policy will lead HCMC to face a drastic rise in labor migration, and ultimately resulting in urban expansion. However, the location of HCMC (being a coastal city) and climate change spiral its vulnerability to flood risk. To mitigate such a hindrance, we need to implement effective adaptation solutions. The risk-based adaptation planning requires plausible and accurate flood loss estimation. Nevertheless, few studies focused on estimating flood loss using machine learning (ML) approaches at the study site. Most of these studies do not account for predictive uncertainty in the modeling process.

In this study, we investigate the potential of different ML approaches, namely random forest and support vector machine, for estimating flood loss in HCMC (for the residential sector). In addition, we designed a Bayesian network which accounts the predictive uncertainty in the flood loss modeling in this region. We developed our proposed approach in accordance with a new object-level survey dataset with flood-affected households (n=1530). The survey dataset is composed of information on flood intensity, household characteristics, warning and emergency, private precaution, and damages. In the analysis procedure, initially, we deployed two feature selection strategies (i.e., expert knowledge-based and ML-based) to derive the most relevant features for the estimation process. The selected features along with a systematic learning procedure, are employed to identify a robust Bayesian network structure that reflects the local circumstances of flood damage processes at the study site. The experimental results confirm that the proposed Bayesian network overall has a better predictive performance than other well-established ML approaches in terms of accuracy assessment.

Furthermore, our validated Bayesian network loss model exhibits high practical value for applications at the city-scale since it enables loss estimation even when information about the predictor variables is only partially available. Moreover, including vulnerability variables as predictors in the loss model facilitates the consideration of adaptive behavior in loss and risk assessment. Ultimately, the fully probabilistic model design inherently quantifies predictive uncertainty, which fosters the uncertainty propagation to subsequent elements of flood risk assessment and well-informed decision-making.

Poster

Abstract Title Dike systems shape spatial pattern of flood heavy tails – insights from continuous process-based simulations with Regional Flood Model (RFM)

Authors Mostafa Farrag1, Sergiy Vorogushyn1, Dung Viet Nguyen1, Björn Guse1, Bruno Merz1,2,

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Abstract

Humans build up dike systems along the rivers to prevent frequent flooding since centuries. Dikes may become overtopped or breach during extreme flood events. These processes modify flood frequency distributions at various locations along the rivers. Limited discharge records often do not reflect extreme flow conditions and threshold processes such as dike overtopping. Hence, interpolated frequency curves may be misleading. We apply the Regional Flood Model (RFM) – a process-based hazard model chain covering processes from triggering event precipitation to floodplain inundation – to assess derived flood frequency curves and their spatial distribution in the Rhine basin. We run a 3000-years synthetic simulation of daily weather fed into hydrological and hydraulic models. We then compare scenarios with and without induced dike overtopping and floodplain inundation. In particular, we analyze, how tail heaviness of Generalized Extreme Value distributions is affected by dike overtopping and inundation processes. We identify regions, which strongly affect tail heaviness and analyze how far downstream this effect propagates.

Poster

Abstract Title Societal-hydrological interactions of multi-purpose freshwater reservoirs under global changes coevolutionary scenarios

Authors Eduardo Mario Mendiondo (1), Pedro Gustavo Camara da Silva (1), Greicelene Jesus da Silva (1), Marcos Roberto Benso (1), Gabriela Chiquito Gesualdo (1), Adelaide Cassia Nardocci (1), Karina Simone Sass (1), Josicleda Domiciniano Galvincio (2), Danielle de Almeida Bressiani (3), Enio Pereira Bueno (4), Luz Adriana Cuartas Pineda (5), Maarten S. Krol (6), Tercio Ambrizzi (1), José Antônio Marengo (5)

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Abstract

New patterns of freshwater reservoir security for multiple uses, including water supply, food production, and energy, can be achieved by exploring ecological and economical alternatives in existing water infrastructure to assure the equilibrium of the water-energy-food-ecosystem nexus. Around that concern, the Brazilian semi-arid region has experienced water scarcity and increasing demand causing a critical reduction in the reservoirs' water level. Linked to the notion that to mitigate scarcity it is still necessary to build more reservoirs, this leads to an unsustainable cycle, aggravating the paradox of unequal affordability among social sectors and contributing to increasing multi-risks and vulnerabilities for the water users. One of the emerging techniques to manage water scarcity is the construction of floating photovoltaic systems (FPVs) to diversify the energetic resources, reduce greenhouse gas (GHG) emissions and minimize the rate of evaporation from water bodies. In this regard, Brazilian territory has a large potential to explore energy cogeneration using the surface area of installed reservoirs (approximately 22,000 in all territory) and taking advantage of the solar radiation incidence favored by the country's geographic location. Supported by the FAPESP-FACEPE project named "Global changes and sustainable development with water-energy viability and economic solvency", this work aims to analyze the potential of generating photovoltaic energy in freshwater reservoirs in the Brazilian semi-arid region, to increase energy efficiency and water resources use while reducing greenhouse gasses by replacing fossil fueled energy. Therefore, we propose the selection of a multipurpose reservoir in the Brazilian semi-arid region, as well as the formulation of scenarios that involve stored volume and FPVs % coverage. Furthermore, we propose calculating performance metrics for greenhouse gas reduction, energy gain, and evaporation rate changes and analyzing these results through a socio-hydrologic perception model aligning four water security dimensions: human, environmental, economic, and resilience. These findings will allow for more efficient use of reservoirs in the semi-arid region, ensuring advances in water security.

Poster

Abstract Title Developing generic reservoir operating rules for inclusion in the national-scale hydrological modelling of Great Britain

Authors Saskia Salwey (1), Gemma Coxon (1,2), Francesca Pianosi (2,3), Rosanna Lane (4), Michael Bliss Singer (5,6,7), Chris Hutton (8)

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Abstract

To meet growing water demand and to satisfy an increasing population, reservoirs are continually being integrated into river systems across the world. The presence of a reservoir can dictate the downstream flow regime, such that in many locations, understanding reservoir operations can be crucial to understanding the hydrological functioning of an impacted catchment. Consequently, over the last two decades, correctly representing reservoirs, and their operations, in hydrological modelling frameworks has become a key area of research for simulating water availability. Although substantial progress has been made in modelling reservoir operations (which control how water volumes are distributed across space and time), there is still no consensus on the best way to define, calibrate and evaluate operating rules within hydrological models. In most locations, data describing reservoir operating rules are not available, and timeseries of reservoir inflow, outflow and storage are often unpublished. Consequently, modelers must simplify and generalize sets of release rules from very little information, particularly where they are to be applied across large scales (e.g. across hundreds of reservoirs). Generic reservoir operating rules have typically been tested and developed using the Global Reservoir and Dam (GranD) database and thus are biased towards large irrigation reservoirs (which make up the majority of the dataset). Whilst operating rules have also been tested across many hydropower and multipurpose reservoirs, a gap remains for the definition of generic reservoir operating rules designed for smaller water supply reservoirs that can be applied nationally in countries such as Great Britain (GB).

In this study, we integrate a new generic reservoir simulation component into a national-scale hydrological model of Great Britain and compare simulation results from two modelling scenarios (with and without the new reservoir component). The first scenario, where reservoirs are omitted, is used as a benchmark representative of current modelling practices in GB (where none of the national-scale hydrological models include reservoirs), whilst the second uses a set of generic operating rules focused on simulating small, water resource reservoirs. In both scenarios, we use Multiscale Parameter Regionalisation (MPR) for model calibration. To assess the suitability of our operating rules for simulating future conditions and evaluating water availability during hydrological extremes, we test the consistency of model performance across the onset, duration and recovery from droughts. This study will demonstrate the importance of including reservoir representation in hydrological models of Great Britain, and will introduce a set of operating rules suitable for smaller reservoirs with a focus on water supply.

Poster

Abstract Title Policy assessment of the hard-path vs. the soft-path using a socio-hydrological model: A case study from Kelani River Basin, Sri Lanka

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Abstract

Simulation results from Global Climate Models (GCMs) are being used by researchers all over the world to predict extreme flood events and to plan, design and implement diverse projects. Human-flood interactions based on climate predictions are not being discussed enough in such initiatives because of associated uncertainties. In this study, a socio-hydrological model (SHM) was used to predict the human-flood dynamics under changing climatic conditions in the Lower Kelani River Basin (LKRB) of Sri Lanka which is an unprotected floodplain. The purpose of the study is to identify and understand the probable highest vulnerable scenarios under green society path (GSP) /unprotected floodplain and technological society path (TSP) /protected floodplain for the 2025-2100 period. As the first step, suitable GCMs were identified, downscale and a bias correction was conducted. Then the probable annual maximum rainfall values were calculated for the period of 2025-2100 under the RCP 8.5 scenario. Based on a Hydrological model, the high-water levels , and it was used as realistic input data to apply SHM to the study site. The simulation results show that, flood memory under the GSP may remain at higher levels due to the high frequency of flooding and the population density may gradually decline. Further, the predicted flood damage values remain at stable levels due to the elevated flood memories. But the frequent damages may hinder the economic development of the floodplain. The damages under the GSP could be reduced with accurate soft measures. Under the TSP, a growth in the population can be seen. The damages from the rare disasters could be reduced if awareness sessions are conducted at regular intervals. Overall, the identified human-flood interactions are vital to understand the future basin wide changes under both hard and soft paths.
Key words: socio-hydrology, socio-hydrological predictions, climate
change, hard measures, soft measures, Kelani River Basin, Sri Lanka

Flashlight Talk

Abstract Title Sustainable management of groundwater resources under climate change in the Emilia-Romagna region in Italy

Authors Ilaria Delfini (1), Andrea Chahoud (2), Alberto Montanari (1), Daniel Zamrsky (3)

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Abstract

Groundwater overexploitation is a recognized global challenge for sustainable development. The most relevant impacts include deterioration of water quality, land subsidence, aquifer depletion, and threats on water security. Furthermore, groundwater is essential in mitigating the effects of long-term droughts that are increasingly occurring in several continents.

In this context, a responsible management of groundwater resources becomes crucial to minimize the negative impacts of withdrawals, and to ensure the sustainability of groundwater exploitation. In this study we perform a series of simulations and assess the effects of groundwater pumping on alluvial fans in the Emilia-Romagna region (Italy). A large agricultural plain is located in this area, and its subsurface consists of multiple aquifers at different depth levels in fluvial sediment deposits of several hundred meters thickness in total, underlaid by marine sediment deposits. Here, agricultural production heavily relies on groundwater for irrigation, particularly during hydrological droughts.

To study this system a numerical groundwater flow model has been developed and calibrated using the MODFLOW 6 numerical code. This model is based on a previous application of MODFLOW to the whole Emilia-Romagna area by the Regional Agency for Environmental Protection (ARPAE), and extends over a wide area east of the Secchia River.

Simulations are generated for various boundary conditions and several scenarios of future climate and water pumping. The aim is to get an insight of the combined effects of changes in natural and artificial stresses on aquifers. This, in turn, would provide a guideline for sustainable aquifer management under different climatic conditions.

Flashlight Talk

Abstract Title Hydro-economic spatial decision support for water allocation using water use and productivity indicators

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Abstract

The identification of the optimal (efficient) economic allocation water allocation can support the decision making and the definition of management instruments. Understanding hydrologic and socioeconomic trade-offs contributes to integrated water resource management. We developed an innovative method to identify and prioritize regional productive arrangements, linking a water resource network model to an economywide model in a spatial decision support system. Farther, the integrated economic platform can represent socioeconomic impacts of water management instruments. The proposed method uses hydro-economic indexes with exploratory spatial data analysis to identify productive arrangements whilelabor, GDP and raw water demands are the main model inputs. The normalized concentration index, calculated for all economic sectors in each of the municipalities, is the linear combination of indicators of specialization, concentration, and relative importance of sectoral employment, which is used to identify the Hotspots, or economic clusters. Furthermore, the following water use indicators (associated with goal 6.4 of the Sustainable Development Goals of the United Nations) and the productivity indicators were determined for each cluster and sector: water use efficiency, water use intensity, labor productivity and unit labor costs. Those indicators made it possible to evaluate and compare each Hotspot (of an economic sector) related to their importance to promote productivity growth in the region. This strategy of water allocation among users carried out using those factors and others related to the pertinence or not of critical areas in terms of water availability was able to simulate the use of integrated economic and regulatory instruments. The method was applied to four basins in Northeast of Brazil, during a period of water scarcity. Results showed important trade-offs between user allocation and reservoir storage in the distinct regions and economic sectors. Tradeoffs were noted, for example, between the service sector with less water demands and the agriculture sector with lower employment and higher water demands (e.g., sugarcane cultivation). In general, water demands with inferior efficiency and fewer impact on employment received major cuts in water allocation during water stress periods. Such results should support the decision in defining the management instruments, in a transparent and accessible way, contributing to adaptive governance, especially in regions with frequent water scarcity and growing water transfer needs, as is the case in Northeast Brazil.

Flashlight Talk

Abstract Title Comparison of evolutionary pathways of water-rice coupled systems over the past 70 years in two contrasting watersheds in Japan

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Abstract

We describe the interplays of water and food production over the 70 years (1950-2020) of Japanese watersheds. Here, we focus the changes on the rice transplanting period because the period is critical for land preparation and requires considerable water for puddling. The transplanting periods have shifted from mid-June in the 1950s to early May in the 2000s.

We propose a framework for assessing how the shifts of the rice transplanting period affected the production of rice and drought risks based on two process-based models: a crop growth model and a hydrological model that incorporates reservoir operation and irrigation water use. Each of the models simulates crop yield and drought risk independently. The hydrological model was driven by the meteorological data for 1958-2020, compiled using reanalysis data (JRA-55) and observed data. The crop model was driven by the meteorological data for the period of 1981-2000, assuming the meteorological conditions from 1958-1980 did not differ from those of 1981-2000. We conducted the simulation with shifted transplanting dates (or starting date of irrigation) from the current date by one week up to five weeks earlier and later. We then integrate the results of mean crop yield and drought risk for each transplanting date to examine the interrelated nature of crop production and drought risk.

We applied the method to two watersheds where rice irrigation is the dominant water use but contrasting in terms of hydrological regimes: one is the Shinano river with snow melting supplies the spring streamflow and the other is the Kinu river under drier spring conditions. The earlier transplanting periods in the 2000s increased the yield in both watersheds because earlier transplanting ensures longer growing periods until the heading of rice. On the other hand, the changes in the drought risk differed. In the Shinano river, the earlier transplanting date resulted in lower drought risk. We found the current transplanting period corresponds to the day that minimizes drought risk and maximizes yields, suggesting there seemed to be fewer trade-offs between rice production and drought risk. We supposed the shift in the transplantation period would have been relatively smooth. In the Kinu river, the earlier transplanting date resulted in higher drought risk. Thus, the shift in the transplanting period and the higher yield of rice could not have been achieved without reservoir construction in the watersheds. Indeed, the capacities of dams constructed in the two watersheds differed in terms of the ratio of total reservoir storage over mean annual flow (SoF): SoF in the Kinu river (96.25) greatly exceeded that of the Shinano River (6.29). The low flow conditions before and after the construction of the dam show little change in the Shinano River, while the Kinu River shows a large increase in the low water flow during the early irrigation season. We highlight the importance of the socio-economic (i.e., increasing food production) can be a driver of changes in water cycles.

Flashlight Talk

Abstract Title Grey Water Footprint of Rapidly-Urbanized Tropical Areas Worsened by the Coevolutionary Amazon-Sanitation Paradox

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Abstract

As new water infrastructure is being planned in tropical urban areas under rapid changes, one traditional belief is that the codependency of both Wastewater Treatment Plants (WTP) with regional biome climate to help dilute grey water footprint (GWF) remains pervasive. Hereby we argue that counterintuitive phenomena should be considered when expanding urban drainage infrastructure: the behavioral water footprint cycle and the technological effect. Our hypothesis addresses that co-spiralling inequalities exacerbate these paradoxes in rapid-changing tropical urban areas, namely the water-health-and-hygiene (WASH) and the water-energy-food and ecosystems (WEFE). This contribution aims to : understand causal loops of historically-pervasive cycles of the sanitation-poverty-biodiversity connection in rapidly-urbanized tropical areas and predict these cycles under drivers of global changes, and feasible pathways of proactive solutions based on science-for-policy and in practice. Our methodology first points to causal loop diagrams showing: the traditional response to growing grey water footprint in rapidly -urbanized tropical areas, which consists of a mix of behavioral and technological pressures. For instance, we analyze how GWF is linked to WASH social inequalities, socioeconomic damage, public pressure, new urban water treatment plants (UWTPs), but with socially-unequal water-energy supply. Second, we expand the analysis to both the new behavioral water footprint cycle with consequent more pressure on local/ regional biodiversity, with ecosystems degradation, and the technological effect of illusive codependency on UWTPs with increase community vulnerability to the non-stationary natured of co-occurrence of multiple hazards, i.e. droughts and floods. Third, we start applying this socio-hydrological approaches to South American examples of embedded spatiotemporal scales: the Coevolutionary Amazon Sanitation & Health (CASH-reactive) Paradox, and the Recycling Water Asset for Sustainable Habitats (ReWASH-proactive). From these two nested system approaches (CASH-ReWASH, reactive to proactive) we present preliminary assessment for selected Brazilian areas. We discuss how the combination of two dynamics, as behavioral as technological, can lead to paradoxical outcomes, unintended consequences, but even possible new virtual cycles to mitigate water extremes linked to social inequalities, if linked to socially-driven Unsolved Problems in Hydrology (UPH) and with viable tools for Prediction in Ungauged Basins (PUB). Finally, we present future recommendations to adapt these

methodology to other biomes, scales and cultural localities, especially for participatory risk management of unprecedented floods and droughts under climate change.

Flashlight Talk

Abstract Title Improved understanding of hydrological change in Central Asia and its implications to society

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Abstract

Central Asian river basins with their runoff formation zones in high mountains are currently experiencing the impact of increasing temperatures and changes in precipitation. The headwaters thus exhibit decreasing glacierization, changes in snow cover characteristics and changing runoff response. These changes are likely to intensify in future, as temperatures are projected to grow further. Both hydropower industry and irrigated agriculture in the downstream areas strongly depend on the water availability, its seasonal and long-term distribution. In order to improve water management policy in the region and understand the societal relevance of hydrological change, reliable assessments of historical variations of water availability and future projections in the runoff formation zones of Central Asia are necessary.

We present an assessment of hydrological changes in Central Asia that is based on the historical observations of hydrometeorological data. Additionally, expected hydrological changes until the end of the 21st century will be presented that are based on the hydrological evaluation of climate projections from IPPC scenarios.

The results indicate regionally varying impact of changing climate on the hydrology. River basins, located in the western part of Central Asia, are experiencing least glacier retreat compared to eastern parts of the region. The changing climate will further influence the inter-annual flow regime with peak discharge being shifted from late summer towards early summer due to increasing temperature and earlier snowmelt. Water availability in August, the month with the largest glacier melt contribution, will strongly decrease mainly due to the decrease in glacierization. This may have most significant implications to the agricultural sector in the region. The obtained results provide important information in understanding ongoing hydrological processes in times of climate change as well as their societal relevance in the region. The results can also become important for decision makers in developing strategies for water management.

Flashlight Talk

Abstract Title Why rainwater is harvested in different ways and what this means for household water insecurity – findings from a mixed-methods study in rural South Africa

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Abstract

Worldwide, rainwater harvesting (RWH) is gaining importance as alternative water source for water insecure households that face drought and water scarcity. RWH is especially useful in the widely dispersed settlements of rural South Africa, where water infrastructure and services are only partially developed and often dysfunctional and unreliable. Surprisingly, according to previous studies and data from the South African General Household Survey, only 1 to 3 % of South African households practice rainwater harvesting; however, these studies and surveys have only considered conventional RWH systems, i.e. industrially manufactured gutters and large 4 to 6kl-tanks. In our case study in rural Kwazulu-Natal, over 90% of households practiced RWH, yet only 25% harvested rainwater in a conventional way. The majority of households collected rainwater in what we call a “makeshift mode”, using short, homemade gutters made from metal sheets, hollow tree trunks or plastic bottles that route the water into 210 l-drums, tubs or bowls. We aimed to investigate the reasons for the differences in the RWH mode (conventional or makeshift) and explore what the different modes of RWH mean for some aspects of household water insecurity. Our analysis is based on ethnographic field work in rural uMvoti, including field observations, interviews, participant observation, and a household survey with 67 households. Field observations suggested that income, water access and type of housing all contribute in interrelated ways to the mode of RWH that rural households could practice. We triangulated these hypothesised relations statistically. Moreover, our statistical analysis yielded new hypotheses for further ethnographic field work and allowed us to quantify the strengths of the effects: the share of round huts has a much greater effect on RWH mode than household income. For upscaling RWH in rural areas, therefore, the specific water needs and housing types of households need to be considered. While some households may benefit from new drums and gutters that are tailored to their round huts, other households may need to transition to conventional RWH with large tanks, which requires at least one building with straight roofs. Certainly, makeshift RWH is less efficient than conventional RWH systems in terms of volume, but can be advantageous in terms of water quality and affordability. Presumably, makeshift RWH is prevalent in other parts of rural South Africa and should be considered in future RWH research. With regards to the methodological stance of our study, we propose the iteration of ethnographic field work and statistical modelling as a useful research process for learning about particular places.

Flashlight Talk

Abstract Title Challenges on EU Transboundary Water Resources Management. The Iberian Peninsula case

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Abstract

In Europe, the Water Framework Directive (WFD) has on its core the principles and goals of integrated water resources management. However, those are most difficult to apply and achieve when that requires the interplay of different Member-States which is the common case as 60% of the European territory corresponds to transboundary river basins. That requires the collaboration and cooperation of institutions, water authorities and services and the involvement of stakeholders, calling for sharing of data, harmonization of procedures and processes, namely on modelling tools and monitoring water quantity and quality as well as on adaptation to climate change effects, and for collaborative and joint management of floods and scarcity and drought situations. And that shall be done in compliance with the national water resources policy and management frame of each of the involved states. The required effective transboundary cooperation is also highly dependent on the historical tradition and agreements between the sharing countries.

This work aims at providing an overview of the progresses made in transboundary water management in EU since the enforcement of the WFD, after entering on the 3rd 6 year-cycle of its implementation, emphasizing the corresponding challenges and perspectives to achieve the aimed environmental goals in the next future. That having a more specific focus in the southern European region, most affected by projected climatic changes. For this purpose, the Iberian Peninsula case, where Portugal and Spain share five river basins that form four international river basins districts (IRBD) framed under both national's water laws revised under the WFD and the so called Albufeira Convention (AC) agreement, in force also since 2000, is focused. The AC defined the framework of bilateral cooperation for the sustainable management of the shared river basins, and also an operational board, the CADC (Commission for Convention Development and Appliance) which, by means of different Working Groups has been supporting not only the implementation of the AC but also of the WFD and the EU Floods Directive, approved and transposed later. Under that frame, the two countries have been evolving from coordinated River Basin Management Plans (RBMPs) and Flood Risk Management Plans (FRMP) for each national part of the four IRBDs to envisaged joint RBMPs and FRMPs elaborated in common by both Portugal and Spain.

Developments and challenges for transboundary water resources managements on the IP, framing the EU context, will be addressed, namely in terms of extreme events (floods and scarcity and drought), ecological flows and water resources sustainability, call and conditions for exemptions, pricing policies and public participation, taking into consideration climatic changes, aiming to a more effective transboundary river basins' water resources management.

Flashlight Talk

Abstract Title Trace organic compounds in River Erpe – The most important findings from 12 years of research

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Abstract

The increasing concentrations of trace organic compounds (TrOCs) in water bodies worldwide are of major concern. In addition to a general load reduction and a better understanding of ecotoxicological effects of TrOC cocktails, it is important to better understand the pathways and fates of this large group of compounds in the environment. The River Erpe (Brandenburg, Germany), which receives treated wastewater from an urban wastewater treatment plant, is an excellent location for such research, as TrOC concentrations are exceptionally high compared to other German rivers, allowing processes to be reliably studied without much analytical effort such as prior enrichment steps of water samples. In addition, the river system offers a variety of reaches that differ in hydrology and streambed morphology allowing diverse types of investigations. In the last 12 years, more than 100 researchers have been involved in several large and numerous smaller studies on the River Erpe. Topics included the role of hyporheic zones in the self-purification capacity of streams regarding TrOCs, seasonal changes, interactions between easily degradable organic matter and TrOC attenuation, the importance of identifying flow paths for understanding biogeochemical processes, the effects of management measurements such as macrophyte removal on the fate of TrOCs, the impacts of losing conditions on TrOC input to aquifers and bank filtration systems, the effects of discharging treated effluent of a big novel industrial site on the water composition of the river, and identification of microbial key players associated with TrOC removal and many more. Ongoing research covers topics such as bioremediation, the impacts of migrating bedforms on the fate of TrOCs and the effects of droughts on water quality at bathing sites in the receiving River Spree. Highlights of the research and future directions are presented.

Poster

Abstract Title Isotope investigation on groundwater recharge and dynamics in aquifers of savannah region in northern Togo

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Abstract

Subject to intense exploitation because of the impacts of climate change, groundwater in northern Togo is the main resource for domestic, agricultural and industrial uses. The region is consisted on two geological entities: the Birrimian granite-gneissic basement in the North and the Volta basin underlain by a clay-sandstone sequence in the South [1]. The objective of this study is to evaluate the residence time of water in the different aquifers to ensure a better management of the resource. The methodology adopted combines hydrogeological, piezometric and isotopic tools. The results of the isotopic analyses were obtained within the framework of the International Atomic Energy Agency projects RAF7011 and RAF7019; 45 groundwater samples for tritium and 15 for carbon isotopes. These samples were collected and analyzed.

The piezometric map shows that groundwater flows from the basement area into the Volta Basin. The tritium values of the waters vary between the detection limit (0.3 TU) and 3.8 TU. The overall mean tritium value is 1.5 ± 0.9 TU for waters in the crystalline basement and 0.5 ± 0.6 TU for those in the Volta Basin. The frequencies of tritium contents according to lithology show that for tritium contents lower than 1 TU, 68% of these waters are located in the Volta Basin and 32% in the Birrimen basement. These low levels of tritium put ancient waters that predominate in the Volta basin. These results also show two main periods of recharge: a pre-nuclear recharge with tritium levels below 0.5 TU and a post-nuclear recharge with levels above 2 TU [2]. The tritium contents have thus highlighted the existence of two periods of recharge that occurred during different episodes: on the one hand, the ancient waters resulting from infiltration during the pre-nuclear period in the Volta basin to the south, and on the other hand, the recent waters recharged by current infiltration of rainwater to the north in the Birrimian. Samples with tritium contents below the detection limit (< 0.3UT) were analyzed by carbon-14. The activities obtained range from 95 pcm to 25 pcm. The low activities are obtained in the Volta basin and confirm the existence of two recharge periods. Carbon-14 dating shows the existence of modern waters in the basement confirmed by the direction of flow deduced from the piezometry. On the other hand, the Volta Basin abounds with ancient waters whose ages deduced from radiocarbon dating go back to 16800 years BP. Recharge of these aquifers is Holocene and Upper Pleistocene in relation to the low permeability lithology of the basin.

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Poster

Abstract Title Hydrological Process Understanding in data-scarce Indian Himalayas: An Account of Field Experiments for Sustainable Watershed Management

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Abstract

Water security is a major challenge in the mountain habitats worldwide. Springs are primary water source for communities in the Indian Himalayas which are declining due to rainfall variability, landuse transformations and anthropogenic impacts. Water resources sustainability demands a robust and comprehensive management system proficient in scaling up conventional mitigation methods and implementing scientific evidence-based watershed management. In this work, we operationalize pilot observatories and integrate the application of hydrological time-series, stable isotopes and water chemistry to understand spring watershed responses. Springs (a1, p1, p2, p3) were instrumented for hydrodynamic assessment through Hydrographs, flow recession analysis and correlation functions to quantify the system memory and lag interdependence between rainfall and discharges. Isotopes and water quality were sampled monthly at selected springs/streams (S1-S17, St1-St5) from December 2021 to reflect on the geochemical evolution of springwater, and decipher the origin (recharge) of water types. Further to assess remote ungauged montane watersheds, water yield was simulated using an ecosystem modeling suite and watershed indices were developed.

The time-series of spring (a1) reveal intricate flow pathways, less celerity, and significant aquifer storage potential from Q10/Q90 and Q50/Q90 metrics compared to p1, p2, p3. Hydrograph recessions specified a diffused fracture system for a1 ($\alpha = 0.038$), resulting in flow continuity and the gradual emptying of the aquifer. A steady decline of autocorrelation for a1 (rxx[k]) depicts high system memory of 120+ lag days. Stable isotope values range from -8.1‰ (S12) indicating anthropogenic forcing at recharge zones to -9.7‰ (S6), representative of natural recharge conditions. The characteristic $\delta^{18}O$-δD regression is shallower than Global Meteoric Water Line, indicative of multiple moisture source mixing. S6 being monitored for intervention planning, shows isotopic values distinctive of high elevations and far transport of water-bearing clouds. Two hydrochemical facies HCO_3-Ca and mixed HCO_3-Ca-Mg, were determined from the Piper ternary diagram refer to carbonate rock geology and flow evolution through pathways. The quantified lumped water balance components were translated into watershed indices. A flow retention index, evaporative index, and dryness index of 0.71, 0.43, and 0.75, respectively, imply a dominant overland flow contribution and less potential for evaporative loss, which could fare better in potential for intervention efficacy for sustaining perennial flows.

The research aims to improve the understanding of mountain hydrological processes and drivers of groundwater fluxes. Critical hydrological insights into complex mountain spring systems integrated with water security indices that are easily communicable to watershed managers, stakeholders, and administrative agencies is crucial for informed decision-making. Such an integrated-approach permits detailed process understanding and limits erroneous interpretations. Policymakers can extend the results across the Indian Himalayas to design watershed management frameworks.

Poster

Abstract Title Assessment of spatio-temporal variation of surface water balance components in data-scarce in tropical large-scaled river basin

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Abstract

Assessment of the spatio-temporal variation of surface water balance (SWB) is crucial for the sustainable water resources managements in large-scaled river basins. The detailed investigation requires several hydro-climate, physiological and hydrogeological catchment characteristics information's. The development of physical-based hydrological models for investigation of spatio-temporal dynamics of SWB for such a large-scale river basin with scarcity of catchment characteristics information is highly challenging. Therefore, this study focused to investigate the spatio-temporal variation of long-term mean monthly, seasonal, and annual SWB such as actual evapotranspiration (AET), surface runoff (SRO) and interception (I). The WetSpass-M fully physical-based hydrological model was chosen for investigation of spatio-temporal variation of SWB. The standardized potential evaporation index (SPEI) package of R-studio was used to estimate PET and spatially interpolated for the catchment using ArcGIS system. Further, PET and AET used for estimation of spatio-temporal variation of crop water deficit (WD). The chosen modelling approaches in this study was demonstrated in high data scarce large-scale East African river basin such as Omo river basin, Ethiopia. The sensitivity of global and local parameters of the WetSpass-M model for SWB was analysed. It was found that AET and I are insensitive to average rainfall intensity, while SRO is highly sensitive. The spatio-temporal variation of SWB components such as RRO, AET, and I in the Omo River basin are highly influenced by LULC type variation rather than soil types. The river basin experiences annual AET and SRO of 771.7 mm/year and 722 mm/year with spatial variation values ranging from 337 to 2150 mm/year and 28.8 to 2160.5 mm/y, respectively. The model performance estimated from simulated and observed SRO yielded ECNS = 0.90 and R2 = 0.80 values in the validation, implying that the adopted models can be a good choice for the investigation of spatio-temporal SWB in the large-scaled river basins.

Poster

Abstract Title Bulk water allocation policy in Mahaweli H region Sri Lanka; Lock in of a water management policy due to prevailing cultural norms

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Abstract

Societies are embedded with different water use cultural norms and they are shaped by the economic level of the society. In fact, for sustainable water system management, an awareness on water use cultural norms is crucial. Wherever the policies are implemented without concerning above have come stuck. In Sri Lanka, an irrigation system management program known as bulk water allocation (BWA) was implemented in the Mahaweli H region in 2002. Mahaweli H region is located in the dry zone of Sri Lanka and it is the firstly developed area of the Mahaweli Development Project by providing paddy lands and irrigation water to farmers. As there is water scarcity in the area, dry season water management is crucial for productive farming. In that sense, the objective of the BWA concept is to provide farmers with access to water at a pre-determined quantity for each season while also requiring farmer organisations (FO) to operate and maintain the secondary and tertiary canal system. The planners expected that this concept would improve direct demand management, active farmer engagement, foster a sense of ownership of water system and minimize the reliance on government irrigation subsidies. After about two decades of putting the strategy into practice, we investigated the dry season irrigation water usage of the right and left bank main canals of the Kala Wewa reservoir, the main source of water that irrigates the rice fields in the Mahaweli H region. The canal water duty (ratio of seasonal water issue (mcm) to the cultivated area (ha)) and cropping intensity (the ratio of cultivated area to the total area) are used as an indicator to evaluate the effectiveness of irrigation supplies. Although with variations, water duty values showed a fall trend and cropping intensity values showed an increase trend after the initiative was implemented. This hints the success of the policy. However, during the last decade, water duty seems to be increasing and cropping intensity seems to be decreasing. The short-term (5 years) and long-term (10 years) moving averages of water duty indicates an upward tendency and cropping intensity shows downward trend particularly in the last decade. The lowering of the performance can be attributed to the government's lack of financial and administrative support and the failure of resource mobilisation by FOs towards maintenance of secondary and tertiary canal system. When the farmer economy is not sufficiently diversified, this lock-in state of the BWA policy is influenced by the long-standing beliefs on free irrigation. Therefore, it is vital to focus on the policies that may raise the farmer economy in parallel to BWA program where farmer willingness to pay for irrigation cost sharing rise. Thus, conceptualizing and understanding the feedback that can be generated from the prevailing water use cultural norms is important to achieve sustainable water management policies.

Poster

Abstract Title Seasonal distribution of river flow in the Lower Dnieper subbasin

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Abstract

For the needs of the national economy, it is always necessary to have a reliable quantitative assessment of the water content of rivers throughout the year, seasons, and month-to-month. An assessment of the seasonal and monthly distribution of natural runoff will allow for the provision of an estimated amount of runoff that can be used for the needs of the population without additional runoff regulation measures.

The main result of the performed research is the determined features of the seasonal distribution of the flow of the rivers of the Lower Dnipro subbasin, which are based on the observation materials up to and including 2015.

The rivers of the Lower Dnieper subbasin are entirely located in the steppe zone of the Black Sea Lowland, which characterizes the territory as arid. The climate of the territory is moderately continental, with an annual amount of precipitation of 441–513 mm and an average annual air temperature of +8.5-9.8 °C. The snow cover is not stable.

The Lower Dnipro sub-basin is unique, as it is home to the largest main canals that were built to transfer the regulated flow of the Dnipro to the arid steppe regions of Ukraine in order to irrigate agricultural land and provide water to low-water regions.

In recent years, a low-water phase has been observed on most rivers since 2006, on the Mokra Sura and Kinska rivers since 1989, on the Samara-Kokhanivka River since 1980, while on the catchments of the Ingulets River, a high-water phase can be noted since 2009, probably caused by anthropogenic influence.

The average long-term module of annual runoff on the rivers of the Lower Dnieper sub-basin varies from 0.42 l*s-1*km-2 Mokri Yaly River - Hrushivskyi village to 1.95 l*s-1*km-2 Ingulets - village. Oleksandro-Stepanivka, the range of variation coefficient of variation is 0.44-0.90, and the average ratio Cv/Cs=2.5.

The coefficient of variation of the annual flow is generalized for the territory at the level of 0.54.

The calculated flow distribution was carried out in the following periods: spring from February to April, midsummer from May of the current year to January of the following year.

The month with the most water is March, when from 15.8 to 31.7% of the annual runoff is formed. In the month of May, from the current month to January of the next year, from 1.0 to 9.7% of the annual runoff is formed.

Calculate the intra-annual distribution of runoff by the layout method for irrigation purposes with an estimated probability of exceeding P = 25%, 50%, 75% and 97%.

For the rivers of the Lower Dnipro sub-basin, the spring season is February, March, and April; summer-autumn: May, July, August, September, October, and November; and winter: December and January of the following year.

The amount of cash flow for individual seasons and periods is determined by the sum of average monthly expenses for the specified months.

The intraseasonal distribution is taken as the average for each of the three groups of water content (abundant water group, which includes years with flow assurance per season P <33%, average water

content 33 <P <66%, low water P> 66%).
In order to allocate years included in separate water groups, it is necessary to arrange the total costs for the season in descending order and calculate their actual supply.
For rivers without stable ice cover, the runoff in the spring period is estimated at 52.2-63.0%, and in the summer–autumn period at 25.9-31.1%, depending on the water content of the year; and for rivers with stable ice cover, the spring runoff is 50.0-81.0%, summer–autumn 14.3-40.5%, and winter only 4.8-9.5%, depending on the water level of the year.
In a very low-water year, the volume of runoff in the limiting season is critically close to the ecological runoff levels on the rivers of the Lower Dnieper sub-basin; therefore, in such years, strict measures should be taken to comply with consumption norms by water users.