Water Security and Climate Change Conference

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Cuenca, Ecuador
21–23 November 2023

Book of Abstracts

Legal Details

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Preface

Dear Esteemed Participants,

We welcome you to the Water Security and Climate Change Conference 2023! In an era defined by unprecedented environmental challenges, this gathering serves as a critical platform for fostering dWialogue, sharing knowledge, and advancing solutions to address the intricate interplay between water security and climate change.

The Water Security and Climate Change Conference (WSCC) is an annual event where scientists, policy makers, and stakeholders from various sectors discuss the diverse facets of water security and its relationship to climate variability and climate change. The conference strives to go beyond science and build bridges between the state-of-the-art in multiple disciplines and different groups of stakeholders and practitioners. The WSCC aims to provide a platform for discussions on water and food secure societies, by creating a stimulating environment that produces innovative ideas and clear pathways towards their implementation. This successful conference has already taken place in Thailand, Germany, Kenya, Mexico, and Vietnam.

As an initiative of the 'Higher Education Excellence in Development Cooperation – exceed' program the WSCC been initially implemented under the auspices of the Sustainable Water Management in Developing Countries network (SWINDON) and the Centers for Natural Resources and Development (CNRD) in close cooperation with the Asian Institute of Technology (AIT). The scientific and organizational committee has been continuously expanded and today includes the Food Security Center (FSC), the University of Cuenca, and the SDG^{nexus} Network.

This conference brings together a diverse community of scholars, scientists, policymakers, and practitioners from around the world, united by a shared commitment to unraveling the complexities of water security in the face of a changing climate. Our collective expertise, experiences, and innovative ideas will contribute to a deeper understanding of the challenges ahead and the development of sustainable, equitable, and resilient water management strategies.

Welcome to the Water Security and Climate Change Conference 2023!

On behalf of the Scientific Committee

Dr. Björn Weeser

Agenda

Welcome Session

21.11.2023 09:00 - 09:45

Moderation: Andrea Malquín

The Welcome Session paves the pathway for the WSCC2023. Besides essential logistical information to ensure your seamless participation and an overview about the diverse sessions and activities scheduled for the coming days, welcoming addresses will be given by the University of Cuenca, the Head of Cooperation of the Federal Republic of Germany in Ecuador, the German Academic Exchange Service.

09:00 09:05	Opening Words	Rolando Celleri & Björn Weeser
09:05 09:10	Rector of the University of Cuenca	Maria Augusta Hermida
09:10 09:20	Head of Cooperation of the Federal Republic of Germany in Ecuador	Barbara Schulz-Hönerhoff
09:20 09:30	DAAD- German Academic Exchange Service Higher Education Excellence in Development Cooperation	Sherif Azab-Els
09:35 09:45	Overview of the WSCC23 program	Rolando Celleri & Björn Weeser

High-Level Panel Discussions

The High-Level Panel Discussions provide a platform to bring together influential voices, foster knowledge-sharing, and generate meaningful discussions that can inspire attendees and drive advancements related to the conference topic. The panelists are invited by the steering committee and share their expertise, experiences, and opinions on a defined topic, engaging in a dynamic and interactive conversation.

The sessions will be recorded, and the videos will be uploaded to the conference media channels, where they will be freely accessible.

HP1: Future-proof systems for a changing world - Adapting to extremes as the “New Normal”

21.11.2023 09:45 - 10:45

This High-Level Panel discussion, moderated by Prof. Dr. Lars Ribbe, opens this year’s WSCC by addressing key challenges of changing environments in response to climate change and water issues.
The “new normal” of our environment is characterized by systemic shocks and crises, which are much more unpredictable and extreme than ever before. Within this new reality we are facing the challenge of safeguarding the valuable attributes of our social, economic, and ecological systems while recognizing the need for adaptation and transformation. This requires a comprehensive and differentiated strategy that engages all parts of society to find innovative, effective, as well as sustainable, fit-for-purpose solutions.
The panel participants represent our society from the fields of science, politics, business, and development sector and will bring their regional and subject-specific expertise to the panel in order to outline the characteristics of future-proof systems that can meet the challenges of climate change and water security. A central task of the panel will be to further shape the guiding questions of the WSCC 2023 conference to provide important impulses for a controversial, open and at the same time target-oriented discussion.

Persons:

Andreas Haarstrick (Moderator)	Professor for Bioprocess Engineering Leichtweiß Institut at the TU Braunschweig
Christian Birkel	Water and Global Change Observatory University of Costa Rica
Lars Ribbe	Institute for Technology and Resources Management in the Tropics and Subtropics (ITT) at the TH Köln - University of Applied Sciences
Diana Ulloa	Red Agua Ecuador
Andrés Martínez Moscoso	Director de Instituto de Investigaciones Jurídicas Universidad San Francisco de Quito
Victor Shinde	Head Climate Centre for Cities National Institute of Urban Affairs Core 4B, India Habitat Centre

The Keynote Sessions are for invited thought leaders and visionaries to address the gathering. Keynote speakers will be invited to Cuenca to deliver their talk in person. These sessions will be recorded and shared through the conference media channels.

Keynote Speaker

KS1: Theme 1 - Co-producing climate adaptation strategies for mountain water security

22.11.2023 09:00 - 09:45

Wouter Buytaert

Abstract

Mountains are among the most at risk of global climate change. They combine highly complex and variable biogeochemical processes with vulnerable populations and development challenges. The high complexity of such systems is a challenge to the design and implementation of adaptation strategies. They need to be adapted to the local environment, but also with the socio-cultural setting and specific human and environmental needs. A co-production approach can help ensuring that the multi-faceted needs and preferences of vulnerable communities are accounted for. Using experiences of projects in South America, Africa, and South Asia, my talk elaborates the challenges and opportunities of co-producing adaptation strategies for water security, and highlights some success stories using novel approaches and technologies for data collection, analysis, and knowledge production.

Wouter Buytaert is a renowned hydrologist and professor of Hydrology and Water Resources at Imperial College London, affiliated to the Department of Civil and Environmental Engineering and the Grantham Institute – Climate Change and the Environment.
His research focuses on environmental change and its impact on the water cycle, with a specific focus on managing water resources and mitigating flood and drought risks – particularly in the Andes and Himalayas regions. Throughout his career, Wouter Buytaert has published numerous research papers and articles, contributing significantly to the scientific community's understanding of hydrology and water-related challenges. His work enhances the connection between science and policy, equipping policymakers and water resource managers in climate and water vulnerable regions with pivotal decision-support tools. In addition, Wouter serves as an editor of the EGU journal Hydrology and Earth System Sciences and acts as the Specialty Chief Editor of Frontiers in Earth Science. In 2022, Wouter received the prestigious Darcy medal of the European Geosciences Union, reflecting his outstanding scientific achievements in the field of water resources research and management. Furthermore, he is part of the UNESCO IHP writing team for the World Water Development Report, and supports IHP in the promotion of open science and knowledge co-production in water management.

Keynote Speaker

KS2: Theme 2 - Strategies and challenges for soil and water management and increasing resilience to climate change in agricultural production systems in Brazil

22.11.2023 10:00 - 10:45

Aluísio Granato de Andrade

Abstract

The conversion of natural areas into productive areas made it possible to increase the supply of food, fiber, energy and other raw materials for the development of humanity. However, many lands that generated wealth through agricultural activities are currently degraded or in the process of degradation. It is estimated that, in the world, around 33% of land has some type of degradation. In Brazil, these areas already reach more than 100 million ha. This degradation situation could worsen with ongoing climate change. The occurrence of increasingly frequent extreme events, such as high-intensity storms, causes an increase in the spread of erosive processes and the rise in temperature generates greater water consumption for agricultural production, negatively impacting a wide range of crops, which creates risks for food security. Adaptation gains relevance as evidence indicates the occurrence of impacts associated with climate change, which can influence, positively or negatively, natural, human, productive and infrastructure systems. Possible impacts for Brazil and South America consist of the extinction of habitats and species, mainly in the tropical region; replacement of tropical forests with savannas and semi-arid vegetation with arid; increase in regions in a situation of water stress, that is, without enough water to meet the demands of the population and an increase in pests in agricultural crops, in addition to the displacement and migration of populations. In order to plan mitigating actions, it is extremely important to anticipate the impacts on the productivity of different agricultural production systems and the quality of the products. An increase in temperature could lead to an increase in the frequency of extreme events in different regions of Brazil, as well as a change in the rainfall regime, with a greater occurrence of droughts, floods, flooding, landslides and consequent population displacements in the affected regions. These changes will have consequences on society, ecosystems and different sectors of the economy. The absence of a national soil and water conservation policy was highlighted by the Audit Report on Soil Governance in Brazil as one of the main risks for the sustainable management of these resources. On the other hand, some more current initiatives point to directing efforts to reverse this situation, through the execution and evolution of these policies, such as the National Policy for the Recovery of Native Vegetation, the Bill: National Policy for Use, Management and Conservation of Agricultural Soil, the National Soil Survey and Interpretation Program of Brazil (PRONASOLOS), which will make it possible to detail soil information in the country at scales more compatible with planning for the sustainable use of soil and water resources, the National Water Resources Policy , especially the Water Producer Program, the Low Carbon Emission Agriculture Plan and also initiatives from some States of the Federation with the Hydrographic Microbasins Programs. Considering the extensive underutilized areas, with varying levels of degradation, existing in Brazil today, the application of available technologies with greater sustainability and resilience to climate change, such as integrated agricultural production systems, represent an opportunity to increase national agricultural production without the need to expand the agricultural frontier through deforestation and also contribute to reducing the impacts of climate change with greater carbon sequestration in the soil and agroecosystems and reduction of greenhouse gas emissions. The continental expression of Brazil will require overcoming a set of challenges in managing soil and water resources to promote integrated action by public and private institutions and greater participation by society in actions to mitigate climate change in different biomes, with vegetation, relief , different soils and climate, in addition to contrasting socioeconomic and cultural aspects.

Aluísio Granato de Andrade is a Brazilian agronomic engineer who works as a senior researcher at the National Soil Research Center of the Brazilian Agricultural Research Corporation (Embrapa Solos). He is a specialist in soil science and land use planning, with over 30 years of experience in the field, focusing on the sustainable use of soil and water resources.

He studied agricultural engineering at the Federal Rural University of Rio de Janeiro (UFRRJ), graduating in 1988. He went on to obtain a master's degree in Agronomy (1993) and a Doctorate (1997), both at the same university (UFRRJ).

At Embrapa Solos, he has been coordinating research, development, and technological innovation projects in the areas of soil use, management, conservation, and recovery since 1996. Currently he is the coordinator of the project "Participative Construction of the Brazilian National Plan for Sustainable Soil and Water Management". He has held various positions at Embrapa Solos, including Technical Head and Deputy General Head from 2004 to 2008, and Technical Director of the Agricultural Research Company of the State of Rio de Janeiro (PESAGRO-RIO) from November 2009 to January 2012. Besides, he was the technical director of the Association of Agricultural Engineers of the State of Rio de Janeiro (AEARJ) from 2009 to 2012.

After working as professor at the Department of Soils of UFRRJ from April 1995 to January 1996, he holds a professorship in Recovery of Degraded Areas at PUC-Rio since 2007.

Keynote Speaker

KS3: Theme 3 - Confronting the Politics of Water Security

23.11.2023 09:00 - 09:45

Jami Nelson-Nuñez

Abstract

Increasing access to drinking water was one of the success stories of the Millennium Development Goals. Yet, eight years into the Sustainable Development Goals, there is reason to believe that we are increasingly off target. To address the challenge of water security, we need to contend with misconceptions about why people lack access to water and recognize the institutional roots of water inequities. Because institutions serve to create clarity and regulate behavior, they protect the status quo and become obstacles in responding to rapidly changing water landscapes. In this talk, I draw from what communities have taught me about institutional arrangements that can increase local water security as well as what lessons political science can offer regarding our shared challenge ahead to reshape institutions to address water security at national and global levels.

Jami Nelson-Nuñez is an Associate Professor and Chair of the Department of Political Science at the University of New Mexico.

Her research focuses on the politics of water across the Americas. With projects in Bolivia, Peru, Chile, Honduras and the American Southwest, Dr. Nelson-Nuñez explores the policies and institutional arrangements that shape how government ministries, local mayors, rural technicians and NGOs interact to deliver water services to underserved and marginalized groups. Other projects explore approaches to managing water security within the context of climate change. This includes work in the Central American Dry Corridor where rural communities face growing water scarcity as well as a project on the political dynamics of expanding desalinization capacity in the United States and Chile. Most recently, Dr. Nelson-Nuñez joined a collaborative project between researchers and indigenous communities in New Mexico to develop onsite water testing technology to identify heavy metal contaminants.

Dr. Nelson-Nuñez has published widely on water policy, including in the journals of World Development and Water Policy, and serves on the editorial board of journal Comparative Studies in International Development. She is the co-founder of the annual University of Colorado Water Sanitation and Hygiene (WASH) Symposium, and she has organized events to bring greater attention to issues of water justice, including the Greenleaf Symposium on Rural Transformation in Latin America's Changing Climate, the Water and Climate Change in the Central American Dry Corridor Workshop, and the UNM Water Politics in Latin America speaker series.

Thematic sessions

The Thematic Sessions host the oral presentations in which authors present their work in a brief format. Oral presentations are selected and assigned to a thematic session by the committee based on the submitted abstract.

Each session starts with a five minutes introduction, followed by five presentations of 12 minutes and three minutes of discussion and closes with a 10 minutes general discussion.

Theme 1 - Water and Climate: Challenges, Opportunities, and Innovative Solutions

T1 S1: Water Management and Hydropower Integration in a Changing Climate

21.11.2023 11:15 – 12:45

Organizer: Rolando Célleri Alvear, Pablo Guzmán, Paul Muñoz

The session “Water Management and Hydropower Integration in a Changing Climate” offers a profound exploration of the crucial nexus between hydropower, water management and optimization, and the ever-evolving climate. With a focus on the intricate dynamics of hydropower, it sheds light on the resilience required to confront natural climate change and address water deficits. Moreover, the session explorers a strategic framework of cost-benefit sharing in preparation for extreme events that may disrupt the delicate equilibrium.

Hydropower, as a pivotal source of renewable energy, can support the transition to a low- or zero-carbon energy system and mitigate climate change impacts. At the same time, hydropower stations interact manifold with the environment. The interactions span from negative impacts on the aquatic ecosystem to problems related to the sediment transport. The interplay between these elements shapes landscapes and ecosystem dynamics and has far-reaching consequences for both energy production and environmental conservation.

As natural climate change becomes more pronounced, the adaptability and resilience of water management practices are paramount. Using cost-benefit approaches can improve the water allocation, particularly under climate extremes. Hence, the session explores how innovative solutions can mitigate the impact of water deficits, ensuring the sustainable allocation and use of this vital resource and demonstrate how suitable water management can support the mitigation process.

This session unravels the intricate interconnections between hydropower, sediment transport, resilience, water management, and the adaptive strategies necessary to navigate a changing climate. Discover how these integrated practices contribute to the sustainable future of water resources and energy generation in the face of climatic uncertainties.

The objectives of this session are to establish the main climate change threats to hydroelectricity as well as to explore and emphasize the crucial interplay between hydropower dynamics, water management strategies, and climate resilience, while also demonstrating innovative solutions and routes of action to mitigate water deficits, ensuring sustainable resource allocation, and supporting climate change mitigation efforts.

Time	Title	Speaker
11:15 11:20	Welcome and introduction	
11:20 11:35	Impacts of climate change on the hydropower potential of a multipurpose storage system project in Bolivian Andes	Ivan Alexis Chavez Flores
11:35 11:50	Integrating intermittent renewables via hydropower can impact other water-related sectors	Jose Miguel Gonzalez Cabrera
11:50 12:05	Climate variability impact on long-term capacity of hydropower reservoirs in Andean regions. Case of study: Cañete river, Peru.	Miluska Anthuannet Rosas Barturen
12:05 12:20	Influence of Low-Impact Development in Flood Control: A Case Study of the Febres Cordero Stormwater System of Guayaquil (Ecuador)	Fabian Quichimbo
12:20 12:35	Cost-Benefit Sharing for Water Security: A Case of River Basin in India	Nitin Bassi
12:35 12:45	General discussion and summary	

T1 S2: Ecosystem Resilience and Sustainable Practices

22.11.2023 11:15 – 12:45

Organizer: Alicia Correa, Björn Weeser

In the face of environmental challenges driven by a changing climate, the session on “Ecosystem Resilience and Sustainable Practices” explores innovative approaches aimed at safeguarding our planet’s delicate balance. Within this session, the presenters will cover various topics, including methodological guides, adaptation strategies, and the integration of circular economy concepts to foster resilient ecosystems. The discussion will encompass diverse terrains, ranging from headwaters in the Tropical Andes to coastal ecosystems in the Pacific and the Mexican Caribbean.
Key themes of this session are centered on the pivotal roles of biodiversity, ecosystem services, and natural infrastructure in climate adaptation and mitigation. Circular economy principles will also take center stage, aiming for sustainable resource use and reuse, particularly focusing on enhancing the resilience of ethnic communities in the face of climate change. Speakers will examine human-induced pressures on high-altitude ecosystems and emphasize the role of native forests -as natural infrastructure- and wetlands for water security, resilience and adaptation of such ecosystems. Furthermore, the session will explore the impact of socio-economic development on lowland ecosystems and how circular economy practices contribute to their resilience. The aim is to ensure these ecosystems retain their vitality and continue to serve their inhabitants amidst evolving environmental conditions.
Overall, this session is aimed to gain a deeper understanding of how innovative practices can fortify our planet’s ecosystems and contribute to a more sustainable future for all.

Time	Title	Speaker
11:15 11:20	Welcome and introduction	
11:20 11:35	Methodological guide for ecohydrological monitoring in Andean basins: towards an integrated analysis of biodiversity and ecosystem services	Jan Baiker
11:35 11:50	The Potential of High-Andean Forests to Provide Ecohydrological Resilience to Climate Change in the Andean Páramo	Giovanny Mosquera
11:50 12:05	A low-cost framework for estimating high-altitude wetlands' contributions to streamflow	Anthony Ross
12:05 12:20	Water related NbS´s and circular economy for indigenous communities in Colombia	Diana Lucia Diaz Romero
12:20 12:35	Sustainability of the Mexican Caribbean: Converting Weaknesses into Strengths	Rodolfo Silva
12:35 12:45	General discussion and summary	

T1 S3: Building Climate Resilience in Water Systems: Strategies and Solutions

23.11.2023 11:15 – 12:45

Organizer: Björn Weeser, Alicia Correa

This session highlights the pressing need for climate resilience in water systems and delves into a multifaceted exploration of strategies and solutions crucial for ensuring a sustainable and secure water future.

The talks address the key topics of water supply, water resources, and the availability of safe drinking water, with a particular focus on the unique challenges faced by cities in their quest for sustainability. From the assessment of social-ecological systems in subtropical regions, demonstrated in the Mexican Rioverde Region, to the innovative approaches used in the middle-sized Latin-American city Cuenca for sustainable water management, this session offers a comprehensive overview of the latest research and practical solutions. “Making thirsty cities sustainable” underscores the importance of adopting a nexus approach for water provisioning, as demonstrated in the case of Quito, Ecuador. “Aquavida” sheds light on the improved living conditions of communities promoting resilient societies to climate change. As cities continue to expand and face the consequences of climate change, the “Urban River Management Framework” in India introduces a powerful tool to propose holistic management of rivers that encompass environmental, social, and economic aspects, ensuring the well-being of both the population and the natural ecosystems.

Throughout this session, discussions will encompass strategies to maintain biodiversity, secure water supply, and engage stakeholders effectively. Join us to explore the innovative approaches and practical solutions that contribute to building climate resilience in water systems, guaranteeing a sustainable water future for all.

Time	Particulars	Speaker
11:15 11:20	Welcome and introduction	
11:20 11:35	Making thirsty cities sustainable: a nexus approach for water provisioning in Quito, Ecuador	Dunia González-Zeas
11:35 11:50	Sustainable water management under climate change in a middle-size Latin-American city	Ana Ochoa-Sánchez
11:50 12:05	Aquavida: contribute to water Security through access to safe drinking water	Yenny Alejandra Restrepo Gesama
12:05 12:20	Assessing social-ecological systems for resilience to climate change in sub-tropic regions: an integrated sensitivity model-based approach for water security and stakeholder management.	Osmar Alejandro Farias Garduño
12:20 12:35	Urban River Management Framework: A tool to enhance climate resilience in Urban Areas	Jyoti Verma
12:35 12:45	General discussion and summary	

Theme 2 - Water & Climate Resilience in Agri-Food Systems

T2 S1: Climate change, crises and shocks affecting agri-food and ecosystems

21.11.2023 11:15 – 12:45

Organizer: Marcus Giese, Alejandro Pieters

Climate change, various crises and shocks are affecting agri-food and ecosystems by threatening food and water security. One of the highest impacts is addressed to climate change in combination with water scarcity and the observed trend of increasing extreme events. To improve the resilience and responsiveness of agro-ecosystems during a process of transformation and climate change adaptation we need to increase our knowledge on management impacts on system's key components such as the water cycle. Case studies dealing with water footprints, risk assessment and farmer's perceptions are important contributions to identify promising adaptation pathways of agriculture to climate change.

Time	Particulars	Speaker
11:15 11:20	Welcome and introduction	
11:20 11:35	Water footprint of sugarcane cultivation in a semi-arid climate region.	Florencio Lourdinha
11:35 11:50	Climate Change Impacts on Agricultural Water Footprint Using CORDEX Climate Scenarios.	Correa Alicia
11:50 12:05	Climate trends and farmer;s perception about climate change and its potential impact on food security through agricultural activities, San Marcos - Cajamarca	Rojas Luciana
12:05 12:20	Climate change and food security in mountain agri-food systems: Unpacking resilience and adaptation in Tehri Garhwal, India	Neha Yadav
12:20 12:35	Adaptation Pathways for Agriculture in Central Asia under Climate Change	Petrick Martin
12:35 12:45	General discussion and summary	

T2 S2: Innovation and Technology for Agri-Food Systems transformation

22.11.2023 11:15 – 12:45

Organizer: Alejandro Pieters, Marcus Giese

New and innovative technologies are key to develop sustainable agri-food systems. Water has become a highly competed resource and agriculture uses a large share of available water on the planet. The scenarios are further exacerbated due to the increased chance of extreme climatic events leading to water scarcity and drought promoted by climate change. More efficient and sustainable uses of water in agri-food systems are needed, which would include reuse and water treatment, smart agriculture, water management and assessing the sustainability of current irrigation systems.

Contributions will allow the comparison of different innovation approaches to design more efficient and sustainable agri-food systems in relation to water use, management and water quality improvement.

Time	Particulars	Speaker
11:15 11:20	Welcome and introduction	
11:20 11:35	Wastewater reuse for agriculture – Treatment with low-cost trickling filters in different climates in Peru and Cameroon	Kraus Manuel
11:35 11:50	Biorefineries: the link between agroindustrial wastewater and green energy	Victor Alcaraz-Gonzalez
11:50 12:05	Morphological development and productivity of bean cultivated with reclaimed water and biosolid	Kato Mario T.
12:05 12:20	The effect of vapor pressure deficit on genotypic nutrient uptake and biomass production of hydroponically grown tomato	Detering Theresa
12:20 12:35	Understanding sustainable issues in Andean irrigation systems: insights from 235 systems	Berrones Gina
12:35 12:45	General discussion and summary	

T2 S3: Societal and economic improvements to increase resilience and adaptation capacity

23.11.2023 11:15 – 12:45

Organizer: Gina Berrones, Adrián Sucozhañay

As we face environmental degradation and escalating resource demands, the need to adapt and enhance resilience is more pressing. This dynamic landscape is shaped by technological advances, urbanization, and the vital role of policies and governance. Innovation is pivotal in driving sustainable economic improvements, while public-private partnerships play a central role in addressing resource scarcity and climate change. Therefore, understanding the current state of the populations' development is crucial to recommend and focus actions to adapt to climate change.
This session aims to examine insights and solutions to move towards a future characterized by increased resilience and adaptability. It will focus on understanding the relationships between societal and economic improvements and the urgent challenges we face.

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11:15 11:20	Welcome and introduction	
11:20 11:35	The Gulf of Nicoya Food-Climate-Biodiversity NEXUS in Costa Rica	Christian Birkel
11:35 11:50	Sustainable rural development starts with water	Nátali Maidl de Souza
11:50 12:05	Improving Food-Nutrition and Water Security Outcomes through the Adoption of Climate-smart Practices: Evidence from Agricultural Households in South Africa	Omotayo Abiodun Olusola
12:05 12:20	Farmers´ perceptions and strategies for adaptation to climate variability in an Andean mountain agroecosystem	Mishel Palacios
12:20 12:35	"Are the rains failing us?": Exploring female rice farmers' perceptions and adaptation to climate change and food insecurity in Northwest Cameroon	Lotsmart Fonjong
12:35 12:45	General discussion and summary	

Theme 3 - Water Security: Science-Policy-Society Dialogue (Priorities & Implementation)

The water issue is an integrative part of a chain of responsibility that links science, politics and society. Unfortunately, this chain of responsibility still has too many gaps (mostly at the political level), which hinder a real implementation of the goals in reality. Water security requires incorporating water sector development priorities into national strategies worldwide to adapt to climate change. Science and policy makers need to work closely with civil society to adapt and implement measures which effectively solve the majority of water and climate-related problems.

T3 S1: Science-policy-society interaction and problem solution

21.11.2023 11:15 – 12:45

Organizer: Andreas Haarstrick, Kai Münnich

The session wants to work out the role of science, policy and society to tackle the water crisis also in the context of climate change. What needs to be done urgently and how should it be done? Global experience in project implementation shows that although the basic problems are often very similar, the local approaches to solving them can be very different. Even when using best available practices, the existing knowledge of the local population and the respective social and cultural characteristics must be taken into account in order to ensure the acceptance and sustainability of the project.

Time	Particulars	Speaker
11:15 11:20	Welcome and introduction	
11:20 11:35	From Knowledge to Governance: Understanding Water Security Dimensions in the Mira-Mataje Transboundary Catchment	Aliya Assubayeva
11:35 11:50	Integrating society in the planning of adaptation measures based on water consumption habits. A pilot project in an Andean city.	Johanna Ochoa Ruilova
11:50 12:05	Urban water security: A comparative assessment and policy analysis of five cities in diverse developing countries of Asia	Kaushal Chapagain
12:05 12:20	The Chillca Participatory Ecohydrological Monitoring System – a community science-based pilot project for the resilience of high-Andean pastoral systems	Dina Farfan Flores
12:20 12:35	Best Practices for Water-Scarce Cities: Proposed Policies towards an Integrated Urban Water Management in Egypt and the MENA Region	Zeina ElZein
12:35 12:45	General discussion and summary	

T3 S2: Methodologies to cope with water security

22.11.2023 11:15 – 12:45

Organizer: Andreas Haarstrick, Kai Münnich

In addition to the impact of climate change on available water, its quality is also of great importance, not only with regard to the supply of drinking water, but also in the field of agriculture and industrial production. The possible causes of natural or anthropogenic contaminants that affect ecosystems as well as human health are manifold. The effects also on economic efficiency especially for large-scale water distributions have to be considered in the context of WS index calculations and modeling. This also applies in particular to new, water-intensive technologies that enable a switch to green energies. This session tries to find an answer.

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Time	Particulars	Speaker
11:15 11:20	Welcome and introduction	
11:20 11:35	Network-based model integrating water quantity and quality in an economic-integrated modeling platform: Total Phosphorus load in the Capibariba river basin and its impact on three other interconnected basins in Pernambuco, Northeast of Brazil	Laise Alves Candido
11:35 11:50	Mapping fluoride ions in Latin American ground waters as a tool to promote water security	Elvis Carissimi
11:50 12:05	Baseline of Water Security in Ecuador: A Multidimensional Analysis and Prioritization for Conservation and Restoration	Boris Ochoa-Tocachi
12:05 12:20	Assessing the potential of nature-based solutions as sustainable land and water management strategies in the High Tropical Andes páramo ecosystem	Kalina Marcela Fonseca Largo
12:20 12:35	Water issues related to green hydrogen production in a semi-arid region in Brazil	Jose Araruna
12:35 12:45	General discussion and summary	

T3 S3: Society interaction and involvement to solve water management problems

23.11.2023 11:15 – 12:45

Organizer: Andreas Haarstrick, Kai Münnich

In many countries, in addition to economic and technical problems, there are also cultural and social obstacles that hinder successful project implementation. The position of women in many societies is particularly striking. Although they are largely responsible for procuring water for the households, especially in rural areas without a stationary water supply, the proportion of women in senior management positions is very low. In addition, there is often the socio-economic aspect that poorer sections of the population are more affected by water scarcity than sections that are more privileged. This session aims to find answers on how to close this gap between research, technical feasibility and actual implementation.

Time	Title	Speaker
11:15 11:20	Welcome and introduction	
11:20 11:35	Factors influencing women's representation in water resource management	Maria Isabel Chumi Pasato
11:35 11:50	Water crisis, women and water self-management: the case of the Independence Basin in Guanajuato Mexico.	Gabriela Morales Aguilar
11:50 12:05	Bridging the gap between water research and practice	Prabin Rokaya
12:05 12:20	Water sustainability: Socio-ecological description of Panama using MuSIASEM approach for 2019.	Lucila Chang-Fossatti
12:20 12:35	Co-created Participatory Approaches to Water Security Research and Multi-Level Governance that Leaves No One behind	Juliana Hayden-Nygren
12:35 12:45	General discussion and summary	

Workshops

WS 1: Toolbox for Early Career Scientist

21.11.2023 14:15 - 15:45

Organizer: Alicia Correa, Björn Weeser, Sherif Azab-Els, Johanna Orellana-Alvear

The “Toolbox for Early Career Scientists” workshop is designed to provide early career scientists (ECS) a comprehensive set of skills and knowledge to navigate the complex world of scientific research, funding, mentorship, and the art of delivering an effective elevator pitch. Participants are invited to join the “Toolbox for Early Career Scientist” workshop to equip themselves with the essential skills and resources required for a successful scientific career. Whether they are at the outset of their academic journey or aiming to enhance their research skills, this workshop is the gateway to a brighter future in the world of science. This is an opportunity to invest in their academic and research success that they should not miss.

Workshop Content:

1. Unlocking Funding Opportunities provided by the German Academic Exchange Service (DAAD)
2. Sherif Azab-Els from the DAAD headquarter in Germany will provide insights into the diverse range of scholarships, grants, and funding opportunities. The participants will particularly learn how to navigate the application process for master’s, PhD, and postdoctoral research
3. The Power of Mentorship
4. Johanna Orellana, the director of the PROMEMCI mentoring program, showcases the importance of mentorship in shaping academic and research journeys. Participants will understand how mentorship relationships can lead to new opportunities, offer guidance through academic challenges, and provide valuable career development advice.
5. Perfecting Your Elevator Pitch
6. In this hands-on exercise, guided by Alicia Correa and Björn Weeser from the SDGnexus Network, attendees will develop the essential skill of crafting a compelling elevator pitch. Whether explaining their research, introducing themselves to potential collaborators, or seeking opportunities, a concise and engaging elevator pitch is crucial. This session will provide practical guidance and opportunities to refine their pitch, ensuring they can confidently convey their message in a concise and impactful manner - and practice their pitch in the further cures of the conference.

Key Takeaways:

- Knowledge of DAAD funding opportunities and the ability to navigate the application process.
- Insight into the importance of mentorship and strategies for establishing meaningful mentor-mentee relationships.
- Enhanced ability to craft and deliver an effective elevator pitch.
- Networking opportunities with fellow young scientists and potential mentors.

WS 2: Water Security Index

21.11.2023 14:15 - 16:15

Organizer: Kaushal Chapagain, Victor Shinde

Water is at the heart of basic human security—food, energy, culture, aesthetics. How water is managed will have repercussions on almost every aspect of human security, which is why achieving adequate water security is among the top priorities of government policies across the globe. While formulating policies to enhance water security are important, even more crucial is monitoring the changes brought about by implementing these policies. This comes from the notion that the need of the hour in today's time is to operationalize water security. However, as the adage goes, "we cannot manage what we cannot measure".
This workshop will introduce the participants to a tool called WATSAT (Water Security Assessment Tool) that is meant to address this very need—How to measure water security? WATSAT has been developed by the Asian Institute of Technology (Thailand), the National Institute of Urban Affairs (India), Thuyloi University (Vietnam), Tribhuvan University (Nepal), and Central University of Rajasthan (India).
WATSAT is a web-based tool written in the C#.net programming language with the welcome page interface written in JavaScript and HTML. WATSAT comprises a three-layered structure—dimensions, indicators and variables—that ultimately results in the Water Security Index (WSI). It comprises five dimensions and twelve indicators and provides users with a long list of potential variables to choose from to reflect the indicators. The tool has been developed to make it as user-friendly as possible, keeping in mind that its actual design purpose is to facilitate city authorities and decision-makers to make an objective evaluation of the water security situation and foster practical solutions to improve water security in the city.

Guidance Notes for Participants:

Please bring a laptop with you for the hands-on exercise.
Supporting journal articles for the scientific background on the water security assessment framework:
How to measure urban water security? An introduction to the Water Security Assessment Tool (WATSAT). doi: https://doi.org/10.30852/sb.2023.2166
Measuring water security: A vital step for climate change adaptation. doi: https://doi.org/10.1016/j.envres.2020.109400
Urban water security: A comparative assessment and policy analysis of five cities in diverse developing countries of Asia. doi: https://doi.org/10.1016/j.envdev.2022.100713
A disaggregated assessment of national water security: An application to the river basins in Thailand. doi: https://doi.org/10.1016/j.jenvman.2022.115974
Please feel free to explore the web-based version of the WATSAT tool at http://www.watsat.org/ prior to the training workshop.
Exercise data for the hands-on session are provided here for your reference.

WS 3: Water security challenges to social-ecological systems: a multi-perspective approach

21.11.2023 14:15 - 15:45

Organizer: Fabian Drenkhan, Alex Fremier, Mario Córdova, Rolando Célleri

Implementing integrated solutions to promote water security can be hindered by both biophysical, socioeconomic and governance factors, including climate and land use changes, as well as changing water demand and water policies. The concept of Integrated Water Resource Management has been around for decades, and new applications of integrated water solutions have emerged in local watersheds from across the globe. In this session, we aim to highlight innovative solutions linked to water security of social-ecological systems and related challenges for research and decision-making. In this session, we invite participants to present in a rapid format an existing, local-scale, innovative approach to water security. Our goal is to prepare a multi-case study manuscript highlighting emerging approaches that balance competing water needs and differing values. Afterwards, we will invite the audience to an informal meeting to further the conversation.
Conference participants interested in presenting their case study can email Fabian Drenkhan fdrenkhan@pucp.pe to receive further instructions.

WS 4: Policies for making agri-food systems resilient to climate change: what we do know and what we should know

22.11.2023 14:15 - 15:45

Organizer: Martin Petrick, Aliya Assubayeva

This interactive workshop draws on the participants' expertise to provide a sketch of the current knowledge on policies for climate resilience in agriculture and food systems. After an introductory input by the organizers, we collect the insights of participants on which policies work for making agri-food systems more resilient against climate change related risks. To foster dialogue, a focus will be on experiences gained in specific countries or regions the participants do research on. In a second interactive round, we will identify knowledge gaps and draft the outline of a future research agenda.

WS 5: Diving into uncertainty: Decision making for Climate Change Adaptation in the mangroves of Guayas, Ecuador

22.11.2023 14:15 - 15:45'

Organizer: Alba Calles Procel, Sudeh Dehnavi, Lucia Calla Durandal, Sandra Avendano Rondon

The aim of this workshop is to raise awareness of how local knowledge and cultural context influence decision-making for climate change adaptation, sustainable ecosystem management, and securing the community livelihoods.
The case study is the mangroves in the Inner Estuary of the Gulf of Guayaquil "Don Goyo", situated in the southern region of Ecuador. These ecosystems, classified as intertidal wetlands, thrive

in the transitional zone between the ocean and the terrestrial environment. Nevertheless, despite their ecological significance in providing coastal protection, and their vital role in sustaining the livelihoods of local communities, these mangroves face ongoing and imminent threats associated with habitat loss.
This interactive workshop explores climate change adaptation, emphasizing inclusive decision-making that values local knowledge and community perspectives, allowing participants to experience the challenges faced by decision-makers in addressing environmental issues. Consists of three main parts: introduction, game play (participatory discussion groups) and de-briefing. The game play part is divided into three rounds, each representing a different phase of decision-making: Round 1 - Understanding the Basics, Round 2 - Contextualizing Decisions and Round 3 - Informed Decision-Making. The Participants are expected to decide on the climate change adaptation measures in the context of the introduced case study and to revisit and work on their decision in each round based on the information received.

Learning Outcomes: By the end of the workshop, participants have

- explored the challenges and complexities involved in the mangrove management of Gulf of Guayaquil
- developed critical thinking skills by adapting their strategies based on real-world insights

Key Takeaways:

- Recognizing the role of cultural and social contexts in shaping climate change adaptation strategies.
- Appreciating the value of the local knowledge to sustain ecosystems under climate change uncertainties.

This workshop is part of the Project “Strengthening the Climate change, ecosystems and livelihood nexus in coastal zones of Ecuador - CELICE” between University of Applied Science - TH Köln, German and ESPOL University, Ecuador. The project is funded by the German Academic Exchange Service (DAAD).

WS 6 - Water Funds: A Financial Mechanism towards Water Security

22.11.2023 14:15 - 15:45

Organizer: Eduardo Villagómez, Bert De Bievre, Pablo Lloret

Water Funds have proven to be an innovative and efficient solution that focuses on rising funds for implementing different strategies for watershed conservation and restoration, based on science and recognizing ancestral knowledge and previous social experience.

In this session we will present different experiences from the very first water fund (started in 2000), to the newly created Andean Water Funds Platform, which includes 10 different funds from 3 countries in Latin America. Special attention will be given to the relationship with research, monitoring and academia.

After a short presentation from the panelists, that will include achievements and current and future

challenges, we will start an open discussion where we hope to identify new opportunities to collaborate with different partners in applied research focused on water security.

WS 7: Theme 1: Hydro-climatic Nexus: Unveiling Scientific Perspectives on Water and Climate Challenges

23.11.2023 14:15 - 15:45

Organizer: Alicia Correa, Rolando Célleri

Workshop Overview:

This workshop is shaped to extract, discuss, and refine scientific perspectives originating from Theme 1 of the WSCC23 conference, exploring challenges and opportunities at the intersection of water and climate within the following activities:

Activity 1: “Hydro-climatic Ice Breaker Bingo”

Description:

Engage in stimulating game aimed at decoding terms related water and climate. This seeks to found a common understanding and consensus on such topics. The terms will be distributed in the form of cards to participants.

Outcomes:

- Mechanisms for better science communication
- Working group on WSCC23 scientific communication

Activity 2: “Hydro-climatic World Café Discussion”

Description:

Explore the scientific café (coffee) stations, each with key themes to develop ideas from the scientific knowledge gained during WSCC23 Theme 1. Scientists will rotate between stations, contributing ideas and insights to foster inclusive and participatory approaches. Finally, our reporters will summarize the discussions.

Outcome:

- A short document with synthesis of proposals for the development of scientific perspectives, potentially shaping research-driven outcomes and ideas for a community paper.

Join “Hydro-climatic Nexus” and become part of a scientific workshop dedicated to unveiling perspectives on water and climate nexus and related challenges and opportunities. Moreover, network with diverse scientific actors in a collaborative and dynamic setting.

WS 8: Theme 2: Pathways for sustainable agro-ecosystems transformation

23.11.2023 14:15 - 15:45

Organizer: Marcus Giese, Alejandro Pieters, Gina Borrones, Adrian Sucozhañay

Climate change and multiple crises demand for resilient and responsive agri-food systems. Many concepts have been developed and promoted to accelerate a sustainable systems transformation. The food, energy and water nexus is adding complexity with regard to competing land-use strategies while natural resources and ecosystem services need to be safeguarded. Therefore, pathways for system transformation need to make sure that modern agriculture ensures the provision of food and bioenergy, but on the other hand, meets the criteria of sustainable development. This can only be achieved through inter- and transdisciplinary cooperation. When describing promising pathways for sustainable systems transformation, obstacles, opportunities, knowledge gaps, and required resources must be identified from different, multi actor perspectives.
The workshop will promote knowledge exchange and discussions towards promising pathways of sustainable agro-ecosystems transformation.
After a short introduction round to identify the diversity of the participants the workshop will gather ideas and views from participants on various guiding questions in a world café format.

14:15 14:25	Welcome and introduction	Marcus Giese, Alejandro Pieters, Gina Borrones, Adrian Sucozhañay, All participants
14:25 15:25	World Café: small groups rotate between thematic tables and discuss guiding questions with the host	All participants
15:25 15:45	Reporting of table hosts, summary of results, plenum discussion.	All participants

WS 9: Theme 3: Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)

23.11.2023 14:15 - 15:45

Organizer: Andreas Haarstrick, Lars Ribbe

The seriousness of the global water crisis first came to international attention in 1992 at the United Nations Conference on Environment and Development in Rio de Janeiro, known as the Rio Earth Summit. In response to this event, the United Nations General Assembly designated March 22, 1993, as the first World Water Day, an annual opportunity to highlight the significance of freshwater as a life-sustaining resource.
Three decades have passed since the Rio Summit, and while some progress has been made in addressing global water issues, many regions continue to face critical water challenges. These challenges have intensified due to factors such as rapid population growth, industrialization, the unsustainable use of natural resources, and the ever-advancing impacts of climate change. Scien-

tific reports from water experts worldwide emphasize the urgent need for the world to adapt and prepare for a looming water crisis. The reckless exploitation of nature and ongoing climate change are exacerbating these issues, leading to irreversible processes that disrupt delicate ecological balances, with biodiversity at the core. If current practices persist (business as usual), we are likely to reach the much-discussed tipping points by 2050.

One of the key obstacles to addressing water scarcity is the slow pace of institutional adaptation, particularly in the context of climate change. The global water crisis is, in part, a governance crisis, with inadequate and unsustainable water management. A common issue is the lack of integrated political and administrative approaches at different levels. Local and regional cooperation is often lacking or poorly implemented. We need to develop and implement governance structures more rapidly.

Water should be a recurring item on the global policy agenda, rather than addressed only sporadically at conferences every few years. By 2050, not only the projected 10 billion people on Earth will have to contend with reduced water resources, but this challenge will also play a crucial role in shaping adaptations and solutions in the face of climate change. We must continuously address critical water issues, tackling environmental, economic, and health problems simultaneously.

The magic formula lies in 'reliable and cooperative partnerships between states.' Without effective cooperation, we risk failure.

Objectives

In line with the thematic direction of this workshop, we would like to focus on the following points:

- from scientific knowledge and knowledge transformation to solution-oriented implementation
- inclusive and participatory approaches for adaptation
- cross-sectoral implementation of SDG 6
- AI and the design of future water supply and resilience infrastructure in urban areas and agriculture.

The following impulse questions may be used for further orientation:

- How can we trigger policy change?
- How can scientific recommendations be successfully communicated to policy makers?
- What effective ways are there for water experts to help policymakers translate effective public policy actions on water into long-term solutions and could AI help?
- Ultimately, achieving water security requires a long-term, cross-party, and even cross-generational political commitment. What kind of promising hydro-diplomacy do we need (national, international)?
- What is the role or responsibility of academia in this context?
- Are there any tangible avenues for strengthening the interface between science and policy?

Closing Session

23.11.2023 15:45 - 17:15

Moderation: Andrea Malquín

The closing session finalizes the WSCC23 journey of discussing the diverse facets of water security and its relationship to climate variability and climate change. The session promises to be a culmination of the diverse and enlightening discussions that have taken place over the past three days revisiting the key highlights and pivotal moments of the conference.

Agenda:

1. Thematic Impressions
2. Three conference themes framed the in-depth exploration of crucial topics. We will delve into each conference theme, presenting key impressions, insights, and takeaways. This structured approach will allow attendees to reflect on the multifaceted nature of our discussions and reinforce the impact of the conference on various sectors.
3. General Wrap-Up
4. A comprehensive overview of the entire conference will be provided, emphasizing the overarching themes that emerged. Attendees will gain a holistic perspective on the conference's significance and relevance including key-statistics about the WSCC23.
5. Looking Ahead - WSCC 2024:
6. First details for the next WSCC in 2024 will be announced.

Content

Water Management and Hydropower Integration in a Changing Climate > Oral Presentation

36. Impacts of climate change on the hydropower potential of a multipurpose storage system project in Bolivian Andes
37. Integrating intermittent renewables via hydropower can impact other water-related sectors
38. Climate variability impact on long-term capacity of hydropower reservoirs in Andean regions. Case of study: Cañete river, Peru.
39. Influence of Low-Impact Development in Flood Control: A Case Study of the Febres Cordero Stormwater System of Guayaquil (Ecuador)
40. Cost-Benefit Sharing for Water Security: A Case of River Basin in India

Ecosystem Resilience and Sustainable Practices> Oral Presentation

41. Methodological guide for ecohydrological monitoring in Andean basins: towards an integrated analysis of biodiversity and ecosystem services
42. The Potential of High-Andean Forests to Provide Ecohydrological Resilience to Climate
43. Change in the Andean Páramo
    A low-cost framework for estimating high-altitude wetlands' contributions to streamflow
44. Water related NbS´s and circular economy for indigenous communities in Colombia
45. Sustainability of the Mexican Caribbean: Converting Weaknesses into Strengths

Building Climate Resilience in Water Systems: Strategies and Solutions > Oral Presentation

46. Making thirsty cities sustainable: a nexus approach for water provisioning in Quito, Ecuador
47. Sustainable water management under climate change in a middle-size Latin-American city
48. Aquavida: contribute to water Security trough access to safe drinking water
49. Assessing social-ecological systems for resilience to climate change in sub-tropic regions: an integrated sensitivity model-based approach for water security and stakeholder management.
50. Urban River Management Framework: A Tool to Enhance Climate Resilience in Urban Areas

Climate change, crises and shocks affecting agri-food and ecosystems
> Oral Presentation

51. Water footprint of sugarcane cultivation in a semi-arid climate region
52. Climate change and food security in mountain agri-food systems: Unpacking resilience and adaptation in Tehri Garhwal, India
53. Climate Change Impacts on Agricultural Water Footprint Using CORDEX Climate Scenarios.

54. Climate trends and farmer's perception about climate change and its potential impact on food security through agricultural activities, San Marcos - Cajamarca
55. Adaptation Pathways for Agriculture in Central Asia under Climate Change

Innovation and Technology for Agri-Food Systems transformation > Oral Presentation

56. Wastewater reuse for agriculture – Treatment with low-cost trickling filters in different climates in Peru and Cameroon
57. Biorefineries: the link between agroindustrial wastewater and green energy
58. Morphological development and productivity of bean cultivated with reclaimed water and biosolid
59. The effect of vapor pressure deficit on genotypic nutrient uptake and biomass production of hydroponically grown tomato
60. Understanding sustainable issues in Andean irrigation systems: insights from 235 systems

Societal and economic improvements to increase resilience and adaptation capacity> Oral Presentation

61. The Gulf of Nicoya Food-Climate-Biodiversity NEXUS in Costa Rica
62. Sustainable rural development starts with water
63. Improving Food-Nutrition and Water Security Outcomes through the Adoption of Climate-smart Practices: Evidence from Agricultural Households in South Africa
64. Farmers' perceptions and strategies for adaptation to climate variability in an Andean mountain agroecosystem
65. "Are the rains failing us?": Exploring female rice farmers' perceptions and adaptation to climate change and food insecurity in Northwest Cameroon

Science-policy-society interaction and problem solution> Oral Presentation

66. From Knowledge to Governance: Understanding Water Security Dimensions in the Mira-Mataje Transboundary Catchment
67. Integrating society in the planning of adaptation measures based on water consumption habits. A pilot project in an Andean city.

From Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)> Oral Presentation

68. Methodological guide for ecohydrological monitoring in Andean basins: towards an integrated analysis of biodiversity and ecosystem services.
70. Best Practices for Water-Scarce Cities: Proposed Policies towards an Integrated Urban Water Management in Egypt and the MENA Region.
71. Network-based model integrating water quantity and quality in an economic-integrated mo-

deling platform: Total Phosphorus load in the Capibariba river basin and its impact on three other interconnected basins in Pernambuco, Northeast of Brazil.

73. Mapping fluoride ions in Latin American groundwaters as a tool to promote water security.
74. Baseline of Water Security in Ecuador: A Multidimensional Analysis and Prioritization for Conservation and Restoration.
76. Assessing the potential of nature-based solutions as sustainable land and water management strategies in the High Tropical Andes páramo ecosystem.
78. Water issues related to green hydrogen production in a semi-arid region in Brazil.
79. Co-created Participatory Approaches to Water Security Research and Multi-Level Governance that Leaves No One behind.
81. Factors influencing women's representation in water resource management.
82. Water crisis, women and water self-management: the case of the Independence Basin in Guanajuato Mexico.
83. Water sustainability: Socio-ecological description of Panama using MuSIASEM approach for 2019.

Poster Presentations

84. Assessing the impact of climate change on olive yield in Turkey using precipitation, temperature, and frost events data.
85. Climate changes impacts on drinking water supply and adaptation strategies.
86. The impact of climate change on wheat productivity and the role of irrigation in saline soil environments in Uzbekistan.
87. Assessing climate change impacts on agriculture, livelihood, food security, and health of Palestinian farming community and household consumers. How to robust adaptation strategies they practice under political uncertainty?
88. Water Remediation by using non-conventional-feedstock for manufacturing carbonaceous nanocomposites: Considering Green Chemistry and Safe-by-Design Principles.
89. Sustainable Water Management through Greywater Recycling: A Case Study of an Eco-Hammam Project and Environmental Education Integration in Casablanca.
90. Technical innovations solutions for water security in transboundary water resources between Algeria, Tunisia and Lybia in arid area.
91. Methodology to estimate the investment gap for the sustainable management of ecosystems that provide water ecosystem services for the provision of sanitation services.
92. Water and Sanitation and GEE emissions in Brazil.
93. Technical Efficiency of Water Recovery Plants From Circular Economy Approaches.
94. Risk-informed decision-making for critical infrastructure in a climate change context.
95. Water Quality Trend Analysis in the Paratibe river basin, Pernambuco, Brazil.
96. Socioecology of the traditional farm. A contribution to local food sovereignty in the village of Bocas del Palo, Jamundí.
97. Transition towards Water Sensitive Cities in Colombia: Public Spaces as platforms for

Ecosystem´s services recovery.

98. Coupling water and society under the concept of Headwater Dependent Systems.
100. Looking beyong glaciers to understand mountain water security
Identifying key indicators for assessing water-related ecosystem services in global lakes.
101. Nature-based solutions, part of the key solutions for Latin America to move towards the water and climate goals.
102. Unveiling Galapagos' precipitation dynamics: A Citizen Science-inspired Initiative to better understand the Water Resource Relevance.
103. The potential of self-managed water organizations as agents of sustainability in Cochabamba.
104. Exploring the Impact of City expansion on Andean Agri-Food Systems
105. Generation of benefits through the coexistence of cochas and bofedales in the semi-arid Andes (Peru)
106. Data-driven solutions for ungauged basins: A novel method for satellite precipitation data
107. fusion (Ecuador)
108. Innovative Forecasting Strategies: From Satellite Data to Enhanced Hydropower Efficiency in Ecuador (Ecuador)
109. Exploiting Global Data to Understand the Mechanisms of Extreme Precipitation in the Tropical Andes: From Subcontinental to Local Scales (Ecuador)
110. Evaluation of lab-scale Anaerobic Baffled Reactor using a Rumen Liquid for Domestic Wastewater (Mexico)
111. Evaluating Water Security under Changing Climate in Tropical Forests: A Multi-Dimensional Approach (France)
112. Flood Susceptibility Mapping leveraging Analytical Hierarchy Process Based on GIS and Remote sensing Techniques —A Case Study of Nam Ngum River Basin (NNRB), Lao PDR (Japan)
113. Embryonic development and spawning of Ucides occidentalis (Crustacea) for recovery in mangrove sites in Ecuador (Ecuador)
114. One decade of headwater catchments hydrological monitoring to reinforce evidence of conservation strategies (Ecuador)
115. Development of the satellite-based Rainfall Retrieval Algorithm for Galapagos Archipelago using GOES 16: A Key to Understanding Water Availability in Galapagos (Ecuador)
116. Large-scale water resources contribution areas for hydropower generation at Paute Mazar station (Ecuador)
117. What is the status of water security in Pokhara (Nepal)? An approach for enhancement with nature conservation (Nepal) ID:
118. Flood Hazard Management Strategy in Sitirejo Malang District, East Java, Indonesia (Indonesia)
119. Priorities for local communities and SDG#6 Inclusive and participatory approaches for solution-oriented implementation in the South of Ecuador (Ecuador)

120. Heavy metals could threaten water security in Andean Mountains (Ecuador)
121. Heavy metals could threaten water security in Andean Mountains (Ecuador)
122. Towards Resilient Land Use Systems. A Network Approach to the Water-Energy-Land-Food Nexus (Colombia)
123. Exploring the ecohydrological response of paramo ecosystems to extremes: A rainfall inhibition experiment (Ecuador)
124. How do storm characteristics influence concentration-discharge hysteresis in a high-elevation tropical ecosystem? (Ecuador)
125. Streamflow drought identification to support water resources management in an inter Andean Tropical catchment (Ecuador)
126. Analyzing the Rain-Storm Types in the Tropical Andes that Generate Flooding Events (Ecuador)
127. Innovative Feature Engineering for Peak Runoff Forecasting: Leveraging Radar Precipitation
128. Estimates for Sustainable Water Management. (Ecuador)
129. Modified Irrigation Sustainability Index for the assessment of irrigation systems in low-impact agricultural basins (Ecuador)
130. Effects of land use change from natural coverages to pastures in a mountainous area of the southern Ecuadorian Andes (Ecuador)
131. Analysis of Water Consumption Patterns in Three Neighborhoods of Cuenca, a medium-size Andean City: A Preliminary Assessment to Promote Adaptation to Climate Change (Ecuador)
132. Framework to evaluate the applicability and limitations of climate change projections to support adaptation at catchment and city scale.

Abstract

Water Management and Hydropower Integration in a Changing Climate > Oral Presentation

Impacts of climate change on the hydropower potential of a multi-purpose storage system project in Bolivian Andes

Ivan Alexis Chavez Flores[1], Santiago Mendoza Paz[1], Patrick Willems[1], Mauricio Florencio Villazon Gomez[2]

[1] KU Leuven, Department of Civil Engineering, Hydraulics and Geotechnics Section, Leuven, Belgium
[2] UMSS, Department of Civil Engineering, Hydraulics Laboratory, Cochabamba, Bolivia, NA,

Hydropower is essential for shifting to less fossil-intensive energy production towards a more sustainable future. Climate change threatens future hydropower projects. Changes in precipitation, temperatures, and evapotranspiration might affect future river discharges and hydropower potential of multipurpose projects like Rositas (Bolivia). Placed in the Río Grande basin within the Andes region, Rositas aims to secure irrigation, flooding control, hydropower production, and to export clean energy. However, the climate change impacts on the project are unknown. This research studies the changes on Rositas' hydropower potential, using the Coupled Model Intercomparison Project phase 5 (CMIP5) regional climate models for the near (2040-2069) and far (2070-2099) future to evaluate river flow impacts for three future scenarios (RCP 2.6, 4.5, 8.5). K-means is used to cluster 101 stations under similar climate features to apply statistical downscaling (quantile perturbation and delta change) at catchment scale. Hydrological models, SWAT+ and HEC-HMS, are used to estimate the impacts on water availability and hydropower potential. Results show that river discharges are marked by a decrease in the dry season and an increase in the wet season. In hydropower potential, we observed an increase in annual potential up to 11% for the near future and 9% for the far future. However, seasonal energy potential decreases by up to 30% in June, July, and August, while November, December, and January experience an increase of up to 25%. These results help to understand water and climate risk linkages for climate change adaptation strategies in Rositas Project and highlight the necessity for innovative water management solutions to avoid water conflicts.

Abstract

Water Management and Hydropower Integration in a Changing Climate > Oral Presentation

Integrating intermittent renewables via hydropower can impact other water-related sectors

Jose M. Gonzalez[1], Julien J. Harou[1]

[1] The University of Manchester, Manchester, UK

Large-scale integration of intermittent renewable sources, such as solar and wind, can accelerate the transition to low-carbon energy systems, mitigate climate change impacts, and increase electricity access. Hydropower can support this transition because its operational flexibility can be used cost-effectively to counteract the variability and seasonality of intermittent renewables. However, using hydropower to provide energy system flexibility services can affect aquatic ecosystems and create intersectoral conflict. We introduce a multi-objective design framework to address this issue and demonstrate it on a national-scale case study for Ghana. Our results show that available hydropower flexibility can be deployed to support expanding intermittent renewables by 38% of the total generating capacity in the country. However, this would increase the sub-daily flow variability of the main national river by up to 22 times compared to the historical baseload hydropower operation that does not support intermittent renewables. The increase in sub-daily flow variability is estimated to damage the river ecosystem and reduce national crop yield revenue by up to US$169 million annually. We propose an alternative approach that uses a diversified investment strategy, including intermittent renewables, bioenergy, transmission network expansion, and smart operation of existing hydropower. We show that such designs can maintain acceptable flow variability and agricultural performance while meeting future national energy service goals and reducing CO2 emissions. The proposed framework can support governments and power system planners by designing efficiently diversified energy investment portfolios and highlighting their sectoral and emission trade-offs.

Abstract

Water Management and Hydropower Integration in a Changing Climate > Oral Presentation

Climate variability impact on long-term capacity of hydropower reservoirs in Andean regions. Case of study: Cañete river, Peru.

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Recent changes in the global climate, and especially changes in precipitation patterns and rates, may have an impact on the sedimentation of storage reservoirs in Peru, jeopardizing the provision of resources for the local population. Therefore, we study the Cañete River basin in the western Coastal Range of Peru, as it plays an important role in the socioeconomic development of the region. In the middle lower basin the 220 MW El Platanal hydroelectric plant and the Capillucas reservoir are located. They supply water and energy to the surrounding area. We use a hydrological model (HEC-HMS) together with a sediment transport model (HEC-RAS) to simulate future changes in river discharge and sediment load. The collected climatic data was used to calculate the sedimentation of the Capillucas storage reservoir. Ten scenarios were developed, a combination of two precipitation patterns and five different precipitation rates, in order to simulate potential extreme events in the region. The average sediment load of the Cañete River was estimated at 981 kTon/year upstream of the Capillucas reservoir and showed that the useful life of the structure is about 17 years. Our results show that the lifespan of the Capillucas reservoir ranges from 7 years for the most pessimistic scenario to 31 years for the most optimistic scenario. This is much shorter than the projected lifespan of 50 years. Peru currently has a large growth in energy demand of 8% per year and has pushed a significant growth in hydroelectricity of all Andean countries. As such, our results demonstrated the vulnerability of Andean hydroelectric reservoirs to future climate change and variability.

Abstract

Water Management and Hydropower Integration in a Changing Climate > Oral Presentation

Influence of Low-Impact Development in Flood Control: A Case Study of the Febres Cordero Stormwater System of Guayaquil (Ecuador)

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Abstract: Urban flooding is a major problem in many coastal cities. The rapidly shifting patterns of land use and demographic increase are making conventional approaches to stormwater management fail. In developing countries such as Ecuador, a lack of monitoring, financial constraints and absence of proper policies exacerbate flooding problems. This work assesses the implementation of two Low Impact Development strategies (LIDs), namely, green streets and rain barrels, as nature-based solutions to mitigate flooding problems. The use of the "Stormwater Management Model" (SWMM) helped to contrast the new approach with the current state of the drainage system, including normal and extreme scenarios. With an implementation of 1.4% (19.5 ha) of the total area with LIDs, the reduction of runoff for short events (200 min) is around 20%, and for extreme events (within 24 h) is around 19% in comparison to the conventional approach. Flooded nodes were reduced to 27% for short events, and to 4% for extreme events. The peak flooding system had a reduction to 22% for short events and 15% for extreme events. These highlights help to increase city resilience, and authorities and stakeholders should engage in climate actions to reduce flood risks complementing drainage operations with nature-based solutions. Moreover, calibrated results in this article serve to increase awareness among municipal authorities regarding the importance of maintaining flooding records to improve modelling results for decision-makings processes.

Abstract

Water Management and Hydropower Integration in a Changing Climate > Oral Presentation

Cost-Benefit Sharing for Water Security: A Case of River Basin in India

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This study demonstrates the use of a cost-benefit approach for improving water allocation among riparian states through its application in one of the river basins in India that experiences climate extremes, the situation which is experienced in other river basins in India as well. First, a water balance using Water Evaluation and Planning (WEAP) tool for a business-as-usual scenario for 2011-50 is prepared and scenarios considering socio-economic changes leading to high economic growth, physical changes due to climate change, and policies related to water supply augmentation and demand management were developed for the Mahanadi basin. Second, the model results were used to assess the economic feasibility of interventions identified under various scenarios through a cost-benefit sharing approach. The results show that the basin experiences a yearly average water deficit of 5,429 million cubic metres (MCM) under the business-as-usual scenario, which increases to 6,781 MCM under the high economic growth scenario. Even with water supply augmentation and demand management interventions and increased runoff due to climate change, the upper riparian state is likely to continue to experience a water deficit. However, this can be reduced, if the lower riparian state allows the upper riparian state to divert about 1,500 MCM of additional water annually up to 2050. The assessment offer solutions and strategies for improving water management and water reallocation among riparian states and thus a window of opportunity for policymakers and water managers to resolve water-related disputes in transboundary basins.

Abstract

Ecosystem Resilience and Sustainable Practices> Oral Presentation

Methodological guide for ecohydrological monitoring in Andean basins: towards an integrated analysis of biodiversity and ecosystem services

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Mountains play a key role at the global level: they provide different basic ecosystem services for a significant percentage of the world's population, both rural and urban, and are one of the main centers of origin and areas of high biological diversity on earth (hotspots). At the same time, they are ecosystems vulnerable to anthropogenic pressures and sensitive to climate change. In the Tropical Andes there is still a large gap in terms of the collection and availability of ecohydrological (water, soil, vegetation and their interactions) and climatic-meteorological data, which serve as the basis for sustainable adaptation to the effects of global change. This fact stands out of proportion to the number of projects focusing on water security that are currently underway in this region. Our methodological guide for ecohydrological monitoring in Andean basins is a tool that allows a more comprehensive view of the dynamics of ecosystem services and vegetation (including specific, structural and functional diversity), by generating integrated long-term information on these dynamics and the key compartments and processes linked to water ecosystem services, such as hydrological regulation, in scenarios of environmental change at multiple scales of analysis (watershed, micro-watershed, landscape, ecosystems/plots). This guide is mainly aimed at formulators and managers of public and private water security projects with an ecohydrological approach. In addition, it is expected that it will contribute to the development of research to fill the information gaps on the impacts of various natural infrastructure interventions, conservation, restoration and adaptation strategies based on ecosystems, through ecohydrological monitoring.

Abstract

Ecosystem Resilience and Sustainable Practices> Oral Presentation

The Potential of High-Andean Forests to Provide Ecohydrological Resilience to Climate Change in the Andean Páramo

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High-Andean forests (Polylepis sp.) at ~3,000-5,000 m a.s.l. are sensitive bioindicators of global climate change. Investigating their ecohydrological role is thus key to understanding how the water cycle of Andean headwaters could be affected by predicted temperature increases in the region. We estimate the annual water balance of a Polylepis forest catchment in the Andean páramo using a unique set of ecohydrological measurements and compared it with that of a tussock grass dominated catchment. Streamflow and evapotranspiration (ET) were the main components of the forest catchment water balance, accounting for 59 and 44% of annual gross rainfall, respectively. Forest ET was mainly composed of evaporation loss from canopy interception (68% of the ET flux), whereas transpiration was rather low (32% of the ET flux). Remarkably, the water yield of the Polylepis forest catchment (0.60) is only slightly lower than that in its counterpart covered by the tussock grass (0.64). Both, reduced transpiration and high water yield in the forest catchment likely result from the combined effect of high water storage in the soil and the persistent occurrence of fog and drizzle that helps suppress forest ET. The carbon-water nexus of the system shows that although the forest catchment presents a similar water yield and flow regulation capacity as the grassland catchment, soil organic matter content in the forest site (48%) is significantly higher than in the grassland site (32%). Our findings provide key insights into the vegetation-water-carbon nexus in high Andean ecosystems, suggesting that native forests could act as natural infrastructure for water security and play a key role on the resilience and adaption of the Andean páramo to climate change.

Abstract

Ecosystem Resilience and Sustainable Practices> Oral Presentation

A low-cost framework for estimating high-altitude wetlands' contributions to streamflow

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Mountain water resources are among the most vulnerable to climate change but play an important role in sustaining downstream populations. High-altitude wetlands (HAW) are a characteristic feature in many mountain regions; however, few studies have aimed to understand their influence on water resources. Here, we present a low-cost framework for quantifying flow through HAW. Using the headwaters of the Vilcanota-Urubamba basin as a case study, we combined hydrological data from a small in-situ network of loggers with remotely sensed seasonal wetland extent maps to build a hydrological conceptual model of HAW dominated catchments. This disaggregates the contribution of end members (surface runoff, glacial melt, and subsurface hillslope and wetland outflow) to total streamflow. We used the linear reservoir concept to estimate subsurface hillslope and wetland outflow by constructing representative unit hydrographs. The wetlands exhibited high seasonal variability in areal extent, which corresponded well with wetland water levels. They also showed high spatial heterogeneity in hydrological response with residence times between 1 and 30 days, indicating prolonged wetland contributions throughout the dry season (constituting 74% of core dry season flow). The results suggest a crucial role of HAW in dry season baseflow, water flow regulation and storage, demonstrating their potential as nature-based solutions for water security in seasonally dry Andean catchments. However, for international relevance, an expansion of monitoring sites is required to upscale our hydrological understanding of HAW and their contributions to mountain water resources.

Abstract

Ecosystem Resilience and Sustainable Practices> Oral Presentation

Water related NbS´s and circular economy for indigenous communities in Colombia

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Most vulnerable communities to climate change are those that directly depend on ecosystem services in degraded environments, thus exposed to an increased flood/draught risk. This is the case of three groups of Colombian Embera indigenous people, whose populations have been forced to migrate to peripheral urban areas without access to safe water or sanitation. "Bania Do Bari" project was set up to provide this communities with infrastructure to increase access to water and sanitation while exploring circular economy models. Access to water was developed/ improved by installing infrastructure to achieve permanent supply. Sanitary facilities, collectively designed for cultural appropriation, were installed and connected to a series of NbS's for wastewater treatment, re-naturalization and reuse. Because of its innovative elements, the infrastructure operates with opportunities for replication in other regions of Colombia. Components to accomplish circular economy such as constructed wetlands for wastewater treatment (CW's) operate with modular configurations adapting treatment capacity to indigenous migratory dynamics, innovative CW's for nutrients elimination reduce 90% of total phosphorus and 75% of total nitrogen concentrations without energy or additives consumption. Treated effluents irrigate fruit trees fields, while Colombian regulation for direct reuse in agriculture of treated wastewater is fulfilled in 28 of 31 parameters. Phenols, oils, and manganese concentrations are being addressed. "Bania Do Bari" can be seen as a pilot of a circular economy model for integrated and adaptive water management, and as a treatment configuration that reduces to a minimum the need to obtain permits for water withdrawal and/or wastewater discharge from/into natural water bodies.

Abstract

Ecosystem Resilience and Sustainable Practices> Oral Presentation

Sustainability of the Mexican Caribbean: Converting Weaknesses into Strengths

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The main tourist attraction of the Mexican Caribbean, to date, has been the scenic richness of its coastal and marine ecosystems. However, these are now dramatically overexploited, and the region faces complex challenges related to its socio-economic development and a resulting downturn in the status of conservation of its ecosystems. The transdisciplinary project described here focuses on diversifying economic activities and technological development to reduce energy and food demand (neither are sufficient locally), promote better use and conservation of natural resources (water and coastal ecosystems), and train local stakeholders committed to the development of a circular economy. This project focuses on developing technologies for the restoration, conservation, and more balanced use of the natural resources of the Mexican Caribbean. At the conference, our presentation will detail the results of six focal areas: 1) Renewable energy: development of devices capable of harnessing energy from oceanic currents, and from the salinity gradient between treated waste water and sea water; 2) Restoring coastal-aquatic ecosystems using innovative technologies to restore coral reefs, seagrass beds, and coastal lagoons; 3) Restoring coastal-terrestrial ecosystems through the use of a range of technologies to restore coastal dunes, mangroves, and flood forests; 4) Exploiting Sargassum by using Sargassum-based membranes and filters for the treatment of polluted water and ion exchange; 5) Reducing energy demand by the implementation of systems that improve the thermal comfort of houses and buildings; and 6) Developing technology for using salinity and thermal gradients to produce freshwater, energy, and fertilizers.

Abstract

Building Climate Resilience in Water Systems: Strategies and Solutions > Oral Presentation

Making thirsty cities sustainable: a nexus approach for water provisioning in Quito, Ecuador

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Abstract: In view of accelerated climate change and urban demographics, balancing human and ecosystem needs for water resources is a critical environmental challenge of global significance. Because water, agriculture, health and energy are inextricably linked sustainable development goals (SDGs), actions in one policy area commonly have impacts on the others, as well as on the ecosystems that natural resources and human activities ultimately depend upon. Managing urban water supply systems therefore requires a nexus approach that integrates goals across sectors, reduces the risk that SDG actions will undermine one another, and ensures sustainable resource use. We developed a transdisciplinary methodological framework based on a Pareto frontier analysis to define the sustainable solutions of a multi-objective optimization among four competing criteria, water provision, water quality, energy cost and biodiversity conservation. The study was applied to three mountainous headwater basins in the Ecuadorian Andes, which provide around 30% of the total water supply of Quito's water utility. We found that an optimized management of water intake structures would meet current consumption needs while reducing the probability of emergence of water pathogens and limiting the impact on aquatic biodiversity by 30% and 9% respectively, without any increase in energy costs for pumping water from other sources. Nonetheless, under future scenarios of climate change and water demand, higher energy consumption and therefore an increase in operating costs, would be needed to meet urban demand and preserve environmental conditions. The range of Pareto optimal water supply strategies across the nexus provides valuable information for decision makers to support a sustainable management of water resources

Abstract

Building Climate Resilience in Water Systems: Strategies and Solutions > Oral Presentation

Sustainable water management under climate change in a middle-size Latin-American city

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Warming and changes in the magnitude and distribution of precipitation have already affected natural and human systems in Latin America and especially the Andean Mountain region. Here, water availability depends on rainfall and surface water, since in most of the tropical Andes there are not aquifers nor snow cover. Thus, this region is highly vulnerable to climate change. Sustainable water management is therefore key for climate change adaptation. In this study we present an integrated water management approach for middle-size cities based on strategies and guidelines for securing the water availability given the expected climate change and increase in water demand. This approach is based on 5 principles: i) identifying future water availability in headwaters, ii) projecting water consumption based on geospatial demand, iii) managing water demand, iv) coping with supply, demand and aging infrastructure, v) inter-institutional agreements including policy generation. The study is conducted in Cuenca, a middle-size city (~ 600 000 inhabitants) located in the Southern Andean region of Ecuador. Particular emphasis is put on water demand projections, based on observed consumption data, and water consumption habits, measured in representative neighbourhoods in the city, with active participation of social groups. Adaptation to the expected scenarios will include green-blue infrastructure, nature-based solutions and water consumption reduction that will be decided with society and decision-makers. Thus, the project sets an example of how academia can work together with civil society groups, drinking water facility and decision-makers to create sustainable cities. These actions can be further replicated in other middle-size (Latin-American) cities.

Abstract

Building Climate Resilience in Water Systems: Strategies and Solutions > Oral Presentation

Aquavida: contribute to water Security trough access to safe drinking water

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Grupo Argos Foundation is committed to contributing to water security in the territories and improving the quality of life of the communities. We base our strategy on the capacity development of the communities to guarantee sustainable access to water, with the quantity and the quality required for human and ecosystem necessities, promoting resilient societies to climate change. Accordingly, the strategy includes water conservation programs, environmental education programs, and access to alternative solutions for drinking water for the communities. This way, in 2019 and 2020, we implemented two pilots to assess two alternative family solutions for community access to safe drinking water, evaluating usage, social adoption, adaptability to the rural conditions and time sustainability criteria. These pilots allowed us to identify the best option, to scale the program and to impact 1.800 families in 2021 and 5.500 in 2022. Thus, the program contributes to achieving SDG 4, Quality Education, especially target 4.a. related to the number of schools with access to drinking water; SDG 6, Clean Water and Sanitation, and its target 6.1., related to universal access to drinking water; the SDG 1, No Poverty, and the target 1.4, concerning the number of homes with access to drinking water, among others. The program has proved to have an immediate impact by improving the living conditions of the communities with a special focus on children and young people, women, and older people of low income in rural areas, a population who often are more prone to suffer the effects of not having drinking water such as being more susceptible to diseases related to water, spending more time in housework or spending more money to buy drinking water.

Abstract

Building Climate Resilience in Water Systems: Strategies and Solutions > Oral Presentation

Assessing social-ecological systems for resilience to climate change in sub-tropic regions: an integrated sensitivity model-based approach for water security and stakeholder management.

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The sub-tropic region of Rioverde, San Luis Potosi, Mexico, confronts escalating ecological disturbances due to climate change, particularly rising temperatures. These shifting climate patterns are already impacting daily life in the region, exacerbating water scarcity and existing socio-economic vulnerabilities. This study identifies key interventions to enhance social-ecological resilience and adequately adapt to environmental changes. The Sensitivity Model (SM) is used as a foundation, integrating participatory action research principles, Sustainable Livelihoods Framework, and the Theory U framework to involve stakeholders in problem-solving. Through a livelihoods survey and a 3D modeling activity, a comprehensive social-ecological system (SES) of 25 variables across five dimensions was defined. Critical variables influencing the system's behavior include community awareness, local commerce, services and communications, while knowledge of productivity, water culture, and environmental education are highly affected. The interconnectedness of the system was analyzed using Q-value and P-value categorizations. Most variables exhibit critical behaviors, indicating mutual influence. Functional clusters were generated, proposing intervention strategies for co-management enhancement and policymaking with stakeholder involvement. The study yields practical insights to fortify climate change adaptation in socially vulnerable contexts, facilitating active engagement and stakeholder involvement by harnessing the SM alongside awareness-based system change methods. The integrative approach enriches the scientific understanding of complex systems and offers intervention strategies, thereby fostering water security and a resilient future for the region.

Abstract

Building Climate Resilience in Water Systems: Strategies and Solutions > Oral Presentation

Urban River Management Framework: A Tool to Enhance Climate Resilience in Urban Areas

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Healthy rivers are excellent avenues for climate change adaptation—protecting against fluvial floods, reducing the urban heat island effect, and augmenting groundwater recharge, among others. However, despite their manifold benefits, urban rivers are in a dilapidated state in many parts of the world. To address this issue, the Indian government launched the 'Urban River Management Plan' (URMP) framework in 2020. The authors were part of the team that developed this framework. The framework takes a systems approach to propose holistic management of rivers that encompass environmental, social, and economic aspects. At the heart of the URMP framework is a 10-point agenda against which cities need to take action for managing the stretches of rivers within their jurisdiction. We applied the URMP framework in the city of Ayodhya (North India) in 2022–2023 in four stages. First, we developed a thorough scientific baseline that involved GIS-based spatial mapping of water quality, hydrology, ecological health, land use, planning norms and regulations, and socio-economic factors. Second, we conducted structured focused group discussions with diverse stakeholder groups to decide on the thrust areas of action. Third, we designed 23 interventions (engineering, policy, and governance) for addressing the areas of action. For example, one intervention is designing a wastewater reuse plan for areas within 3 km of sewage treatment plants. Another is designing a 30 m wide riparian buffer along the river banks. Yet another is diagnosing the health of ponds using a set of performance indicators. Fourth, we developed a roadmap for the implementation of the URMP. This paper provides a comprehensive description of the design of the URMP framework and its implementation in the city of Ayodhya

Abstract

Climate change, crises and shocks affecting agri-food and ecosystems > Oral Presentation

Water footprint of sugarcane cultivation in a semi-arid climate region

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Sugarcane cultivation has a significant historical economic importance for Brazil. In the face of potential climate variations, including periods of severe drought, the water demand necessary for sugarcane cultivation is likely to amplify the water deficit in semi-arid regions. Thus, there is an urgent need to understand the effective contribution of available water to optimize water resource utilization and alleviate conflicts. This article aims to assess the impact on green and blue water footprints of sugarcane farming over a decade in Brazil's semi-arid zone. The water footprints were determined using The Water Footprint Assessment Manual's methodology, with evapotranspiration data estimated through FAO's CROPWAT 8.0 software. During the analyzed period, the blue water footprint—representing surface and groundwater usage—escalated by 14.04%, especially after the peak of the water crisis in 2012. This increase in the blue water footprint, about overall cropping demands, indicates the need for irrigation to achieve the required crop growth. Statistical analysis established strong correlations ($r > 0.7$) between water footprints and components, including precipitation, insolation, and relative humidity. The dry period increase the pressure on water resources, requiring more irrigation to allow sugarcane growth. Hence, adopting decision-making support and management strategies is crucial to mitigate conflicts resulting from water usage in times of scarcity.

Abstract

Climate change, crises and shocks affecting agri-food and ecosystems > Oral Presentation

Climate change and food security in mountain agri-food systems: Unpacking resilience and adaptation in Tehri Garhwal, India

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This study explores climate change impacts on food security and nutrition in Tehri, a mountainous district of Uttarakhand. It critically examines how climate variability influences smallholder farmers' resilience and adaptive capacities. By employing a social vulnerability approach and a food systems framework, the research aims to shed light on the complex interplay between climate change, human vulnerability, and the sustainability of mountain agri-food systems. Primary data was obtained through comprehensive household surveys and focus groups conducted in 10 villages across two blocks in Tehri district. To gain a nuanced understanding of local perceptions and adaptation strategies in the face of climate risks, semi-structured interviews were held with 256 smallholder farmers. The study deploys a mixed methods approach, integrating quantitative and qualitative data to examine the interactions between climate change, community vulnerability, and food systems. The findings reveal that climate variability disrupts traditional dietary and nutritional patterns, triggering a shift towards less diverse and less nutritious diets. Socio-economic disparities lead to uneven adaptive capacities within the community. Despite attempts at coping, agricultural resilience is challenged by resource constraints and inadequate infrastructure. However, traditional knowledge systems and biodiversity conservation present potential pathways for enhancing sustainability. The research underscores the urgent need for inclusive, context-specific adaptation policies that harness local resources and traditional wisdom. The study uncovers shared challenges in climate change adaptation by comparing it with other mountain regions. The research contributes to the design of robust adaptation strategies

Abstract

Climate change, crises and shocks affecting agri-food and ecosystems > Oral Presentation

Climate Change Impacts on Agricultural Water Footprint Using CORDEX Climate Scenarios.

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Climate change affects water resources, particularly in terms of scarcity and its impact on supply chains like food production, thereby threatening food security. Quantifying current and future water consumption in agriculture through the agricultural water footprint fosters cross-sectoral decision-making at different scales. Our study employs the Site-sPecific Agricultural water Requirement and footprint Estimator (SPARE:WATER) to explore climate change effects on agricultural water footprint (WF) in Colombia. It was driven with an ensemble of high-resolution (0.22°) CORDEX regional climate model projections under the emission scenarios RCP2.6 and RCP8.5. Historical data from fifteen weather stations were used to bias-correct (EQM) the model's gridded data. This corrected data was spatialized using IDW interpolation. Ten important crops were selected based on national production relevance. Crop characteristics such as harvested area, yield, and crop coefficients were obtained from local and FAO references. The analysis covered green and blue WF for the near (2060) and far future (2099), relative to the present (2020). Preliminary findings reveal a national WF of 45 km3/yr. Crops with the largest WFcrop are cocoa (30k m3/t), coffee (18k m3/t), and palm oil (8k m3/t) nationally, with variations at the departmental level. From the regional agricultural perspective WFarea, plantain, and banana are also significant. Under scenario 2.6, the green and blue WF in 2060 and 2099 do not exhibit large changes compared to 2020. Nevertheless, under scenario 8.5 a substantial increase is evident in blue WF, 49% by 2060 and 96% by 2099. Cocoa and coffee demonstrate the highest water requirement in future. We aid in fostering informed water management in the future of agriculture.

Abstract

Climate change, crises and shocks affecting agri-food and ecosystems > Oral Presentation

Climate trends and farmer's perception about climate change and its potential impact on food security through agricultural activities, San Marcos - Cajamarca

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Climate change represents a growing threat to food security as it alters temperature, humidity and precipitation patterns, which are fundamental factors for agricultural production. This places small-scale farmers, especially those in developing countries, in a vulnerable position because their socioeconomic characteristics limit their capacity to adapt. In Peru, the region with the second highest vulnerability index to food insecurity is Cajamarca, where agriculture is an indispensable economic activity. However, there are no studies that show the impact of the socio-environmental crisis on their agricultural practices and, therefore, on their food security. This project aims to determine if there is a relationship between climate trends and the perceptions of farmers and the general population on climate change and its potential role in food security and agricultural activities in Andean communities residing in three different altitudinal levels in the province of San Marcos, Cajamarca: José Sabogal, San Marcos and La Grama (3075, 2251 and 1990 m.a.s.l., respectively). Also, the main agro-climatic factors that could influence these perceptions (changes in precipitation, temperature and humidity patterns) will be evaluated through meteorological stations (Onset - RX2102) and satellite data from ERA-5. The results will contribute to a more accurate understanding of the manifestations, effects and relevance of climate change in rural populations and will provide relevant information to decision makers to design adaptation strategies linked to local needs.

Abstract

Climate change, crises and shocks affecting agri-food and ecosystems > Oral Presentation

Adaptation Pathways for Agriculture in Central Asia under Climate Change

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This contribution summarises the effects of climate change on agri-food systems in Central Asia, a region characterised by a high vulnerability to weather risks. Based on recent literature and original primary research in the region, we highlight the main projections and explore pathways for adaptation measures. Agricultural production in Central Asia has historically been subject to large yield fluctuations. Climate change is likely to increase production and income risks further, directly jeopardizing SDGs 1, 2, 3, 6, and 15. This applies especially to irrigated agriculture relevant in South Kazakhstan, Tajikistan, Turkmenistan and Uzbekistan, where river flow is likely to decrease towards the end of the century as a result of glacier peak melt and growing competition for the water from riparian states. In Kazakhstan and Kyrgyzstan, animals will suffer from pasture degradation, heat stress and increasingly scarce drinking water. On the other hand, grain cultivation in the northern steppe regions of Kazakhstan could also benefit from climate change, such as from milder winters and higher rainfall, with ensuing income increases by up to one third. Governments across the region should promote adaptation measures to protect particularly vulnerable producers and promote more resilient agri-food systems. These are sensible measures irrespective of the challenges of climate change. They include adjustments in the selection of crops and irrigation infrastructure, enhanced cultivation techniques in arable farming, improved pasture management, greater support for training and further education, institutional reforms in agriculturally relevant state services, administrative reforms in the areas of risk assessment and local self-government and access to global emissions trading.

Abstract

Innovation and Technology for Agri-Food Systems transformation
> Oral Presentation

Wastewater reuse for agriculture – Treatment with low-cost trickling filters in different climates in Peru and Cameroon

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SDG 6, “Clean Water and Sanitation for All,” is particularly challenging due to inadequate wastewater treatment facilities and widespread dependency of economy, agriculture, and people on surface water resources. The lack of appropriate wastewater management, coupled with open sewers clogged in many places by household waste such as plastic bottles, exacerbates the problem. Precipitation events often lead to flooding and the spread of pathogens into the environment, posing significant risks to communities. a low-tech wastewater treatment system was conceptualized, tested, and implemented in both Cameroon and Peru. The system’s design aimed to address specific local needs and conditions while emphasizing the use of locally available materials, such as plastic lids. In Peru, the primary objective was to treat wastewater and reuse it for irrigation purposes in food production. In Cameroon, the focus was on reducing the spread of waterborne diseases resulting from faecal contamination into local drinking water resources. The implementation of the low-tech wastewater treatment system utilizing unconventional trickling filter media proved to be a valuable solution for both regions. The results demonstrated substantial reductions in total suspended solids (TSS) ranging from 65-82%, chemical oxygen demand (COD) from 70-88%, as well as total nitrogen (TN) from 30-40%, and total phosphorus (TP) from 16-32%. Microbiological analyses indicated reductions in colony forming units, including Escherichia coli (E. coli), total coliforms (TC), and enterococci. In Cameroon, the two-stage treatment system shows promising results for reducing relevant wastewater parameters. In Peru, the system enabled the safe reuse of water for food production purposes.

Abstract

Innovation and Technology for Agri-Food Systems transformation
> Oral Presentation

Biorefineries: the link between agroindustrial wastewater and green energy

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Nowadays, integrated actions aimed at protecting water bodies, combating climate change, and diversifying the energy matrix with renewable sources are three of the main items of interest worldwide. An important key to achieving the goals and objectives related to such interests is the concept of biorefinery, wherein the goal is to obtain as many add-valued products as possible from organic solid waste and wastewater. Particularly, byproducts like biodiesel, biomethane, and biohydrogen, are being highly valued as potential sources of energy. This talk aims to highlight the potential of wastewater treatment processes as biohydrogen producers in this biorefinery-bioenergy framework. Two of them are especially important; Dark Fermentation (DF), Microbial Electrochemical Cells (MEC). By coupling these two bioprocesses, DF may recover 1/3 of the available hydrogen contained in wastewater while transforming the remaining organic macromolecules into Volatile Fatty Acids (VFA) and CO2. Then, VFA may be fed to a MEC process for recovering the remaining (theoretical 60-70%) hydrogen. Moreover, VFA coming from DF processes as well as mineral carbon (i.e., CO2) produced in both, DF and MEC, may also be fed to a third bioprocess, e.g., a Microalgae Production Photobioreactor (MPP) in which new valuable biomass may be produced. In his turn, this biomass may be used to produce biodiesel, complementing the biorefinery and increasing its bioenergy potential. These bioprocesses have a dynamical behavior highly nonlinear, and they are very sensitive to perturbations. Thus, modeling, control, and optimization approaches are necessary for guaranteeing the efficiency and performance of these bioprocesses. Its inclusion in the whole engineering perspective of biorefineries is also discussed.

Abstract

Innovation and Technology for Agri-Food Systems transformation
> Oral Presentation

Morphological development and productivity of bean cultivated with reclaimed water and biosolid

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Prolonged drought coupled with expanding agricultural production with increasing use of mineral fertilisers, have led farmers to seek alternative sources of water (W) and nutrients to support food production. The use of treated domestic sewage (TDS) as reclaimed water, also sanitised sludge, has been highlighted due to the presence of essential nutrients and water for plants. In this experiment, reclaimed water and biosolid (composted sludge) in cowpea cultivation, were proposed. The plants were grown in a greenhouse using pots arranged in randomised blocks, with eight treatments (T) and four replications each: T1, irrigation only with W (absolute control); T2, W+NPK fertilisation (conventional cultivation); T3, W + Fe + Zn; T4, W + biosolid; T5, irrigation with TDS; T6, TDS + NPK; T7, irrigation with TDS + Fe + Zn; T8, TDS + biosolids. At the end of the experiment, plant development parameters and grain yield were evaluated. Plants irrigated with TDS and/or fertilised with mineral fertilisers or biosolid showed good aerial part and root system growth, besides a suitable grain yield. T8 stood out, with plants reaching greater aerial part height (170 cm), fresh (97 g) and dry (12.9 g) leaf mass, stem diameter (7.5 mm), main root weight (4.8 g) and grain yield (14.8 g plant-1). These values were not significantly different from those achieved by treatment T2 (conventional cultivation) by the Kruskal-Wallis's test ($p < 0.05$). Therefore, the results showed that cowpea cultivation with TDS and biosolid was positive by achieving satisfactory morphological development and grain productivity, without using mineral fertilisers or water of other sources.

Abstract

Innovation and Technology for Agri-Food Systems transformation
> Oral Presentation

The effect of vapor pressure deficit on genotypic nutrient uptake and biomass production of hydroponically grown tomato

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Controlled environment farming based on hydroponics, a method of growing plants without soil, is becoming increasingly important in resource-efficient crop production. Hydroponic plant production potentially draws on a multitude of water sources including treated municipal wastewater as basis for nutrient solutions. However, reconciling the required water quality with consistently high yields still presents a major challenge, since crop varieties vary in their nutrient uptake dynamics as a function of environmental conditions. In order to assess the potential of wastewater in a water and nutrient management strategy, the phenologically nutrient requirements of the crop under varying environments need to be understood. In a greenhouse experiment in humidity-controlled growth chambers at the University of Hohenheim, we investigated the dynamics of nutrient uptake, plant growth, and plant morphology of four tomato varieties grown at different vapor pressure deficits (VPD) in low concentrated nutrient solution. The nitrogen concentration in the nutrient solution was kept at a level as expected in anaerobically-aerobically treated wastewater. The results revealed significant varietal differences within plant morphology and nutrient uptake which were affected by air humidity. At high VPD, cv “Saluoso” took up from the nutrient solution about 44% more total nitrogen than “Reddery”. This varietal difference increased to 59% under low VPD. These situational responses indicate that choice of variety, adequate setting of atmospheric conditions and any combination thereof constitute important aspects for optimizing nutrient uptake, plant growth, and ultimately yield for growing tomatoes hydroponically in controlled environment farming systems.

Abstract

Innovation and Technology for Agri-Food Systems transformation
> Oral Presentation

Understanding sustainable issues in Andean irrigation systems: insights from 235 systems

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Irrigated agriculture drives social, productive, and economic progress by enhancing productivity, improving livelihoods, and promoting food security. Achieving sustainability in Andean irrigation systems requires multiple interventions involving technical cooperation, policymaking, and research to ensure profitability and ecosystem safeguarding. However, the historical lack of detailed data on the status of Andean irrigation systems considering economic, environmental, and social factors has made it impossible to generate effective policies, regulations, planning, and decision-making. This study analyzes the socio-economic, infrastructure, gender, governance, and management aspects of 235 irrigation systems in Southern Ecuador. Data were gathered by the regional government via semi-structured interviews with representatives of water user associations. The interview was designed by an interdisciplinary team from the university, regional government, and an NGO. The systems were classified based on irrigated areas as micro (<10 ha), small (10 – 100 ha), medium (100 – 500 ha), and large (>500 ha). The results showed that the prevailing challenge within irrigation systems is the absence of specialized knowledge in the operation and maintenance of water conveyance to farmers' plots, resulting in inequitable water distribution. Additionally, the main concerns across all systems are governance dysfunctionality and the lack of regulations for product marketing, which leads to economic losses for farmers. Microsystems are the most vulnerable and are characterized by limited production areas that can lead to agricultural abandonment and jeopardize local food security. Using this information, policymakers can formulate strategies to foster the development of diverse systems types.

Abstract

Societal and economic improvements to increase resilience and adaptation capacity> Oral Presentation

The Gulf of Nicoya Food-Climate-Biodiversity NEXUS in Costa Rica

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The Gulf of Nicoya (Golfo de Nicoya on the Nicoya Peninsula in Costa Rica) is an enclosed and shallow marine system and tightly connected to the terrestrial environment. In recent years, the ability of local fishermen to catch an adequate amount of fish has been severely impacted. This is concerning given that 3000 artisanal fishermen provide 60% of the needs of the nation. One particularly damaging factor is contamination from fertilizers originating from industrial farmlands (sugar cane, melon, rice, a.o.), that drain into rivers and the gulf. The impact of fertilizers leads to algae blooms and subsequently to coastal hypoxia. This in turn negatively impacts fisheries resources, local economies, food security and biodiversity. Additionally, climate change has forced the normal catch (mainly sea bass) to head for cooler and deeper waters and on land to increase irrigation facilitating leaching of fertilizers. In this study, we address the issue of terrestrial and marine food security and climate change adaptation applying a source-to-sea approach: i) we measure the nutrient export of contributing streams to the gulf, ii) assess the nutrient sources with the relatively simple GIS-based model SciMap to iii) simulate oxygen dynamics and potential algae growth in the gulf with a simple 1D oxygen mass balance model that relates oxygen availability to potential algae dynamics and fish growth, and iv) develop desirable futures for local communities using the modelling tools in workshops. The tools and data from this multi-disciplinary approach are used attempting to positively shape Costa Rican policy.

Abstract

Societal and economic improvements to increase resilience and adaptation capacity> Oral Presentation

Sustainable rural development starts with water

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In the last 20 years, Lama/State University of Ponta Grossa has carried out technical assistance and rural extension activities in 30 municipalities in the state of Paraná/Brazil. In this state, smallholder farming represents 75% of the production units (229,000) and occupies 67% of the people present in the countryside. The regional landscape comprises the headwaters of the river basins of the Tibagi, Iguaçu, Ivaí, Cinzas (Paraná River basin) and Ribeira (Atlantic basin), whose protection is vital for the maintenance and quality of water resources throughout the state. The Lama/UEPG working group believes in networking with family farmers, rural communities and their representative instances. For this purpose, in recent years the Lama/UEPG has approved several research and extension projects whose premise is the sustainable rural development of smallholder farming. In all achievements, the construction of water, soil and biodiversity conservation begins. With that in mind, a pool of production actions was developed; production of quality food (agroecological), certification of organic products, rescue and socialization of indigenous seeds, ecological management of pastures. With food production, where the cultural component is respected, agro-industrial transformations and differentiated commercialization formats are studied. Agro-industries, often with simple physical processes were implemented. Forms of fair trade and e-commerce eliminating barriers in agricultural chains are being practiced. At the same time, challenges arose, including young people and peasant women. Therefore, numerous technical assistance and rural extension activities were developed, so that due to the multidisciplinary team and academic commitment, all practices are scientifically robust.

Abstract

Societal and economic improvements to increase resilience and adaptation capacity> Oral Presentation

Improving Food-Nutrition and Water Security Outcomes through the Adoption of Climate-smart Practices: Evidence from Agricultural Households in South Africa

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Agri-food systems in developing countries face significant challenges such as climate change, environmental pollution, resource degradation, and increased price volatility. South Africa's (SA) agri-food system is highly vulnerable to these effects due to overreliance on irrigation-fed systems. Climate-smart agricultural (CSA) practices have been promoted as a sustainable strategy to address these challenges. However, little is known about their role in enhancing food and water security, particularly in SA's context. A nationally representative dataset of 504 maize farmers in SA during the 2022/2023 production season was used to analyze factors influencing farmers' decisions to adopt CSA practices. In the study, long-term rainfall variability had a positive effect on farmers' adoption decisions, suggesting policy measures to increase resilience to weather variability in SA. Additionally, the adoption of CSA practices had a positive and significant impact on food-nutrition and water security, but the impact differed across quantiles of food-nutrition -water security outcomes and agro-ecological zones. Understanding the determinants of adoption of CSA practices could facilitate the design and dissemination of strategies to enhance farmers' resilience at all levels. Furthermore, strengthening extension services and incorporating climate change sensitization delivery could also enhance the adoption of climate-smart practices. These findings may be beneficial to the implementation of the government flagship program on food-nutrition and water security in SA and suggest that promoting climate-smart agriculture can be employed as part of domestic efforts to achieve the UN's SDGs to end hunger, achieve food-nutrition and water security, and promote sustainable agriculture.

Abstract

Societal and economic improvements to increase resilience and adaptation capacity> Oral Presentation

Farmers' perceptions and strategies for adaptation to climate variability in an Andean mountain agroecosystem

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The lack of information on how climate affects agricultural systems and farmers' response to climate variability is a major obstacle to developing efficient water and resources management plans. The perception of farmers is fundamental, since they are the ones who subsist in the field, face the changing conditions, and their information is necessary for decision making. In this research we provide information on the farmers' perceptions and their adaptation strategies to climate variability in an Andean mountain area (3000 m a.s.l.), representative of the complex interactions between agroecosystems, local communities, and environmental changes. These areas have a highly variable climate and are strongly affected by extreme meteorological events. We interviewed all members of a social organization (comuna) whose livelihoods are agricultural and livestock activities. Results show that the changes that most affect farmers are strong variations in the dynamics of rainfall, temperature and the increment in the occurrence of frost. The increased frequency of extreme events makes them highly vulnerable because they entirely depend on small-scale agriculture. Livestock farmers have left agriculture mainly because they could not adapt to climate change, especially to the occurrence of frost, that now can occur in any month of the year; indeed, they have lost all their crops in a single event, ruining their production and seasonal income. The comuna has an irrigation system thanks to external funding and this is the only adaptation strategy that benefits all farmers. Due to economic constraints, they are unable to adapt to changing conditions and might opt to abandon the fields.

Abstract

Societal and economic improvements to increase resilience and adaptation capacity> Oral Presentation

“Are the rains failing us?”: Exploring female rice farmers’ perceptions and adaptation to climate change and food insecurity in Northwest Cameroon

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Rice is one of staple food consumed in Cameroon whose production is largely in the hands of women. Studies show that rice farming and output are sensitive to temperatures and rainfall in Africa (IPCC, 2022). In Northwest Cameroon where 18.3% of the people is food unsecured, large-scale rice is grown by the state funded Upper Noun Valley Development Authority. The contribution of small farmers, mostly women to the share of total rice produced from this region is sizable. Faced with current disequilibrium in local demand and supply for rice in Cameroon, this paper interrogates how climate change is affecting the role of small-scale rice farmers in the Northwest to food security. It analyses the adaptation strategies of women to the climate-food security nexus in the backdrop of a volatile local and global context. We use the purposive and snowball sampling techniques to identified and administered interviews and questionnaires to 100 female farmers who have been growing rice in the region for at least 15 years. Findings indicates significant link between climate change and rice production as the coefficient of determination (R2 = 0.624. Erratic temperatures and rainfall affect rice farming as seen in stunted growth and floods which tend to reduce farm outputs. Women have attempted some vital strategies which have been unable to reverse the negative trends in rice output because of scale and other gender factors. They do not have the funds, technology, land rights and capacities to deal with the effects brought about by climate change, thus, affecting food security. We suggest how these women can be assisted through micro credit, small-scale dam projects and climate smart agricultural that integrate local knowledge and opportunities for rice farmers to grow their output.

Abstract

Science-policy-society interaction and problem solution> Oral Presentation

From Knowledge to Governance: Understanding Water Security Dimensions in the Mira-Mataje Transboundary Catchment

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Over the last two decades, water security has gained significant attention due to multifaceted and cross-scale water challenges. The Mira-Mataje transboundary catchment in South America, shared by Colombia and Ecuador, is a critical ecological corridor facing escalating water and environmental degradation. However, research on water management and governance in this area is still in its early stages. To address this gap, the objective of this study is to comprehensively investigate the dimensions of water security as addressed by the academic community and explore how these dimensions are reflected in the relevant water policy and governance framework governing the catchment area. Additionally, the research aims to uncover the prioritized dimensions of water security among local and ethnic communities inhabiting the catchment. Qualitative research methods are applied, including a critical literature review, a Delphi survey involving water stakeholders, and semi-structured interviews with community leaders. The findings of this study are expected to shed light on the urgent need for inclusive and participatory approaches in water governance that incorporate the bottom-up knowledge and values of ethnic communities. The integration of local perspectives -often overlooked- into current and future knowledge and water governance systems are pivotal in addressing water security challenges in transboundary contexts effectively. Ultimately, this research seeks to contribute to the development of adaptive responses, incorporating knowledge, rules, and values, that prioritize the societal context, strengthen climate change adaptation, and enhance resilience.

Abstract

Science-policy-society interaction and problem solution> Oral Presentation

Integrating society in the planning of adaptation measures based on water consumption habits. A pilot project in an Andean city.

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Population growth in urban areas brings challenges to middle-size cities as climate change might decrease water availability. Adaptation strategies are key, especially when they are collectively built. We collected information about citizens´ households locations, water consumption habits, perceptions of changes on water quality and quantity and strategies to save water. After a verification and validation process, we found qualitative and quantitative information about water consumption of social groups that aims to understand if people living in different socioeconomic sectors have different perceptions and habits. Along with this, water availability projections under climate change scenarios to the year 2050 are being developed. This information is relevant to propose and evaluate water saving strategies considering a gender perspective as well as local capacities, behavioral and educational aspects, green-blue and gray infrastructure and to propose public policy improvements. The integrated work of academia, society and the city´s public water company are key to plan long term water adaptation solutions. Our study develops a methodology to adapt to reduced water availability and generate improved local adaptation strategies under climate change scenarios, which can be replicated in middle-sized cities. Analyzed information already shows that there is limited knowledge about the amount of water consumed each month per household and that people are not used to checking their water bills. However, there is willingness to implement saving strategies such as collecting rainwater for household tasks that do not demand drinking water.

Abstract

From Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)> Oral Presentation

Methodological guide for ecohydrological monitoring in Andean basins: towards an integrated analysis of biodiversity and ecosystem services.

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Mountains play a key role at the global level: they provide different basic ecosystem services for a significant percentage of the world's population, both rural and urban, and are one of the main centers of origin and areas of high biological diversity on earth (hotspots). At the same time, they are ecosystems vulnerable to anthropogenic pressures and sensitive to climate change. In the Tropical Andes there is still a large gap in terms of the collection and availability of ecohydrological (water, soil, vegetation and their interactions) and climatic-meteorological data, which serve as the basis for sustainable adaptation to the effects of global change. This fact stands out of proportion to the number of projects focusing on water security that are currently underway in this region.

Abstract

Our methodological guide for ecohydrological monitoring in Andean basins is a tool that allows a more comprehensive view of the dynamics of ecosystem services and vegetation (including specific, structural and functional diversity), by generating integrated long-term information on these dynamics and the key compartments and processes linked to water ecosystem services, such as hydrological regulation, in scenarios of environmental change at multiple scales of analysis (watershed, micro-watershed, landscape, ecosystems/plots). This guide is mainly aimed at formulators and managers of public and private water security projects with an ecohydrological approach. In addition, it is expected that it will contribute to the development of research to fill the information gaps on the impacts of various natural infrastructure interventions, conservation, restoration and adaptation strategies based on ecosystems, through ecohydrological monitoring.

Abstract

From Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)> Oral Presentation

Best Practices for Water-Scarce Cities: Proposed Policies towards an Integrated Urban Water Management in Egypt and the MENA Region.

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Water scarcity is a growing challenge in arid countries. Egypt faces significant water challenges including scarcity, pollution, inefficient irrigation practices, and the potential impacts of climate change. We propose actions and policies that promote an integrated water management approach for Egypt. We carried out a systematic review to select a set of criteria from the environmental, economic, social, governmental, and physical dimensions of urban water management. We selected Peru, Namibia, and South Australia to study their best practices for integrated urban water management. We then assessed which of the approaches can be adapted to the Egyptian context. These included directing percentages of water fees to ecosystem projects, treatment of wastewater to be potable, participatory approaches to engage the community, educational campaigns, and knowledge dissemination. We then carried out interviews with key stakeholders in the water sector in Egypt to validate our proposed approaches. They supported knowledge dissemination, offered suggestions for the use of water fees in environmental projects, and criticized treatment of wastewater into drinking water. We drafted specific recommendations at the organizational and urban levels. We recommended establishing a General Organization for Water Management to oversee water-related organizations and ministries; prioritizing the economic conditions to support alleviation of water subsidies; increasing public awareness; and creating a public database for water knowledge. We recommended decentralized water management and water-sensitive urban design. The value of these approaches is their applicability, with minor adaptations, to countries with similar or close climatic and socio-economic conditions, such as the MENA region.

Abstract

From Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)> Oral Presentation

Network-based model integrating water quantity and quality in an economic-integrated modeling platform: Total Phosphorus load in the Capibariba river basin and its impact on three other interconnected basins in Pernambuco, Northeast of Brazil.

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Integrated Water Resources Management recognizes the interconnection between people, ecosystems, and hydrology and promotes a coordinated management of natural resources that maximizes economic and social welfare without compromising the sustainability of ecosystems. Very few studies in the recent literature include concerns about water quality when discussing ways to expand the applicability and usefulness of models that integrate hydrological and economic aspects. This research aims to integrate quality (total phosphorus - TP) constraints into a network-based optimization model that points to the socioeconomic impacts of allocations by integrating an Input-Output Model and a Computable General Equilibrium Model. This model will use the functionalities of a Spatial Decision Support System developed with resources from Brazilian research funding agencies (CNPq and CAPES-ANA), called HEAL (Hydro-Economic Allocation) system, and will be incorporated into it. The ongoing case study deals with the basins of the Capibaribe, Ipojuca, Una and Sirinhaém rivers in the State of Pernambuco-Brazil, which will be interconnected through the Agreste pipeline and receive water from the São Francisco River Transposition Project

Abstract

(PISF). The 4 interlinked basin model was already executed under scenarios with different priorities and its results were analyzes and published. After the integration of TP modeling in the adapted node-link network, TP concentration and/or eutrophication status will be used as quality constraints to the water allocation and its results will be compared to those previously obtained. This assessment can be based on the changes on the amount of water allocated to municipalities, sector, analysis unit, etc. and on the Gross Domestic Product and jobs variation.

Abstract

From Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)> Oral Presentation

Mapping fluoride ions in Latin American groundwaters as a tool to promote water security.

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One critical aspect of water security is the presence of high concentrations of fluoride ions in drinking water, which can pose significant health risks. According to the World Health Organization (WHO), the maximum acceptable fluoride concentration is limited to 1.5 mg L-1. However, in Brazil, levels above this limit are frequently detected in wells used by the population. This situation has raised concerns about dental fluorosis, a condition commonly diagnosed by pediatric dentists, not only in Brazil but across Latin America. To address this pressing issue, a network of experts specializing in fluoride research was established, known as RELIFYF (www.relifyf.com). Inside this network, this work aimed to map areas of high vulnerability to fluoride ions. To achieve this, various geospatial data were utilized, including maps of land use, land cover, rock formations, and population density. By overlaying these data sets, it was possible to identify regions most susceptible to elevated fluoride concentrations, providing crucial insights for targeted interventions and resource allocation. Results showed several regions with fluoride ions concentrations ranging from 2 to 3 mg.L-1. Yet, the most fragile regions of land use and occupation are also the most fragile regions of the rock formation, and with this, the reason for the large concentration of fluoride ions found in this region may come from these two factors over the same area of the municipality. In conclusion, the study of fluoride vulnerability serves as essential pillars in the quest for water security that with reliable data que be extrapolated in Latin America, as a potential tool for decision-making towards a future where safe and accessible water is available to all.

Abstract

From Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)> Oral Presentation

Baseline of Water Security in Ecuador: A Multidimensional Analysis and Prioritization for Conservation and Restoration.

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The Ecuadorian Coalition for Water Security is a voluntary association of public, private, civil, and academic partners. To determine critical areas to strengthen water security (WS), establishing a national baseline was deemed essential. Here, we developed a methodology that encompasses five dimensions of WS: environmental, domestic, economic, social, and resilience. We identified 28 variables that represent key attributes of WS. These are applicable to the entire national inland area, allowing for spatialization and combination through a geographic multicriteria approach to produce five dimensional WS indices. These indices are then combined into a national multidimensional WS index and categorized in discrete groups at a resolution of 1 km by 1 km. The overall average of WS in Ecuador is classified as moderate (3.09/5). Environmental WS ranks at 3.48/5, primarily due to the conversion of natural water source ecosystems into productive lands. Domestic WS is moderate (3.32/5) and mainly affected by deficient

Abstract

sanitation services. Economic WS is the lowest (2.36/5) because of significant water demand from agriculture, hydropower, and industry. Social WS is rated as low (2.79/5), particularly because of the prevalence of water-related diseases. Lastly, Resilience WS ranks at 3.26/5, compromised by extreme events such as landslides, floods, droughts, wildfires, and climate change impacts. We identified 96,632 km2 where WS is high or very high and should be conserved. Additionally, there are 82,238 km2 where WS ranks as low or very low, highlighting the importance of restoration initiatives. Despite its limitations, this initial baseline of WS in Ecuador serves to optimize efforts by directing actions and allocating resources to the most critical areas multidimensionally.

Abstract

From Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)> Oral Presentation

Assessing the potential of nature-based solutions as sustainable land and water management strategies in the High Tropical Andes páramo ecosystem.

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The páramo ecosystem plays a vital role in the water supply for Andean communities; however, its deterioration in response to political, economic, social, technological, environmental, and legal (PESTEL) pressures threatens their water security. Nature-based solutions (NbS) can be designed to restore this type of ecosystem, but limited evidence of the effects of NbS on the páramo and PESTEL pressures have limited their implementation. We provide a novel integrated framework that identifies the PESTEL factors that favor (or constrain) NbS in the páramo and quantifies their effects using scoping review, remote sensing, and water quality assessment techniques. Our living labs are the Upper Pita and Cutuchi River Basins in Ecuador, which supply drinking and irrigation water to Quito and Latacunga cities. According to the PESTEL analysis, páramo in Pita over the 20th century was mainly transformed into large farms (haciendas) dedicated to camelid grazing in conjunction with the

Abstract

water and electricity development infrastructure. Contrasting, the focus in Cutuchi was on pine afforestation, as well as irrigation and mining development. In 1999, at the local (municipal) level, the NbS were promoted to restore the Pita páramo. Between 2010 and 2017, NbS were implemented, and by 2022 there was evidence of high-quality drinking water sources and 73% of the páramo being conserved. Conversely, the failed implementation of management strategies, including NbS at the provincial level and even within protection zones throughout Cutuchi, led to marginal water quality and further páramo reduction to 32% by 2022. Our approach reveals those PESTEL factors that lead to the success of NbS with potential for replication in other páramo areas and ways to avoid failure.

Abstract

From Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)> Oral Presentation

Water issues related to green hydrogen production in a semi-arid region in Brazil.

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The energy transition is now a reality on a global scale and a commitment of nations to issues related to climate change. In this way, green hydrogen has been named one of the best bets in the energy transition to a carbon-neutral world since it could be obtained through renewable-source electrolysis and can replace fossil fuels in carbon-intensive industries. In Brazil, a green hydrogen hub is beginning to take shape on the coast of the State of Ceara. The State has a unique and very strong geographical position with very advantageous weather conditions and is a major producer of wind power and solar energy. It is expected 106 metric tons of green hydrogen per year by 2030. However, the State is situated in a semi-arid region and water is a crucial resource since to produce such an amount of green hydrogen it will be necessary to supply 0.32-0.54 m3/s of extra pure water to the electrolyzers. Several water supply sources were assessed and transboundary freshwater, desalinated seawater, and water reuse were the best options. The State will receive 10 m3/s from the San Francisco River but it will be primarily used for human and animal supply. Its current cost for industrial use is R$ 3,486.72/1,000m3. Desalinated water plants will be installed in the Pecem Port Complex and its current cost is R$ 1,013,56/1,000m3 (excluding production costs). Reuse water will be obtained from the wastewater treatment ponds situated in the West Zone of the city of Fortaleza. This water could supply the hydrogen plants in Pecem Port Complex through an existing 35Km pipeline. Its current cost is R$ 704.57/1,000m3. Life Cycle Analyses considering resource use and pollution of water bodies determined that water reuse is the best option.

Abstract

From Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)> Oral Presentation

Co-created Participatory Approaches to Water Security Research and Multi-Level Governance that Leaves No One behind.

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Introduction: Our international research consortium, Coproknet, explores inclusive, participatory legal research approaches to implement SDGs 6, 11, 13, 14 at global, EU, and local levels. Coproknet's research-action team will present participation based, co-created research approaches (PAR) adopted in water governance case studies from the EU and LATAM. The case studies demonstrate a PAR approach to water security and climate change research is the defining factor in bridging knowledge gaps between the law, environmental sciences and communities. In climate vulnerable regions, the engagement of a broad range of stakeholders, including indigenous communities, enables citizen involvement in policy formulation, climate observation and providing practical yet transformative solutions for multilevel climate adaptation and resilience strategies. Results: A co-created report delivered at the Inter-American Commission of Human Rights (May 2018) and subsequent IACHR rebuke of the Peruvian Government; issue of an emergency health plan for communities near the Amazon's Tigre and Marañon watersheds; constitutional court (Peru) ruling against a major petroleum company; development of a CL&CBR (critical legal, community based research) platform hosting modular courses on collaborative water governance increasing

Abstract

researcher mobility between Brazil, Norway, EU; granted major MSCA-PF scholarship for PAR research project, High Seas Energy at NCLOS (Norway, Argentina); DAAD funded workshop series, 1 co-authored book, 2 scientific reports (2022-2023, Germany, Italy). Problem-solving approach: PAR integrates stakeholders in all research design, data collection, analysis, and dissemination of findings. PAR approaches utilise visual aids to co-design legal and educational documents.

Abstract

From Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)> Oral Presentation

Factors influencing women's representation in water resource management.

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Within the organizations in charge of water management in rural areas, there is an underrepresentation of women in decision-making positions. Despite the fact that their relationship with water is key due to their knowledge of its integral management and that they will be the ones who directly suffer the consequences of climate change; their participation in the management of water resources is secondary, with men being the main protagonists in decision-making. The project aims to identify the key elements that affect the representativeness of women in 35 organizations in a hydrographic basin located in southern Ecuador. The organizations in this basin were selected based on a prior diagnosis of the main gaps and inequalities in terms of roles, gender relations, use, access, and control of resources. Through surveys, users will value the level of participation of women. Additionally, interviews will be applied to key actors to establish the functions performed in leadership roles for water resource management. Finally, the information obtained from participatory rural diagnoses will allow us to explore the community's relationship with water, in addition to identifying existing problems. It should be noted that the validation of the surveys and the results is a construction between the Academy, the Machángara River Basin Conservation Committee, and the community. As preliminary results, 48.45% of women hold some leadership position within the 35 organizations that manage the water in this basin, however, only 31.43% are presidents. Through participatory rural diagnosis, it was identified that discrimination, lack of training, and empowerment determine the level of participation and involvement of rural women in decision-making for water resource management.

Abstract

From Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)> Oral Presentation

Water crisis, women and water self-management: the case of the Independence Basin in Guanajuato Mexico.

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Gender inequalities regarding water are profound and persist at all levels, with serious socio-environmental repercussions. Unsustainable economic practices affect the quantity and quality of water around the world, where women and girls are responsible for collecting it in 80% of households without access to piped water. The Independence Basin, located in the north of Guanajuato, is a state characterized by registering one of the greatest water imbalances in Mexico since access to drinking water represents a problem of monopoly and inequity, thanks to the privileged holdings of large economic capital of some families and companies who have access to large quantities of premium water, while rural dwellers continually struggle for access to water. The current form of water governance lacks a democratic system of distribution, so the existence of inequity in access to water leads to the emergence of self-managed forms as processes of defense of the right to water, either through aid to civil associations or payments for private water services, in which the role of women is key to water security. Collecting water is usually a task assigned to women, especially in rural areas, where women are dedicated to creating strategies to collect it, i.e., walking long distances to fetch and collect, constructing rainwater harvesting systems, or building contour bunds and stone bunds for water infiltration. Also, through narrative practices, women give clear meaning to the different components of the ecosystem they inhabit. For these reasons, even in mixed groups, women are prominent in the preservation of the commons, in the practice of environmental ethics, and in the new politics of recognition. Transition to water security need to be recognized through their organized actions.

Abstract

From Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)> Oral Presentation

Water sustainability: Socio-ecological description of Panama using MuSIASEM approach for 2019.

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The search for sustainability is a topic that has resonance nowadays because of the scarce resources in our countries and the increasing demand for the sustenance of the growing population. Therefore, this research aims to analyse Panama's water sustainability for 2019. In order to achieve sustainable development, it is necessary to study the complex relationship between the availability of the resource, its demand and its impact on society; this is proposed to be examined through the methodology of the Multi-Scale Integrated Analysis of Social and Economic Metabolism or MuSIASEM scheme, which interrelates economic, demographic and ecological variables of the country to generate indicators that allow diagnosing the viability of the system and the most vulnerable points to achieve sustainable development. From the data reviewed, it was found that Panama uses most of its water (88%) for agricultural activities, being the first consumption at the national level, followed by the supply for the Panama Canal locks (9%) and, finally, drinking water consumption (2%); the remaining (1%) is used for industrial, livestock and commercial activities. Given the importance of the agricultural sector, the different crops were studied by analysing their water footprint, which resulted in the highest consumption of extracted water (blue water) for sugar cane. On the other hand, analysing the intensive variables of water consumption per hectare of the crop, we have the highest consumption of mechanised rice in one of the provinces. As a result, the Panamanian government has allocated research to mitigate these consumptions, such as the genetic modification of rice to reduce its water footprint.

Abstract

From Water and Climate: Challenges, Opportunities, and Innovative Solutions> Poster Presentation

Assessing the impact of climate change on olive yield in Turkey using precipitation, temperature, and frost events data.

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Although olive production has always been a crucial element of the Turkish economy, studies examining the impact of climate change on olive yield from an economic point of view are quite limited in numbers and scale. This study fills in this gap by employing a novel data set comprised of variables on climate change at province level. Panel data analysis is employed to observe the effects of climate variables on olive yield in Adana, Antalya, Aydın, Balıkesir, Bursa, Çanakkale, Gaziantep, Hatay, Mersin, İzmir, Manisa, and Muğla provinces during the period 1968-2018. The results derived through variations reflected in seven models indicate that olive yield is significantly affected by temperature variability, the number of frost days, and the decline in rainfall levels. Moreover, in parallel with the findings reported in the literature, we find that the timing of climate-related changes is also important for olive yield. We believe these findings can guide policy-makers in reshaping the policy tools that are intended to address the vulnerability of olive production to climate shocks.

Abstract

From Water and Climate: Challenges, Opportunities, and Innovative Solutions> Poster Presentation

Climate changes impacts on drinking water supply and adaptation strategies.

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Concerns about the quality of drinking water have grown worldwide as climate changes have an increasing impact on water supply systems. Unfortunate incidents of drinking water contamination associated with climate-related events in several countries around the world have made authorities aware of the need to improve the decision-making processes that ensure potable water to the population. This conference will present the impact of the various climate-related variables that may affect water quality from source to tap, and the adaptation solutions that must be elaborated. Based on original data and models from recent work undertaken by the NSERC Drinking Water Research Chair at Université Laval (Quebec City, Canada), the presentation will focus on the future impacts of changes in climatic patterns (precipitation, temperature, droughts) on water quality variability at the catchment level, the operational decisions associated with treatment infrastructures, and the occurrence of contaminants in drinking water. The research results show an urgent need for water supply systems to adapt their decision-making strategies to protect the health of the population from increasing exposure to regulated and emerging contaminants. Such strategies should include adapted protocols for improved protection of water sources (watersheds and aquifers), ensuring more resilient water-related infrastructures, and implementing better spatiotemporal surveillance and monitoring of water quality from the watershed to the citizen's tap. National governance must also be adapted in order to reinforce the regulatory framework for drinking water, promote a multi barrier approach for safe water at the national level (water safety plans), and provide sufficient financial resources to local authorities.

Abstract

From Water and Climate Resilience in Agri-Food Systems> Poster Presentation

The impact of climate change on wheat productivity and the role of irrigation in saline soil environments in Uzbekistan.

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Introduction. The global temperature raise that triggers various natural calamities is a serious threat to the ecosystems and economies in many parts of the world. Particularly, regions such as Central Asia, where livelihoods heavily rely on the sustainability of water and land use systems are very vulnerable to climate change and face serious challenges of water, food, income security. Methods. Wheat supply projections are based on a fixed effects panel model estimating the combined ex-post effects of climate change, irrigation water and soil salinity on wheat productivity across 158 Uzbek districts in 2008-2017.Secondary data on dataset represents both irrigated and rain-fed farming districts in Uzbekistan. Results. The study reveals 2.85% reduction in wheat production on average due to the summer temperature rise rate. Irrigation itself increases production but also furthers soil salinization, which negatively affects crop output. Wheat supply-demand gap elevates under the SSP3-RCP7.0 scenario implying serious challenges to national food security. The results of the study highlight the region's heavy reliance on irrigation water use and its vulnerability in terms of climate change, particularly considering already high levels of soil salinization. Meantime, increasing population and consequent raise in food demand in future may result in enormous wheat supply-demand gap as also shown under SSP3-RCP4.5 scenario. The remaining climate scenarios also indicate that current wheat supply barely meets domestic wheat currently and there will not be much concerns over future food security if only population decreases. Maintaining long-term food security and alleviating the impact of climate change requires more fundamental improvements in water and soil management mechanisms in the region.

Abstract

From Water and Climate Resilience in Agri-Food Systems> Poster Presentation

Assessing climate change impacts on agriculture, livelihood, food security, and health of Palestinian farming community and household consumers. How to robust adaptation strategies they practice under political uncertainty?

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Agriculture in Palestine is threatened by climate change (CC). The threat magnifies under restrictions imposed by the Israeli occupation on access to agricultural water and land. This study aims to assess CC impacts on agricultural activities, livelihood, food security, and health of Palestinian farmers, herders, and household consumers, from their own perspectives; and investigate adaptation strategies practiced by farmers and herders under political restrictions; and actions needed to robust adaptation. Qualitative data was collected through in-depth interviews with 12 farmers and herders and 12 consumers, including 8 women, from Yatta and As Samoa towns in Hebron governorate. Data was analyzed using 'Thematic Analysis'. Results show that reduced duration of planting seasons; increased pests and plant diseases; decline in forage and grazing fields, shortage of drinking water for livestock; and reduced working hours on farm are major impacts of CC (mainly droughts). These impacts lead to decline in crop yield and milk production. Agricultural impacts adversely influence the livelihood, food security, and health of farmers, herders, and household consumers, such as income loss from decreased agricultural produce and marketing activities; scarcity and reduction in consumption of food; and stress, anxiety, and depression. As adaptation measures, farmers use water tanks to store irrigation water for dry seasons; apply fertilizers and mulching to improve crop yield and soil fertility; and cultivate resistant crops. Herders make hay and practice mob grazing to supplement and preserve rangelands for their livestock feeds. Farmers and herder engage in occupations other than agriculture to improve their livelihood, and secure and store food in boom season for use in lean season.

Abstract

From Water and Climate Resilience in Agri-Food Systems> Poster Presentation

Water Remediation by using non-conventional-feedstock for manufacturing carbonaceous nanocomposites: Considering Green Chemistry and Safe-by-Design Principles.

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Introduction Water pollution is a pressing global concern, demanding innovative and sustainable approaches to remediate contaminated water sources. This project focuses on utilizing unconventional lignocellulosic waste materials to create efficient carbonaceous materials and nanocomposites for water remediation. The research aims to design environmentally friendly carbon-based materials and integrate them into nanocomposites. Methods Unconventional lignocellulosic waste, specifically dry pods of higuerilla (Ricinus communis), was sourced, ground, and pretreated to preserve valuable components (cellulose, hemicellulose, and lignin). Pyrolysis transformed these components into carbonaceous materials, and nanocomposites (biochar+Fe3O4/ZnO, biochar+Fe3O4) were fabricated. Materials were characterized using SEM, FTIR, EDS, DRX, pH, and electrical conductivity. Independent experiments evaluated pollutant removal efficiency. Results The optim pyrolysis temperature was determined at 500°C. Carbonaceous materials showed significant pollutant removal, with nanocomposites removing 100% of paracetamol after 3 hours. Cr(VI) removal and methylene blue removal efficiency were also notable. Langmuir and Freundlich's isotherms were calculated. All materials are characterized Solving a problem To address the issue of safe disposal of adsorbent materials, the project explores physical and chemical strategies for reutilizing biochar and its composites. Desorption processes and plasma treatment techniques were evaluated to regenerate adsorbents, ensuring efficient material use and promoting a sustainable water treatment strategy. The project aims to develop eco-friendly solutions for water remediation, contributing to cleaner and safer water resources.

Abstract

From Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)> Poster Presentation

Sustainable Water Management through Greywater Recycling: A Case Study of an Eco-Hammam Project and Environmental Education Integration in Casablanca.

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Water scarcity and environmental degradation pose critical global challenges, particularly in rapidly urbanizing areas. Addressing these concerns requires innovative and sustainable water management approaches. This study explores the integration of environmental education in sustainable water management in Casablanca, Morocco. The research focuses on an experimental study using a Moving Bed Biofilm Reactor (MBBR) system for greywater treatment in Hammams. This technology offers a promising solution for sustainable water reuse, alleviating strain on freshwater resources. Additionally, the study assesses the feasibility of establishing an educational garden in a public school, irrigated with treated greywater, to promote environmental education and sustainable practices among students. Combining qualitative and quantitative methodologies, the research selects the most suitable treatment technology for the Eco-Hammam Project. The participatory approach empowers students, teachers, and community members to collaboratively develop and implement environmental education projects. The transformative impact of the Eco-Hammam Project serves as a model for fostering water-conscious behaviors and environmental stewardship among students. By promoting sustainable practices and environmental awareness, this initiative contributes to a more resilient and water-conscious society. By linking wastewater treatment and reuse with garden watering, it exemplifies a holistic approach to addressing environmental concerns and nurturing environmental consciousness. The findings offer practical guidance for developing resilient and sustainable water management practices, vital for an environmentally responsible future amidst escalating water challenges in urban settings.

Abstract

From Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)> Poster Presentation

Technical innovations solutions for water security in transboundary water resources between Algeria, Tunisia and Lybia in arid area.

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The North-Western Sahara Aquifer System in North Africa, extends over a total area of one million km2. This transboundary aquifer system is shared by three neighbor countries Algeria, Libya and Tunisia. The overexploitation of the Aquifer System, with all the environmental and socio-economic impacts it implies, has led the three countries to gather around common objectives with a view to controlling water demand, improving its productivity and protecting the environment. The SASS project which was structured around two main components: • A “socio-economics” component that has as objective the analysis and understanding of the irrigator’s behavior for a better valorization of water resources; • A “demonstration pilots” component that aimed to prove the feasibility and acceptability of technical innovations to treat the major issues of the Saharan agriculture. The technical innovations adopted at the level of the six pilots to address these issues concern: a) recourse to solar energy, b) Brackish Water Valorization through demineralization c) Rehabilitation of lands degraded due to water stagnation, d) Irrigation Efficiency and Agricultural Intensification. All the technical innovations introduced in the demonstration pilots were supported by a participatory approach that implicates all actors involved in groundwater use and management. Farmers were involved in all stages of the pilots’ implementation, starting from the design until the final realization of the pilot. All activities were conducted in a way that ensures the interaction with the primary actor (farmer) and tries to convince him that he could produce more with less water.

Abstract

From Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)> Poster Presentation

Methodology to estimate the investment gap for the sustainable management of ecosystems that provide water ecosystem services for the provision of sanitation services.

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One of the SDG 6 targets is “Protect and restore water-related ecosystems, including forests, mountains, wetlands, rivers, aquifers and lakes.” For this, as part of the planning, it is necessary to measure the size of the problem in terms of investment. In this sense, a practical methodology is proposed, which mainly uses secondary information, to estimate the investment required for the sustainable management of ecosystems that provide water ecosystem services for the provision of sanitation services. The methodology contemplates as secondary information: Landsat images processed in Google Earth, a fabDEM digital elevation model, the Soilgrid world soil map and Senamhi’s PISCO product. All this information is processed in the R software for the application of Rusle’s equation. This procedure will allow estimating, in terms of hectares, the problems faced by the ecosystems found in the basins that provide water for sanitation. Then, through an econometric methodology, the unit costs per hectare are estimated according to the particular characteristics of the ecosystems in each basin and with this the approximation of the investment gap in natural infrastructure for the sustainable management of ecosystems that contribute with water to sanitation. This methodology can be replicated in any region of the world in areas of the basins that provide water for the provision of sanitation services. Therefore, the application of the methodology will contribute to decision-making by the governments of the countries, international cooperation and institutions related to water security and sanitation, mainly in the process of planning and allocation of resources for financing of projects in natural infrastructure.

Abstract

From Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)> Poster Presentation

Water and Sanitation and GEE emissions in Brazil.

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Wastewater Treatment Plants (WWTP) are considered sources of Greenhouse Gases (GHG) emissions, making them subject to mitigation actions. As part of the strategies to combat climate change, there is the C40 Network, an initiative that brings together cities around the world with goals aimed at reducing emissions and adaptation - including the elaboration of Climate Action Plans. In Brazil, the cities of Salvador, Rio de Janeiro, Curitiba and São Paulo make up the C40. Thus, the objective was to analyze how these cities incorporated issues related to emissions in WWTPs in their municipal climate plans. For this, a document review was conducted using keywords to identify mentions and excerpts related to emissions. However, in general, there are advances in the recognition of ETEs as potential actors in the fight against climate change. It is important that dialogues and exchanges take place between cities, aiming to overcome challenges and build coordinated actions. In addition, it is essential that laws and programs at the national level are implemented to support and encourage not only local initiatives in these cities, but throughout Brazil. From 2021, the Plan lists specific goals for each sector of the city, including the waste and sewage treatment. Among the actions to face climate change, there are reports with GHG operation and monitoring data by the water and sewage concessionaire (2021-2024 period). It is noteworthy here that one of the specific objectives of Climate Plan - Sao Paulo is precisely to reduce emission factors during sewage collection and treatment by 2030.

Abstract

From Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)> Poster Presentation

Technical Efficiency of Water Recovery Plants From Circular Economy Approaches.

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Located in the center-west of the Argentine Republic on the Andes mountain range, the province of Mendoza is characterized by an arid climate, with scarce flows in its rivers and irrigated basins that receive an annual average of 230 millimeters of rainfall. The province is experiencing its 13th consecutive year of water crisis. This water situation undoubtedly forces agricultural producers and the public system to be more efficient in the use of scarce natural resources, aiming to minimize production losses both in quality and quantity, which can consequently the profits of agricultural companies and the society in general. Failure to adapt will result in a detriment to production with possible abandonment of agricultural activity and/or a decrease in the price of property for productive purposes. The reuse of the water resource is an alternative to the unsatisfied demand for agricultural irrigation (596-1,155 hm3 per year) and contributes to the revaluation of the resource. AySAM is a state-owned company that has 21 purification facilities that treat 4,000 l/s from 350,000 connections and irrigate 3,600ha. The operation of these facilities exceeds the original design capacity, by an average of 80%. This situation implies additional costs in operation and maintenance, deterioration of the infrastructure and compromises technical and managerial decision-making. The productive performance of the wastewater treatment plants (WWTPs) is analyzed by employing non-parametric techniques. Irrigation, decision-makers at AySAM, and stakeholders would benefit from having a better understanding of which of these approaches would cost effectively address this series of problems considering future uncertainties.

Abstract

From Water and Climate: Challenges, Opportunities, and Innovative Solutions> Poster Presentation

Risk-informed decision-making for critical infrastructure in a climate change context.

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The intensification of climate risks due to climate change is a reality. In addition, there is huge uncertainty about future climate hazards in many world regions. Critical infrastructure is endangered, and the consequences are not only material but involve enormous economic losses and limit the nation's development. Therefore, the PIEVC protocol for assessing public infrastructure vulnerability to climate change impacts has been developed and outlines a process to assess the infrastructure component responses to the impacts of a changing climate. This protocol describes a step-by-step methodology that is scientifically rigorous, but it is oriented to a practical application by technicians/engineers to enhance local risk-informed decision-making about infrastructure design, development, operation & maintenance, under climate change scenarios. It has been applied in Canada, Peru, Costa Rica, Brazil, Vietnam, and other countries, and it keeps expanding its scope to other latitudes, especially those more vulnerable. The outcomes of this evaluation allow the identification of infrastructure that require a more detailed adaptative engineering analysis. Moreover, it helps to integrate "engineering adaptation measures" into the infrastructure's life cycle. The PIEVC protocol is a reliable methodology/tool that develops and establishes risk management processes to guide a risk-informed decision-making approach. Decision-makers from the public and private sectors can use this tool to prioritize adaptation measures and increase the climate resilience of key infrastructure linked to hydropower generation, water regulation & flood protection structures, water supply systems, and others.

Abstract

From Water and Climate Resilience in Agri-Food Systems> Poster Presentation

Water Quality Trend Analysis in the Paratibe river basin, Pernambuco, Brazil.

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Industrial and urban development in many places has contributed to the intensification of pollution in river basins. Over time, it has become essential to develop forecast and trend studies on the water quality of water bodies, as a form of management. Thus, the present work aims to analyze the trend of water quality parameters in the Paratibe River basin, in Pernambuco, Brazil. The Mann-Kendall test was used, which is a statistical tool for analyzing trends and identifying temporal patterns of positive or negative changes in data series, with a significance level of 5% ($p = 0.05$). Among the data used, the 3 points monitored by the State Environment Agency (CPRH) were selected, located in the water catchment area (PA-10), in the industrial district of Paulista (PA-15) and in the residential area of Paulista (PA-25), with a database with annual information between 2001 and 2019, with information on Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO), Ammonia and Phosphorus. The results obtained indicate that there is a significant trend for DO and BOD in all points analyzed ($p < 0.05$). In this case, for point PA-10, which consists of the water intake site, there is a positive trend for DO and a negative trend for BOD, showing an optimistic scenario, with an increase in DO and a reduction in BOD. This perspective is opposite at points PA-15 and PA-25, whose sites encompass greater intensity of environmental impacts, where DO shows a negative trend and BOD a positive trend. Ammonia showed no trend or changes in behavior ($p > 0.05$). For Phosphorus, a significant trend was found for point PA-10 (negative) to point PA-25 (positive). In view of this, it is possible to understand the influence of urbanization and industrialization on water quality and its impacts.

Abstract

From Water and Climate Resilience in Agri-Food Systems> Poster Presentation

Socioecology of the traditional farm. A contribution to local food sovereignty in the village of Bocas del Palo, Jamundí.

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This research is carried out and financed within the GRCF Project – Water Security and Sustainable Development Hub for international cooperation. The ancestral agriculture and the ethnoculturalism of the black communities maintain and reproduce the forms of life associated with nature. In this case, the objective of this research is to analyze the traditional afro-farmer farm in the village of Bocas del Palo, Jamundí - Valle del Cauca, as a socio-ecological system and its relationship with local food sovereignty. It starts from the question: How are local food sovereignty and the traditional afro-farmer farm related under the socioecological system approach? Where it seeks to describe the socio-ecological system of the traditional farm and the related ecosystems as fundamental components of the agri-food system of the community. The materials and methods used for this research consist of a mixed methodology where qualitative methods were used from participatory diagnostic tools and spatial and temporal techniques through the use of SIG. The analysis focuses on the analytical categories of two components: food system and socio-ecological network system, for which data matrices are used, and the IBM-SPSS and Atlas-Ti software articulated to spatial and temporal processing. The main results are the characterization of traditional farms and related ecosystems and the identification of community actions to contribute to the construction of local food sovereignty. The main conclusions are that the community food system is focused on self-consumption, exchange and short marketing circuits; and that their livelihoods are linked to the wetland system and the Cauca river.

Abstract

From Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)> Poster Presentation

Transition towards Water Sensitive Cities in Colombia: Public Spaces as platforms for Ecosystem´s services recovery.

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Cities need to interact more harmoniously with their environment, especially with regard to water systems and the urban water cycle. Currently, public space design standards in Colombia do not include rainwater management for reuse in buildings and irrigation of green spaces, wasting potable water on activities that do not require it. Integrated public space design can also help reduce urban temperatures, especially in dense and centrally located areas. Adapting cities and public spaces to climate change is crucial, especially in geographic contexts such as Colombia, where the La Niña climate phenomenon, which, will further increase precipitation in regions of Colombia, making urban and rural populations more vulnerable to flooding, landslides and sea level rise. This study aims to characterize urban systems related to public spaces potential for Nature Based Solutions (NBS) adoption and its functioning in three Colombian cities with different altitudes, climates and urban morphologies: Bogotá, Bucaramanga and Cartagena. The potential for NBS solutions in urban context was assessed with land suitability analysis and Multicriteria Decision analysis tools. The results showed that adoption of NBS in public spaces and urban design guidelines can be a valuable strategy to prepare our cities to climate change, and provide a better support for urban ecosystems services in Colombia.

Abstract

From Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)> Poster Presentation

Coupling water and society under the concept of Headwater Dependent Systems.

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Billions of people depend on water sourced upslope by glaciers, snowpack, wetlands and other surface and groundwater stores. Changing temperatures and precipitation patterns are shifting the timing, volume and quality of water available to human and natural downstream systems. Growing demands for water place the furthest downstream users and ecosystems at particular risk to water insecurity if existing governance structures fail to adapt to changing hydrologic conditions and user demands upstream. This confluence of headwater dependence, climate change, and cross-scale governance make these systems particularly complex and difficult to understand. Yet, while research on water resources is well developed, the key elements of this confluence remain compartmentalized by discipline, place and existing organizing frameworks. Here, we summarize our team's shared cross-discipline and cross-site learning aimed at bringing together headwater dependent knowledge to build a water-focused research network across the Americas, presenting «headwater-dependent systems» as a conceptual tool for integrative learning, system level thinking and realistic solutions. Our approach places increased emphasis on teleconnections and encourages governance that embraces the reconnection of supply and demand. It recognizes and gives license to consider non-traditional boundaries to water management.

Abstract

Moreover, it provides a stronger voice to people who do not necessarily comprehend water as only for economic good, particularly those who view water as a constitutional right. By explaining our approach, we attempt to foster a more effective interdisciplinary study of water resources and implementation of integrated solutions to counteract impacts from climate and non-climatic drivers of change.

Abstract

From Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)> Poster Presentation

Looking beyond glaciers to understand mountain water security.

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The cryosphere is a crucial component of water provision to downstream societies, as it contributes to dry-season flows and sustains diverse ecosystems in many mountain regions worldwide. However, many glacierized watersheds experience far-reaching changes due to declining glaciers and snowpack, climate change impacts, and socioeconomic development. The implications for downstream water supply are therefore manifold and complex and threaten future water security. In this study we argue that the limited understanding of interactions between the cryosphere, glacial and non-glacial water stores, river runoff and people hamper climate change adaptation and long-term water security. Meaningful assessments of mountain water security require therefore a holistic social-ecological perspective that interlinks the wider catchment hydrology and people with improved data and process understanding. Water security assessments can then be guided by a fully coupled hydrological risk framework under a variety of possible future scenarios of glacier shrinkage, catchment alteration and socioeconomic development. Essentially, this requires a good understanding of interrelated upstream-downstream systems and the spatiotemporal propagation of meltwater through the terrestrial water cycle. Improved data and more diverse knowledge collection are a priority, and these should be integrated into a collaborative science-policy-community framework. This can support a wide set of strategies that guide effective and robust adaptation pathways. These may include, among other, exploring catchment-specific benefits of nature-based solutions to increase the buffer function of wider catchment hydrology to water loss from glacier shrinkage and to enhance long-term water security in a watershed context.

Abstract

From Water and Climate: Challenges, Opportunities, and Innovative Solutions> Poster Presentation

Identifying key indicators for assessing water-related ecosystem services in global lakes.

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Freshwater lakes play a crucial role in regulating and maintaining hydric, climatic, and biological processes within landscapes, while also providing water to support human activities. Effectively assessing the aforementioned water-related ecosystem services (ESw) is essential for the sustainable use of lakes as sources of freshwater. Especially when they are susceptible to the hydrologic changes resulting from climate change impacts and the subsequent adapting strategies. Therefore, it is essential to identify suitable metrics that can measure the ESw across different landscapes, type of impacts, and management strategies. In order to provide accessible information on this subject, we conducted a comprehensive review of scientific literature focusing on ESw provided by freshwater lakes, as well as the metrics used to quantify these services. By employing machine learning models and statistical analysis, we grouped the ESw together with their respective metrics. Our findings reveal that certain metrics can be used to assess multiple ESw, regardless of landscape and management characteristics. We present these metrics and propose the best-ranked ones as indicators. These indicators can be employed to assess the ESw of freshwater lakes on a global scale. Our study proposes a novel opportunity to assist in the identification of management strategies aimed at decreasing the climatic vulnerability of human populations reliant on freshwater lakes as sources ESw. The next challenge in our work is to model various management strategies for freshwater lakes under the influence of climate change impacts.

Abstract

From Water and Climate: Challenges, Opportunities, and Innovative Solutions> Poster Presentation

Nature-based solutions, part of the key solutions for Latin America to move towards the water and climate goals.

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Introduction. Latin America [LA] faces enormous risks in water quantity, quality, and water disasters related to droughts and floods. Nature Based Solutions [NBS] are key for LA to advance towards Sustainable Development Goals [SDG] 6 and 13. This work aims to contribute to make NBS visible as key solutions towards Water Security for LA. Methods, Results and Solution of the Problem. This qualitative study follows the case study strategy and investigates NBS related to water and sanitation (quality and quantity), and water extreme events related to climate: droughts and floods. It particularly poses critical water related challenges in LA based on recent and relevant examples of Argentina, Chile, Ecuador, Peru and Uruguay. These water-related challenges encompass water quantity and quality and consider the variable climate change the region is facing through water (droughts and floods). The study also analyzes: (a) NBS related to water: starting from the key concepts of Water Security, Nature-based Solutions, Ecosystems, and Ecosystem services; poses a Scheme of the Relation between them, and highlights NBS relative to water (Water Supply Regulation, Water Quality Regulation, and moderation of Extreme Events such as Floods and Droughts); (b) NBS experiences in the region: two specific cases (good practices) in LA are included: (i) water protection areas as a governance strategy to maintain, conserve and protect water sources, resulted also in awareness of water care in the country, Ecuador, and (ii) aquifer infiltrations, an initiative arose from a group of agri-export leaders in a water stress area that is central to the Peru's economy, with relevant results to positively improve the aquifer's water imbalance. It concludes recommending a call for action.

Abstract

From Water and Climate: Challenges, Opportunities, and Innovative Solutions> Poster Presentation

Unveiling Galapagos' precipitation dynamics: A Citizen Science-inspired Initiative to better understand the Water Resource Relevance.

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Most of the freshwater on the Galapagos is groundwater, which is recharged mainly by precipitation, making it susceptible to any change in the water resources. A growing need to explore cost-effective data acquisition data has established Citizen Science (CS) as an alternative to monitoring hydrological variables. The integration of low-cost sensors in CS initiatives has made measurements of hydrological variables more affordable. Therefore, we proposed a citizen science initiative to be implemented on Santa Cruz Island, the most inhabited island in Galapagos, to study the dynamics of the precipitation in the altitudinal gradient of the island under El Niño Event from 2023-2024. We recruited 10 citizen science participants to measure 10-min precipitation using low-cost sensors designed for this project. The sensors were installed along the altitudinal gradient from Baltra to Cerro Crocker, and from Cerro Croker to Puerto Ayora. The implementation of our citizen science initiative involves 5 phases, 4 of which are currently in progress and will continue until October 2023. Firstly, we have engaged in communication with stakeholders to understand their needs regarding the study of precipitation. As a second step, we have created a database and a dashboard to display the collected data. Next, we have recruited and shared knowledge on the proper use of the sensors with the participants. Subsequently, we have strategically installed the sensors according to the altitudinal gradient criteria. Finally, the data collection phase will span from October 2023 to July 2024, capturing the entire warm season during the El Niño event. The findings from this study will provide valuable insights for policymakers and stakeholders involved in water resource usage, and administration.

Abstract

From Water Security: Science-Policy-Society Dialogue (Priorities and Implementation)> Poster Presentation

The potential of self-managed water organizations as agents of sustainability in Cochabamba.

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This presentation proposal will present information about self-managed water systems in the city of Cochabamba (Bolivia), particularly regarding their organizational forms and their subsequent performance as sustainability agents compared to public operators. Community water operators in Cochabamba gained prominence in the year 2000 during the 'Water War,' becoming a symbol for global struggles over water and resistance to privatization. The presence and strength of these organizations have been the result of decades of neglect by the State, resulting in a vast array of diverse community-based solutions that were constantly seeking an adequate response to the problem of water access, first and foremost, as well as the resolution of technical and financial issues and negotiation with external actors. Just as privatization posed a significant threat to this collective construction, the current policy focused on state protagonism could pose a threat to other positive aspects of self-management in terms of group solidarity and environmental sustainability. We maintain the hypothesis that, while state intervention is necessary to ensure the availability of the resource, large-scale management may adversely affect its rational use and consumption. This hypothesis will be explored through case studies in Cochabamba, proposing an important factor for considering creative forms of resource co-management in social contexts where the State's capacity is weak, in the pursuit of its sustainable use. We believe that this knowledge is essential to avoid the negative social and environmental consequences of policies solely focused on the supply.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Exploring the Impact of City expansion on Andean Agri-Food Systems

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In the Ecuadorian Andes, agri-food systems are mainly developed on a small scale. Most of them are located near cities, which in some cases is an advantage for commercialization, but in other cases it causes people to abandon their agricultural activities to work in the city. However, without information, it's not possible to understand the situation of these systems that were key food producers during the COVID-19 pandemic. In this context, research was conducted with the aim of identifying the impact of city expansion on nearby small-scale irrigation systems. We interviewed 23 farmers to characterize the agri-food systems located less than an hour drive from Cuenca, in the southern Andes. Our findings indicate that in these systems, the economy doesn't depend exclusively on agriculture, with very few people living solely from that. Small parcels, the lack of irrigation water in the dry season, and more frequent dry spells, are the main drivers of low production. Thus, the migration rate is high and most people work in the city after leaving the irrigation system. About 65% of the irrigation users' committee is made up of old adults, while young people show no interest in continuing agricultural practices. As a result, systems are under-utilized, investments in technology to improve the production are lost, and some users resort to using the water for domestic activities due to the lack of drinking water. In conclusions, (i) the lack of detailed information about irrigation systems leads to ineffective investments, (ii) due to city expansion, people are leaving the countryside in search of other economic alternatives, (iii) without adequate policy, food production and security is severely compromised.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Generation of benefits through the coexistence of cochas and bofedales in the semi-arid Andes (Peru)

Walter Leyva Molina[1], Jessica Tafur[1], Fernando Quinto[1], Fabiola Cardenas[1], Rossi Taboada[1]

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The basins located in the Southern Tropical Andes (8°S-27°S) only receive moisture from the Amazon due to the arid climate system of the Pacific coast, for which reason they have monomodal precipitation regimes, with a clear gradient of humidity that decreases from east to west. Given this configuration and considering the risks of drought scenarios, seasonality is clearly a key factor in the hydrological regime, which must be taken into account in order to meet the needs of the population. Under these conditions and after noticing the reduction of water sources in the headwater of the Apacheta basin (4000 masl), the community members of the Tunsulla in the Ayacucho region (Peru), around the year 2008 began the construction of rustic reservoir or “cochas”, in order to have water for domestic and livestock use. This implementation was carried out in a natural environment, which has a bofedales system that is used by the local population for the practice of livestock. With this, the coexistence of two water harvesting systems was generated. This work, through the reconstruction of the implementation process of 6 cochas with respect to the year 2021, analyzed the resulting benefits and identified that the families of the Tunsulla community quadrupled their income and today have made this infrastructure part of their heritage, which allows them to have water permanently. Added to this, the bofedales system was evaluated to know its condition during the same year, resulting in a “good” state according to the scale of Flores (2005). However, indications of factors that could affect their condition were detected, together with incipient pasture management practices.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Data-driven solutions for ungauged basins: A novel method for satellite precipitation data fusion (Ecuador)

Patricio Luna[1], Paul Muñoz[1], Rolando Celleri[1], David Muñoz[2]

[1] University of Cuenca

[2] Virginia Tech

In recent years, climate change has emerged as a critical concern, affecting access to water, sanitation, food production, hydropower generation and more. Estimating water availability poses a global challenge, primarily due to the lack of conventional monitoring of crucial variables like precipitation. However, the scarcity of in-situ precipitation stations presents both an opportunity and a challenge. The opportunity lies in exploiting the variety of freely-available satellite precipitation data, while the challenge is to generate a unique precipitation dataset suitable for any hydrological application. In this context, the Three-Cornered Hat Method (TCH) is a novel approach for fusing multiple satellite datasets, accounting for the differences in temporal and spatial resolution. Importantly, TCH aims to fuse three satellite precipitation datasets regardless of in-situ data availability. This is done by considering variances and covariances of the satellite data to develop a unique weighted and uncertainty-reduced precipitation dataset. Here, we aim to demonstrate the value of the TCH data fusion method in runoff forecasting for Ecuador's third most important hydropower plant, The Minas-San Francisco. The anticipated outcome of the proposed runoff forecasting system is a reduced satellite data uncertainty, leading to more precise runoff forecasts. The generated runoff forecasting system is expected to play a crucial role in optimizing hydropower generation in the Minas-San Francisco hydropower plant, thereby offering new tools for effective water resource management and operational hydrology. The potential of the proposed forecasting system is to offer critical information for informed decision-making and action in regions with limited in-situ data availability.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Innovative Forecasting Strategies: From Satellite Data to Enhanced Hydropower Efficiency in Ecuador (Ecuador)

Paul Muñoz[1], Rolando Célleri[1]

[1] University of Cuenca

Hydropower generation in Ecuador is vital for its economic development and for addressing the country's energy deficit. Among the most important plants is the Minas-San Francisco (MSF). However, hydropower generation in most plants of the country is suboptimal due to the lack of hydrological forecasting tools to optimize the energy generation schedule. This issue is further compounded by the absence of an operational rain gauge network in the associated 3400 km2 basin. The only available option is to rely on non-validated satellite precipitation data. To address these challenges, we developed a real-time short-term forecasting system for the MSF plant, consisting of three modules: data acquisition, hydrological modeling, and forecast communication to end-users. The developed forecasting system can effectively handle uncertainties in satellite precipitation data by employing a machine learning (ML) technique. The developed forecasting system is not a mere black-box precipitation-runoff model. Over the years, we have applied various feature engineering strategies in the ML models. These strategies serve to not only exploit satellite data but also incorporate process-based hydrological knowledge of the basin. Forecasting efficiencies, assessed through a combination of performance metrics are promising for hourly lead times, even beyond the response time of the basin. Through this innovative solution, we demonstrate the potential to leverage satellite data that might otherwise be overlooked by traditional hydrological models. Furthermore, our findings offer valuable insights for operational hydrology in data-scarce regions, enhancing water and climate resilience for hydropower and supporting risk mitigation and decision-making for farmers, practitioners, and policymakers.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Exploiting Global Data to Understand the Mechanisms of Extreme Precipitation in the Tropical Andes: From Subcontinental to Local Scales (Ecuador)

Mario Córdova[1], Johanna Orellana-Alvear[1], Rolando Celleri[1], Jörg Bendix[2]

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Hydrological extremes related to extreme precipitation have been more frequent in tropical South America (TrSA) in the last two decades. Precipitation anomalies in the area are related to the complex climate variability that results from the superposition of a number of phenomena that act on different spatial and temporal scales. Moreover, it has been found that drought, extreme precipitation, and flooding are more likely to occur because of anthropogenic climate change in TrSA. Therefore, there is an urgent need to understand these extremes in multiple spatial and temporal scales in order to guarantee water security in the region. In the present study, a combination of global products and weather radar observations was used to unveil the mechanisms behind such extremes in three different scales: 1) TrSA in annual to monthly scales, 2) the tropical Andes in seasonal scales, and 3) the Andes in southern Ecuador at event scale. It was found that ENSO affects extreme events on every scale, it causes diverse precipitation anomalies over tropical South America, influences the monsoon, modulates the low-level jets, and increases the likelihood of extreme precipitation. Anomalies in the ITCZ, the South American Monsoon, and the South Atlantic Convergence Zone were also identified to be connected to extreme precipitation events in every scale, connected at the smaller scales to anomalous patterns of CAPE, wind, and Sea Surface Temperature. The results of this research are being applied to forecast precipitation in southern Ecuador, which is one of the many examples where this knowledge may be useful. The implementation of these models will be helpful to help society cope with the extremes that climate change will make more frequent and intense in the future.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Evaluation of lab-scale Anaerobic Baffled Reactor using a Rumen Liquid for Domestic Wastewater (Mexico)

Alan Rico[1], Juan Francisco Carrera[1], Yovani López[1]

[1] National Technological Institute of Mexico

Water pollution (WP) affects to environment and represents public health problem. In rural areas, no processes that prevent WP due to inadequate management of domestic wastewater (DW), making it necessary to search for treatment for this type of area. The city of Misantla is in the center of México, its wastewater is discharged without any kind of treatment. This study presents the evaluation of a mixture of rumen fluid and wastewater solids as anaerobic sludge within a lab-scale anaerobic baffled reactor (ABR) for DW treatment. The ABR total volume was 32 L divided into 4 sections. 2 L of rumen fluid and DW (1:1) was mixed with 1 L of wastewater solids in anaerobic conditions for 7 days; the solution was then translated into the reactor. ABR was kept in operation for 13 weeks (5 mL/min), and the feed was provided from DW. Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), sedimentable solids (SS), and pH were analyzed based on Mexican standard test methods. The Kolmogorov-Smirnov (α= 0.05) goodness-of-fit test was used to determine if the variable presents a normal distribution. Removal efficiency per week was analyzed by ANOVA (α= 0.05) experiment and Duncan Post-Hoc Test (α= 0.05). The output results for BOD5, and COD reflected a lower value compared with the input. During the last three weeks, the ABR was stabilized and reached the highest removal percentages; 93% and 90% for BOD5 and COD, respectively; meanwhile, pH stabilized in 6.87. Initially, the value of SS was 9 mL/min, and after 13 weeks of operation, the SS was 0.2 mL/min. The statistical analysis shows that there is a difference between the removals of the analyzed parameters. The possible application of ABR for DW treatment with similar concentrations could be effective in rural areas.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Evaluating Water Security under Changing Climate in Tropical Forests: A Multi-Dimensional Approach (France)

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[1] Mixed Research Unit in Agroecology, Agroequipment, Territories, and Crop Systems in Mediterranean Agriculture

[2] Ghulam Ishaq Khan Institute of Engineering Sciences and Technology

Forests and climate are intrinsically linked as trees regulate precipitation and temperature, while water availability affects tree growth and mortality. Ensuring water security in forests is essential to build climate change resilience and maintain a habitable environment. Thus, to understand human-water-forest dynamics, we develop a water security index (WSI) using five distinct dimensions, each represented by several indicators, influencing water security. The society dimension, represented by human wellbeing, citizen engagement, and the protection of Indigenous communities as indicators, encapsulates access to clean water and sanitation, ecosystem preservation efforts, and the wellbeing of indigenous people. The ecosystem dimension, measured using river health, groundwater status, and ecological disturbances, assesses the state of surface and groundwater, as well as the impacts of climate change and deforestation. The productivity dimension, evaluated using indicators such as agricultural, timber and industrial productivities, captures the productive capacity of agriculture, logging, and manufacturing sectors in relation to freshwater exploitation. The disaster dimension incorporates indicators for drought risk, flood risk, resilience and preparedness, addressing the threats posed by hydrological disasters and the capability to cope with extreme events. Lastly, the governance dimension uses policy framework and restoration efforts as indicators to measure the effectiveness of water governance. The indicators, represented in terms of quantifiable variables, are standardised and averaged to calculate the corresponding indicators and, finally, the WSI. The method is subsequently applied to evaluate the status of water security in three different regions in the Amazon.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Flood Susceptibility Mapping leveraging Analytical Hierarchy Process Based on GIS and Remote sensing Techniques —A Case Study of Nam Ngum River Basin (NNRB), Lao PDR (Japan)

Sackdavong Mangkhaseum[1], Akitoshi Hanazawa[1]

[1] Kyushu Institute of Technology

Flood disasters are a recurring occurrence worldwide, and Lao PDR is no exception, facing such calamities annually. The study is investigated a flood susceptible region in Nam Ngum River Basin (NNRB), Lao PDR. The Nam Ngum River Basin (NNRB), situated in the central part of Lao PDR, serves as a primary Mekong tributary. It holds immense importance due to its substantial size, covering around 16,800 km2, which accounts for approximately 7% of the entire country's area. Notably, the basin contributes significantly to the overall flow of the Mekong River, providing approximately 14% of the annual flows that make up about 40% of the country's contribution to the Mekong River's flow. The river originates at an elevation of 2,800 m in the northeastern region of the basin and flows southward for 420 km until it reaches its outlet at the Mekong River. The methodology employed a combination of the Analytical Hierarchy Process (AHP), Geographic Information System (GIS), and Remote Sensing Data to assess the influence of each criterion on the final outcome. Based on the relative importance of these criteria, the flood susceptibility map was then extracted by overlaying the spatial data of the study area. To access flood susceptibility, the conditioning factors consist of 10 base layers such as rainfall, elevation, land use and land cover, lithology, distance from rivers, soil texture, slope angle, drainage density, and topographic wetness index (TWI), and NDVI were prepared from the spatial database using ArcGIS 10.6. The final flood-inundated areas were reclassified into 5 different classes of flood susceptibility as very low, low, moderate, high, and very high. The final suitability model outputs are vital to mitigate the serious impact of flooding and assist flood managers.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Embryonic development and spawning of Ucides occidentalis (Crustacea) for recovery in mangrove sites in Ecuador (Ecuador)

Leandro Parrales[1], Alba Calles[1], Jaime Cuadrado[1]

[1] Polytechnic School of the Littoral-ESPOL

In Ecuador, the red crab Ucides occidentalis is an important part of the culture, gastronomy and economy of the country, which seeks to develop sustainable management in artisanal fishing communities, since it is increasingly difficult to obtain the resource due to the indiscriminate fishing of the species. Crab females were collected in the “La Caleta” site by the crabbers and fishermen association of the Puerto Roma community, in the Gulf of Guayaquil. The present study allowed the development of a protocol for the transport of ovate females, embryonic development and spawning management of U. occidentalis under laboratory conditions with controlled parameter. The methodology was based on the reproductive study of Ucides cordatus. The results showed that a female can generate approximately 159.313 eggs regardless of the size of the telson, that color and smell conditions of the ovigerous mass can be recognized prior to spawning. For the embryonic analysis it is concluded that there are 8 development stages, which each one of them could be documented during the growth process that took place in 15 days and that the hatching of the crab larvae coincides with the full moon phase during the rainy season in Ecuador. In addition, biometric analysis, egg count, and zoea 1 larval development were performed.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

One decade of headwater catchments hydrological monitoring to reinforce evidence of conservation strategies (Ecuador)

Braulio Lahuatte[1], Paola Fuentes[1], Enrique Quinteros[1], Veronica Guaman[1], Wilson Vega[1], Fabricio Rivera[1], Andrea Vera[1], Bert De Bievre[1]

1 Quito Water Conservation Fund-FONAG

Within environments with heterogenous geomorphology, geology, and vegetation cover a high temporal and spatial hydrological monitoring allows to understand the improvement in hydrological dynamics in degraded catchments that have been under restoration for nearly a decade. The hydrological behavior of three small Andean paired catchments (less than 2.52 km2) have been monitored since 2014 by closing water balance with precipitation and discharge measurements. The paired catchments M1, M2, M3 showed different hydrological dynamics since the first monitoring year despite they are next to each other. M1 is a catchment non-reactive to precipitation, with low water yield and good water regulation. M2 is a highly reactive catchment with poor water yield and regulation, and M3 is a highly reactive catchment with good water yield and regulation. Differences in hydrological dynamics between the catchments are caused by the heterogenous conditions within them. The temporal variation of hydrological indexes (i.e. 95th discharge percentile, and ratio between 95th and 10th discharge percentile) shows that the 95th discharge percentile (low flows) in M1 and M2 tends to increase in the last years. In M2 the 95th and 10th discharge percentile ratio during wet years decreases, in other words water regulation improves. These results may be produced by the restauration strategies implemented in the area, yet the increase in baseflow coincides with the wetter years during this monitoring decade, therefore future dry periods should validate these results. A high frequency monitoring network allowed us to first, establish differences in hydrological dynamics between paired catchments and second, assess the long-term temporal variability of hydrological behavior in each of them.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Development of the satellite-based Rainfall Retrieval Algorithm for Galapagos Archipelago using GOES 16: A Key to Understanding Water Availability in Galapagos (Ecuador)

Nazli Turini[1], Byron Delgado Maldonado[2], Jörg Bendix[1]

[1] University of Marburg

[2] Charles Darwin Foundation (CDF)

The IPCC report “”Climate Change 2022: Impacts, Adaptation, and Vulnerability”” highlights that climate change leads to more frequent and severe extreme events, which have profound consequences for nature and human populations, especially concerning precipitation patterns. The increasing intensity of these extreme events poses significant challenges, resulting in the loss and damage of ecosystems and communities. In the Galápagos archipelago, the primary source of water supply is rainfall; hence rainfall plays an essential role in biodiversity and people in this region. Short- and long-term rainfall dynamics and the impact of climate change on rainfall are poorly understood, primarily due to lack of consistent spatial-temporal rainfall information. For this reason, satellite rainfall products could be the source that provides area-wide precipitation observations in space and time. The poster presents the Galápagos Rainfall Retrieval (GRR), an innovative satellite-based rainfall retrieval algorithm. It aims to offer a high spatio-temporal resolution (2 km, 10 min) rainfall product retrieved for the Galápagos archipelago in near real-time. The proposed algorithm combines physical methods with machine learning techniques, utilizing sequences of Geostationary Earth Orbit infrared (GEO-IR) images to estimate both cold season Garua drizzle and warm season convective rainfall. The validation process involves two steps: i) using independent microwave-only IMERG-V06 rainfall data, which was not utilized during the model training, and ii) employing a newly established network of automated weather stations (AWS) with a high temporal resolution of 10 minutes. This AWS network covers W-E and luff-lee transects across the study area of three islands (Isabela, S. Cruz, S. Cristóbal).

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Large-scale water resources contribution areas for hydropower generation at Paute Mazar station (Ecuador)

Juan Contreras[1], Daniela Ballari[1], Pablo Guzmán[1]

[1] University of Azuay

[2] University of Cuenca

Water resource availability determines hydropower generation. Therefore, knowing the flow generation areas is vital for planning. The hydroelectric system of Paute Integral, located in the eastern foothill of the Andes in southern Ecuador, produces 35 % of the country's total energy. The spatial and temporal relationship between water resources and hydropower generation is poorly known. It is due to the deficiencies of hydrometeorological monitoring in the region. This study explores the strength of the relationship between intra-annual water resource variability with hydropower generation at the Paute Mazar hydropower station during 2010-2020. Through ERA5-Land and MSWX (reanalysis products), we explore the relation of hydropower generation with streamflow (derived from water balance), runoff (surface and sub-surface) and volumetric soil water at different depths (from 0 to 289 cm) employing the Spearman correlation test. Results show different spatial correlation patterns with hydrological variables. A positive relation for all variables is observed with cumulative values from 2 to 4 months in most of the basin. Higher cumulative times of hydrological variables correlate with the highlands and the eastern part of the basin. In addition, to relate spatial patterns with landscape (i.e., topography or land use cover), we delimit areas with the strongest correlation and associated cumulative times for each hydrological variable. These results suggest a delayed response of the hydropower generation with water availability and provide insights about the large-scale contribution areas for hydropower generation.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

What is the status of water security in Pokhara (Nepal)? An approach for enhancement with nature conservation (Nepal) ID:

Kishor Kumar Shrestha[1], Vishnu Prasad Pandey[1]

[1] Tribhuvan University

Current urbanization trend/pattern coupled with climate change is affecting water security in cities, primarily through impact on water availability (quantity, quality, and reliability). This study aims to assess water security status in urban area using a framework with five dimensions, twelve indicators, and thirty-six variables. It covers water supply and sanitation, water environment, water-related disasters, water productivity and governance. Potential measures for improving water security in Pokhara (Nepal) has also been analyzed. Results revealed that status of water-security is satisfactory in most dimensions with requirements for proper institutional management and plans for future scenarios. However, it indicates a few water-related challenges for improvement. Analyzing the interventions for enhancing water security indicates the potential for administrative as well as technological updates, policy revision along with creative application of traditional practices. Further, the effective use of natural settings for conservation with nature-based solutions, including green-grey infrastructures, could be efficient to lessen the impacts of the associated hazards with enhancement in water quantity and availability. Since Pokhara has specific climatic characteristics with one of the highest average annual precipitations in the country (>3800mm), requires prompt improvements in water management due to lack of such consideration in the city. These challenges reveal the potential to frame the opportunities for improving water security through such consideration with output-based approach to the city famous for tourist destination.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Flood Hazard Management Strategy in Sitirejo Malang District, East Java, Indonesia (Indonesia)

Aptu Andy Kurniawan[1]

[1] Padjadjaran University

The flood claimed many lives. About 30% of Indonesia's regions are at risk of flooding. When disaster-prone areas are occupied by low social capacity, this situation causes high disaster risk. Designing river basin management policies is one approach to flood mitigation. This study aims to determine the layout of river basin management policies in Greater Malang, Indonesia. A Geographic Information System "GIS" approach will be used to identify flood-prone areas within the Panguluran River. The metrics used to determine flood plains are slope, rainfall, land type, land use, and topography. This study used an Interpretive Structural Modeling (ISM) approach in establishing policy guidelines for Panguluran River Management. His 20 experts from relevant interest groups collaborate to define policy directions. As a result, it was found that approximately 15 % of the river basin in Sitirejo Malang district is in a high flood risk area. The results also established a priority on reducing river sedimentation in management policies for Panguluran Watershed.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Priorities for local communities and SDG#6 Inclusive and participatory approaches for solution-oriented implementation in the South of Ecuador (Ecuador)

Diana García[1 2], Anne Carr[1 2], Andrés Sánchez[1 2]

[1] University of Azuay

[2] Polytechnic School of Chimborazo

Mining has taken a leading role in economic growth and sustainable development in Ecuador due to the global expansion of extraction projects in the last fifteen years particularly in the Latin American region. As a consequence of this new wave of mining investments, social mobilization and conflict have increased. Thus, claims regarding access to land, environmental protection and water supply come particularly from indigenous and rural populations. This panorama reflects the lack of coordination between government institutions, communities and miners, and the lack of control of mining activities are factors that contribute to the ineffective compliance with environmental policies in the gold mining sector. This poster presentation analyzes, with a mixed methodology, the forms of participation of local communities and the use of legal mechanism in two cases in the province of Azuay in southern Ecuador for the defense of water and territory. In addition, this study introduces an alternative environmentally friendly technical process (to mercury) for the local mining industry. All of these mechanisms, participatory, legal and technical are realized with the collaboration of universities in co-building community capacity and agency expansion.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Heavy metals could threaten water security in Andean Mountains (Ecuador)

Verónica Guamán[1], Juan Pesántez[1], Christian Birkel[2], Rolando Célleri[1], Jorge García[1], Patricio Crespo[1]

[1] University of Cuenca

[2] University of Costa Rica

People in the tropical Andes, from the high mountains to the lowlands, highly depend on water generated in their headwaters. It is widely accepted that the water quality in these undisturbed areas with minimal anthropogenic influence meets high standards of quality. Despite this, high concentrations of heavy metals have been observed. In this study, we have gathered long-term data (2008-2021) from 28 streams ranging from 2695 to 3770 m.a.s.l. to assess its spatiotemporal variability. Water samples were analyzed for heavy metals, and other solutes to assess water quality dynamics. We used boxplots, multivariate statistical analyses, and compared our solutes concentrations to international water quality standards. Our findings reveal three water groups: (1) sites with high concentrations of Ca and Mg in the low elevation streams, (2) sites with high concentrations of Al, As, Fe, Mn, Zn in the headwaters, and (3) sites with high concentrations of Fe and Mn in the streams that represents catchments mostly covered by wetlands. Most sites meet drinking water standards, but some streams exceeded the allowed criteria for Al, As, Cd, Fe, Mn and Pb by up to 30 times. These parameters presented high concentrations mainly during high flows, except for Cd, whose concentrations at one site were above allowed limit unrelated to flow conditions. According to our results, the presence of heavy metals in water bodies could be attributed to geological particularities and could be exacerbated by changes in the hydrometeorological and land use conditions. Establishing a baseline water quality in these streams and assessing their natural variability holds vital importance for water managers in the context of predicted future scenarios of climate change and anthropogenic pressures.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Heavy metals could threaten water security in Andean Mountains (Ecuador)

Javier Avila-Larrea[1 2]

[1] University of Cuenca

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The importance of improving the whole process of SDG implementation lies in the fact that the indicators selected, adjusted, or constructed, ultimately come to shape how users of irrigation systems, deal with a concept and at best discuss it and bring it to public action; therefore, a governance in the framework of metacoupling with a systems approach (intra and inter-coupling) is necessary. To address these shortcomings, a comprehensive assessment of the state of the art in a unified framework was conducted. The following main results were achieved: the disconnection of the human and the natural in social-ecological systems generates that their critical thresholds are exceeded; the metacoupling framework uses a systems approach to make the stages of irrigation systems visible; governance of the means is concerned with the way in which objectives are achieved, therefore, it takes into account all the stages that influence and are influenced by irrigation: water catchment, adequate distribution, clean production, and adequate, efficient and sovereign product placement. In this logic, there is a relationship with 13 indicators in the capture stage, with 39 indicators in the production stage, and with 9 indicators in the commercialization stage; in total with 9 SDGs, whose indicators also play the role of satisfiers of needs in a positive and negative way. Finally, this problem finds answers in the “routes” of the indicators that generate the most positive results.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Towards Resilient Land Use Systems. A Network Approach to the Water-Energy-Land-Food Nexus (Colombia)

Jorge Marco[1], Miguel Angel Ramirez[2], William Martinez[2], Iván Lizarazo[2], Jorge Montero[2], Nadia Combariza[1 3], Alicia Correa[3]

[1] University of Andes

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[3] Justus Liebig University

This paper illustrates the importance of incorporating the land perspective (L) into Water-Energy-Food (WEF) nexus approaches. While the WEF nexus has received attention as a means to achieve interdependent sustainable development goals, several studies show that interactions among its nexus elements are context-specific and strongly influenced by land use changes. We propose a novel analytical framework to establish the extent to which land use changes impact the composition and resilience of the WELF nexus. We hypothesized that, by maximizing resilience, decision-makers can design more effective and targeted policies for achieving long-term sustainable development goals. This is because greater resilience improves the capacity of land use systems to manage uncertainties and recover from disruptions like global change or political instability. Our framework is applied to the region of Maria La Baja, a sub-watershed located in the Colombian Caribbean. The results show that the WELF nexus manifests differently across different spatial scales, wherein Food (agriculture) consistently emerges as a crucial factor in maximizing resilience. The significance of other nexus elements like Energy and Water varies considerably depending on the scale of analysis. Other factors like abandonment of agricultural lands or increased deforestation play a key role in determining resilience at sub-regional scales. Finally, we recommend which land use options can be most effective in maximizing resilience.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Exploring the ecohydrological response of paramo ecosystems to extremes: A rainfall inhibition experiment (Ecuador)

Jorge Ramon[1], Patricio Crespo[1], Christian Santander[2], Franco Tamayo[2], Heidi Asbjornsen[3]

[1] University of Cuenca

[2] University of Azuay

[3] University of NewHampshire

Mountain grassland ecosystems face increasing and prolonged droughts, threatening millions of livelihoods. Understanding how rainfall extremes impact soil water content and páramo ecological configuration remains limited. To address this, a rainfall inhibition experiment was conducted at Zhurucay Ecohydrological Observatory (~3662 to ~3900 m a.s.l.). Three paired 9 m² plots representing natural (N) and grazed (G) grasslands, with steep (slope ~ 20%) and flat (slope <5%) areas, were used. Key measurements included hourly soil water content (SWC) at 0.2 m depth and Shannon diversity index. Analysis of the SWC measurements revealed a wide range of responses with values spanning from saturation conditions (~0.77 cm3/cm3) to wilting point values (~0.53 cm3/cm3), resulting in a decrease of soil humidity by 1.5 – 25%. Furthermore, the SWC structural change analysis showed that, regardless of the land cover, treatments in steep areas experienced a higher number of structural changes than those on flat zones. On the other hand, Grazed plots displayed higher Shannon diversity, indicating richer species compared to natural plots dominated by a few abundant species. These results suggest that extreme rainfall is likely to reduce soil water content and alter páramo ecology. This highlights the need for a more comprehensive understanding of the Andes region, especially in the face of the challenges posed by climate variability and their effects. Our findings are pivotal for future research on catchment regime shifts and tipping points under extremes.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

How do storm characteristics influence concentration-discharge hysteresis in a high-elevation tropical ecosystem? (Ecuador)

Pablo Peña[1], Juan Pesántez[2], Christian Birkel[3], Giovanny Mosquera[4], Viviana Arízaga-Idrovo[2], Enma Mora[2], Patricio Crespo[2]

[1] University of Giessen
[2] University of Cuenca
[3] University of Costa Rica
[4] University of San Francisco of Quito

Within tropical catchments, hydrometeorological factors significant influence stream chemistry variability. Understanding the driving forces behind these fluctuations is crucial for gaining insights into catchment functioning, especially concerning rainfall-runoff processes that govern the storage and transport of solutes. Hysteresis provides a valuable tool for assessing solute delivery mechanisms in streams, as they are based on characteristic Concentration-Discharge relationships. This study aimed to link hysteresis indicators and hydrometeorological variables measured in a high-elevation experimental catchment. To achieve this, we used a wealth of high-resolution data, encompassing various solutes such as Al, Cu, DOC, TNb, Ba, Ca, Mg, Na, Sr, K, Si, and Rb. The findings reveal that geogenic solutes (Na, Sr, K, Si, Rb) primarily exhibit clockwise hysteresis behaviors, while biogenic solutes influenced by soil processes (Al, Cu, DOC, TNb) display anti-clockwise hysteresis, mobilized with streamflow. Hysteresis indicators were most influenced by discharge rates and solute concentrations, showing that their increasing values led to near-zero hysteresis indicators, highlighting a direct linear response of solute dynamics to discharge. This study enhances our understanding of how catchments store and release solutes, which is essential for improved water resource management to secure water services. It provides insights into the complex dynamics of solute transport and their potential impacts on water quality and supply. Due to this, the alterations in hysteresis loops can serve as indicators of changes in the catchment normal functioning. These changes may be exacerbated under climate change scenarios that directly influence the catchment's hydrometeorological regime.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Streamflow drought identification to support water resources management in an inter Andean Tropical catchment (Ecuador)

Adrián Sucozhañay[1], Rolando Célleri[1]

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Hydrological drought has become important worldwide due to its direct connection with the impacts on the population. In the Andes mountains, this is especially relevant because the main sources of water are rivers and streams. However, methods to identify droughts have not been widely explored in these places that have a fast hydrological response and high variability. Therefore, the objective of this study was to compare different approaches to identify streamflow droughts in a mountain basin of the tropical Andes. For this purpose, the fixed and daily variable threshold were tested using four discharge stations with daily streamflow data. Both thresholds detected hydrological droughts of short average duration compared to other places, between 17 to 13 days. Excluding minor duration events (less than 10 days), the average duration increased to 33 to 29 days. The main differences between the thresholds were that: (1) the variable threshold identified a greater number of events, and (2) the fixed threshold produced a higher average duration and deficit. In terms of severity, both thresholds were similar. With a visual inspection of the events, it was observed that the variable threshold breaks the fixed threshold events into two or more events of shorter duration during the dry months of the year (nov to jan), resulting in a reduction of the average duration. However, the fixed threshold did not identify events in the wet part of the year (mar to sep), producing a higher number of events for the variable threshold. These observations can be used by decision makers to improve warning systems and implement them in combination with different water demands.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Analyzing the Rain-Storm Types in the Tropical Andes that Generate Flooding Events (Ecuador)

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Extreme events have negative impacts on both natural and human systems, such as economic and life's losses. The lack of reliable information in remote areas makes it hard to analyze and forecast extreme events such as rain-storms. Also, in areas such as the Andes, the complex topography is another barrier to obtaining reliable rainfall data. Then, to capture rain-storms, high resolution data is required because rainfall is characterized by high spatiotemporal variability. In this context, the study aims to identify and analyze types of rain-storms in the tropical Andes by using a clustering approach (k-means). This study was conducted using 4 years of data retrieved from an X-band radar. This radar is located in southern of Ecuador at 4450m a.s.l. Rain-storms events and features such as duration, rain rate, and reflectivity were identified for each event. Then, the k-means algorithm was applied to derive rain-storm types. Three rain-storms types were identified. These types were associated with characteristics similar to convective, mixed and stratiform rainfall types. Also, these types showed a marked difference between month and hour of occurrence. This novel classification will be useful to characterize rain-storms and improve our knowledge about its variability. Finally, this is the first step to assess its influence in flood events.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Innovative Feature Engineering for Peak Runoff Forecasting: Leveraging Radar Precipitation Estimates for Sustainable Water Management. (Ecuador)

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The intricate relationship between climate change and water systems intensifies hydrological risks, such as floods, generating challenges for scientists, policymakers, and stakeholders. In particularly vulnerable regions like the tropical Andes, these risks pose severe threats to sustainable development, biodiversity, and the security of water resources. Given the scarcity of hydrometeorological data in these zones, risk assessment becomes all the more intricate. To address this, we leveraged radar precipitation estimates as a key tool for peak runoff forecasting in complex and remote zones. In response to these challenges, we applied the Random Forest (RF) machine learning method along with a Feature Engineering (FE) strategy to transform and extract precipitation attributes from this radar data, which were subsequently incorporated into the forecasting models. This innovative approach yielded enhanced forecasting models, demonstrating that the derived characteristics from precipitation data lead to more accurate forecasting. By analyzing 26 peak runoff events in a catchment in Ecuador, our enhanced models highlighted the importance of innovative modeling strategies. The improved efficiencies of these models highlighted the value of Feature Engineering in addressing peak runoff challenges and offer directions for adaptive approaches. In summary, combining radar data, ML, and FE provides an approach toward achieving SDG13 (Climate Action) in Andean systems. This method promises to be of great assistance for sustainable water management, fortifying resilience against climate disruptions in data-scarce regions.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Enhancing hydrological forecasting for hydropower generation: integration of soil types, land use and terrain-based information (Ecuador)

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Hydrological forecasting is a crucial task for enhancing hydropower generation in Ecuador. However, due to factors such as data limitations, budget constraints, or the inherent complexity of hydrological systems, many hydropower plants do not employ hydrological models capable of accounting for the effects of diverse soil types, land uses, and other terrain features. This deficiency leads to suboptimal hydropower generation. In this study, we propose an innovative deep-learning forecasting technique, the Long-Short Term Memory (LSTM) neural networks, which integrates soil type, land use, and slope maps with the well-known empirical Soil Conservation Service Curve Number (SCS-CN) method. Our objective is to address the complexities of a mountain basin representative of the Andes in Ecuador, which supplies water to the country's third most significant hydropower plant in terms of energy generation. The forecasting efficiencies, assessed using the Nash-Sutcliffe efficiency, were 0.93, 0.77, and 0.67 for short-term lead times of 1 (nowcasting), 6 (flash floods), and 11 hours (response time of the basin), respectively. Furthermore, the use of additional metrics demonstrated the models' capability to forecast peak flow values and improve the closure of the hydrological balance in the basin. In conclusion, the systematic integration of satellite precipitation data with soil types, land use, and terrain-based features enables enhanced flow forecasting across extended lead times. This research introduces a methodological framework for leveraging the strengths of deep-learning techniques in conjunction with process-based hydrological knowledge. It paves the way for optimizing hydropower generation not only in the Andes but also in other regions.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Modified Irrigation Sustainability Index for the assessment of irrigation systems in low-impact agricultural basins (Ecuador)

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Water is vital for sustainability, supporting life, agriculture, and ecosystem balance. Sustainable irrigation is essential for preserving the environment, soil, and water resources while remaining economically viable, and socially acceptable, and ensuring food security. Not all irrigation systems are highly productive, currently, the irrigation sustainability index (ISI) is a method to quantify its effectiveness, allowing comparability, and adaptability to different systems. However, the method relies on scarce environmental field survey data, limiting its application in data-scarce regions. To address this, an alternative is proposed using irrigation surveys and geospatial data. This work proposes the Modified Irrigation Sustainability Index (MISI), which includes four main components: Biogeographic data from soils, climate, hydrology, and vegetation. Socio-demographic data, covering water conflicts, organization, shifts, and costs. Institutional data, including administrative support, financing, and related projects. Technological data, including system type, irrigation methods, reservoirs, and materials. Factors define the MISI components in turn. Its calculation customizes factor and component weights for specific systems, enhancing accuracy and adaptability. These changes make the index more precise for different systems, particularly in low-impact agriculture which is scarcely studied. MISI results may support decision-making by detailing the sustainability of irrigation and its key factors. MISI values are categorized as high, medium, or low, facilitating global and local comparisons across diverse irrigation technologies. It's a valuable tool for monitoring and addressing current and future irrigation system challenges and supporting SDGs.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Effects of land use change from natural coverages to pastures in a mountainous area of the southern Ecuadorian Andes (Ecuador)

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Andean ecosystems conservation is of vital importance. These regions play a crucial role in supplying water to surrounding populations and providing ecosystem services. In this context, this research evaluates the impacts of land use change on the dynamics of organic matter and nutrient cycling in a source area of water recharge in southern Ecuador. The research questions are: a) How do the production and decomposition of biomass in litterfall material vary in soils with natural vegetation cover, grassland (PA), natural forest (NF), and pasture areas (PO) used for livestock? and b) How does the dynamics of organic matter at the soil-plant level differ among vegetal covers? To carry out this research, monitoring plots have been established by cover, where areas have been located for the collection of recently fallen plant material with a frequency of 15 days for forest cover and 45 days for grass and pastures cover, for a period of one year. In the same plots, soil samples have been taken at two depths: 0 – 10 and 10 – 20 cm. Preliminary results after twelve months of monitoring have shown significant differences in litter production with 4805.19 kg ha-1 for NF, 3786.37 kg ha-1 for PA and 332.96 kg ha-1 for PO. Regarding the decomposition of the litterfall material, 41% of mass lost was found in NF, 33% in PA, and 92% in PO, after 300 days. In the analysis of soil properties, we observed an average of 56% organic matter (OM) for NF and PA coverage, and 29% for PO coverage. And, the bulk density values were found to be 0.31 g cm-3 for NF, 0.28 g cm-3 for PA, and 0.59 g cm-3 for PO. The findings suggest scientifically based management practices for agricultural producers, promoting proper use and decision-making for the maintenance of these ecosystems and their future ser.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Analysis of Water Consumption Patterns in Three Neighborhoods of Cuenca, a medium-size Andean City: A Preliminary Assessment to Promote Adaptation to Climate Change (Ecuador)

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Growing concern about climate change has led to the need to understand and adapt to potential impacts in various regions of the world. This research focuses on characterizing water consumption patterns in three neighborhoods of Cuenca City, located in the Andean region of Ecuador, as an essential step for understanding local challenges in a climate change context. Our approach aims to promote local sustainability and resilience to water stress. Neighborhoods were selected based on their different socio-economic, infrastructure and demographic factors. 14 years of monthly water consumption was used. The results highlight significant differences between the neighborhoods. There is a general upward trend in consumption over the years, with peaks in the summer months and lower values in the winter. The year 2013 stands out for the highest consumption. However, from 2018 onwards, there is higher variability in consumption levels, indicating the influence of changing factors on the water usage pattern over time. Differences in consumption can be related to changes in attitude towards water saving, changes in demographic composition of households or due to a water rate increase.

Overall, our findings underline the need for personalized, neighborhood-based, adaptation strategies to reduce water use or to promote water savings. As we move forward, nature-based solutions will be proposed to reduce water consumption in these Andean neighborhoods. This analysis provides valuable information for local authorities, contributing to more efficient water management and successful climate change adaptation in an Andean context.

Abstract

Frow Water and Climate: Challenges, Opportunities, and Innovative Solutions > Poster Presentation

Framework to evaluate the applicability and limitations of climate change projections to support adaptation at catchment and city scale.

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For years, researchers have alerted about the impacts of climate change (CC) based on historical trends or a modelled future. Although useful to enforce mitigation strategies, there is a distance between climate scientists and decision-makers who should use climate projections to plan adaptation strategies. Despite the availability of global and national projections, their use is limited as they are not directly interpretable, face large uncertainties, and have a coarse resolution. Therefore, a framework is used to evaluate five available CC projections (WordClim, NASA NEX-GDDP, CC Knowledge Portal and two national projections for Ecuador) by identifying their key findings, applicability, and limitations at catchment and city scale. Their scope, spatio-temporal resolution and scenarios are analyzed. In addition, climate and bio-climatic indicators of extreme precipitation, droughts, high/low temperatures are calculated to characterize the baseline period and to compare the projected impacts. Results show that some climate indicators such as the number of hot days and the duration of dry spells converge in the five CC projections. Nonetheless, other indicators, mainly those related to extreme precipitation, have large uncertainty with even the sign of change signal differing between projections. Agreement in the signal of CC gives confidence to decision-makers, while divergent results require careful interpretation to avoid skepticism. With this framework, decision-makers can identify climate risks that can be expected with more certainty. Thus, they can already design some adaptation strategies with the available information. Moreover, this evaluation detected limitations of current projections that require further research or the development of local projections.

Abstract