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Preface

The effects of global warming have been evident for decades; the number of people affected by the impacts of climate change continues to rise. Furthermore, the disruption of ecosystems through unabated urbanization, inappropriate agricultural practices, deforestation, and pollution are among the factors undermining the environment's capacity to sustain a sustainable living!

Water security and climate change are not only key concerns of the 21st century, but they are closely interlinked. Water security is an indispensable foundation for food and energy security, for economic activities, for public and ecosystem health, among others. In the coming years, climate change is going to alter the water balance in most parts of the world, climate extremes will become an ever-growing challenge and vulnerability to climate- and water-induced hazards will increase.

The years 2020 and 2021 reveal to many people what vulnerability means. The Covid19 pandemic has created a state of uncertainty and threat in many parts of the world and illustrates how interconnected today's societies are. However, the current situation also demonstrates the role science can play. More than ever, politics is calling for evidence-based research. The current situation thus offers an opportunity for a paradigm shift that could be conducive to a promising water and climate policy.

Climate- and water-related challenges can only be met if science and practice are closely interlinked! In this line, the Water Security and Climate Change conference (WSCC) aims at providing a platform for knowledge exchange, fostering dialogue and innovation, and starting new initiatives, collaborations, and projects. It is our particular interest to initiate and support a dialogue between the "water" and "climate change" communities, fostering nexus thinking and ultimately creating impact beyond the conference as such.

Thus, let us join forces to advance the role of science in decision-making and policy creation towards water security and climate resilience.

The WSCC is an initiative of the 'Higher Education Excellence in Development Cooperation – exceed' program, which consists of more than 90 universities worldwide. The conference has been implemented since 2016 under the auspices of the Centers for Natural Resources and Development (CNRD), the Sustainable Water Management in Developing Countries (SWINDON) network, the Food Security Center (FSC) as well as the Asian Institute of Technology (AIT). In 2021, WSCC is convened by the Vietnam Academy of Water Resources (VAWR) on behalf of the Exceed network.

- On behalf of the WSCC Organization Team

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Keynotes

Secure and Manage the Water We Eat in a Changing Climate

Monday, 01. March, 08:45am - 09:15am (CET) Moderation: Michael Hoppe



Stefan Uhlenbrook

- International Water Management Institute (IWMI)

Professor Stefan Uhlenbrook' s main expertise includes water and sustainability assessments, hydrological process research and water resources management with focus on developing solutions for pressing water challenges. He is a renown academic, published >150 peer-reviewed papers and is frequently invited speaker at high-level meetings worldwide. He has led many research and development projects that have demonstrated the impact of global changes on water cycle dynamics in different hydro-climatic regions worldwide, and they provided effective solutions to address these challenges. He is experienced on translating science-based knowledge to effective policies and strategies that contribute to environmental, economic and societal sustainability (i.e. Agenda 2030). Recently, he has enlarged his interest to food production system transformations to provide healthy and nutritious food for all and the central role of water and ecosystems.

Stefan Uhlenbrook is the Strategic Program Director Water, Food and Ecosystems at IWMI, Colombo, Sri Lanka. Before he was the Coordinator of the UNESCO World Water Assessment Programme (WWAP) and the Director of the UNESCO Programme Office on Global Water Assessment in Perugia, Italy (2015-2019). He previously worked at the UNESCO Institute for Water Education (now IHE Delft), as Professor of Hydrology (since 2005), Deputy Director (Vice-Rector) for Academic and Student Affairs (2000-2014) and Director a.i. (acting Rector; 2014-2015). Stefan obtained his PhD (1999) and habilitation (2003) in Hydrology at the University of Freiburg, Germany, where he worked also as assistant and associate professor (2000-20004).

Interconnected Vulnerabilities and Risks for Water Security in the Context of Climate Change

Tuesday, 02. March, 08:15am - 09:05am (CET) Moderation: Michael Hoppe



Zita Sebesvari

- United Nations University, Institute for Environment and Human Security

Dr. Sebesvari heads the Environmental Vulnerability and Ecosystem Services (EVES) Section at UNU-EHS. She is an internationally recognized expert in the fields of social-ecological risk assessments, ecosystem-based disaster risk reduction (Eco-DRR) and ecosystem-based adaptation (EbA), with a focus on low-lying coastal areas, such as river deltas.

Dr. Sebesvari is author or co-author of around 80 publications, and served as a Lead Author of the IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (SROCCC, Chapter 4 and Summary for Policymakers; 2019). She has 13 years of research experience in Vietnam focusing on coastal areas across Vietnam.

Keynotes

Managing Water in a Changing Situation for the Mekong River Basin

Wednesday, 03. March, 08:15am - 09:05am (CET) Moderation: Michael Hoppe



Thim Ly

- Mekong River Commission

Dr. Thim Ly is the Chief River Basin Planner of the Planning Division of the Mekong River Commission (MRC) Secretariat. He has over 20 years working experience with various international organizations in variety of fields of development including more than 15 years working in water resources management in the Mekong Region. He holds a Master degree in development planning from the University of Dortmund, Germany, and a PhD degree in development studies from the University of Bonn, Germany. His field of interest lies in water resources planning and management.

Climate Change and Water Security Across the Asia Pacific - from Local to Regional Scales

Thursday, 04. March, 08:15am - 09:05am (CET) Moderation: Michael Hoppe



Nicholas Schofield

- Global Future Research

Nick is Director of the Global Future Research and Professorial Fellow at the University of NSW. He has led Australian research programs addressing salinity, eutrophication, sediments, pesticides, river and wetland health, groundwater and biodiversity loss. Internationally, Nick is delivering programs on climate change and water security, river basin management, irrigation modernisation, water sensitive cities and environmental water. Nick was formerly Director of the Global Water Institute (UNSW) and CEO, International RiverFoundation. He has qualifications in astrophysics and catchment hydrology and is a member of the IWA Strategic Council and Fellow of the Royal Society (NSW).

From Coping to Adaptation: Integrated Strategies to Build Resilience to Water-related Risks for the Most Vulnerable > Oral Presentation

Understanding, Assessing and Managing Flood Risk in Vietnam: A Review of the Literature

<u>Nguyen, Minh Tu</u>¹; Sebesvari, Zita¹; Souvignet, Maxime^{1,2}; Bachofer, Felix³; Braun, Andreas⁴; Garschagen, Matthias⁵; Schinkel, Ulrike⁶; Yang, Liang⁵; Nguyen, Linh Khanh Hoang⁷; Hochschild, Volker⁴; Assmann, André⁸; Hagenlocher, Michael¹

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A large proportion of Vietnam's populations and economic assets are located at river deltas and other low-lying areas, exposing these areas to multiple hazards such as sea-level rise (SLR), storm surges, typhoons, and flooding. Despite the heavy losses and damage caused by floods, information and data on the development of solutions to flood risk reduction and adaptation, including a synthesis of existing information on flood risk patterns and drivers of flood risks, remains insufficient. This study aims to evaluate the current status, persisting gaps and challenges regarding the understanding, assessment and management of flood risk in the country based on a systematic review of existing flood risk assessments (n=77 papers) in Vietnam. The literature review revealed that different risk conceptualizations were applied in flood risk assessments in Vietnam, of which 65% of the reviewed papers did not provide a risk definition. Assessments had a tendency to prioritize physical and environmental over social, economic or governance-related drivers of risk. In addition, future-oriented assessments tend to focus on hazard and exposure trends, while vulnerability scenarios are often lacking. The review also showed a low number of studies that engaged with local stakeholders in the assessment of risk and development of solutions. Ecosystembased adaptation and flood risk insurance were also rarely considered in flood risk assessments in Vietnam. Based on our review, we point out existing gaps in flood risk assessments and management, and provide recommendations for future research on flood risk in Vietnam.

KEYWORDS flood risk assessment; vulnerability; disaster risk reduction; Vietnam

From Coping to Adaptation: Integrated Strategies to Build Resilience to Water-related Risks for the Most Vulnerable > Oral Presentation

Determinants of Adaptation Choices to Climate Change by Fishermen: The Case of Rural Fishing Communities in the Southern Region of Benin

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Centre of Excellence in Agricultural Development and Sustainable Environment (Federal University of Agriculture, Abeokuta, Nigeria)

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This study identified the determinant of adaptation strategies to climate change in the southern region of Benin among fishing communities. A two-stage sampling procedure was used to collect primary data from 330 fishermen using a questionnaire for the survey. Data were analysed using simple descriptive statistics tools and multivariate probit model. The results showed that the most common adaptation used by fishermen were pen culture, acadja,diversification to crop production activity and diversification to poultry activity. Acadja and pen culture are two endogenous strategies. The multivariate probit results revealed that education level and access to training were significant with positive effect on the use of pen culture as adaptation strategy. Age, marital status and membership of an association were significant with negative effect on the diversification to crop production activities as strategy. Therefore, policy should be focused on awareness creation on climate change through different sources such as training and extension.

KEYWORDS Climate change, Adaptation strategies, fishing communities, Multivariate probit model

From Coping to Adaptation: Integrated Strategies to Build Resilience to Water-related Risks for the Most Vulnerable > Oral Presentation

Socio-economic Analysis of Floating House Techniques: Innovative Flood Adaptation Strategies in Bangladesh

Zannat, Zahrun; Murshed, Sonia Binte

Institute of Water and Flood Management, Bangladesh University of Engineering and Technology contact surzannat@gmail.com

Flood, a recurrent disaster in Bangladesh, has recently become erratic in nature. Its duration and intensity pattern is changing. Adaptation strategies at the local level need to be enhanced to mitigate the negative impact of floods. Both structural and non-structural measures are commonly used to avoid flood risks. However, there are very few assessments of community-based adaptation from local, economic, and social contexts. This study is a test case to assess two prototypes, innovative floodproofing measures, i.e., amphibious and retrofitted houses, in the floodprone Sirajganj district of Bangladesh. We explore the potential challenges to contextualize these Dutch adaptation techniques from Bangladesh's perspective. Besides, a participatory GIS tool is used to assess the flood damage. Community resilience has been analyzed by semi structured interviews, direct observation, and participatory rural appraisal tools. Moreover, an economic analysis was done to assess the amphibious and retrofitted houses' costs and benefits. The Application of this new adaptation technique is proved to be technically guite sound but needs regular maintenance. Again, from an economic point of view, it is suitable for the local community if it gets a subsidy from the government. The study leads us to assess the challenges and the appropriateness of this new floating house technology before implementing it at a mass scale at the local level.

KEYWORDS Amphibious and Retrofitted House, Community Resilience, Socio-Economic, Adaptation Practice From Coping to Adaptation: Integrated Strategies to Build Resilience to Water-related Risks for the Most Vulnerable > Oral Presentation

Climate Change Preparedness, Adaptation and Mitigation Strategies: Perception of Fisheries Communities in Batticaloa, Sri Lanka

Selvanayagam, Vasanthakumary¹; Swaminathan, Divya Rajeswari²; Balakrishnan, Arularasi³

1: Eastern University, Sri Lanka; 2: BaWngalore University, India; 3: University of Peradeniya, Sri Lanka

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The impacts of climate change on the sustainability of the fisheries sector are on the front line at both the local and global levels. Climate change awareness, preparedness, adaptation and mitigation strategies are becoming significant to empower the local and global fisheries communities. Batticaloa is a low elevation coastal area in Sri Lanka, often vulnerable to the adverse climatic condition of flood, cyclone and drought. Fishing is an essential contributor to the food supply, food security and economic livelihood of the community in the Batticaloa district. In the recent past, climate change impact on the fisheries sector and associated livelihoods are growing in this district because of their high socio-economic and naturalistic value. The main objective of this study is to assess climate change awareness, coping mechanisms, adaptation responses and mitigation strategies of the Batticaloa fishing communities to combat the impact of climate change in the region. Firstly, the literature review was done and secondly, qualitative data was gathered using semi-structured interviews, key informant interviews and participant observation among the local communities. The results show that in the recent past severity of the climate-related impacts has risen and unpredictable weather changes have severely affected the fisheries' livelihoods in the study area. The study also indicates that climate change awareness, preparedness and adaptations knowledge are low among the local community. This study provides suggestions and mitigation measures that can be implemented to reduce the adverse impacts of climate-related impact on the fishing community in Batticaloa for their sustainable existence.

KEYWORDS Climate change, fisheries communities, Sri Lanka, Mitigation, Adaptation

The Roles of Standards in Securing Urban Waters and its Interventions > Oral Presentation

Challenges and Opportunities of Water Security in Southeast Asia

Koottatep, Thammarat

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The Roles of Standards in Securing Urban Waters and its Interventions > Oral Presentation

Establishment of a Standard for Testing Performance of Residential Wastewater Treatments in Thailand

Duangsri, Pichet

Thailand Industrial Standard Institute

The Roles of Standards in Securing Urban Waters and its Interventions > Oral Presentation

Implementation of Standards for Water and Sanitation Sectors in Viet Nam

Rep. Ministry of Construction Vietnam

Ministry of Construction Vietnam

TBA

The Roles of Standards in Securing Urban Waters and its Interventions > Oral Presentation

Quality Management and standards for the implementation of decentralized waste water management within the urban context in Southeast Asia

<u>Fladerer, Frank</u>

BORDA Southeast-Asia

Special Session on the Mekong Region > Oral Presentation

Salinity, Wind and Wave Effects on Sediment Transport at Mekong River Estuaries

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Sediment transport at river estuaries strongly features estuarine and fluvial processes driven by river discharge, wind, wave, current, sediment concentration, and sea salinity concentration. Estuaries and their sedimentation processes are important for the diversity of species like fish, shellfish, other aquatic plants, and mangrove forest so scientific studies should be conducted on sediment transport and its driven factors to make sure animals and plants that depend on them are thriving. In this paper, we investigate the effects of salinity, wind and waves on sediment transport in the coastal estuaries of the Mekong Delta using a wellcalibrated Delft 3D model against observations. In the estuaries nearshore zone of the Mekong delta, we found that salinity plays an important role in the process of sedimentation and pushing mud and sand into the sea. Wave and wind are the main factor that dominates sediment transport in the longshore coastal zone. Interestingly, our modeling results show that the amount of suspended sediment transported to the Southwest direction was dominant compared to the amount to the Northeast direction. This unidirectional transport of sediment may be driven by the nearshore current along the Mekong Delta coastline from the estuaries of Mekong river to Ca Mau peninsula.

KEYWORDS Salinity, wind, waves, sediment transport, Mekong River Delta

Special Session on the Mekong Region > Oral Presentation

Research on Local Water Storage Solutions to Irrigate Fruit Trees in Droughty and Salty Conditions in the Mekong Delta

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The Mekong Delta is a major area of fruit tree with an area of about 366,661 hectares, accounting for nearly 40% of the total area of fruit trees of Vietnam, annually supplying international and domestic markets about 4 million tons of fruits, including: mango, pomelo, durian, star apple, dragon fruit, jackfruit, rambutan, oranges, tangerines... However, salinity intrusion in the dry season in recent years, especially in 2019-2020 appears early, prolonged, the salty content was continuously maintained at a high level, making more than 25,000 hectares of durian, rambutan, and jackfruit died by salinity and water shoetage problem. Specific damage in the provinces: Ben Tre 5,448ha, Tien Giang 3,909ha, Vinh Long 862ha, Long An 702ha, Tra Vinh 241ha ..., thousands of hectares of other fruit trees in the whole Mekong Delta were also severely affected, productivity and product guality reduced. Research on calculating water demand and proposing local water storage solutions to irrigate fruit trees in droughty and salty conditions is essential, research results will be presented in detail the application of water storage facilities for durian and grapefruit gardens (ensuring a stable volume, allowing the addition and increasing stored water when farmers need, to maintain water with suitable guality for irrigation), x a basis for replication of the model at major fruit areas in the Mekong Delta.

KEYWORDS Fruit trees; Local water storage; Mekong Delta; Water demand, Water shortage

Special Session on the Mekong Region > Oral Presentation

Mekong Delta Shoreline Response to Changing Human Intervention Based on Numerical Model

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TBA

Special Session on the Mekong Region > Oral Presentation

A Sediment Budget for the Mekong Delta Using a Process-Based Model

Vo Quoc Thanh

Special Session on the Mekong Region > Oral Presentation

FEWS – AMD: An operational salinity forecasting and water quality data knowledge platform in Ben Tre and Tra Vinh Provinces, Vietnam

Dinh Phuong Trang; Marcel Marchand

TBA

Special Session on the Mekong Region > Oral Presentation

The Master Plan for River Training of the Lower Mekong: Needs and Outlooks

Nguyen Nghia Hung; Le Manh Hung; Dinh Quoc Phong

Catch-MEKONG – Saltwater Intrusion and Morphodynamics in the Mekong Delta: Status, Impacts and Future Developments. Results of a 5-year Research Project

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The multidisciplinary German Catch-MEKONG project consortium, consisting of three research institutes and two companies, collaborated with Vietnamese partners on pressing environmental problems regarding saltwater intrusion and morphological stability of the Mekong Delta. The partners covered expertise in the fields of hydrology, hydraulic and coastal engineering, remote sensing, geography, sensor development, and information technology. In general, the project aimed to analyze the effects of Mekong upstream developments on downstream systems in the Mekong Delta. Using a cross-sectoral approach, other influencing factors were also investigated, such as changes in the coastline possibly caused by climate change and changes in land use systems. All research results were communicated as easily accessible, standardized, multidisciplinary and comprehensive as possible. The collected data and results of the project were communicated via an information management system to a large number of stakeholders from administration, planning and science at local to international level. The "Mekong Knowledge Hub" established for this purpose brings together web-based environmental systems technology and a comprehensive database of Catch-MEKONG results and spatial data. The proposed contribution provides a comprehensive overview of all activities that were carried out in Catch-MEKONG project period from 2014 to the end of 2019.

KEYWORDS Mekong Delta, hydrology, hydraulic and coastal engineering, remote sensing, sensor development

Special Session on the Mekong Region > Poster Presentation

Regional Planning in the Mekong Delta – The System: Freshwater, Saline Water, and Land Uses Determines – Planning Questions – The R&D Project ViWaT-Mekong-Planning Develops Planning Support Tools

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Supporting Food Security Through the Use of Rainwater Harvesting to Supply Vertical Hydroponic Systems in Andean Cities

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The lockdown of the COVID-19 pandemic provided evidence of the importance of locally-produced food for Andean cities and communities. However, in certain areas, urbanization growth and/or the lack of farming land make it difficult to locally produce crops. In addition, climate change will strongly affect mountain areas, reducing the availability of water for irrigation systems and increasing conflicts across water-dependent sectors. Some strategies have been developed to partially solve these problems such as vertical hydroponic systems. Hydroponic crops do not need farming soil nor large areas, have reduced water consumption compared to traditional systems, and improve crop quality. However, when implemented in cities, these systems use costly drinking water. Besides, chemical residual components from water treatment, reduce the efficiency of the system and alter the nutrient solution composition. One alternative to drinking water is the use of rainfall harvesting systems that can help to increase water availability. Thus, a combination of these two strategies is a good solution to enhance land and water use. The objective of this study was to evaluate the use of rainfall water to feed vertical hydroponic systems in the Andean city of Cuenca, Ecuador. First, a conceptual model was developed to simulate the rainfall harvesting system. Parallel to this, a low-cost, modular hydroponic system was designed and implemented in local settings. Then, the model was used under local precipitation conditions and different water use scenarios required by hydroponic crops. The system was evaluated under efficiency indexes and the development of crop biomass. Finally, this resulted in guidelines for the design of modular, rainfall-fed hydroponic systems that can be easily implemented in urban settings. We demonstrate that these systems can help achieve food security and SDGs 2, 11 and 12 in Andean cities.

KEYWORDS Hydroponic, rainfall harvesting, food security, Andes

Building Resilient Food Systems Through Efficient Water Use > Oral Presentation

Unlocking the Potential of Agricultural Productivity and Water use Efficiency in the Eastern Nile Countries

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Securing agricultural commodities for a growing population requires a paradigm shift in agricultural systems. We crucially need to answer the question of which development pathway in agriculture should be followed and to quantify its demands of water and land resources. The current research aims to address these questions in the Eastern Nile Basin countries (ENB), i.e. Eqypt, Sudan, and Ethiopia, where such knowledge is scarce. Firstly, the study utilized open-source datasets, mainly based on earth observations, to understand the spatio-temporal variability of croplands' areas, Precipitation (P), Net Primary Productivity (NPP), actual evapotranspiration (ETa), Water Use Efficiency (WUE), and Crop Water Productivity (CWP). Secondly, the study utilized available data on agricultural statistics (harvested area, production, yield, and water footprint (WFP)), to identify proxies for potential water-savings and higher yield values. The study follows a scenario-based approach that evaluates four development pathways towards securing sufficient production of crops by 2050 in each country. While the horizontal scenario suggests a continuation of the business-as-usual, i.e. same WFP and average yield values, three vertical scenarios assume that increased efficiency can improve the WFP and yield values. Results show that substantial amounts of the needed water and land could be saved by 2050 by following the vertical development pathways. Nonetheless, the three countries, especially Egypt, are expected to face a severe challenge to satisfy their future demand for the main crops by 2050 in most scenarios. Our investigation provides key messages to promote cooperation and benefit-sharing between the three riparian countries beyond political boundaries. The findings of the current study have broad implications on the sustainable development of natural resources and water and food securities in such a vital-and conflicted-region.

кеуwords Water use efficiency, Remote sensing, Yield gap, Scenario development, Benefit-sharing

Use of the Leachate Produced in a Landfill in Veracruz, Mexico as a Liquid Biofertilizer

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According to the World Bank, the world generates around 2 billion tons of municipal solid waste (MSW) annually and more than 30 % are not properly collected or disposed. Furthermore, 70 % of cities use open dumps and landfills as final disposal sites. One of the disadvantages of these landfills is that produce leachates which are characterized by high organic and inorganic pollutant concentrations. For that reason, it is necessary to treat leachates in order to mitigate their environmental impacts on soil and water.

This research consists of treating leachate produced in Martinez de la Torre, a small city in Veracruz, Mexico with the objective of employ it as a liquid biofertilizer, giving added value to something that was previously a hazardous waste. This initiative contributes to the circular economy as it integrates a waste into a new value chain and could also increase food production.

The leachate collected in the sanitary landfill of the municipality will be treated in three different methods: the first one is storing in which the leachate must be at room temperature (around 30°C) for 8 weeks; the second one will be in an anaerobic bioreactor for 8 weeks and in the third one will be fixed in a charcoal medium.

In order to determine the best treatment of leachate, the liquid biofertilizer will be applied in a bean experimental crop and the effect of the three different treatments will be measured. Parameters to be evaluated are germination percentage and plant growth in terms of stem length, number of leaves and number of lateral branches.

KEYWORDS leachate, landfill, biofertilizer

The Climate, Land Use and Food "Triple" Challenge and Opportunity for Uganda

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Uganda has a rapidly growing population and her backbone is rainfed agriculture. However, with a changing climate, rainfed agriculture is highly constrained, and increase of the farmland area offers only a temporary relief.

Considering both the national and regional scales in Uganda; for the period between 2001 and 2017, this research employed remote sensing datasets on Net Primary Productivity (NPP), land cover types, drought indices, and climate variables, i.e. precipitation, temperature, and evapotranspiration to examine the impacts of climate extremes and land cover changes on food production. Furthermore, using a Regime Shift technique, the performance of the ten major crops in Uganda over the last 6 decades was detected.

NPP in farmlands is found very sensitive to climate variability with spatial variations over the different geographical regions. There also seems to be a step into offsetting food insecurity through increased food production owing to massive conversion of mainly forests and permanent wetlands into farmlands. Indeed, the total production of the major crops in Uganda is derived mainly by the increase in area harvested affirming the step towards food security.

Unfortunately, this step forward stands a very high risk to aggravated climate change impacts especially since carbon sinks are reversed into carbon sources and thereby impacting crop production further, as climate change escalates. Fortunately however, results from some crops illustrate the potential to increase crop production without necessarily expanding the cropland area as their yield was responsible for overall production gains.

Therefore, Uganda may, instead, consider exploiting the maximum yield potential of crops through, for instance, augmenting rainfed agriculture with irrigation and enforcing effective policies rather than expanding farmland area.

These findings collectively contribute to our comprehensive understanding of the importance of policies that ensure food security, promote better water for production management while preserving a healthy environment.

KEYWORDS Uganda, Climate extremes, Land cover/use dynamics, Food systems

Urban Water under Climate Change: Transition, Management and Governance > Oral Presentation

Revealing Structural Racism in Access to Drinking-water and Health of Population: The Case of Hepatitis A in the State of Rio de Janeiro Between 2007 and 2018

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This study discusses the associations between water, health and racism between 2007 and 2018 in 57 municipalities in the state of Rio de Janeiro. Through a qualitative and quantitative methodology, the Principal Component Analysis technique was applied to define the main axes among the set of sanitation indicators in the National System on Sanitation. After identifying the four axes with the highest percentage of variance contribution, they were correlated through Pearson's Correlation Analysis with data about incidence of Hepatitis A in the period under analysis. The PC3 and PC4 axes showed a correlation coefficient of -0.29 and -0.31 with p-value (<0.05), pointing to a significant association between Hepatitis A and quality of water. In addition, the mean incidence rates of Hepatitis A for the groups of black and white population were tested through analysis of variance, finding a highly significant difference between these social groups. The black population has approximately 103 cases of Hepatitis A per 100000, while the white population has only 11 per 100000. This reveals the reality of structural racism as a tool for the distribution of inequalities in the state of Rio de Janeiro, a local expression of a centuries-old national issue.

KEYWORDS Hepatitis A, PCA, sanitation, drinking-water

 $\label{eq:constraint} \mbox{Urban Water under Climate Change: Transition, Management and Governance > Oral Presentation$

Addressing Water Sensitivity Through Wastewater Reuse: Issues and Challenges in Bangalore, India

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Pressure on water resources in urban areas is increasing, with increasing demand and limited water sources. Combined with the growing awareness of environmental issues, it has increased attention to the potential for treating urban sewerage as an alternative water resource, primarily for non-portable purposes. But, reusing wastewater is not an easy task in developing cities like Bangalore, India. Bangalore is one of the fastest-growing cities globally. The population of Bengaluru city has grown from 4.2 million in 2001 to 8.4 million in 2011, and currently, it is 1.3 crore. This rapid growth has overstressed the existing infrastructure of water supply and wastewater collection and treatment. This paper reviews water sensitivity in Bangalore city, the efficiency of wastewater treatment plants, and the impact of wastewater on downstream. In this work I have used both quantitative and qualitative data. We studied water supply and demand to know Bangalore water's sensitivity, and we also found the sources of drinking water. We examine the sewage treatment plant located on this polluted river to see the efficiency level. We went on downstream to know the impact of wastewater on people who are staying along the river. We have collected water samples to find out the efficiency of treated water, and we did have an interview with farmers about the issues they are facing. While downstream farmers are using this water for irrigation without knowing untreated wastewater is a health hazard, and from these, the agricultural products are contaminating. We find out that the impact of treatment plants on the wastewater is nil, and Bangalore city does not have a separate stormwater drainage network. It makes a significant impact by bringing a lot of pollutants downstream. Realizing the potential of wastewater reuse in Bangalore will require a lot more interest from the government and the public.

KEYWORDS Sewerage Treatment plant, Wastewater Recycle, Reuse, Health Hazard, Water Sensitivity

 $\label{eq:constraint} \mbox{Urban Water under Climate Change: Transition, Management and Governance > Oral Presentation$

Green Infrastructure for Sustainable Urban Water Management in Amman, Jordan

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Rapid population growth and continual urbanization in Amman city creates unprecedented challenges. Among the most important challenges is provision for water and sanitation for 4.5 million people. Climate change is also a source of challenge that significantly impacts water quantity prediction and water supply planning. Hence, sustainable water management is an urgent need in Amman. Though green infrastructures (GI) offer effective, sustainable measures for water management, incorporation of such measures by local planning authorities in Amman is very limited. This study investigates the role of GI-based urban water management practices to identify the appropriate practices, if any, to be implemented in Amman. GIS software was used to generate various thematic layers, which were integrated to assess the potential contribution of proposed GI systems. The results show that 52 to 100 % of surface area in the delineated watershed in Amman is impervious. The estimated peak runoff volumes for a 2-yr return period rainfall events is about 19.5 m3/s. Based on this study, it is proposed that the local planning authorities in Amman should adopt strategies that aim at promoting the use of rain water harvesting, rain gardens, and infiltration treatment facilities. Such strategies should improve Amman resiliency and help to achieve efficient use of the city limited water resources.

KEYWORDS Green infrastructure, GI, Sustainable Water Management, Amman, Water Harvesting

Urban Water under Climate Change: Transition, Management and Governance > Oral Presentation

Water-sensitivity of Statutory Development Plans of Bhopal and Melbourne: A Critical Review

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The ever-increasing urban population coupled with haphazard development and the impacts of climate change have increased the stress on the water resources of cities. Water crisis, in both the developing and developed nations, is not a looming threat; cities across the world are already facing a water crisis, with several already having witnessed the threat of 'day-zero'. Urban planning, especially in the highly populated Indian cities, needs radical improvements to mitigate the effects of overexploitation and pollution of water resources. The concept of water-sensitive cities has emerged in recent years as one of the probable solutions. While most of the strategies following this concept have focussed at a local level, planners must consider incorporating the concept at a pan-city level for water-sensitive cities to emerge. Water-sensitive proposals in statutory plans are the most likely to get implemented owing to the legislative support they receive. This paper critically reviews the water-sensitive proposals of the statutory development strategies and plans for Melbourne, a model water-sensitive city, and Bhopal, a rapidly growing Indian city. The implementation mechanism and monitoring processes for the plans are also compared. While Bhopal's statutory plans focus primarily on the landuse Melbourne's strategies are more diverse. Monitoring their implementation is another contrasting element in the strategies of the two cities. The key learnings which could be adopted in the plans for Indian cities to make them more water sensitive have been discussed in the paper. The findings of this research would find relevance with urban planners, designers and decision-makers.

κεγwords water-sensitive cities; development plans; statutory plans; sustainable development; urban water management

Urban Water under Climate Change: Transition, Management and Governance > Poster Presentation

Indicators for Tourism Scenarios of Climatic Vulnerability in Hydrological Attractions in San Luis Potosí, Mexico

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It's a fact that climate variability has caused negative impacts on economic activities such as tourism, this condition turn it vulnerable due to the physical and socio-economic components that involve their practices, since the climate conditions are directly involved with the success or failure as a touristic space, especially those that depend on practices, that involve natural attractions like hydrological, inasmuch as their quantity, quality, and presence, are concomitant with the possibility of visiting them and constitute not only a landscape resource and object of tourist attraction, it also means a source income for the service providers that operate in them.

While these sites are exposed and sensitive to climatic variations, their resilience to recover and sustain the socioeconomic conditions of those who depend on them is reduced. Therefore, the construction of a methodology and identification of tourism indicators that allow identifying vulnerable sites and the factors to which are vulnerable through the identification of scenarios is a fundamental aspect to improve the management of these sites through early promotion, prevention, and early solution at the effects of climate variability.

From this perspective, the state of San Luis Potosí, Mexico is a geographic space with abundant biodiversity and tourist demand associated with natural hydrological attractions in the regional context. This work presents, in the first instance, a baseline to identify the anomalies of precipitation and temperature in these sites, followed by the identification of physical and socioeconomic indicators of exposure, sensitivity, and resilience to, finally, identify the tourist sites according to the level of vulnerability to climate variability, an instrument that will improve risk management caused by climate change.

KEYWORDS climate change tourism, climate scenarios, vulnerability

Solutions Towards the Water-Energy-Food Security Nexus > Oral Presentation

Water-Energy Assessment of Sound Groundwater Management in Mendoza, Argentina

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Historically, water resource is considered key for economic development in the arid province of Mendoza where grapevine production explains 50% of the agricultural GDP while also fostering agro-industries, labour markets and commercial activities. For more than a decade scarcity is the new normality of water management in the region that experienced shortages between 20 and 40%. Green infrastructure investments were carried out in the wine area of Valle de Uco after a long disputes process between stakeholders that derived on greater opportunities for production while alleviating pressure on the aquifer. An unexpected benefit from project implementation is the increasing water budget that stakeholders have which, in turn raises new frictions on water assignment within the irrigation system. Accounting with production statistics and energy consumption data for groundwater pumping this research seeks to estimate the economic and environmental benefits of improved water security for agricultural production while defining relevant intervention points for similar scenarios.

KEYWORDS groundwater; water-energy nexus; nexus; Mendoza

Utilizing WEF Nexus approach in Central Asia

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Central Asia is a region where water security is inextricably linked with energy, food and the environment. The region's geophysical diversity, encompassing great mountain ranges and abundant freshwater sources along with vast steppes and arid landscapes, generates diverse notions of water security in the region.

The pressure on and demand for water, energy and food are mounting due to a rapidly growing population, human migration, urbanization, globalization, intensification of food production, and negative effects of the climate change. Globally, agriculture alone is responsible for 70% of total freshwater withdrawal, while food production and supply chain utilize approximately 30% of the total energy used (FAO). In Central Asia, substantial water use for agriculture is putting pressure on water resources reaching as high as 90% of the total freshwater withdrawal, while hydroelectricity generation is averaging at about 40% of all energy production.

The Regional Environmental Centre for Central Asia (CAREC) in collaboration with Global Nexus Secretariat plans to strengthen regional and national dialogues in Central Asian States on the Water, Energy and Food (WEF) Nexus with an ultimate goal of institutionalizing the WEF Nexus approach at national and regional governance structures and investment decisions. CAREC will develop WEF Nexus tools and methodologies, which will contribute to WEF Nexus value-added approach on transboundary and national small-scale demonstrations. The focus will remain on building the evidence base for increased application of the WEF Nexus approach into regional, national and local planning, policy making, regulatory and implementation processes for water, energy and food security.

The WEF Nexus approach can lay the pathway toward a "Green Economy" and support effective implementation of the Sustainable Development Goals (SDGs) since SDGs 6 (water), 7 (energy) and 2 (food security) are not only connected to each other but also are key to the WEF Nexus.

KEYWORDS water, energy, food, security, nexus

Solutions Towards the Water-Energy-Food Security Nexus > Oral Presentation

Remote Sensing and Machine Learning for Real-Time Runoff Forecasting in Large Complex Mountain Basins – Application to Hydropower Optimization

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Hydropower generation in Ecuador is vital for its economic development. However, hydropower production is not optimal due to the lack of hydrological forecasting tools. Therefore, dam operators cannot anticipate the incoming discharge and thus optimize the energy generation schedule, producing significant economic losses. The difficulties for developing such tools are generated by the absence of operational rain gauge networks. The exploitation of Remote Sensing (RS) imagery as an alternative data source is also a challenge due to the large elevational range, sometimes spanning from sea level to more than 4000 m a.s.l.. Here, we developed an hourly real-time runoff forecasting system for the Minas-San Francisco powerplant, one of the most important in terms of energy production (catchment extension 3300 km2). We used data retrieved from the IMERG-early run precipitation product and a hydrological station located at the powerplant's intake works. The forecasting system contemplates real-time data acquisition and processing, application of forecasting models for several lead-times (1 to 16 hours), and delivery of forecasts to dam operators. For developing the forecasting models, we selected a Machine Learning (ML) technique, the Random Forest (RF) algorithm due to its capability to generalize under limited feature space scenarios. Results revealed forecasting model efficiencies better than Nash-Sutcliffe =0.93, RMSE=15.43, and PBias=7.89, for all lead times. Models are continuously improved by increasing the data extent for training and by performing additional feature engineering strategies, from which we highlight soil moisture mimicking and recursive forecasting. Delivery of real-time runoff forecasts provide dam operators with the tools for optimizing the energy generation schedule of the powerplant, and for safely planning maintenance activities. The successful use of RS combined with ML in this study sets the basis for hydropower optimization in the country since most powerplants are located in remote areas where in-situ measurements are not feasible.

KEYWORDS Discharge forecasting, IMERG, Real-Time, Machine Learning, Optimization

Energy for Amman Water Supply

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About 15% of the national energy consumption in Jordan is consumed by the water sector. Fossil fuel and natural gas make the lion's share of the energy mix in Jordan, which leads to serious environmental consequences such as climate change. About 40% of Jordan's population lives in the capital, Amman; as a consequence, considerable energy is needed to deliver water to Amman from west, south and east Jordan for domestic use. Two main water sources to Amman come from the Jordan Valley, namely, King Abdulla Canal (KAC) and Zara Mai'n springs. KAC is the source of raw water to Zai water treatment plant, which supplies about 73 MCM/yr to Amman. The Zara Mai'n springs is the source of raw water to Sweimeh desalination plant which supplies about 47 MCM/vr to Amman. Water from these two sources is pumped against an elevation difference of about 1400 m. The energy associated with pumping from these two sources for the year 2017 was 363,962,000 Kw.h and 226,525,437 KW.h for Zai water treatment plant and Zara Mai'n springs respectively. Another source that consumes a considerable amount of energy is the Disi water which is pumped from south of Jordan to Amman a distance of about 325 Km. The Disi fossil water supplies about 100 MCM/vr of drinking water to Amman. Energy needed to pump the Disi water to Amman is estimated at 422,142,653 KW.h. Specific energies for these three sources are 4.22, 4.05 and 4.85 KW.h/m3 for the Disi, Zai water treatment plant and Zara Mai'n springs. Carbon Dioxide equivalent of the GHG emissions associated with these three sources are estimated at 652,033 ton CO2 eq./yr based on a conversion factor of 0.6439 kg CO2 eq. /KW.h, which makes about 3% of Jordan's GHG emissions.

KEYWORDS Water for energy, Amman water supply, Disi water, King Abdulla Canal, Zara Mai'n springs

Solutions Towards the Water-Energy-Food Security Nexus > Oral Presentation

Considerations on the State of the Art of the Water-Energy-Food Nexus in Computable General Equilibrium Models: A Critical Analysis of Modeling Issues

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The review work aimed to analyse how the Water-Energy-Food (WEF) Nexus is introduced and dealt with in Computable General Equilibrium (CGE) models.

It evaluated the relevance of these instruments in the literature, assessed their strengths and weaknesses and identified possible ways of improvement.

Understanding how this modeling option addresses the Nexus is increasingly important considering the pressures that population, consumption trends and climate change are putting on its elements. Indeed, CGEs are particularly useful for this task, considering that this type of models is particularly fit to address interdependencies and transmission patterns existing across countries and, most importantly, economic sectors. Therefore, it is important to comprehend them specifically.

As a result of the review process, it was found that, while the usefulness of this instrument is confirmed, there is significant space for improvement of these models.

In the current literature, indeed, CGEs mostly rely on integration with other models (e.g. hydrological models) and not on a full integration within the models themselves.

Therefore, a gap exists regarding the explicit introduction of the Nexus in CGE models, especially for what concerns the water endowment. Furthermore, the way in which the models deal with different spatial and temporal scales, as well as the issue of competing water uses across the sector, and the energy sector in particular, are some of the biggest current modeling problems. Consequently, this work finds that most of the issues are linked with lacks in the economic representation of water and concludes that this specific issue creates an important challenge for future research, especially in order to provide a comprehensive economic assessment of the impacts on the WEF Nexus.

KEYWORDS Water-Energy-Food (WEF) Nexus; Computable General Equilibrium (CGE) models; Economic Modelling

Regional Droughts in the Greater Mekong Doom Long-distance Power Transfers to Temporary Failures

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Large investments in the hydropower sector have transformed Laos in the socalled 'battery of Asia', which now exports most of its electricity production to the neighboring countries. While the ecological and hydrological alterations caused by hydropower dams have received substantial attention, their role within the regional power systems is not well understood. The Greater Mekong is exposed to seasonal and inter-annual climate variability, raising the prospect of a strong dependence of hydropower production and export on water availability. By extension, one may expect that sudden changes in the available hydro-electricity are likely to affect the operating costs and CO2 emissions of the electricity sector. To test these hypotheses, we developed a high-resolution water-energy model and applied it to the Laotian-Thai grid-the first international power trade infrastructure developed in the region. Simulation results over a 30-year period reveal a cyclic pattern underpinning the relationship between climate, water, and energy variables: as water availability fluctuates between dry and wet conditions, in response to El Niño and La Niña conditions, so too does the power system behaviour, whose generation mix must periodically lean towards thermo-electric and hydropower resources. The periodic fluctuations extend to annual production costs and CO2 emissions, for which we observe a possible range of variability of about 250 M\$ and 5 Mt per year. Banking on these results, we discuss opportunities for improving system performance and facilitating electricity exchange across Laos and Thailand.

KEYWORDS Water-energy nexus, Hydropower, Climate variability, Mekong River Basin, El Niño

Storm Surge Forecasting System in The Gulf of Thailand during Pabuk Tropical Storm 2019

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Tropical Storm Pabuk struck the Southern of Thailand in January 2019 while people were celebrating their new year. The storm was formed in the South China Sea on the last day of 2018 and continued into 2019 and had a landfall in Pak Phanang, Nakhon Si Thammarat province on the 4th January 2019. The storm brought heavy rain, strong wind and high level of surge that caused a widespread of coastal flooding especially in the low-lying area. Its formation and track were closely monitored and predicted for the strength, track and impacted area using the storm surge forecasting and early warning system for the Gulf of Thailand that was developed using Delft-FEWS as operational platform since 2014. Delft3D-FM and SWAN models were used to compute the total water level that combined effect of tide, wave and surge. Tropical Storm Pabuk had finally hit the land at Pak Phanang, Nakhon Si Thammarat on 4th January 2019 afternoon with wind speed reaching 83 km/hr. It was found that the model could capture the whole phenomena satisfactory. The results of the storm surge forecasting system was used to provide warning and evacuate the people in time before the storm had hit the land. The comparison between computed and observed water level from the water level stations showed strong correlation and good agreement. The inundation area was also estimated using wetting and drying scheme in Delft3D-FLOW. SRTM 90m was used for the land topography to simulate coastal flooding during the storm. The estimated inundation area using the model has been compared with observed flood map from RADARSAT-2 satellite. The results showed a good agreement especially in the low-lying area including estuary, mangrove and local community area.

KEYWORDS Gulf of Thailand, Tropical Storm Pabuk, Early warning system, Storm surge, Inundation

Operational Water Management Developments in Southeast Asia > Oral Presentation

eAtlas: Towards a Vietnam Resilient to Climate Change

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With a long coastline, low elevated deltas, and a large population relying on agriculture for living, Vietnam is among the most vulnerable countries to climate change effects, including sea level rise, intensified droughts, floods, tropical cyclones and other extreme weathers. Raising the awareness of Vietnamese people on climate and climate change effects is the key to mitigate these effects and ensure a sustainable development of the country. However, available information about the country's climate is limited, dispersed, unstructured and difficult for the major population to access and digest. In this eAtlas project, we create a series of atlases of the country's climate conditions using multiple sources of observations, mainly from satellites. The atlases consist of a number of principal environmental variables including surface temperature, humidity, wind, vegetation index, sea level, ocean current, waves, and primary production. These sources of information can be accessed freely at the eAtlas website with detailed instructions and supporting graphic tools. We also provide a number of case studies as guidelines on how users can extract information and learn from the atlases. This product can be useful for education at high school and university levels and to anyone who wants to understand the climate system in Vietnam. We hope that this product will contribute towards building a Vietnam resilient to climate change.

KEYWORDS atlas, climate system, climate change, satellite observation

Assessment on the Sediment Yield and Annual Runoff of the Pulangi Dam Reservoir Watershed Basin and Impact of Climate Change Using Soil and Water Assessment Tool (SWAT) Model for Reservoir Sustainability

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Climate change can accelerate erosion due to frequent and intense rainfall events that affect greater amounts of streamflow and sediment washing into rivers, reservoirs, and streams. Sedimentations is a great threat to the sustainability of reservoirs. The estimated global storage volume to be lost due to sediments is 0.5 to 1% annually. In the Philippines, the Pulangi dam reservoir experiencing a serious sediment problem mainly due to land conversions and plantations on its watershed and the effects of climate change on it. Thus, it is very essential to predict the sediment yield and runoff volume realistically in terms of soil conservation techniques in the Philippines. In this research, the Pulangi Dam Reservoir Watershed Basin (PDRWB) was modeled using Soil Water Assessment Tool (SWAT) to predict the future annual runoff and sediment yield and climate change impacts on its watershed basin. For the calibration and validation phase, the SWAT-CUP was utilized. The model was calibrated with monthly discharge data for the year 1995-1998 and validate for the year 2000-2003 and with limited observed sediment yield datasets, it was calibrated in the year 2014 and validated in the year 2015. Uncertainty analysis and calculation of efficiency indexes were accomplished through the SUFI-2 algorithm. According to the coefficient of determination (R2), Nash Sutcliffe efficiency, and bias correction, the calculation indicates a good performance for both calibration and validation periods and acceptable agreement between observed and simulated values of monthly scale discharge and sediment yield. These results further applied for the analysis of the sediment effect on the river runoff of the Pulangi River. Thus, sediment outcomes illustrate reservoir management and runoff river utilization that contributes to the sustainable water resource management of Pulangi watersheds.

KEYWORDS Pulangi Dam, Sediment yield, ArcSWAT, Runoff, Climate Change

Building Resilience to Hydrometeorological Hazards in Southeast Asia > Oral Presentation

Leptospirosis Risk from Hydrometeorological Patterns under Climate Change

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Leptospirosis is a zoonosis strongly related to water. Documented outbreaks often follow events of intense precipitation and flooding through a variety of possible mechanisms. We study the effect of hydrometeorological variables on leptospirosis risk for different areas of the world based on historical data. Based on that analysis and on climate projections, we estimate how the risk of infection from that effect is altered by climate change. We show that hydrological modelling can predict part of the risk, which can mitigate the burden of disease through preventative measures. Although our analysis covers several world regions, our main focus is on Southeast Asia, and Malaysia in particular. The research we present was performed within the UnderWRiDE project, which is part of the Understanding of the Impacts of Hydrometeorological Hazards in South East Asia programme.

KEYWORDS Leptospirosis, Southeast Asia, hydrometeorological extremes

Uncertainty in Estimated Flood Losses from National and Global Derived Depth-damage Functions: A Case Study in Malaysia

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Assessment of flood vulnerability is crucial in managing flood risk. Among the important components in flood vulnerability assessment is the depth-damage relationship that depicts the degree of impact to receptors given a range of depths that acts as the flood damage indicator. Country-specific depth-damage function has been developed in many countries based on analysis of post flood events and elicitation of empirical data. But unlike most developed countries, establishment of depth-damage relationships has seen to slowly progressing in developing countries. The lack of depth-damage functions derived locally in some countries (i.e. national flood damage function) has led international bodies to propose national depth-damage relationships using simplified economic indicators (i.e. global derived flood damage function). Though the international efforts have provided opportunities for flood vulnerability and risk assessment of those countries, uncertainty in flood vulnerability between a global derived flood damage function and a national derived flood damage function where there is available is rarely discussed. The present study attempts to look at the uncertainty of the two when taking exposure of heterogeneously located buildings on a flood prone area into the vulnerability assessment, using a residential area in Malaysia. The national derived flood damage function is taken from the developed function under the jurisdiction of Department of Irrigation and Drainage (DID) and the global derived flood damage function is from the Joint Centre Research-European Commision. The investigation was carried out on a local area in Kelantan, Malaysia, where quantitative assessment on the variation of results from the two different models were investigated. The result shows that the uncertainty if large by multiple hundreds difference and would aggravate for rare (i.e. higher water level) flood events. There is a need to cautiously used the depth-damage function to avoid erroneous estimation of flood risk, which may cause unnecessary misleading information.

KEYWORDS flood risk assessment, vulnerability, depth-damage function, stagedamage function, uncertainty

A Comparison of Models, to Study Future Agricultural Land Use Change in the Mun River Basin

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Using the Mun River Basin in Thailand, this study aims to investigate the relationship between different land use (LU) types and their future transitions. Using stakeholder engagement, the FLUS (Future LU Simulation) and the Dyna-Clue model along with an optimization tool, seven future scenarios up till 2060 were created: Business as usual. Conservation. Productivity. Urbanization. Multi-Objective, Policy-based and Water-stressed. This paper also fills the gap in literature by investigating the differences in the model's methodology and their results. Though simulation accuracy of the models was similar (FLUS having a slightly greater accuracy than Dyna-CLUE), the FLUS model proved easier to use, with practical problems associated with Dyna-CLUE. Moreover, key differences in LU distribution was observed, especially for Perennial and Orchards, To calculate the contribution of each driving factor on future LU distribution and transition, logistic regression analysis took place. Research found that Paddy Field extent in future years was observed to decrease in favor of other LUs with the key drivers of this change associated with Slope, Elevation and Drainage. Overall findings contribute to a better understanding of future LU change and potential watershed management ideas for the Mun River Basin and its local stakeholders.

KEYWORDS FLUS, Dyna-Clue, Agricultural Land Use Change, Driving Factors, Thailand

Adapting to Climate Change: Strengthening Urban Water Resilience > Oral Presentation

Adapting to Climate Change: Strengthening Urban Water Resilience

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TBA

Adapting to Climate Change: Strengthening Urban Water Resilience > Oral Presentation

Web-based Interface for Urban Flood Warning System in Bangkok Area

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Bangkok is suffered from urban flood every rainy season. Because of extreme weather, rainfall in Bangkok becomes more sudden and heavy in the recent years than in the past. Flooding in the urban environment or so called "urban flood" guickly occurs in a short period of time and affects to life guality and property losses such as terrible traffic jam and flooded houses. There are a lot of factors both physical and meteorological that impact on urban flood such as drainage system, infrastructures, precipitation etc. In this study, an urban flood warning system has been developed by integrating the flood guidance threshold with the 1hr now-casting rainfall from the weather radar. The threshold is calculated by historical rainfall data from rain gauging stations over the province at least 10 years. The system is applied by overlaying technique between 1hr now-casting and threshold. The warning area is appeared when the now-casting rainfall equals to the threshold. Urban flood area is warned by web-based interface and operating system presents every 6 minute base on the frequency of the weather radar. The warning area is detailed by vulnerable Bangkok flood area and Bangkok sub-district. Moreover, urban flood warning by web-based interface is useful for general public and technical staff. General user can access to the interface for route preparing and avoid flood risk area, while technical staff uses to an early warning for drainage system operation and Bangkok flood mitigation. Therefore, warning interface is important for urban flood prevention in Bangkok because of quick warning and high performance.

кеуwords Urban flood, Weather Radar, Web-based Interface, Flood warning, Bangkok

Water Adaptation Governance at Local Level

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The study contributes to develop a framework to understand water adaptive governance by studying the case of Punjab province of Pakistan. The commandand-control paradigm or top-down governance mechanism of water resource management that dominated 20th century water policy has resulted in vulnerabilities due to its inadequate localized policies and adapting to change and uncertainties. Considering these shortcomings, in recent years and specifically on the heels of the Paris Agreement, alternative water policy frameworks and adaptive water management systems are developed. This study focuses to understand new dynamics of water adaptation governance in local context by studying the case of Pakistan. Pakistan is facing severe water crises and it may run dry by 2025. Pakistan is ranked as the third most water-stressed country in the world. It has the world's fourth highest rate of water use. It is imperative to introduce improved water management and adaptation systems to enhance water use performance and water productivity. This study is conducted to investigate water adaptive governance at local scale in Pakistan. Water crises are escalating due to poor governance of water resources, lack of communication and education on water crises, and lack of investment and infrastructure development. The Punjab government has launched massive level awareness campaigns on water scarcity and use of water for domestic use and for irrigation purposes in the province. One of the notable initiatives is preparation of provincial level action plan in compliance with national water policy of Pakistan. The subnational government is promoting adaptive and integrative water management by using polycentric institutions and analytic deliberation processes by engaging local actors. The water resources management is emphasized, but potential benefits depend on appropriate multi-institutional and multi-stakeholder coordination to water resources management. Through these mechanisms, water adaptation governance can contribute to sustainability, good governance, conflict management, and social-ecological resilience in water resource systems.

KEYWORDS Water Scarcity, adaptive governance, subnational level, Pakistan

Adapting to Climate Change: Strengthening Urban Water Resilience > Oral Presentation

Understanding Water Insecurity Dynamics in Slums of Dhaka

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Water security refers to the capacity of a population to access sufficient, affordable, and acceptable quality water and safe sanitation to lead a healthy life without disturbing the environment. Ensuring water security becomes more challenging particularly in slums for myriad reasons encompassing social, economic, and environmental dynamics. But the interventions taken for improving slum water security follow 'one size fits all' policy- disregarding inter-slum differences. Dhaka, the capital city of Bangladesh is no exception. The city is still facing difficulty to provide protection from urban flooding and reliable access to water and sanitation to its slum residents. Hence, Dhaka needs comparative studies to understand how the dynamics of water insecurity function in different slums. The study compared water insecurity of two slums, namely Tejgaon and Baganbari, in terms of social, economic, and environmental aspects covering availability, accessibility, affordability, quality, and sanitation issues. Using multicriteria assessment, we evaluated water insecurity indices individually and determined the total water insecurity of the selected slums. The research focused on primary sources of data from focus group discussions, key informant interviews, and semi-structured Interviews along with groundwater data from Bangladesh Water Development Board and satellite images. Our study findings capture significant water insecurity in Tejgaon compared to the Baganbari slum. Tejgaon turns out to be almost 200 times more socially and economically water insecure- informal water supply, the price hike of water and the insufficient number of water collection points are the prime reasons. On the contrary, Baganbari slum is twice environmentally insecure because of widespread flooding and degraded water quality. The interslum differences highlight that water security in slums is highly contexted. Hence, policies not only need to address the water rights of people living in slums but also need specific guidelines to ensure evidence-based contextual solution generation.

KEYWORDS Water Security, Slums, Urban Water, Vulnerability

Irrigation and Drinking Water Security under Climatic Extremes: Empirical Analysis and Policy Lessons > Oral Presentation

Development and Application of a Water Security Index Incorporating Future Challenges in the Aegean Coast

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Pressing impacts of climate change and population increase exacerbate the existing stress on water resources and jeopardize the water security. In this study, a water security index is developed using the Pressure-State-Response (PSR) framework by identifying the driving forces, dimensions and indicators of water security. After rigorous literature review and consideration of the study area, four dimensions (measured by sixteen indicators) were determined - resource (which is a measure of existing water quality and quantity), access and use (which considers the impact of population and access to existing resources), capacity (which emphasizes the factors that influence the efficient use of water), and sustainability (which considers the impact of land use and management). The study area includes four neighbor provinces in the Aegean region (Aydın, Denizli, Mugla and Usak) of Turkey which are dominantly agricultural areas. Plausible future scenarios are created to investigate the impacts of climate change (RCP 4.5 and RCP 8.5) and population dynamics and these scenarios indicate that the region will become heavily water stressed in near future and changing population dynamics will further aggravate. This index and its application in an agricultural study area could provide policymakers with necessary information for guideline formulation using the four dimensions, resource use, access, capacity and sustainability of existing water resources, for sustainable water management under future climatic and demographic changes.

KEYWORDS water security index, climate change scenarios, population dynamics

Irrigation and Drinking Water Security under Climatic Extremes: Empirical Analysis and Policy Lessons > Oral Presentation

Climate Resilient and Sustainable Options for Functional Household Tap Water Connection in State of Maharashtra, India

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International Business Forum of Bangladesh, Bangladesh

Irrigation and Drinking Water Security under Climatic Extremes: Empirical Analysis and Policy Lessons > Oral Presentation

Climate Variability and Water Management in a River Basin in Eastern India

Nitin Bassi

Presentation by Nitin Bassi based on research study by Dr. M. Dinesh Kumar and Nitin Bassi

TBA

Irrigation and Drinking Water Security under Climatic Extremes: Empirical Analysis and Policy Lessons > Poster Presentation

AMICA Project: Automated Monitoring and Irrigation Control Advancement Project

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The Philippines is an archipelago where agriculture plays a fundamental role in food security and employment. It is located in the Western Pacific Ocean, surrounded by naturally warm waters that will get warmer as average sea temperatures continue to rise making it vulnerable to climate change. Recent natural phenomenon brought by climate change affected crop production worsening the food security of the country. Hence, there is an urgent need to continuously improve climate change adaptation technologies that are available and suitable to the agriculture sector.

Alternate Wetting and Drying or AWD is a proven water-saving technology that helps farmers with water scarcity brought about by climate change (Lampayan et al. 2003). One improvement of AWD is the development of an Information Communications Technologies or ICT tool by the International Rice Research Institute or IRRI through the WateRice Project (Yadav et al. 2017).

The ICT tool was coined as AutoMonPH (for automatic monitoring) which consist of a water level sensor installed in the AWD observation well pipe with GSM modem to communicate water level to farmers. AutoMonPH will make it easier for farmers to measure and control water level and subsequently oblige them to adapt AWD.

The paper deals on the discussion of continued development, evaluation and adoption of cost-effective ICT tool for automated water monitoring within the irrigation network of ten (10) pilot National and Communal Irrigation Systems of National Irrigation Administration for improving decision-making on water management by farmers, facility technicians, field personnel and officers.

KEYWORDS Automated Monitoring, ICT Tool, Alternate Wetting and Drying

Irrigation and Drinking Water Security under Climatic Extremes: Empirical Analysis and Policy Lessons > Poster Presentation

Future Climate Change Impact on Agricultural Water Resources for Rice Cultivation in Malaysia

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With a rapidly growing population, Malaysia is struggling to sustain her target 70% self- sufficiency level. Climate uncertainty and change is further jeopardizing rice yield production nationally. The impact of future climate change on local rice yield production concerns many stakeholders, yet there remains a lack of systematic study of the nonlinear relationship between the regional climate, watershed hydrology, paddy management practices and crop yield. We present our study findings of the projected future climate change impact on the Muda granary area that represents 40% of rice production in Malaysia. The Soil Water Assessment Tool (SWAT) model is used to characterize a 4,500 square-kilometer watershed, which consists of rainforests in the upper subbasins and rice paddies in the coastal plains, and whose irrigation water resource is regulated via dams. The model is configured using field data, then calibrated and validated using observed weekly averaged streamflow and seasonal rice yield. Simulation results show the Nash-Sutcli e e ciency (NSE) for streamflow to be 0.63 and 0.45 in the calibration and validation periods respectively, while the NSE for seasonal rice yield ranges from 0.46 to 0.75, except for the season 1 validation period. We further assess the catchment response to projected climate change using bias corrected Regional Climate Model output from the Coordinated Regional Climate Downscaling Experiment Southeast Asia (CORDEX-SEA) project and found increased seasonality in the future river flows, i.e. up to 50% increase in Season 1 and 30% decrease in Season 2 under the RCP 8.5 early century scenario, which would affect water availability and consequently management decisions for paddy irrigation. Future work will consider projection of rice yield under different adaptation practices, to inform policy changes towards more resilient paddy management strategies.

KEYWORDS SWAT, rice, streamflow, agricultural water resource, climate change

Irrigation and Drinking Water Security under Climatic Extremes: Empirical Analysis and Policy Lessons > Poster Presentation

Ecological Health and Water Quality of Village Ponds in the Subtropics Limiting their Use for Water Supply and Groundwater Recharge

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Ponds are a typical feature of many villages in the subtropics and have been widely used as important sources of water for agriculture, aquaculture, and groundwater recharge, as well as enhancing village resilience to floods and drought. Currently, many village ponds are in a very poor state and in dire need of rejuvenation. This paper assesses the current water quality status and ecological health of twelve sub-tropical village ponds, situated in western Uttar Pradesh, India. This assessment is used to evaluate their wastewater treatment needs in relation to potential village uses of the water. Physico-chemical (Secchi depth, total phosphorus, and total nitrogen) and biological (Phytoplankton chlorophyll-a) indicators highlight hypertrophic conditions in all the ponds. The study indicates that the status of village ponds requires significant investments in wastewater treatment to restore their use for many purposes, including aquaculture, although some may still be acceptable for irrigation purposes, as long as pathogenic bacteria are not abundant. We propose increased implementation of decentralized systems for wastewater treatment, such as septic tanks and constructed wetlands, to reduce the organic and nutrient loads entering village ponds and allow their use for a wider range of purposes.

KEYWORDS Phytoplankton Trophic status Wastewater treatment Water resources Aquaculture

Circular Design-Built Strategies for Climate-Friendly and Citizen-Driven Urban Water and Food Systems > Oral Presentation

Potential Nutrient Conversion Using Nature-based Solutions in Cities and Utilization Concepts to Create a Circular Urban Food System

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The current food system is characterized by a one-directional flow of resources from rural areas into cities, where most food is consumed. Essential macronutrients for agriculture are mostly provided from limited resources (e.g. phosphorus) with a large climate footprint. Finally, the nutrients contained in consumed food are discharged via urban sanitation systems. Alongside end-of-pipe technologies recovering nutrients at conventional wastewater treatment plants, nature-based solutions (NBS) provide a robust and low-energy alternative to recover water and nutrients for food production.

This paper aims to identify the potential contribution of processes utilizing NBS to close water and nutrient cycles in the urban-agricultural system, leading to a circular food and bioeconomy. In particular, a Substance Flow Analysis (SFA) approach is used to assess water sources and nutrients that could be recovered and reused in cities using NBS. The reuse potential to cover production of the major food groups is assessed, and the non-food biomass that could be additionally produced. The resource conversion model was developed on a conversion basis, i.e. the nutrient budget based on population, and a holistic utilization concept of all available secondary nutrients and water, using the city of Vienna as an example. The developed model includes household water and nutrient discharge, their metabolization in NBS-treatment processes as demonstrated by the EU-funded HOUSEFUL project, specific crop nutrient requirements and yields, as well as greenhouse versus outdoor farming conditions in the temperate central European climate.

Results indicate that by applying NBS, secondary resources can cover the nutrient requirements of all vegetables produced within the municipality, with significant excess to be returned to peri-urban and rural agriculture or used for non-food biomass production. Finally, the model can inform the selection and design of NBS to optimize NPK metabolization and availability in secondary fertigation water to accommodate specific crop nutrient demand.

KEYWORDS wastewater, circular economy, food systems, nature-based solutions, nutrients

Circular Design-Built Strategies for Climate-Friendly and Citizen-Driven Urban Water and Food Systems > Oral Presentation

SUDS Missed Opportunity in Indian City: Case Example Dwarka, India

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In the last few decades, rapid and unplanned urbanization has resulted in a growing urban population, which transformed into regions of exceptional socio-economic value. By removing vegetation and soil, grading the land surface and saturating soil air content, urban developments are more likely to be flooded, which will be further exacerbated by an anticipated increase in the number of intense rainfall events, due to climate change. This paper presents a case study of existing sustainable approaches to urban flood management, by comparing the new urban water management approach practice with that in Dwarka, India and critically assessing whether lessons can be learnt from the Sponge City initiative. The authors have identified a strategic research plan to ensure that the sponge city initiative can successfully respond to extreme climatic events and tackle pluvial flooding. Hence, this review suggests that future research should focus on (1) the role of retrofit and suitable SuDS (Sustainable Drainage Systems) in challenging water environments for different catchments; (2) the development of a robust SuDS selection tool, ensuring that the most effective devices are installed, based on local factors. The result shows that if strategies for only reduction of overall runoff coefficient are applied than 22% of reduction in peak discharge achieved and after that if retention strategies for effective drainage systems applied for 5-10 % of public open space than 100% of exceeding peak discharge is reduced.

кеуwords flood management; urban flooding; Sustainable Drainage Systems; sponge cities

Circular Design-Built Strategies for Climate-Friendly and Citizen-Driven Urban Water and Food Systems > Oral Presentation

An Integrated Blue-Green-Grey Infrastructure Solution for the At Risk-sinking Coastal Regions in the Context of Kochi

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Coastal regions worldwide are experiencing receding shorelines. The recent report of the Intergovernmental Panel for Climate Change (IPCC) highlights that the coastal inundation risk in the future will concentrate in Asia. The coastal lands now home to 200 million people could fall permanently below the high tide line by 2100, according to Coastal Digital Elevation Model data developed by Climate Central, Kerala, the South Indian located along the Arabian Sea with a coastline of 580kms now has 19 urban applomerations (Census 2011) all concentrated along the coastal stretch with most population density in the state characterized by a sprawling urban development pattern and not a concentrated one. Kochi was the first Urban Agglomeration in Kerala to have 1 million plus population in 2001 and it has 21 lakhs population with a population density of 4800 persons/sg.km (2011 census) spread along the 48km coastal stretch with parts of it projected to sink, by the year 2050 due to global Climate change (Climate Central). This will have a huge impact on the local coastal based economies - coastal & inland fishing, coir making, etc. along with damages to life and property in the region. The paper attempts to devise urban design guidelines to mitigate the future coastal inundation by adopting an integrated Blue-Green-Grey infrastructure as a solution to guide future development in the Kochi city region. The research method involves comparing the existing urban development pattern with population densities, landform conditions, and vulnerability risks within the Kochi Urban Agglomeration region and develop context specific design guidelines by analysing the existing Blue, Green and Grey components in the city. The research outcomes shall be further used by urban designers as reference to formulate coastal management urban design framework for the remaining coastal cities in Kerala.

KEYWORDS Costal inundation risks, urban density and vulnerability, Integrated Blue-Green-Grey infrastructure

Circular Design-Built Strategies for Climate-Friendly and Citizen-Driven Urban Water and Food Systems > Poster Presentation

Device for Phosphorus and Nitrogen Recycling Extracted From Human Urine: Saving Water, Reducing the Discharge of Minerals in Rivers and Utilizing Agriculture

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With the accelerated population growth, it is essential and urgent to create a technique to mitigate the problems caused by domestic effluents. In this context, a project was conceived that would make it possible to save water and recycle phosphorus and nitrogen nutrients from human urine. In addition to bibliographic reviews, AutoCAD software was used to design the device for the collection and recycling process. The collected material is taken to the ammonia generating tank (NH3) added to the urease enzyme through a chemical reaction feeder. The ammonia formed in the tank together with the phosphorus precipitated in the form of insoluble salts is collected in another tank where it is converted into ammonium (NH4 +). With a reactor operating time of 12 hours, it would yield a volume of 165.45 L / day of urine and with a reaction time of 1.5 hours, it would be possible to perform 8 cycles and obtain 0.97 kg of ammonia in hydrolyzed sampling. 5870 mgNL-1 and 132.36 g of phosphorus. In addition to helping to save water consumption in discharges, the implementation of this technique can reduce the discharge of ammonia and phosphorus in rivers by recycling these minerals and using them for agricultural purposes. This project has the potential to be applied in any region and meets sustainability standards, it is possible to build it on the spot with application in schools, restaurants, airports, bus stations, public spaces and condominiums.

KEYWORDS Water; Domestic sewage; Urine; Economy; Agriculture

Circular Design-Built Strategies for Climate-Friendly and Citizen-Driven Urban Water and Food Systems > Poster Presentation

Removal of a Mixture of Diclofenac and Naproxen in a Constructed Subsurface Flow Wetland

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The introduction of non-steroidal anti-inflammatory drugs (NSAIDs), also known as analgesics, in natural matrices such as soils, sediments, groundwater and even drinking water is an emerging problem due to its potential influence on human health and biota in the aquatic environment. In Mexico, pharmaceuticals represent 10% of the residues delivered to the environment of which concentrations of naproxen (54 ng/mL), ibuprofen and diclofenac (1.5 ng/mL) have been detected in water (Peña and Castillo, 2015). Conventional treatment processes used to treat municipal wastewater are not efficient to remove these pollutants and so, better alternative treatments such as constructed wetlands could be proposed to complement to process. In this project, a constructed subsurface flow wetland was tested to remove a mixture of diclofenac and naproxen. The system was tested feeding a synthetic solution (3mg/L diclofenac, 5mg/L naproxen) in a continuous flow during 105 days reaching a removal efficiency of 80% for diclofenac and 77% for naproxen, with a Hydraulic Residence Time (HRT) of 5 days. The presence of diclofenac and naproxen in the wetland did not cause a phytotoxic effect on plant size, root development and chlorophyll content during the operation period.

KEYWORDS Pharmaceuticals compounds, Constructed Wetlands, Removal efficiency

Nature-Based Solutions in Science, Policy and Practice: Filling the Post-2015 Development Agenda with Action > Oral Presentation

Water Security Analytical Framework from Nature-Based Solutions

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The growing interest in "Nature-Based Solutions" (NbS) to promote water security has motivated recent efforts to develop comprehensive assessment frameworks that integrate both approaches. This study aims to propose a conceptual and analytical framework for assessing water security based on NbS for urban water supply and apply it to a case study in Brazil. The analytical framework was applied to the case of the Guapi-Macacu River Basin, the main source of public water supply in the eastern Metropolitan Region of Rio de Janeiro (Imunana-Laranjal Water Supply System), using the techniques of bibliographic research, document analysis, semi-structured interviews and participant observation. It proved to be appropriate to (i) assess qualitatively the level of water security in the eastern metropolitan water supply system; (ii) assess the relevance and applicability of NbS to promote water security; and (iii) identify the existing NbS initiatives and understand to what extent this group contributes to the water security. The results showed a high level of water stress in the basin, recurrent water scarcity during drought and worsening conflicts over water use. It was also found that the basin has biophysical, social and economic characteristics that are mostly favorable for the implementation of SbN. More precisely, SbN proved to be relevant for increasing water security, as it potentially contributes to reducing the risk related to the stressors "Land use and occupation", "Erosion processes", "Water pollution" and "Interference with water bodies". Regarding SbN-related programs, it was observed that conservation measures are significant. However, the other SbN initiatives in the Guapi-Macacu River Basin are still limited; it is necessary to expand ecological restoration interventions and best agricultural practices across the basin. It was not possible to estimate the magnitude of the impacts of the SbN, due to the lack of monitoring actions for ecosystem services related to water security.

кеуwords Water Security, Nature-based Solutions, Public water supply, Metropolitan Region Nature-Based Solutions in Science, Policy and Practice: Filling the Post-2015 Development Agenda with Action > Oral Presentation

Potential of Nature Based Solution in Controlling Current Flooding of the Great Rift Valley Lakes in Kenya

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The Great rift valley lakes in Kenya are important social and economic sites for many people in the country. They are important tourists sites and are home to 13 globally threatened bird species and some of the highest bird diversity in the world. They are the single most important foraging site for the lesser flamingo and major nesting and breeding ground for great pelicans. There are sizable mammal populations including buffaloes, zebras, black rhino, Rothschild's giraffe, greater kudu, lions, cheetah and wild dogs around the lakes. The lakes contribute highly to the country's GDP. In recent decades the lakes are reported to have experienced drastic increases in sedimentation rates and in the last seven years, the water levels in some of the lakes have risen to 9-12 meters. The rise in water levels has been contributed to the accelerated soil erosion, land use/land cover changes and climate fluctuations. Most of the rivers feeding the lakes originate from the Mau forest ecosystem which has been highly deforested and degraded within the last three decades. The river waters bring huge amount of floods flash floods with sediments filling in the bottom of lakes. The rising waters have been displacing people, submerging homes, schools, roads, hospitals, farmland and even islands. Increasing river flow variability demands eco-friendly interventions in an integrated sustainability management strategy for the catchment area. The paper report the findings of a desk-top study on the potential of Nature-based solution in controlling flooding of the Great Rift Valley lakes in Kenya. Data on the history of the water rising in the lakes, deforestation of the catchment area has been provided.

KEYWORDS Nature Based solution, Catchment area, Flooding of lakes, Deforestation

Nature-Based Solutions in Science, Policy and Practice: Filling the Post-2015 Development Agenda with Action > Oral Presentation

Sustainability-Oriented Evaluation of Nature-based Solutions in European Cities

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Cities have benefited from being in the proximity of water bodies for centuries. Humans prefer settling on shores and river bends for various reasons. Naturebased Solutions (NBS) can be considered as an adaptation approach toward sustainable urban development that challenges a historical conflict happening in such cities. This conflict originates from two human wills: being close to the water and being secured from the side-effects. Rapid urbanization and climate change have aggravated the extent of this conflict in recent decades.

This study evaluates the impacts of NBS on different sustainability challenges in cities. To achieve this, 80 applied or planned NBS projects from 56 cities are examined. The projects are retrieved from NATURVATION Atlas database. 'Water management' and 'coastal resilience' key challenges are utilized as the first criteria in selecting the projects. Besides, intervention to water-related hazards such as floods, coastal erosion, pollution and unstable water flow is another criteria. A clear explanation of the project objectives is also considered.

Following the selection of the projects, different elements are analyzed. Objectives, key challenges, main beneficiaries and monitoring outputs are assessed to reveal the effects on environmental, social and economic challenges. Types of initiating organizations and relations with adaptation policies on different levels are analyzed to search possible correlations with the impacts. The results are showing that while almost all NBS projects dealing with water-related hazards are accommodating enhancement in the existent environmental conditions to an extent, they are lagging in bringing economic improvements. On the other hand, more than half of the examined projects are likely to contribute to the social challenges -mainly thanks to enhancing health and well-being.

The study reveals how to enhance the diverse benefits of NBS by discussing significant elements and relevant stakeholders in the examined projects with a clear contribution to different aspects of sustainability.

KEYWORDS nature-based solutions, sustainability, water-related risks, adaptation, sustainable urban development
Nature-Based Solutions in Science, Policy and Practice: Filling the Post-2015 Development Agenda with Action > Oral Presentation

Mangroves Restoration in Response to Climate Change: A Case Study in Bac Lieu Province, Vietnam

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The coastal mangrove forest in Bac Lieu Province plays a very important role in reducing waves, storm surges, protecting sea dykes, maintaining biodiversity and providing livelihoods for coastal communities. However, in recent years, due to the impacts of climate change and sea level rise, mangroves have been disappearing at an increasing rate. This study shows the coastline changes in Bac Lieu province in the period from 2000 to 2020 and assesses the efficiency of applied mangrove planting techniques as well as proposes solutions to improve effective mangrove restoration in response to climate change in the study area. The results showed that the coastline of Bac Lieu province tends to erode quickly in the last 20 years. The coastline is divided into 3 main areas: continuous erosion area, intercalation area and regular compensation area. Using bamboo fences and planting mangroves have effectively improved the conditions of the intercalation and regular compensation areas. Appropriate selection of mangrove species, planting seasons and seedling standards are proposed to enhance the success rates of mangrove restoration projects in the study area.

кеуwords Bamboo fences, mangrove restoration, shoreline change, Bac Lieu Province

SDGs in the Light of Synergies, Trade-Offs, and Inclusive Development > Oral Presentation

Sanitation Tariff as a Key Instrument for Water Security

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Access to basic sanitation, even representing two fundamental human rights, is still a large-scale global drama. WHO data show that 2 billion people still do not have access to basic sanitation facilities such as toilets or latrines and 673 million defecate in the open. The present work demonstrates how the sanitation tariff is a central instrument for water security, especially considering the impacts of climate change on the hydrological cycle. The tariff can contribute directly to the goals of SDG 6 of the 2030 Agenda: if well calibrated, it can contribute to universalization and sustainable water management, in addition to positively impacting other SDGs such as SDG 10 to reduce inequalities, SDG 13 combating climate change and SDG 15 for protecting forest cover. Brazil also still faces a huge challenge towards the universalization of sanitation, with about 32 million people without access to water and 100 million without even sewage collection. And the tariff represents about 80% of the total investments in water and sewage in the country. Therefore, 23 proposals for improving the tariff are presented, based on which it would be possible to promote greater integration between sectorial policies on sanitation, agriculture, environment, water resources, among others. It is expected that the results may contribute to increase access for families in situations of poverty, promote the conscious consumption of users, encourage greater efficiency in the provision of the service, promote nature-based solutions for a better water management and collaborate so that transversal objectives are achieved, especially the proper implementation of the Brazilian Code Forestry and the goal of the Brazilian NDC under the Paris Agreement to restore 12 million hectares of vegetation. The work was built from a benchmark with 17 national and 13 international experiences, as well as an opinion poll.

KEYWORDS Sanitation tariff, water security, climate change, human rights

Okavango River Basin – Achieving RBO Goals Adapting the Provisions of SADC Protocol & UN Watercourses Convention

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Mosepele et al., (2019) observe that the OKACOM Agreement obligates the parties to apply the principles related to equitable allocation and sustainable utilization. But they also note significant challenges – uneven standards of water quality, inadequate cooperation among the district level entities, absence of a framework for integrated land use and lack of monitoring mechanisms. The authors believe that the structural asymmetry among the riparians could harm the basin in the long term.

Angola, Namibia and Botswana are signatories to the Southern African Development Community's protocol on shared water courses, SADC (2000), initially passed in 1995 and last revised in August 2000, partly to account for some of the provisions of the UN Watercourses Convention (UNWC), United Nations (1997). The three countries were also among the 106 nations that voted in favour of the UNWC in May 1997. Further, they had also ratified the United Nations Framework Convention on Climate Change.

I argue here that the framework for regional cooperation and the codified principles of international law could be potential tools to bridge the gaps suggested by Mosepele and strengthen cooperation in order to achieve the shared objectives as laid out in the river basin agreement.

The essay flows from an introduction into a hypothesis and the essay question. I then discuss the conceptual elements used to understand the circumstances of the various actors related to the basin and shape the arguments needed to examine the hypothesis and answer the question. The next section presents the discussion and analysis of the various arguments substantiated by references to existing academic literature and the relevant transboundary water arrangements. The next section is a brief conclusion on the basis of the arguments presented in the discussion. The final section is a bibliography of references made to various sources of information related to this essay.

кечwords transboundary water governance, okavango, international law, SADC Protocol, Watercourses Convention

Understanding Water Governance through Strategic Environmental Assessment Approach

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Water governance in Mexico has been focused historically on strengthening water access for industry and food. As the most important natural resource in the country, decision-making about water within Mexico has not had considered the constitutional right to water access for consumption almost anywhere: not in the paper (laws) not in the practice (water rights). Water is still seen as an economic good, not a social one. This was evidenced through a couple of projects developed in the state of San Luis Potosi. Mexico, in which a couple of attempts for giving local and state authorities a supporting tool for decision-making related to water access were developed for the Altiplano and Middle Regions, in San Luis Potosi. Both of these projects used a Strategic Environmental Assessment approach in the development of an Integrated Water Access Management Plan for each region. The use of this approach allowed us to identify the main constraints in the water planning and decision-making sectors that prevent the proper access to water for human consumption in those regions, which are an extremely alike example of the situation in the whole country. Starting from a baseline study, we were able to develop each Integrated Water Access Management Plan based on the real necessities from the people in the rural and urban communities of both regions, considering also the higher strategic objectives of the National Water Programme, State Water Programme, and Local Development Plans. Both of these examples are the only ones of its kind developed in the country.

KEYWORDS water governance, strategic environmental assessment, planning, decision-making

'Owners' vs. 'Beholders': Community Agency and Sustainability of Water Supply Projects in Nairobi City's Informal Settlements

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The renaissance of the local turn in development discourse has consistently called for the recognition of the 'local', that is, the people or communities who are the ultimate beneficiaries of the said interventions as well as the peculiarities of the context if at all meaningful change is to be realized. This has led to efforts to delineate the 'owners' vis-à-vis 'beholders' of these interventions and recognizing the agency of the owners with regard to implementation and ultimately the sustainability of these interventions. Anchored on the stakeholder theory and building on the conceptual foundations of the local turn, this paper examines community agency with regard to the management of communal water supply projects. The paper asks, how and to what extent inclusiveness has been achieved, specifically measuring stakeholder engagement, capacity building, and project governance practices at the community level. The study presents both quantitative and gualitative data (collected through semi-structured questionnaires) from 194 randomly selected water supply projects implemented in the informal settlement areas of Nairobi County, Kenya. The question of inclusiveness has long been emphasized in project design and implementation; but this paper offers reflections from the perspective of the community members, that is, the 'owners' of the project benefits. Further, owing to the COVID-19 pandemic and the resultant restrictions on the movement of external technical assistance, this paper discusses the extent to which the inclusiveness strategies employed have helped the communities continue with the management of their water supply projects.

KEYWORDS owners, beholders, community agency, sustainability, urban informal settlements

SDGs in the Light of Synergies, Trade-Offs, and Inclusive Development $> \ensuremath{\mathsf{Poster}}$ Presentation

Harnessing Synergies Between Climate Action and Economic Growth in Sudan

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Sudan currently is witnessing a deep transformation in the societal and political aspects. Despite its large natural resources (e.g. land, water, and minerals), this country is facing difficulties in sustaining economic growth. Sudan's economy currently is showing severe symptoms of an unsustainable pathway such as hyperinflation and degradation of natural resources. At this crossroad, Sudan must adopt a green pathway that promotes development growth while ensuring the sustainability of environmental and social systems. Harnessing synergies between climate action and economic development would provide entry points to correct the development path. This is mainly because climate action requires not only adapting and mitigating climate change but also promotes the deep transformation of economic systems. In the current research, we reviewed the National Determined Contributions (NDCs) of Sudan and linked them to economic needs. The results of the current research indicate that there is a need to harmonize the NDCs with economic development plans. This harmonization has the potential to maximize benefits gained and minimize cost through synergies and avoid and desired tradeoffs. The findings of the current research are crucial from the perspective of climate mitigation and adaptation and economic growth.

KEYWORDS Climate action and economic growth

The Peril of Climate Change on Water Availability and its Implications on the Triple Roles of Rural Women in Cameroon: Challenges and Prospects

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Many rural communities in Cameroon rely on natural water sources from rivers streams, springs and rainfall for agriculture and domestic uses. The availability and reliability of water from these sources very much depend on the rate of precipitation and temperatures. Household roles in Cameroon are traditionally defined along gender, with women playing a key role in food production, home management and caregiving, among others. Water is vital for women's performance and success in accomplishing these roles. As a result, variability in rainfall and temperature (climate change) will affect rural men and women differently since their role and challenges in society are different. This paper examines the situation of this climate variability on water availability and how it has impacted on women's roles as farmers, home managers and community agents in a predominantly farming community in Southwestern Cameroon. It's based on a survey of a hundred women and interviews conducted with ten local male and female key informants. Findings reveal that climate change has led to the disappearance of a number of water sources and a decrease in the volume of others. This situation poses a challenge on local water availability and by extension, compromises women's productivity and increases the burden on their reproductive and productive roles as farmers, caregivers and home managers. This situation has been further goaded by women's limited land rights which prevent them from expanding or acquiring more land to maintain production. Although individual women are implementing some water saving and adaptation strategies for survival, public assistance and comprehensive macro policy measures including the promotion of gender-sensitive technologies are important to complement and sustain their efforts against climate change.

KEYWORDS Climate Change, Water availability, Women Triple roles, Water saving strategies and technologies

Socio-Economic Aspects of Water and Food Security > Oral Presentation

What Motivates Farmers' to Undertake Farm-level Adaptation Options in India? A Systematic Review of Literature

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Climate change is adversely impacting the livelihoods of farmers in India. To mitigate these impacts several farm-level adaptation measures are employed by farmers themselves in addition to the initiatives at policy level to motivate farmers' adaptation decision to climate change. In doing so, the aim is to provide sustainable livelihood opportunities to the farmers as well as doubling their farm income. However, there is a dearth of comprehensive review of the factors that facilitate farmers' adoption behaviour or act as barriers in the process. The present chapter aims to address this gap through a systematic review of studies that examine the determinants of farm-level adaptation mechanisms in India. We identify the causal relationship between farm-level adaptation options and several determinants including variables related to climate variability and change and other non-climatic factors. Our major findings suggest: (i) non-climatic factors like level of assets and income, education, demographic characteristics, dependency on agriculture, financial characteristics and access to financial institutions are the major motivating factors; (ii) there exist limited studies that establish the linkages between climate variability and change to the uptake of farm-level adaptation options; (iii) similarly, lack of studies with reference to perception, risk attitude behaviour of farmers and the role of climate services as determinants of adaptation. These findings provide important avenues for scholarly communities and policy makers for expanding the domains of future research while re-aligning existing plans to address the observed gaps and develop evidence-based policies to adapt to the adverse impacts of climate variability and change.

KEYWORDS Adaptation; Farm-level; Determinants; Systematic Review; India

Nature Based Adaptation Practices In Ensuring Food Security in Coastal Bangladesh

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This study is aiming to illustrate the nature based sustainable adaptation measures those have been practiced by the coastal people of Mongla of the South Western coastal region recently to ensure food security to minimize human migration to the nearby towns. Focus Group Discussions (FGDs), Key Informant Interviews (KIIs) and household level questionnaire survey were conducted to understand the actual perception of local people regarding water and food security. The spatial distribution of EC shows that only 0.92% areas of groundwater have EC within the acceptable limit whereas the south-eastern area has EC greater than 10000 μ S/cm. Due to the severity in salinity, a favorable condition for shrimp farming was created and agricultural lands were substantially reduced, which forced people either to change their occupation or migrate. Around 68% of villagers practiced shrimp/crab farming while 24% said that, they have been producing different types of saline tolerant crops. While, rest others (8%) have been preparing to migrate to the safe town. Around 68% of respondents cultivate saline tolerant Boro rice, tomato and sweet pumpkin. Local people are using free spaces in their yards and rooftops for cultivating different types of vegetables throughout the year. Eggplant, tomato and different leafy vegetables (Red Spinach and Spinach) are produced in sunny open spaces of the house. Due to salinity, arable land is scarce in the coastal areas. Through vertical farming, farmers can grow more crops in a specific area. Here fresh quality food can be grown throughout the year. As the soil in Mongla is saline, Mulching technique reduces winter injury and helps with weed control and also protects from erosion. Adapting these nature-based solutions, recently a significant number of villagers have decided to reside and explore more options in these coastal area so that their future generation could survive in a challenging environment.

KEYWORDS Coastal people, Extreme soil and water salinity, nature based adaptation, food security

Socio-Economic Aspects of Water and Food Security > Poster Presentation

Agricultural Insurance as an Instrument for Moderating the Hydrological Vulnerability of Vegetable Production in Brazlândia, Federal District, Brazil

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Agricultural activities are directly linked to the availability of natural resources, such as water and soil, straight affected by events of climatic instability. This impact on the production and price of the final product becomes the activity of a high risk compared to others. Farmers in the region of Brazlândia, the agricultural region around the capital of Brazil, have a high economic dependence on agricultural activity for their subsistence and the food security of their families. Irrigated production in the region is highly vulnerable to responses from the rainfall regime, which increases the risk and instability of production. The article proposed the design of agricultural insurance for irrigation of strawberries and lettuce, using the information on the percentage of useful storage and the level of the Descoberto reservoir (the main human supply reservoir of Brasília - Brazilian capital) and the values about production, productivity, and cost of crops. Considered the percentages of lost production as the same as percentages practiced in the reduction of catchment flows in the 2016-2017 water crisis period, this decrease in flow affects the area's productivity by the same percentage. The insurance trigger was considered the moment when the real curve of the reservoir is below the ideal curve. This concluded that agricultural insurance is a useful instrument to aid the economic stability of irrigating farmers. Choosing the reservoir level as a climate index and monitoring its curve as an insurance trigger is feasible, and the information is accessible and understandable. The values related to the agricultural insurance policy contract proved to be fair, as they are based on the current cost of crop production. In the case of the return worst episode in the water crisis, the sum of lost production would generate a maximum indemnity of 7 million Brazilian Reais (30% of productivity).

KEYWORDS Agricultural Insurance, hydrological vulnerability, vegetables

Water-Climate-Nexus: Challenges and Opportunities in Mountainous Regions > Oral Presentation

Exploring the Inter-section of Water Scarcity and Socio-economic and Livelihood Factors in the Indian Himalayan state of Uttarakhand

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Climate change and ecological degradation are two multifaceted and intertwined challenges that cause water stress around the world. The communities in the Himalayan state of Uttarakhand in India depend on natural streams fed by glaciers, rainfall/snowfall for meeting their drinking water and irrigation requirements. Changing rainfall/ snowfall patterns due to climate change and ecological degradation caused by myriad factors like weak institutional capacities and local governance, limited awareness, forest fires, unregulated livestock grazing and deforestation are the key reasons for water stress in the state. Water stress has direct and varied impact on the livelihoods of communities in the state. Indirectly, depleting water resources adversely impact ecological balance and biodiversity leading to increased wildlife ingress into human habitations (monkeys and wild boars in hills) which is a major cause for loss of livelihoods. As a result, people are abandoning agriculture and migrating to plains in search of livelihoods. While the causes of water stress in the state seem to be primarily ecological in nature, the scarcity has multiple, inter-linked effects on aspects such as agriculture, livestock, nutrition, and gender equity. The state's socio-economic and livelihood context is underlined by scarcity of drinking water especially during summer months, low agriculture productivity, changes in livestock related livelihoods, major dependence on remittances and large-scale migration of youth. This paper examines the issue of water stress and its impact on inter-related socio-economic and livelihood aspects in Uttarakhand by utilizing primary survey data of 41435 households in 687 Van Panchayats. The survey was part of baseline construction for Uttarakhand Forest Resource Management Project (UFRMP) supported by JICA. The paper discusses project strategies and interventions to overcome challenges of water stress in the light of gathered data. The findings are useful for socio-economy and livelihoods of community in difficult terrains of Indian Himalayas.

KEYWORDS Uttarakhand, water, UFRMP, JICA, Livelihood

Water-Climate-Nexus: Challenges and Opportunities in Mountainous Regions > Oral Presentation

Emerging Hydrological Risks in Andean Glacierfed River Basins

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Glaciated headwaters play an essential role in safeguarding water security for downstream water use in several tropical Andean basins. However, rapid glacier shrinkage interacts with a considerable increase in water demand and high social-ecological vulnerabilities to pose a threat to long-term water security. Despite important progress in assessing the impacts of glacier shrinkage and consequences for water availability, little is known about the meltwater propagation through the terrestrial water cycle and human vulnerabilities to water scarcity particularly during droughts. Additionally, limited data and understanding of water demand patterns and withdrawals hamper water security and drought assessments at basin scale. Under high complexity and uncertainty, we propose a coupled risk assessment combining water scarcity hazards, exposed people and multiple human vulnerabilities to help overcome some of these limitations. Our integrated risk framework interlinks a broad set of hydroclimatic, socioeconomic and water management variables at unprecedented detail. We put particular emphasis on the interplay of the diverse variables and critical system thresholds that determine the dimensions and spatiotemporal patterns of drought risk. Our risk framework provides a meaningful baseline to support assessments of future water availability for guiding climate change adaptation, drought management, and water resource governance in rapidly changing mountain basins. We identify a specific opportunity to explore the use of nature-based solutions in combination with a strong engagement of local communities and policy makers as a potential pathway to cope with water security hazards and risks.

KEYWORDS meltwater contribution, vulnerability, risk framework, water security, adaptation

 $\label{eq:Water-Climate-Nexus: Challenges and Opportunities in Mountainous Regions > Oral Presentation$

Mapping and Monitoring Mountain Wetlands in Colombian Paramos

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Mountains ecosystems are water towers where major rivers originate. Mountains provide support to wetlands which provide several benefits including water storage, high quality habitat, pasture, nutrient sinks and transformations, and carbon storage. Mountain wetlands are a depleted ecosystem due to land intensification, as well as misunderstanding of their biodiversity value and role as regulators of water and nutrients. Mapping and monitoring the extent and distribution of mountain wetlands is vital for creating a knowledge base for broader water management and sustainable development purposes. However, the remote location and rugged terrain of mountain wetlands creates challenges for mapping and leads to underestimation of wetland extent. This paper examines the potential of radar and optical satellite imagery analysis, supported by cloud computing resources, for estimating the extent and distribution of mountain wetlands in high-altitudinal tropical ecosystems in Colombia. It is shown that multi-source multi-temporal remote sensing helps to improving the quality of such estimates. It is also confirmed that mapping mountain wetlands remains a challenge, in particular ephemeral wetlands which are habitats with seasonal water body and ephemeral plant cover. This nature, combined with their size, shape and phenology, as well as cloudy environments, makes mountain wetlands a difficult target for both visual and digital image analysis of satellite images.

KEYWORDS wetlands, páramo, remote sensing, cloud computing, mapping

 $\label{eq:Water-Climate-Nexus: Challenges and Opportunities in Mountainous Regions > Oral Presentation$

Water Use and Differential Adaptation to Climatic Risk: Experimental Evidence with Farming Producers in Colombian Andes

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Agriculture is one of the most affected sectors by the variation in rainfall levels because of climatic changes. In response, farmers could react in different ways, however, can these reactions be generalizable? Or, on the contrary, are they related to the exclusive conditions of the agricultural producers or their surroundings? How to identify the effects of this heterogeneity?

Using data from an experimental economic game of water extraction carried out in two rural zones in Colombia, we analyze the relationship between the communities' features and producers' conditions over their adaptation decisions in the water use against climate risk, expressed by a low rain shock or a dry season shock. The overall results show how farmers decide to replace rainwater because of the reduction in the level of rainfall. So, they increase the use of a community irrigation district and as a result of the shortage, it reduces cooperation. We found also evidence of a differential pattern at irrigated water use by zones according to the shocks. For instance, in terms of the timing of the reaction in one zone they anticipated the adaptation before the extreme climate event, whereas the other zone put off their adaptation until the severe rainfall reduction occurred and at this moment, they extracted more water than the other producers. We consider different sources of heterogeneity concerning structural factors, sociodemographic and economic conditions in producer communities as possible explanations for these differential paths. This research highlights the importance of knowing and considering the characteristics of each region, which guide different water consumption decisions to face extreme weather conditions.

KEYWORDS Rain, irrigation district, economic games, heterogeneity of users, climate change

Water-Climate-Nexus: Challenges and Opportunities in Mountainous Regions > Oral Presentation

Active Remote Sensing in the High Andes: New Alternatives of Exploiting Radar Rainfall Data for Water Management Applications by Using a Machine Learning Approach

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Rainfall is the main driver of major hazards such as severe floods, soil erosion and rainfall-induced landslides, but it is also key for agricultural production and sustaining river flows. Therefore, monitoring rainfall at high spatiotemporal resolution is paramount, particularly in mountain regions as the Andes, which are affected by orographic rainfall due to its irregular topography. Here, weather radar comes as an optimal solution. However, its effective use in water management has traditionally demanded exhaustive processes for converting the native radar variable - reflectivity - into rainfall rates in addition to dense rain gauge networks for calibration, which are very uncommon in mountain regions. This study aims to leverage weather radar data for water management by directly exploiting the radar reflectivity as a relevant predictor for radar quantitative precipitation estimation (QPE) and discharge forecasting, thus making rainfall-driven applications more accessible both, financially and logistically. A period of two-year data from the highest X-band weather radar (4450 m asl) in a network located in the southern Andes of Ecuador was used to implement machine learning (ML)-based models (random forest) for obtaining QPE and streamflow forecasting at sub-daily scales. Results revealed that radar reflectivity can be efficiently used for providing optimized radar QPE and discharge forecasting estimates, and that its use highly reduce the complexity of processing chains for converting reflectivity into rainfall. This is the first time that radar reflectivity from X-band radar was exploited and found suitable for application in mountain regions since data from operational radars can be used without further pre-processing. It highlighted the benefits and potentials of using a ML approach in radar hydrology. This has tremendous implications on the usefulness of radar imagery in forecasting systems, providing a promising alternative for improving water management in the Andean highlands.

KEYWORDS radar reflectivity, machine learning, water management, mountain regions, weather radar 86

Water-Climate-Nexus: Challenges and Opportunities in Mountainous Regions > Oral Presentation

Towards the Water-Energy-Food (WEF) Nexus Adaptation to Climate Change: The Pacific -Andean-Amazon Transects

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Rainfall is the main driver of major hazards such as severe floods, soil erosion and rainfall-induced landslides, but it is also key for agricultural production and sustaining river flows. Therefore, monitoring rainfall at high spatiotemporal resolution is paramount, particularly in mountain regions as the Andes, which are affected by orographic rainfall due to its irregular topography. Here, weather radar comes as an optimal solution. However, its effective use in water management has traditionally demanded exhaustive processes for converting the native radar variable - reflectivity - into rainfall rates in addition to dense rain gauge networks for calibration, which are very uncommon in mountain regions. This study aims to leverage weather radar data for water management by directly exploiting the radar reflectivity as a relevant predictor for radar quantitative precipitation estimation (QPE) and discharge forecasting, thus making rainfall-driven applications more accessible both, financially and logistically. A period of two-year data from the highest X-band weather radar (4450 m asl) in a network located in the southern Andes of Ecuador was used to implement machine learning (ML)-based models (random forest) for obtaining QPE and streamflow forecasting at sub-daily scales. Results revealed that radar reflectivity can be efficiently used for providing optimized radar QPE and discharge forecasting estimates, and that its use highly reduce the complexity of processing chains for converting reflectivity into rainfall. This is the first time that radar reflectivity from X-band radar was exploited and found suitable for application in mountain regions since data from operational radars can be used without further pre-processing. It highlighted the benefits and potentials of using a ML approach in radar hydrology. This has tremendous implications on the usefulness of radar imagery in forecasting systems, providing a promising alternative for improving water management in the Andean highlands.

KEYWORDS radar reflectivity, machine learning, water management, mountain regions, weather radar

Smart Water Technologies and Digital Solutions to Advance Water Security $> \mbox{Oral}$ Presentation

Mathematical Models Based on Poisson Point Process, Machine Learning and Kalman Filter to Predict and Describe Next Drought in Namibia as a Tool for Farming Management

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Namibia is highly dependent on its natural resources and where farming is one of the main assets for its macro- and family's micro- economies. Rain-fed crops, goats, and cattle are the most common livelihoods in rural areas. To sustain these types of farming, water security is fundamental. In addition to the low rainfall levels in Namibia, very variable temporal rainfall distribution produces huge alternation of good farming years with droughts or extreme rain events which can spoil yields and ruins grasslands. Therefore, the mathematical modeling of the occurrence of extreme events is of high importance to build resilient farming practices. Literature suggests that there are mainly two factors determining the interannual rainfall regime in Namibia: the dynamics of the Angola low and the Botswana high-pressure systems and the incidence of El Niño/La Niña. In addition to atmospheric factors, a Poisson distribution-based probability is also included as an indicator of drought risk based on previous occurrences. In this regard, a methodology is proposed to generate a predictive model to estimate the probability of having an extreme rainfall event in future years. The system is based on a Kalman filter that maintains different conditioning factors. Kalman Filter time epoch starts at the beginning of the historical data series. Each year drought is detected in the historical database, the algorithm records the circumstances in which this event happened. When a drought is detected, the algorithm resets the predictive conditions taking into account the new inputs. The final prediction is based on a Random Forest estimator, so the training data is growing each time a new drought happens. The methodology is applied in the northern half of Namibia where meteorological historical data is available. Possible applications are decision support systems to predict market meat prices, smart livestock trade or to define resilient farming strategies.

KEYWORDS Droughts, Farming, Rainfall modelling, Kalman Filter, Namibia

Smart Water Technologies and Digital Solutions to Advance Water Security > Oral Presentation

Water Talks How Information Flow Can Enhance Governance

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The research focuses on the Diamante and Malargüe river basins from southern Mendoza, Argentina. Social network analysis is deployed to unveil the cornerstones of flow and identify strength bonds and communication bottlenecks that hold or impede water management systems from a better-off status quo.

This research aims to build evidence-based guidelines for water organizations to detect, analyse and overcome barriers in the information flows as well as improving technology diffusion and, ultimately, adoption. Expected and unexpected links between various stakeholders that ease information flow and cloud derive on better design of sector-specific policies.

By employing a social network approach, we derive implications from the structure of the extension groups on discussed topics and central persons, essential for the spread of information. Social networks display the formation of groups and evaluate interconnection between individual members. Characteristics at the network level as well as at the individual level can enhance the identification of information flow and reveal gaps in its distribution.

We found that water management bodies and agricultural extension services are aware of technological and managerial improvements that are not reaching producers or are not being adopted. Elder legislation has built a bottom-up approach ensuring stakeholders' representation but spill-over effects from the management are not yet grasping and achieving benefits for the whole system.

KEYWORDS social networks; governance; Argentina; local knowledge

Smart Water Technologies and Digital Solutions to Advance Water Security $> \mbox{Oral}$ Presentation

Development of a Water Balance Web Application for Costa Rica using Open-source and Global Data

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Hydrological models are key tools for water management and decision-making. Large-scale hydrological models are preferred over single catchment models since they provide information of spatial patterns and provide predictive capabilities in ungauged catchments. Nevertheless, the lack of hydrological data to calibrate and validate the models is a challenge in regions like Latin America. Moreover, the accessibility of results from hydrological models tends to be restricted to experts only since the large amount of complex information is difficult to digest for the nonexpert public. In that sense, web applications to share and visualize hydrological information have being a critical tool to involve decision-makers and society into the education of water management.

In this work, we present the development of an interactive web application for water balance assessments in 605 Costa Rican catchments using open-source tools and open data. We applied the semi-distributed process-based Hydrological Predictions for the Environment (HYPE) model to assess the monthly and annual water resources at the national scale using local data and global products to force and calibrate the model. Global temperature product and a bias corrected precipitation from CHIRPS (Climate Hazards Group InfraRed Precipitation with Station data) were used as model forcings. Daily streamflow from 13 gauges and monthly potential evapotranspiration and actual evapotranspiration from MODIS (Moderate Resolution Imaging Spectroradiometer) were used to calibrate and validate the model.

The results from the HYPE model correspond to the first version of the high resolution and large-scale hydrological system for Costa Rica (HYPE CR 1.0) and are available for the period 1985-2019 through the link https://zaul-ae.gitbook.io/ oacg-hidrologia/. This contribution explains the theoretical basis of this data set and the functionalities of the web application alike.

KEYWORDS Web application, HYPE, hydrological modeling, remote sensing

Smart Water Technologies and Digital Solutions to Advance Water Security > Oral Presentation

Artificial Neural Networks: Closing the Gap Between Big Global Data and Local Environmental Challenges

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This presentation will show the potential of Artificial Neural Networks (ANN) to generate valuable information on water and food security for local communities by processing Big Data from agencies such as NASA and ESA together with on-site monitoring data. It will be presented how ANN based models not only match the capabilities of currently used conceptual models (e.g. SWAT or HEC-hms) when simulating biophysical processes, but also how ANN outperform them given the more flexible implementation possibilities and their unlimited capability to ingest data. It will be shown how a multiple ANN based model can provide information that ranges from topics such as crop yield at farm level, groundwater storage at regional level and drought crisis forecast at watershed level using only one body of data.

ANN are universal approximators. This means that with sufficient data any process that is not a consequence of randomness will show a pattern that can be found, modeled and predicted by an ANN. For environmental resources management this opens the possibility to easily model and predict any process of interest without the limitation of having to find and set-up a conceptual model first. It also allows researchers to model processes where biophysical and anthropogenic processes interact.

This presentation showcases examples of ANN generating information for natural resources management using big data pools in Brazil, Chile and South Africa.

KEYWORDS Artificial Intelligence, Artificial Neural Networks, Water Security, Modelling

Smart Water Technologies and Digital Solutions to Advance Water Security > Poster Presentation

A Regional Coupled Spatially Distributed Hydrologic-Hydrodynamic Model for the Barotse Floodplain, Upper Zambezi Basin

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Although considered as critical for the formation and preservation of wetlands, floodplain hydrology has been hard to characterise. In recent years the demand for an understanding of the hydrological and hydrodynamic processes for the Barotse floodplains is ever increasing especially with the advent of climate change/variability, and expected upstream developments. Yet, the multi-way interactions between river flows, wetland inundation, and groundwater are complex, and poorly understood, compromising studying these changes. Most hydrological and hydrodynamic models applied for large-scale hydrological and inundation modelling lack an advanced floodplain-groundwater feedback mechanism, and thus may over predict inundation extent, depth, and downstream river flow. This is because groundwater reinfiltration and evaporation from the floodplains over a longer time scale than the flood process are not accounted for. Hence, the main objective of this study was to develop and test a first of its kind spatially explicitly coupled hydrological and hydrodynamic model that simulates the two-way feedbacks of upstream runoff generation, flow conveyance, flooding, groundwater re-infiltration, channel flood advancement and attenuation in the Barotse floodplains. We used the hydrological model wflow sbm and the hydrodynamic model LISFLOOD-FP. Our model environment and experiments are available through https://github. com/hcwinsemius/barotse. Wflow sbm and LISFLOOD-FP were two-directionally and spatially coupled using the GLOFRIM coupling framework. (GLObally applicable computational FRamework for Integrated hydrological-hydrodynamic Modelling) coupling framework. GLOFRIM is open-source available through github, https://github.com/openearth/glofrim. Wflow_sbm was calibrated on flow records of gauges, upstream of the Barotse wetlands, and the coupled model was further tested using downstream flow records, groundwater levels and satellite observations. In the presentation we demonstrate first benchmarking results of the fully coupled model system, against non-coupled cases, and observations. A Hydrological model coupled two-way with Hydraulic Model of the floodplain provides improvements in floodplain model simulations and hence better information for Barotse floodplain management.

Smart Water Technologies and Digital Solutions to Advance Water Security > Poster Presentation

Decision Support System for Upgrading Slum Sanitation Management

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One of the biggest challenges of slum areas is the lack of adequate sanitation facilities. There is no best-fit-all solution to upgrading slums and to improving their sanitation facilities. Sanitation systems should be understood systematically. This study aims to create an interactive web-based platform to select sanitation technologies for slum areas. The platform will host a Decision Support System (DSS) will be referred to as UPSS ("upgrading Slum Sanitation"). The first screen will help to identify the slum classification (high, middle, and low slum) by asking the user several questions. The following screens will identify alternative sanitation technologies. The sanitation technologies suggested by UPSS are based on the sanitation chain concept. UPSS will guide stakeholders capturing relevant data about their specific case and determining proper sanitation technologies. The complexity stems create a need for simplification. UPSS can be an answer to that.

KEYWORDS Decision Support System, Slum Upgrading, Sanitation Management

Drought Risk Assessment and Mitigation > Oral Presentation

Approach for a Sustainable Irrigation District in Monterrey, Casanare, Colombia

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The Tua watershed, located in Monterrey, Casanare in the eastern part of Colombia, is considered strictly agricultural land which is demanding an irrigation district to develop its economic activities. Consequently, to understand both the hydrological regional cycle and the water demand both over space and time, factual strategies for a sustainable irrigation system can therefore be derived.

However, the municipality faces the limitation of data scarcity where there is neither climatic stations nor a gauge catchment. Therefore, this contribution provides strategies based on a watershed where different integrated water management tools will be implemented as a planning unit. By using several sources of information and a calibrated-validated semi-distributed model from a similar geomorphological watershed, it is possible to set up a hydrological model for the Tua watershed in order to obtain current and future water yield at the sub-watershed scale, in order to bring water security within the region. Overall, this work gives objective entry points for decision makers to address water management in Monterrey.

KEYWORDS Sustainable irrigation district, watershed similarities, SWAT, climate scenarios, water demand

Drought Risk Assessment and Mitigation > Oral Presentation

Probabilistic Analysis of Meteorological Drought using Markov Chains and Bayesian Networks in the Seasonally-dry Tropics of Costa Rica

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Central America experiences recurrent and severe drought events, particularly in the Central American Dry Corridor (CADC). In 2016, one of the most severe droughts of the last decade, affected 3.5 million people and caused a loss of crops up to 90% in the CADC. The dry season in the CADC is projected to increase in the near future and to adapt to these conditions we need to increase our drought forecasting ability in an attempt to help decision making. Here, we used statistical models based on Markov chains (first and second order) and Bayesian Networks (also first and second order) to develop meteorological drought forecast skills using a long rainfall record of 82 years from the Liberia Airport station in Guanacaste, Costa Rica, We calculated the 1-month Standardized Precipitation Index (SPI) and characterized four drought states (No drought, Moderate drought, Severe drought and Extreme drought). Markov Chains, and Bayesian Networks, were applied to a calibration period from 1937 to 1999 and the years from 2000 to 2019 were used for validation. The models with the best performance were selected using a Probability Ranked Skill Score (RPS). The results showed that the models were well able to represent the climatic seasonality of the dry and rainy season. Markov Chains performed better in the dry season, because its forecast resulted in No drought states for the months from December to April. This was expected due to the characteristic dry season, which should not be confused with drought. Bayesian networks outperformed the Markov Chains generating probabilities of drought states in the rainy season and also when compared to the months in which a drought state was observed. Considering the predictive skill of the latter method, we conclude that such models can help forecasting meteorological drought in an operational early warning system.

KEYWORDS Drought risk, drought forecast, probabilistic models, Markov chains, Bayesian network

Drought Risk Assessment and Mitigation > Oral Presentation

Assessment of Agricultural Drought under Climate Change in Spain

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Drought is an important natural hazard that is expected to increase in frequency and intensity as a consequence of climate change. This study aimed to evaluate the impact of future changes in the temperature and precipitation regime of Spain on agricultural droughts, using novel static and dynamic drought indices. Statistically downscaled climate change scenarios for Spain were used at a total of 374 sites for the period 2006 to 2100. The evolution of static and dynamic drought stress indices over time show clearly how drought frequency, duration and intensity increase over time. Values of static and dynamic drought indices increase over time, with more frequent occurrences of maximum index values equal to 1, especially towards the end of the century (2071-2100). Spatially, the increase occurs over almost the entire area, except in the more humid northern Spain and in areas that are already dry at present, who are located in southeast Spain and in the Ebro valley. This study confirms the potential of static and dynamic indices for monitoring and prediction of drought stress.

KEYWORDS climate change, drought stress, drought monitoring, plant water stress, Spain

Who Drives the Media Discourse on Droughts?: A Case Study of Maharashtra, India

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Print media plays a significant role in producing and reproducing dominant narratives and sub-narratives associated with discourses surrounding climate extremes such as droughts. The present study employed a case-study approach to comprehend discourses surrounding droughts in Maharashtra, India (2014-2019). Maharashtra has observed recurrent drought-events over the past ten years and has been at the center of agrarian crises, farmer suicides, and poor water supply. By incorporating critical discourse analysis (CDA), the study has analyzed printmedia (newspapers) and official documents to identify narratives that reproduce support for particular solutions over the others. The paper has contributed to growing calls within the field for a deeper engagement with critical approaches to media coverage of droughts.

The data collection process (two-tier) resulted in 1609 newspaper articles, which were coded using pre-determined nodes and cases in NVivo. The analysis recognized two distinct narratives, poor water management, and water shortage. These narratives further included six sub-narratives, which influenced solutions (demand or supply-based solutions) proposed or implemented to mitigate droughts in the region. Three dominant families of social actors- agrarian community, municipal corporations, and state government- have produced the media-narratives. These findings brought attention to the "active" role played by social actors in promoting demand or supply-based solutions while silencing others. Unequal power relations among social actors and poor coordination along spatio-temporal scales have been an integral characteristic of mitigation/adaptation strategies offered or implemented.

Last but not least, the findings hinted at the need to incorporate theories of political ecology, discourse theory, and politics of scale to enhance our understanding of agency, power, representation and, production of knowledge while analyzing the effectiveness of drought policies.

KEYWORDS Droughts, Maharashtra, Political Ecology, Critical Discourse Analysis, Politics of Scale

SDG6 in the Urban Context: Assessing, Analyzing and Addressing Synergies and Trade-offs Between SDG6 and Other SDGs Through Innovative Tools and Methods > Oral Presentation

Towards Climate Resilient Municipal Water Supply in Bangkok: A Collaborative Risk Informed Analysis

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Typical top-down approaches to climate change adaptation in the water sector rely on climate models to inform the adaptation design. However, the inherent uncertainty associated with these models makes them open to debate, often resulting in inaction when it comes to adapting to climate change. This study uses Collaborative Risk Informed Decision Analysis (CRIDA), a combined top-down and bottom-up approach which does not rely primarily on climate models. Using the case of the Metropolitan Waterworks Authority, Bangkok, this study demonstrates the application of CRIDA, which includes (a) identifying critical thresholds that impact the system's performance, (b) unearthing the system vulnerabilities through a stress test (scenario analysis), and (c) identifying feasible adaptation interventions. It was found that streamflow, salinity, and turbidity are the key performance metrics of the water supply system. A series of stress tests was conducted by adjusting input variables assuming a wide range of possible future climatic conditions. Frequency curves of the various input parameters were developed to facilitate stakeholders' planning for impending risks and for improving the overall robustness of the system. It is suggested to develop adaptation pathways that can address a range of expected impacts of future climatic conditions on the Bangkok water supply system.

KEYWORDS CRIDA, climate risk assessment, climate change adaptation, water supply system, Bangkok

SDG6 in the Urban Context: Assessing, Analyzing and Addressing Synergies and Trade-offs Between SDG6 and Other SDGs Through Innovative Tools and Methods > Oral Presentation

SDG-based Integrated Scenarios of Mumbai's Water-energy Nexus

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Mumbai is one of the world's largest metropolises and is still growing in population and associated resource use. Two resources providing crucial urban services are energy and water, the systems of which interact in what is known as the urban water-energy nexus. We developed a system dynamics model that incorporates those dynamic interactions and that integrates end-use services, representing the largest share of water-energy connection, explicitly. We use this model to investigate resource use under 3 scenarios: business-as-usual in which the SDGs are not met, a scenario in which relevant SDGs are achieved, and a scenario in which SDG6 achievement is prioritized. We find that expected growth in energy use drives future urban water demand, that a transition to continuous water supply is instrumental to achieving the SDGs, and that the SDGs can be achieved with less water infrastructure expansion compared to business-as-usual.

KEYWORDS Water-energy nexus, Mumbai, SDG

SDG6 in the Urban Context: Assessing, Analyzing and Addressing Synergies and Trade-offs Between SDG6 and Other SDGs Through Innovative Tools and Methods > Oral Presentation

Urban Water Security Assessment at City and Sector Levels

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Enhancing water security is crucial to achieve the Sustainable Development Goal 6 set by the United Nations. Assessing water security is an essential step to address issues, inform planning and implement and monitor water security actions, especially in the urban space, where inequality and diversity pose important challenges.

This work investigates downscaling water security assessment to provide detailed information on local challenges and specific needs of neighbourhoods/ sectors within the city. The spatial distribution of water security in the urban area can provide a more accurate picture of its diversity and help to understand local necessities and identify areas with specific issues. This smaller scale urban water security assessment is then compared to an evaluation based on the traditional urban boundary, considering the entire city, to investigate how relevant and feasible certain indicators are for different urban scales.

To capture multiple perspectives of urban water security, an evaluation framework is presented based on the 4 main dimensions considered by the UN water security definition: Drinking water and well-being, Ecosystems, Water related hazards and climate change and Economic activities and development. Using indicators, a score is computed for every city sector and a water security map is generated for spatial visualization of the results. A case study of the city of Campinas in Brazil is used to illustrate the application of the developed framework.

Providing a more detailed vision of the city can help guide infrastructure planning and contribute new arguments to the development of local initiatives and policies towards improving water security at the community/neighbourhood level. This in turn will lead to an enhanced water security level in the entire urban boundary.

KEYWORDS Urban water security, Indicators, Assessment framework

SDG6 in the Urban Context: Assessing, Analyzing and Addressing Synergies and Tradeoffs Between SDG6 and Other SDGs Through Innovative Tools and Methods > Poster Presentation

Polycentric and Water-sensitive Urban Development – Concept and Potential Transition Pathways

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Cities are centers of growth and innovation, but they have a strong effect on their surrounding environments due to increasing resource requirements. Especially heavy pressure is placed on water resources within and in the proximity of cities. The interlinkage of urban planning and water resources management is therefore a central pillar of successful transition towards sustainability and a future of urban resilience in times of climate change and rapid urbanization. The Agenda 2030 and the New Urban Agenda have presented complex visions for sustainable development. However, their localization remains a challenge; especially in the rapidly growing and economically as well as culturally increasingly important secondary and tertiary cities of South East Asia (SEA), which experience multiple water related burdens simultaneously while lacking the capacities to keep up with fast developments. This research raises the question if the newly emerging polycentric approach to water-sensitive urban planning can support the localization of the NUA and the SDGs in secondary and tertiary cities of South East Asia. The emerging concept aims to integrate context-specific urban planning with sustainable water management and uses centralized and decentralized approaches while it is based on the cooperation between multiple sectors and various stakeholder groups from different centers of decision-making, each of which operates with some degree of autonomy. The research project PolyUrbanWaters follows this emerging concept to co-create strategies for the localization of SDG 6 and SDG 11 with three partner cities in SEA: Sam Neua in Laos, Sleman in Indonesia and Kratie in Cambodia. The process follows a tripartite approach from a baseline assessment towards scenario building and the formulation of transition pathways. The research activities address the interface between water and urban planning from a geophysical, social-ecological, participatory and governance perspective. All processes are guided by a strong science-policy dialogue and accompanied by a continuous capacity development concept across scales.

KEYWORDS water-sensitive, polycentric, urban planning, participatory

SDG6 in the Urban Context: Assessing, Analyzing and Addressing Synergies and Tradeoffs Between SDG6 and Other SDGs Through Innovative Tools and Methods > Poster Presentation

Aligning SDGs to City Plans through Water and Sanitation Interventions: Case Studies from 6 Southeast Asian Cities

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Sustainable Development Goal 6 'Ensure availability and sustainable management of water and sanitation for all' provides guidance to sustainable urban development across 17 goals. Establishment of the 'New Urban Agenda' recognised the role of cities in pursuing sustainable development. Both global agendas share a common value and guide to achieving sustainability. With mandates to strive for sustainable cities, local government officials are charged to go through the process of forecasting, analysing, and budgeting following the applied planning system. By design, planners and executors will 'zoom-in', focus on snapshots of isolated parts defined by tasks and responsibilities and continuously replicate them without revisiting the whole pattern of development. The study aims to compare goals and indicators of local plans and SDGs and define the gaps, identify key challenges and opportunities in addressing the gaps, and potential interventions. A visualization map of SDGs interlinkages dynamics for each city was developed reflecting local perception, which facilitate local decision makers for improving the existing plans and implementations.

KEYWORDS Localizing SDGs, water, sanitation, local planning

Water and Disasters and the Role of Real-Time Geospatial Tools for Operational Planning and Decision-Making > Oral Presentation

Preprocessing of Radar-based Rainfall Estimation for Real Time Flood Forecasting and Early Warning System

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Weather radar is a very useful remote sensing tool for estimating rainfall amounts because of its fine spatial and temporal sampling. Radar rainfall estimates are being increasingly applied to flood forecasting applications. Nowadays, efforts in hydrometeorology are concentrated on finding the causes of ground-based radar uncertainty sources for rainfall estimation. The error sources are interactions between radar with atmosphere and topography. This study aims at preprocessing of radar rainfall data before applying into real time and nowcasting system. Preprocessing starts with removing uncertainty sources such as beam blockage, ground clutter. The purpose is then to compare the rainfall data obtained by rain gauges at different distances from radar with rainfall data at the same distances, verifying the correlation existing between the rainfall values in the adjacent pixels and how the difference between radar and rain gauges data changes. Measurements of rainfall by radar are based on the relationship between the reflectivity factor (Z) and the rain rate (R), which is known as the Z-R relationship so that this analysis also finds the variability of the ZR relationship. The study used radar data from the Bangkok Metropolitan Administration (BMA) in the metropolitan area of Bangkok. The results demonstrate that the importance of the proper adjustment of radar estimates and the use of radar estimates is as close to the ground as possible. Finally, the adjusted radar rainfall is integrated in the decision support and flood forecasting system.

KEYWORDS radar rainfall, uncertainty sources, beam blockage, ground clutter, Z-R relationship

Water and Disasters and the Role of Real-Time Geospatial Tools for Operational Planning and Decision-Making > Oral Presentation

Climate Change Impacts on Precipitation Patterns over Egypt

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Climate change directly influences precipitation amount and frequency. This study investigated precipitation projections in Egypt in the context of climate change. The rainfall simulations with a grid space of 0.44 , generated by the Regional Climate Model (RCM) labeled (RCA4/ESM-LR) available from the CORDEX framework, were used. Three bias correction methods were applied to adjust the RCM outputs: linear scaling (LS), local intensity scaling (LOCI), and empirical quantile mapping (EQM). The results revealed that the performance of EQM was the best, followed by LS method. Accordingly, EQM was used to correct the projection of four annual precipitation indices, namely: annual maximum precipitation (AMP), annual total precipitation (ATP), annual number of rainy day's (ANRD), and simple daily intensity index (SDII) under three climate scenarios (RCP 2.6, RCP 4.5, and RCP 8.5). The temporal and spatial changes in the projected rainfall for three different periods of the century were analyzed relative to the observed rainfall (2004-2014). The projected changes in AMP, ATP, and ANRD showed significant increases under the three considered RCPs scenarios; however, negative changes were detected in few separated locations in the country. The expected increase in rainfall quantity would be accompanied by a considerable increase in the number of rainy days, resulting in a decrease in SDII. The changes will not be uniformly distributed throughout the century and their magnitudes will be regionally dependent and varied also according to the applied scenario. Urgent countermeasures are necessary to be performed to adapt with consequences on associated socio-economic activities.

KEYWORDS Bias correction, Rainfall, Regional climate models, RCP

Water and Disasters and the Role of Real-Time Geospatial Tools for Operational Planning and Decision-Making > Oral Presentation

Advances in Short and Middle-term Riverine Flood Forecasting over the Lower Mekong Basin: Implementation of New Bias-corrected Near-realtime and Forecast Rainfall Information into the Mekong River Commission Flood Early Warning System

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Flood events are one of the most frequent catastrophic natural hazards within Mekong countries, caused by heavy monsoon and tropical storms. At the regional level, the Mekong River Commission (MRC) is mandated by its member countries to support riverine flood forecasting in the Lower Mekong Basin via the Flood Early Warning System (FEWS). Since all countries in the region rely on such flood early warnings and weather forecasts to take preparatory action, there is a major need to increase the accuracy and the lead-time of flood forecasts. SERVIR-Mekong supports MRC Regional Flood Forecasting Service in accessing the latest technology for near-real-time (NRT) monitoring and rainfall forecast prediction to increase the accuracy of short and middle riverine flood predictions. For short-term forecasting, a new bias correction tool is implemented to operationally bias correct the NRT Integrated Multi-satellitE Retrievals for GPM (IMERG) Early Version. This tool called GPM-BICO corrects IMERG with regional in-situ data using multiple bias correction schemes. For the middle-term forecast, the bias-corrected and downscaled version of NCEP Global Ensemble Forecast System precipitation forecasts CHIRPS-GEFS is implemented to replace the current Global Forecast System (GFS) dataset. This dataset provides daily forecast information 15 days ahead at 5 km spatial resolution. The performance of both datasets was evaluated at multiple temporal and spatial scales using several standards and categorical error analysis. Results for the bias-corrected NRT IMERG showed a reduction of up to 50% of the bias and RMSE errors. In case of rainfall forecast, the CHIRPS-GEFS displayed the lowest temporal and spatial error with a longer forecast in comparison with the GFS. This encouraged MRC to implement GPM-BICO and CHIRPS-GEFS into their Flood Forecasting System in an operational setting to improve the lead time, accuracy and spatial resolution of riverine Flood Early Warning in the Lower Mekong Basin.

KEYWORDS Flood Early Warning System, Lower Mekong Basin, bias correction, Satellite-based rainfall data, rainfall forecast

Water and Disasters and the Role of Real-Time Geospatial Tools for Operational Planning and Decision-Making > Poster Presentation

The Use of Remote Sensing and GIS for Drought Risk Assessment: The Case of Southern Province, Zambias

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Droughts exacerbate the increasing pressures on water from population growth, economic activities and escalating competition between users. Remote Sensing and GIS have emerged as valuable tools in the assessment of natural resources and hazards. Southern Province of Zambia is epitomised by highly variable rainfall and arid conditions. Nonetheless, the province is one of the food baskets of the country. Thus, it is necessary to assess the risk of drought in the province.

The study utilised NDVI and LST from MODIS. The study also used CHIRPS and in situ rainfall data. Standardised Precipitation Index (SPI) and rainfall anomaly percentage were derived using CHIRPS so as to assess meteorological drought. Vegetation Condition Index (VCI) was derived in order to assess agricultural drought. Soil Moisture Index (SMI) was determined to assess soil moisture conditions during droughts. Correlations analyses were conducted between NDVI and in situ rainfall, NDVI and CHIRPS, VCI and maize production and yield, and SMI and soil moisture. Drought risk was comprised of hazard, exposure and vulnerability.

The results indicate that NDVI responded quickly to increases in precipitation but lagged in response to reductions. Droughts of the Southern Province were classified as aggressive or regressive. Aggressive droughts were those that increased in magnitude and/or intensity as the season progressed. Regressive droughts were those where intensity and/or magnitude decreased as the season advanced. Regressive droughts where observed to coincide with El Niño. SMI was observed to be lower in agro-ecological Region I and higher in Region IIa. NDVI was correlated to in situ rainfall measurements (0.59). VCI was correlated to maize production and yield (0.66 and 0.84, respectively). SMI was correlated to soil moisture at 5 centimetre depth (0.71). Drought risk was highest in the Zimba district. It was lowest in Mazabuka and Chikankata.

KEYWORDS climate change, adaptive water management strategies, multivariate probit

Resilience to Water-Induced Disasters > Oral Presentation

Linking Extreme Climate Events with Child Marriages in Climate Hotspots: an Outcome or Adaptation Practice?

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Climate change is one of the foremost complicated challenges of our time. The extent of risk that it generates conjointly depends on the extent of effective adaptation measures being taken. While there is no doubt about adverse physical effects caused by climate change, the latter comes along with immense socioeconomic external effects which demand more attention for extensive research work. Commonly yet interestingly it is observed that the climate hotspot regions are the ones where social problems are predominant as well as that world's majority of economically vulnerable population lives. This paper explores the linkage between extreme climate events and child marriages by first proposing the hypothesis that child marriages are likely to increase during and post-extreme events in climate change and child marriage hotspots of South Asia and Africa, the prevalence of which is reciprocally connected with the financial condition of the families, followed by reviewing the existing literature and latest reports from national and international agencies to seek out adequate evidence to support or reject the hypothesis and policy implications. The key findings of this paper are (i) child marriages increase with the onset of climate extremes such as floods and drought. (ii) extreme climate event is rather an instrumental variable that affects the income stability of economically marginalized families which in turn increases the likelihood of child marriages, the primary reasons behind this are often a less dowry at an early age and fewer mouths to feed inside families. (iii) child marriage is also a crude means of adaptation taken by poor families in climate hotspot regions due to fear of sexual violence at community centres where they are forced to displace at times of flash floods, cyclones.

KEYWORDS Extreme climate events, Child marriage, South Asia, Africa

Resilience to Water-Induced Disasters > Oral Presentation

Framework for Measuring Resilience to Water Induced Disaster in Nepal

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Resilience has got traction in the research and development discourse in this decade. It is considered vital for enhancing capacities of populations to prepare for, respond to, and recover from disasters. But resilience is a complex concept and comprises multiple definitions and meanings. Despite its popularity, resilience is still evolving and there is considerable disagreement regarding the common meaning of the term resilience and issues in operationalizing the concept. However, efforts are underway to operationalize it. Continuous efforts to operationalize resilience have given various conceptual model and frameworks. For assessing the resilience of communities prone to water-induced disasters in Extended East Rapti Region, Central Nepal, an extensive review of sixty resilience frameworks that were applied to different countries was conducted. Based on the review and findings of the qualitative study, a capital-based approach was selected for assessing community resilience related to water-induced disasters. Capital based approach envisages that a resilient community should have elements or indicators related to five dimensions or capitals: i) social capital, ii) physical/infrastructure capital, iii) institutional/governance capital, iv) natural / environmental capital, and v) economic/ financial capital. Lists of indicators related to these five dimensions were extracted from the review. Experts' feedback, previous resilience frameworks applied to Nepal and findings from the qualitative study served as a basis for identifying the relevant indicators of resilience for Extended East Rapti Region. Primary survey data will be used to validate this framework.

KEYWORDS Resilience, Capital, Framework, Social, Institutional

Water-induced Disasters and the Differentiated Vulnerabilities of Those Left-behind: Case of Extended East Rapti Watershed

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Although there is a long tradition of labor out-migration in Nepal, the trend intensified since the mid-1990s. It is estimated that about ten percent of Nepal's total population, mostly the able-bodied youths, are involved in foreign employment. This large-scale out-migration has placed significant strain on the social fabric of the local communities, whereby, those left behind in most rural areas are now the women, the children, and the elderly. In the patriarchal social context of the country, the vulnerabilities of those left-behind have increased tremendously during extreme events like disasters. In this backdrop, taking the case of the East Rapti River Watershed (ERRW) located in Chitwan and Makhwanpur districts of Central-Southern Nepal as a case, this study assesses how the increasing male outmigration trend in the EERW has exacerbated the vulnerabilities of the "left-behind" group to water-induced disasters (WID). The findings of the study indicate absence of male members rendered those left-behind relatively vulnerable in all phases of WID- pre, during and post. The left-behind members of migrant households reported challenges in preparing for disasters as they received delayed disaster warnings, lacked a helping hand to prepare for evacuation and subsequently also bore more loss. This proved to affect post-disaster recovery along with instilling feelings of helplessness and insecurity. Further, the left-behind families with sick, disabled or elderly members experienced additional challenges during WID. The study also highlights the role of technology, social groups, and communal cohesion in coping and adaptation of those left-behind.

KEYWORDS Vulnerability, Water Induced Disaster, Migration, Left behinds

Resilience to Water-Induced Disasters > Oral Presentation

Natural Drivers of Water-induced Disasters and Associated Risks: The case of the Extended East Rapti Watershed, Nepal

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Water-induced disasters (WIDs) are generally associated to three roots, namely, natural, social, and developmental. Risks to lives, livelihoods and properties are dependent upon various climatic, topographical, and anthropogenic factors in the watershed and therefore are expected to vary widely within the same watershed. Natural drivers here refer to factors related to weather and climate. This study, for the Extended East Rapti (EER) watershed in central Nepal, characterizes historical and future trends in climatic and hydrological extremes and their spatial variations; discusses the linkages between hydro-climatic extremes; and finally elaborates associated risks. Climatic and hydrological extremes are characterized with a set of 14 and 8 indices, respectively. Climatic and hydrological extreme indices are computed using RClimDex and IHA (Indicators for Hydrological Alteration) tools, respectively. Relationship between hydrological extreme, and reported cases of flooding during that period.

Results showed increasing trends in climatic extremes for the historical period (1980-2005) and are projected a 10-30% increase in RX1day rainfall, 10-50% very wet days rainfall and 15-60% increase in warm nights from the base period until the mid-century. Hydrological alterations in terms of increasing extremes are also clearly visible in maximum flows, minimum flows as well as the shift in the day of maximum flow. Alterations in river flows due to hydro-climatic extremes will have various socio-environmental implications in the EER watershed, which includes but not limited to water and food security, river health and aquatic biodiversity, groundwater abstraction, among others.

KEYWORDS Climate extremes, Hydrological extremes, Water induced disasters

Water and Land for Agriculture and Food > Poster Pitch

Management of the Moghra Aquifer Considering Climate Change Implications

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Egypt is currently facing a significant shortage of freshwater resources which is expected to exacerbate due to climate change, over population rate, and development projects along the Nile River. Indeed, the lack of suitable water for agriculture inhibit agribusiness development. Accordingly, Egypt has planned an ambitious strategy tend to reclaim of 1.5 million acres in the Egyptian deserts exploiting the potential groundwater in aquifer systems. Moghra region, located at the north-eastern corner of the Western Desert, is among the targeted areas where new rural communities would be built mostly depending on the Moghra aguifer. The management of the aquifer is of major concern to maintain its sustainability. Thus, the aquifer system was simulated using MODFLOW software to identify a feasible pumping scenario achieves an acceptable drawdown and the cultivation requirements simultaneously. For long-term management, implications due to climate change and the resulting in sea level rise (SLR) should be considered. Hereby, the Moghra model is utilized to quantify the anticipated losses of the reclaimed area. The rise of the Mediterranean Sea level by 1.0 and 2.0 m has caused mild effects on groundwater levels of the aquifer that may be attributed to its vast dimensions. The water consumption, calculated as the reference evapotranspiration "ETo", is projected to increase under different temperature increase scenarios of 2°C, 4°C and 6°C. Consequently, a reduction in cultivated area by around 5.14 %, 10.29 % and 18 % would be resulted. Developing more efficient irrigation techniques and adopting less water consuming crops are highly recommended.

KEYWORDS MODFLOW, sea level rise, sustainability, land reclamation

Water and Land for Agriculture and Food > Poster Pitch

How Far is Climate Change Adaptation Policy from Practice? Contrasting the Effectiveness and Acceptance of Local and Regional Strategies in Irrigated Agricultural Systems in Northern Italy

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Global climate change poses significant challenges to future agricultural production, with significant implications for global food security, agricultural producer livelihoods, and environmental degradation. Agricultural water systems are highly sensitive and exposed to potentially substantial climate change impacts. In fact, agriculture is the sector most affected by water scarcity, as it accounts for 70% of global freshwater withdrawals and more than 90% consumption. Farmers develop their activity supporting a complex coupled human and natural system characterized by political, economic, institutional, cultural and biophysical conditions. Furthermore, real-world climate change adaptive responses can be differentiated along a number of social, spatial and temporal dimensions, while they can be protective, in terms of taking preventive measures against negative impacts, or opportunistic as they take advantage of potential beneficial effects of climate change. Yet, adaptation can be constrained not only by technical difficulties or scientific uncertainties, but also by the absence of political will and consensus, opposed economic and cultural factors, lack of governance in decision-making processes, conflicting strategies among governments at national and local scale, and shortcoming of tangible results. Previous research highlighted how adaptation strategies and actions need to be evaluated also in terms of their acceptance by stakeholders at different levels (i.e. water authorities, irrigation districts, individual farms). The aim of this contribution is to assess the effectiveness of main climate change adaptation policies carried out in irrigated agriculture in Lombardy (Italy) with respect to what extent and under what socio-economic, environmental and cultural conditions they are being implemented to reduce the gap between theory and practice. For this purpose, we conducted a review of the literature, an evidence-based and SWOT analysis to highlight which driving factors and multifactor criteria should be taken into account to cope with the risk of maladaptation and lack of confidence in achieving climate change adaptation goals.

KEYWORDS anaerobic digestion, wastewater treatment, process control, water reuse, biogas

Nexus Efficiency of Centralized and Decentralized Models for Water Management and Food Production in the Region of Alentejo, Portugal

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The region of Alentejo is characterized for activities such as agriculture, forestry and agro-food industries. The main regions for agricultural production and animal husbandry are the areas of holm oaks and cork oaks. Rural settlements are usually clustered in the hills and in compact villages. Due to these factors there is a heterogeneity in the landscape and productive structures in the region therefore is considered as the food pantry of Portugal. The development of decentralized models for sustainable use of water for agriculture has not been seen yet as a feasible solution to be implemented by governmental programs. The Common Agriculture Policy and current techniques for food production are not fixed to the current situation of agricultural sector in southern Europe, so far the policies have not been able to improve the supply of water and ecosystemic services related. Therefore to stress the importance of sustainable water management through decentralized models such as water retention landscapes as a feasible alternative for regional self sufficiency and regenerative basis for autonomous water supply and food production. The implementation of decentralized system for water reservoir, under the principles of Water Retention Landscapes shows how a sustainable use of water resources and food production can be achieved. On the other hand, how the Nexus accelerate the restoration process of the ecosystems, contributing to the prevention of hazards in regions threatened by erosion and droughts. The systemic approach of MESMIS methodology allows to analyze qualitative and quantitative data to rate the level of sustainability between centralized and decentralized models considering the emerging properties from the interaction between the subunits within the system.

KEYWORDS centralized system for water storage, decentralized system for water reservoir, water retention landscapes, water and food nexus

Water and Land for Agriculture and Food > Poster Pitch

Water Management Optimisation of Pumpkin (Cucurbita Pepo) under Drip Irrigated Field in Ede Southwest Nigeria

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The pumpkin species (Cucurbita pepo) is a crop locally called "Elegede" in the Southwest Nigeria and belongs to the cucurbitaceae family. Its young leaf is used as an indigenous vegetable, and its cultivation is important in solving the problems of malnutrition and contributing to food security in sub-Saharan Africa. However, there is no comprehensive study on water management in pumpkin cultivation in many countries including Nigeria. Due to the crop's sensitivity to seasonal climate variability, its yield and standard fruit size are strongly influenced by water availability. Therefore, the objectives of this study were to optimize water usage in pumpkin production under drip irrigation system as well as the growth parameters like: irrigation frequency, days, depth of water applications, soil types, number of leaves, number of branches, number of flowers, number of fruits, plant height, stem girth, leave area index and yield.

Two categorical factors were considered (Loamy and sandy soil). A 3-factor, five levels yielding a total of 45 experiments was adopted using Central Composite Design of Response Surface Methodology and Design Expert Software Package. Analysis of Variance (ANOVA) for the Two factorial interactions (2FI) models and quadratic model used for optimization of growth parameters shows that all models used were significant (P<0.05).

Therefore, the 2FI model had standard deviation of 17.85 with a mean data value of 60.59. The coefficient of variation (CV %) (Standard deviation expressed as a percentage of the mean) was 29.46, (R2 = 0.47). The pumpkin growth parameters observed during the experiments range from number; leaves (0-132), flowers (0-13), fruits (0-11) and yield (14345-21278 kg/ha). This indicates that irrigation frequency at 0.2%ETc, depth of application at 5cm and sandy soil is considered as the best option for better results on the plant growth performance at every 3 days interval for optimum results.

KEYWORDS anaerobic digestion, wastewater treatment, process control, water reuse, biogas

Nitrogen Inputs for Agriculture in a Tropical Montane Catchment, a Water Quality Ambiguity?

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As human population rises, the pressure for food may intensify agriculture and nitrogen fertilization, increasing the likelihood of water quality deterioration. In the Mau Forest Complex in Kenya, the annual export quantities of nitrogen from smallholder agriculture, assumed to be associated with the use of fertilizers, was reported to almost double those from the native forest (natural ecosystem). However, in the Mau Forest Complex, which lost 25% of its forest cover to agriculture and other encroachment activities, there are no studies that provide empirical information on the amount and spatial distribution of nitrogen inputs into these catchments from smallholder agriculture.

This study aimed at determining the quantity and spatial distribution of fertilizer inputs in a smallholder catchment in the Mau Forest Complex. The study used a farmer's household survey (n=185). Results show that almost all farmers use inorganic fertilizers with an average nitrogen (N) application rate of 41 kg N ha-1 yr-1 diammonium phosphate (DAP). Among the DAP users, 16% additionally apply on average 79 kg N ha-1 yr-1 as NPK fertilizer, and 11% add 29 kg N ha-1 yr-1 as calcium ammonium nitrate (CAN). Overall, the average nitrogen input from inorganic fertilizers is 64 kg N ha-1 yr-1. Only 6% of the cropland is fertilized using manure and other farmland residues with 79% of farmers anticipating to increase their fertilizer application rates in the coming years.

In conclusion, future increase in nitrogen application rate on farmland raises concern on fertilizer use efficiency for food production and may pose threat to water quality and clean water supply within the catchment and downstream. To balance the trade-off between food production and water quality, there is a need to train farmers on appropriate methods, timing and amounts of fertilizer application in order to protect the receiving water bodies from potential future eutrophication.

KEYWORDS Fertilizer, nitrogen, application rates, smallholder farming

Water and Land for Agriculture and Food > Poster Pitch

Effects of Sedimentation on Reservoirs in the Mushibemba Catchment, Mkushi Farm Block, Central Zambia

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Sedimentation is one of the problems that affects the storage capacity of most small reservoirs, and if not addressed on time, may lead to the dams being filled up with sediment and failing to meet the intended objective of providing agricultural water for food and economic security. The aim of this study was to assess the effects of sedimentation on the storage capacity losses of Moffat dam and GRZ weir located in the Mushibemba catchment of the Mkushi Farm Block in Central Province, Zambia. The specific objectives of this study were to (i) determine the storage capacities of two reservoirs; (ii) estimate suspended sediment transport into the streams draining reservoirs and; (iii) determine the rates of sedimentation on the Mushibemba reservoirs. Bathymetric survey using hydrographic boat mounted with a differential GPS was used to collect reservoir depths, water surface elevation and reservoir perimeter. For water quality assessment, water samples were collected at the intake of each reservoir and analysed for concentration of total suspended and total dissolved solids.

The results of the study revealed that the measured volumes of Moffat dam and GRZ weir were 1,180,462 m3 and 197,218 m3, respectively. The measured reservoir capacity values were then compared with the originally calculated designed capacity values to determine changes in storage capacity over the years. The storage capacity losses for Moffat reservoir was found to be 223,789 m3 (16 percent) whereas that of the GRZ Weir was 53,312m3 (21.3 percent). The source of the suspended sediment was mainly attributed to the cleared commercial agricultural land which predominantly consists of clayey to loamy soils. It is concluded that sedimentation in the catchment is fairly low but serious given reservoir capacity losses observed due to agricultural activities despite having a good vegetation cover.

KEYWORDS Sedimentation, Bathymetry survey, Reservoir storage capacity, Suspended sediment

Water Security Hazards and Risks > Poster Pitch

Water Security and COVID-19 Recovery: Lessons from Research in South Asia

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The spread of C19, the urgency to routinely wash our hands, disinfect surfaces and practice social distancing highlighted the importance of access to the water supply across South Asia. The crisis exposed the limits of the past strategies of water supply to rural poor and urban slums. Small population, ranging from 35% in Bangladesh to 60% in India and Pakistan, have a handwashing facility with soap and water in South Asia. Many of them have close family members in foreign countries or cities. The large number of them went back home. In Bangladesh alone, an estimated two million workers travelled back since March 2020. The impact on stretched water supply situation is immense. The situation is not going to improve anytime soon as governments in the region try to address critical economic challenges and finding it difficult to spend on water supply. The risk is a reversal of hard-fought gains to improve lives - and the overall health - of the most vulnerable throughout South Asia. As the countries and development partners come to terms with understanding pandemic-related water security in the region, this is a good time to revisit the important lessons learned from SDIP, particularly for vulnerable groups such as women and children. Our research and engagement in South Asia highlight a lack of the recognition of the linkage between water system management and urban water supply system, integrated groundwater management and provision of water data will be critical to ensure that the economies do not rebound from recovery to response. We recommend an urgent need to take stock of available water from different sources to cater to the combined needs to addressing a pandemic situation and jumpstarting the economies.

KEYWORDS COVID-19, Water security, South Asia

Water Security Hazards and Risks > Poster Pitch

Flash Flood Susceptibility Mapping Using Machine Learning Techniques

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Mapping and assessment of flash flood susceptibility are important elements of flood prevention and mitigation strategies because they reveal the most vulnerable areas based on physical characteristics that determine the propensity for flooding. This study aims to define the flash flood susceptibility zones for the Nam Pam Watershed, a high mountainous area in North of Vietnam with seven machine learning (ML) methods, namely Logistic Regression (LR), Linear Discriminant Analysis (LDA), K-Nearest Neighbors (KNN), Classification and Regression Trees (CART), Gaussian Naïve Bayes (NB), Support Vector Machines (VSM), and Random Forest (RF). Eleven flash flood independent factors were considered, namely elevation, slope, aspect, curvature, soil type, land use, topographic wetness index (TWI), stream power index (SPI), stream density, NDVI, and rainfall. All factors were defined as raster datasets with resolution of 30 x 30 m. A total of 464 flash flood locations were identified by field surveys, of which 80% were randomly used for data training and 20% of the remaining were used for validation. All seven methods give very good accuracy, over 90%, but Random Forest gives the highest accuracy, up to 94.9%. The flash flood susceptibility analysis would be very useful for local government administrators, researchers, and planners in devising flood mitigation plans.

KEYWORDS flash flood, susceptibility mapping, machine learning, random forest, Nam Pam

Water Security Hazards and Risks > Poster Pitch

Policy Responses and Challenges on Cyclone Disasters in Bangladesh: Lessons from Cyclone Sdir, Aila and Amphan

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In the 21st century, natural disasters, and climate change in particular, has become a powerful driver and catalyst of destruction. Cyclone is an extreme climate event posing both long term and short term impact. Using secondary based data and grey literature, this study has explored national and local level policy approaches and its responses, and challenges taken for cyclone disasters in Bangladesh. From 1887 to 2020, around 160 tropical cyclones hit the country of which 50 were severe cyclones (more than category III as per Saffir-Simpson hurricane scale). It is calculated that from 2007 to 2020, nine cyclones of which Cyclone Sidr 2007, Cyclone Aila 2009 and Amphan 2020 were the hardest hit in the coastal areas of Bangladesh. This study reviewed the cyclone disasters in Bangladesh coast but special attention has been given to devastating cyclone Sidr 2007, Cyclone Aila 2009 and Cyclone Amphan 2020. This study specifically focuses on coastal highlights the different considerations of governmental policy approaches and responses such as encourage through various resettlement or relocation planning, resilience oriented practices and development, providing soft and right based policies such as rapid response and distribution plan, insurance, tax policies, incentives etc. By focusing the above considerations, this study found that developing strategic measures at local level with the local people participation; integrating rights, resilience and relocation issues with existing relevant policies and programs; involving community people in policy making and implementation process etc. adequate implementation of soft based policies can reduce the impact of cyclone disaster. Finally, this study pointed out that there is not only need to examine the impact response or ability to cope with cyclone disaster only but also making viable through climate equity and environmental justice perspective.

KEYWORDS Cyclone, Government policy, Coastal area, Community people

Water Security Hazards and Risks > Poster Pitch

Development of Operational Drought Monitoring using Drought index in Thailand

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Drought in Thailand becomes more extreme than in the past decade that may be associated with climate extreme in several parts of Southeast Asia. The challenge of drought monitoring and assessment is "how to indicate drought risk area" because there are a lot of factors affected to drought situation such as rainfall, temperature, water demand and supply. Thailand has a lot of agricultural area and most of agriculture is located in rain-fed area. Irrigation area covers only 12% of the entire Thailand. With this small number of irrigation area, most of the rain-fed agriculture is usually lack of water especially during dry season. This study focuses on meteorological drought because rainfall is very important source of water supply in Thailand. Meteorological drought in Thailand could be defined as a dry spell or no rain in 15 days and number of rainfall is less than 1 mm/day. This study attempts to establish the operational meteorological drought monitoring system than that provides automatically data update according to its frequency. The system contains drought index and accumulated rainfall to indicate provincial drought area. The index is calculated by potential surface analysis (PSA) technique, which factors include repeated drought, annual rainfall and irrigation area. Each factor is defined by different weighting score that depends on priority of affected drought. Accumulated rainfall is determined as a ticker, which defines threshold to indicate drought area. The system represents daily provincial drought area and could be pointed out as a target area to monitor drought situation. This system could help planning officer for water management in dry season to allocate water for water use in several sections such as agricultural, industrial, and public section. However, the system should be improved by adding more factors and modifying the threshold in regional scale separately.

KEYWORDS Drought Index, Drought monitoring, Meteorological drought, Thailand

Water Security Hazards and Risks > Poster Pitch

Situational Analysis Climate Change Impacts on the Livelihood of the Coastal Communities, a Case of Phu Tan District, Ca Mau Province

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As a coastal country, in recent decades approximately 50% of the population in Vietnam is living in near the shoreline. Thus, they have been affected by abnormal weather phenomena such as sea level rise, high temperature, storms, floods etc. that threat the lives and livelihood of local communities. Especially, the most affected area is the Mekong River Delta with nearly 45% of the area which is forecasted to be saline by 2030 and causing heavy damages to the agricultural sector (contributed 17 billion USD to the national GDP) as well as irrigation and drainage systems in low-lying and shallow areas. Typically, Ca Mau province which exposes to both the East and West sea with a coastline of 254km in the recent years has been severely influenced by climate change. The province has lost nearly 10,000 ha of land and coastal forests; infrastructure and properties of local people along rivers have been eroded and seriously damaged; production activities are vulnerable to sea level rise and other hydro-meteorological hazards. This paper aims to provide a situational analysis on how climate change and natural disasters affect the livelihoods of coastal communities in Ca Mau Province, a case study is conducted for Phu Tan District, that addresses problems and proposes urgent measures for climate change adaptation in the near-term and long-term planning.

KEYWORDS sea-level, livelihood, communities, climate change, hazards

Water Security Hazards and Risks > Poster Pitch

Managed Aquifer Recharge in Saline Regions for Enhanced Recovery of Freshwater

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In last five decades groundwater withdrawal has been perceived unprecedented. To improve the groundwater level, different technological development for planned groundwater replenishment known as managed aguifer recharge (MAR). Many arid and semiarid regions are facing severe problem of groundwater salinity where fresh water resources are insufficient due to scanty/erratic rainfall and long dry seasons. For effective utilization of water resources in water scared areas, including the salt affected zones, conventional MAR practices are adopted in which surplus surface water is diverted to the underlying aguifers for its subsequent recovery. The purpose of this paper is to briefly review the recent progress on MAR technique in saline regions along with a summary of current state of knowledge of the topic and recommendations for future research to develop an efficient framework for aguifer storage in salt affected regions. In this paper extensive analysis has been done to understand the situation of saline groundwater, different MAR techniques practiced in saline groundwater regions, How MAR works in saline regions, relationship between fresh and saline water, freshwater pocket generation, different available solutions for mixing phenomena and freshwater spreading including its long-term operation and its socio-economic aspects.

KEYWORDS Aquifer Storage and Recovery, Brackish Aquifer, Freshwater Pocket, Density Dependent Flow, Inland Salinity Water Management and Security in Relation to Climate Change and Policy Making > Poster Pitch

The Interaction of Development Projects and Climate Change on Sustainable Security in Shared Water Bodies, A Case Study: Euphrates and Tigris River Basin

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Euphrates and Tigris River Basin is considered as one of the most conflicting shared watercourses in the world where measures of Iran, Iraq, Syria, and Turkey as its active stakeholders, have had mutual implications on each other and their environment. Development projects such as dam construction by riparian states, which is assumed to strengthen the national security of the countries concerned, have had adverse effects on access to water and water quality. These activities, however, besides their environmental consequences, have raised convulsions and unrest in downstream countries, and have criminalized the region, in a way that the formation of ethnic and terrorist groups has provided the ground for an insecure future in this area, thereby, causing violence and consequently water crimes such as water theft and smuggling, destruction of water infrastructures, deliberate water pollution, diversion of water in upstream, state water corruption, etc. Commitment of such crimes severely endangers water security as well as food security of growing population of surrounding the basin, and therefore, having a direct impact on sustainable security in the region. Lack of a comprehensive legal framework and an operational and strategic institution involving all stakeholders have made the situation proceed convulsively and politically dire. This study suggests that negotiations should be advanced in a bottom-up approach and finally, officials of riparian states continue negotiations based on all gained results for establishing a mutually agreed framework. Our proposed solution is to formulate a comprehensive framework convention, by taking international customary principles and rules in the main text and to envisage a Joint Technical Committee involving representatives of influential countries and to include specific issues of the basin under protocols and amendments through a piecemeal approach. This solution may address reciprocations between different aspects of the subject matter to be regulated.

KEYWORDS anaerobic digestion, wastewater treatment, process control, water reuse, biogas

Water Management and Security in Relation to Climate Change and Policy Making > Poster Pitch

Environmental Monitoring and Management of Land Use and Land Cover Change in the Protected Coastal and Inland Wetlands of El-Burullus and Wadi El-Rayan Lakes, Egypt

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El-Burullus and Wadi El-Rayan Protected areas' wetlands are two of the four Egyptian Ramsar sites of international importance as they contain rich biodiversity. However, due to climatic uncertainties, population growth and human activities, the valuable resources in El-Burullus and Wadi El-Rayan Lakes and their surrounding areas have faced various threats. The aim of this research work was to examine wetlands management in coastal and inland wetlands of Egypt. This was with a view to improving management efforts through the study of the land use and land cover changes that have occurred in the two areas over the past three decades and examine the status of the three main component of wetland ecosystem, vegetation, water and soil as well as their interrelation.

Results of LULC change detection analysis indicated that vegetated land has increased significantly with shrinkage in the water body during the study period. Factors that underpin the observed changes were, fish-farms and reclamation projects which are creating the danger of drying up of the southern parts of the lake, as well as spreading of reed beds. However, for Wadi El-Rayan wetlands, the results of LULC change detection showed that WR wetlands have undergone substantial LULCC over the past thirty years, especially between 2010 and 2019 where land cover change affect 42% of the study area. About 36% of the changes observed during the last decade belong to the LL of WR. The comparison between the vegetation productivity of the two study areas revealed that the lake quality was changing because of soil quality, salinity and pollutants, which reflected in the vegetation productivity. Results also showed that Wadi El-Rayan Lakes' soil total dissolved salts and phosphorous contents are higher than El-Burullus Lake. Regular monitoring of the three main components of wetlands will ensure their sustainable management.

KEYWORDS Environmental monitoring, Environmental management, wetland, El-Burullus, Wadi Water Management and Security in Relation to Climate Change and Policy Making > Poster Pitch

Biodiversity and Water Security: Can We Linkage?

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Water Security is a topic discussed both in urban and rural context, and natural resources management is transversal to this discussion. It is common to find a consensus around nature based solutions provide ecosystem services yield related with water quality and quantity, among other regulation ecosystem services. However, the link between water security and biodiversity is not usually recognized. The objective in this work was to present a methodology to demonstrate this linkage in a didactic way. To develop this exercise, the concepts of biodiversity and water security were revisited to present the definition considered in this approach. The link between a characteristic of environment (biodiversity) and a desired social condition (water security) was considered in the ecosystem function related with climate change, specifically the resilience to extreme climatic events. Since a greater biodiversity of species contribute to whole ecosystem resilience against disturbances, it also has a direct, positive effect, on water security. The methodology focused on the relationship between resilience against climate risks and integral water security and the importance of biodiversity values to increase this resilience in the ecosystems. This relationship was explored using the family Myrtaceae within the context of Atlantic Forest Biome in Brazil and selected indicators from literature to evaluate, analyze and monitor biodiversity, resilience and water security.

KEYWORDS Ecosystem services, Resilience, Nature-based solutions, Climate change

Water Management and Security in Relation to Climate Change and Policy Making > Poster Pitch

Water Management Policies, Risk Factors and Climate Change Effects in Ecosystem and Economics

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The water risk and climatic effects are very effective for observing life indemnity and security during floods, drought, resilience, and storms-like natural disasters. However, appropriate utilization, policies, and systems can get the world rid of such upheavals. Not only for reaching the SDG and Paris Agreement on Climate Change, but also for proper acting with water and controlling climate change can secure our health and economy. But adoption is the one and only wherewithal to cope with climate change and water improper management. Inappropriate administrative procedures and water management suffer the citizens. Besides, cities, especially those that can not resist water, should be governed by eco and climate-friendly systems. Water exploitation acts must be taken to eradicate the vulnerability. Water-related problems enhance disease risks like diarrhea, cholera, dehydration, and kidney infection, and excessive or a little water causes inversion and occurrence like floods, droughts, etc. Extreme flows of water produce electrical energy. Nowadays, charities from various world regions work based on distributing pure water to 663 million people- by FAO who live in the water crisis. Annually, \$260 billion goes in vain due to pure water and sanitation vulnerabilities. Yet \$32 billion—which is used for health care due to the water crisis—can be gained if the water crisis could be eradicated. Global Water Challenge acts are recalling in providing sanitation and hygiene with clean and pure water. To encourage pure water distribution and remove crisis, The Stockholm International Water Institute itself works and awards those who contribute to the motto. Using water by agreement, known as water diplomacy, is highly helpful for making the needed distribution of pure water and managing the crises. And to save the ecosystem and economy, water management programs and policies need to be performed urgently.

KEYWORDS Climate, Water, Risk, Crisis, Economy

Water Management and Security in Relation to Climate Change and Policy Making > Poster Pitch

Assessing the Impacts of Internal Climate Variability on Rainfall under Climate Change Scenarios in the Mun River Basin, Thailand

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This study examines the impacts of the Internal Climate Variability namely El Nino Southern Oscillation (ENSO) and Madden Julian Oscillation (MJO) on rainfall in the Mun River Basin, Thailand. The Southern Oscillation Index (SOI) and Oceanic Nino Index (ONI) were used to develop a relationship with ENSO and rainfall over the study area. Similarly, the Realtime Multivariate MJO index was used to analyse the relationship between MJO and rainfall in the region. A correlation analysis was carried out to investigate the relationship between both ENSO and MJO indices with observed rainfall. Spatial rainfall plots were obtained to study the spatial variation of rainfall during ENSO and MJO phases. Further, 12 Global Climate Models (GCMs) were evaluated to assess their ability to simulate ICV and rainfall over the Mun River Basin. Several performance criteria such as monthly climatology, rainfall variability and ENSO and MJO patterns in the historical period were considered for the evaluation of GCMs. Future GCM rainfall under RCP4.5 and 8.5 scenarios were bias corrected using Quantile Mapping method. The intensity and frequency of future ENSO events were obtained using future sea surface temperature and sea level pressure data from GCMs. It was found that both La Nina and MJO phase 5 produces higher rainfall over the Mun River Basin. ACCESS1.0, CNRM-CM5 and MIROC5 were selected as the best models out of all the models considering their performance in simulating rainfall and ENSO while all the GCMs were failed in capturing the MJO pattern. Bias corrected rainfall showed significant improvements in representing monthly rainfall over the region. However, large uncertainties remain in the projected rainfall and ENSO due to the contradictory results obtained from the selected GCMs. Further improvements should be made in GCMs to improve their ability to capture the ICV modes such as ENSO and MJO.

KEYWORDS ENSO, MJO, GCM, Climate Change

Urban Water Management > Poster Pitch

Modeling Water Security of a Metropolitan under Future Climate and Population Scenarios

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Istanbul is a water-scarce metropolitan based on its annual precipitation. Metropolitan Istanbul and its surrounding catchment has large spatial and temporal differences in freshwater availability. Moreover, the water supply, especially during the dry seasons, does not meet the actual demand due to physical, economic and institutional reasons. Istanbul currently supplies its water resources from 15 sources, including Melen River, 220 km away from the city. Facing the impacts of climate change and the further added stress due to increasing population, immigration, urbanization, and lifestyle changes will exacerbate the city's water insecurity.

For this study as a management solution, we model the catchment area of Istanbul by following Integrated Water Resources Management (IWRM) principles. WEAP, the Water Evaluation and Planning model is specialized in linking supply and demand structures while allowing extensive scenario analysis. This model addresses both bio-physical factors influencing the river and at the same time socio-economic factors affecting the level of domestic, agricultural, and industrial demand and management from the reservoirs. With this capability, WEAP is powerful in combining two different aspects of the considered basin; both water management and catchment hydrology. Therefore, this study analyzes water security in Istanbul, especially the balance between water demand and supply, under different scenarios of socio-economic development and climate change (RCP 4.5 and RCP 8.5 scenarios) until 2100.

The novelty of this study comes from the scenario analysis module. The model confirms the vulnerability of Istanbul's water resources to both climate change and the potential changes in urban dynamics. The city currently invests in substantial infrastructure to transport water from neighboring cities and in the near future this dependency will further increase. The findings of this study are valuable in informing the policy making process of the metropolitan Istanbul with regards to freshwater resources demand management.

KEYWORDS WEAP modeling, climate change, population dynamics, water security, water supply and demand

Factors Influencing Adoption of Smart Water Metering and Domestic Water Consumption: A Case Study of Chennai Metropolitan Region

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India is in the midst of an impending water crisis and cities are the first to be worst affected by periodic water scarcity. Being the epicenters of economic development, cities across India face several environment and sustainable development challenges of which climate change and water insecurity are increasingly becoming an important policy concern for the government. India is also one of the countries with highest numbers of population residing in urban slums and hence the poor are most vulnerable to the effects of climate change on water resources. A majority of cities are prone to extreme weather events such as drought and floods and are highly susceptible to heatwaves. About 600 million people in India face water shortages and it is expected that large cities such as Delhi, Mumbai, Hyderabad, Bangalore and Chennai will soon run out of groundwater and face high risk of day zero. In this context, the paper explores and discusses the case of smart water metering adopted by the residential communities in Chennai Metropolitan Region. Based on primary survey, the paper presents preliminary findings of community perception of water metering adoption and shifting to an efficient pricing mechanism so as to conserve water. The paper highlights the basic findings from the survey with respect to key socioeconomic factors influencing water meter adoption and consumption. The paper examines the opportunities for demand side measures for improving water use efficiency in domestic sector. Basically, the paper discusses the cumulative understanding of the key factors affecting domestic water consumption and the transition to a more sustainable water use through a mix of both economic and technology interventions. We hope the findings of the study will be highly relevant for policymakers in formulating and implementing demand side policies.

KEYWORDS Water Scarcity, Smart Metering, Water Pricing, Water Demand Management

Urban Water Management > Poster Pitch

Modeling urban Flash Floods and the Transport of Pollutant and Pathogen using SWMM: A Case Study of Phnom Penh City

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Urbanization and climate change have increased the risk of urban flood and water pollution, affecting people's safety and health. For better water management in the future and to minimize the impact of the urban inundation and pollution, it is essential to identify vulnerable zones for the urban planner. Simulation analysis is regarded as a practical method to identify overloaded drainage structures and critical sub-catchments. The objective of this study is to apply SWMM model to quantify urban drainage capacity and temporal variation of pollutants and pathogens in Phnom Penh City, Cambodia. The model parameters were calibrated to reproduce the observed flow rate and the concentrations of suspend solids (SS), Escherichia coli (E. coli), and chemical oxygen demand (COD) observed in the drainage channel throughout 2019. The simulated results for the whole observation periods, including the non-rainfall periods, showed that the SWMM model successfully reproduced flood events including those with overloaded situations, which indicate the insufficient current drainage capacity. Simulated results of SS, E. coli and COD well captured the observed temporal variation of concentrations in response to the rainfall, while the simulated concentrations during the non-rainfall periods showed relatively large differences from those observed. These results have proven that the SWMM model can be a useful tool for identifying the critical area for water logging and understanding the transport of pollutants and pathogens in the drainage basin where the untreated wastewater dominates the normal flow. Further study will be necessary for increasing the accuracy of the model simulation and suggesting the countermeasures to reduce flooding and improving the water quality of the stream.

KEYWORDS SWMM, Urban flash flood, Pollutant, Pathogen

Resource Recovery from Wastewater Treatment Plants in Megacities of Developing Countries: Current Status and Potentials

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In developing countries there is a lack of scientific data to support the development of coherent policies on the recovery of resources from wastewater treatment. In this context, it is necessary to implement inventories of the quality and the quantity of the resources in municipal wastewater, the current application status as well as opportunities and challenges for future implementation. This research aims to guide the elaboration of resource recovery projects by providing accurate and up-to-date data of wastewater treatment plants (WWTP) in the Macrometropolis of São Paulo. This region is one of the largest urban settlements in the world, concentrating more than 33 million inhabitants. Data from 143 municipal WWTPs were analysed to understand the current situation regarding the implementation of resource recovery actions in the region. Only 26% of the plants perform at least one recovery practice, and the predominant practice of resource recovery is the internal water reuse. Recovery actions are more concentrated in large plants than in medium and small ones. Sludge is disposed of in landfills, except for three facilities that recycle nutrients from sewage sludge composting. Some managers reported interest in recovering energy from biogas, expanding water reuse and using sludge for agriculture or building materials. Plant size, related legislation, as well as treatment technologies influence implementation of resource recovery and are discussed. The case study results are also compared with other megacities in developing economies. Finally, the authors propose a tool called a framework with several steps that can facilitate planning process and help to achieve the implementation of resource recovery. This framework can support decision-making on the recovery technology. Therefore, the results can provide subsidies for planning of resource recovery in large cities, contributing to advance in their goals of the Sustainable Development Goals (mainly SDGs 2, 6, 7 and 11).

KEYWORDS biogas energy recovery, circular economy, municipal sewage treatment, large cities, water reuse

Urban Water Management > Poster Pitch

Towards Re-Defining Urban Water Supply Monitoring System in Karachi

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This paper presents the experience of initiating the design of large-scale digital monitoring of water infrastructure in Karachi, Pakistan. The proposed concept is built upon the existing water system and aims to create a one go-to repository for all data regarding water infrastructure, supply and governance. We identify the key areas where technological interventions are required by highlighting their impact on the social and urban development of the city. After regress analysis and field research, the author proposes an indigenous approach to improving the water shortage and distribution gaps, which includes computerized base-map and Decision Support System (DSS) that could provide highly detailed maps of water resources and related infrastructures. It also presents the initial interventions of the project that covers an open-channel flow metering sensor network, whose task is to monitor real-time water flow of 60 km water canal from Keenjhar Lake (reservoir) to Dhabeji Station (pump-house); providing an accurate measure of water flows at input to the water utility, Karachi Water & Sewerage Board (KWSB). The authors advocate that the proposed work has the potential to ultimately improve water availability at the tap level and will buy time to properly implement significant increases in water supply, otherwise the new supplies may not bring the required impact, and such information is useful not only to the water utilities but also to public development sectors. This research addresses a key issue of how data transparency and accessibility can solve multi-layered water issues of developing countries.

KEYWORDS Urban Water Supply, Telemetry Sensor Network, Decision Support System, Water Infrastructure Mapping

Using Satellite Imagery to Detect Land Cover Change and the Suitability for Green Roof Retrofit in Preturo Municipality

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Green roof (GR) technique is one of the most effective solution to mitigate the increasing flood risk in urban areas caused by the uncontrolled soil sealing. The use of satellite images allows to identify in vulnerable area, the potential of existing buildings for green roof retrofitting according to four criteria that are roof slope, number of stories, orientation of the roof, number of site boundaries. The aim of the present work is to test the effectiveness of GRs at city scale in preventing the urban flooding events. The case study is Preturo municipality in Southern Italy. The site has been selected as part of Sarno river basin, a catchment that during the last two decades has been interested by several damaging flash floods. The analysis of land use change within Sarno watershed has been carried out using SAR images from ERS-1 and COSMO-SkyMed sensors. The results have suggested that the increase in the occurrence of extreme events matches with the expansion of urban area in the same period, reason why the application of GR technology could lead to a successful stormwater management. Indeed, the coherence estimation of SAR imagery, has detected a build-up area ranging from about 7% to about 12% between 1995 and 2016. An in-depth analysis has been performed moving from basin to city scale with the aim to test the ability of GRs to mitigate the urban flooding using SWMM. Satellite images available in Google Earth have been used to evaluate the suitability for green roof retrofit in Preturo municipality. According to building attributes for GR retrofit, a percentage of GR conversion of about of 7% has been detected resulting in a low attenuation of flooding volume. This finding suggests to couple the GR technology to other Low-Impact-Development practices in order to improve the stormwater reduction.

KEYWORDS Green roof, SAR images, urban flooding, SWMM, green retrofit

Poster Booth

Water Security in Ankara City: Existing Challenges and Overcoming Measures

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"Damlya damlaya çöl oluyor (In Turkish)" i.e. "Many a little makes a desert" is one of the slogans of Ankara Metropolitan City Corporation in present days. With other relevant factors, climate change and pandemics are posing significant challenges in this Turkish capital city. Though city authority has taken a number of strategic and operational measures to ensure water security but this paper explores linkages of related regular forces such as climate change and disasters, and disruptive forces such as pandemics, as well as needed strategic and operational actions to overcome the challenges from these forces. Based on 6 Key Informant Interviews (two experts from Ankara Metropolitan Municipality, two experts from State Hydraulic Works and remaining two experts from Ankara Water and Sewerage Administration) with a semi-structured guestionnaire and grey literature, this paper explored the existing situation of water and climate change and COVID-19 pandemics impact on water in Ankara. This paper focuses that the Ankara City Corporation, Ankara Water and Sewerage Administration and State Hydraulic Works are taking a number of strategic approaches on water to ensure scarcity for city people. However, challenges that needed to overcome for city areas are also highlighted. The study found that still Ankara is lacking behind climate-based in-situ and ex-situ adaptation practices, inadequate climate-based adaptation finance, therefore, developing policy measures such as responsibility-sharing framework for protection among neighborhood level, integrating resilience issues with existing policies, involving local people in policymaking process, developing capacity building for local government authorities etc. can ensure water security in Ankara. As the magnitude of consequences from regular and disruptive forces are unknown, therefore, Ankara should move towards climate justified strategies as well as giving importance of local people's participation in order to develop win-win approach for city areas.

KEYWORDS City authority, COVID-19, Climate change, Water security, Climate justified strategy

Rain Harvest Implementation in a Highly Stressed Watershed: The Case of the Independence Watershed in Guanajuato, Mexico

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In Mexico, the concept of a watershed is problematic, as it is now linked to conflict because inequalities in access to drinking water are a problem that is increasingly evident throughout the country (Castro et al, 2020). Located in Northern Guanajuato Mexico, the Independence Watershed (IW) a.k.a. Upper Laja River Watershed is part of Mexico's longest river basin, the Lerma-Chapala one of the main economically developed and contested regions and an area with great industrial and agricultural activity, whose growth is mainly due to the detriment of its water and soil (Caire, 2003).

The IW is one of the regions suffering from the greatest conflict over water in Mexico, in December 2019, the federal government declared it an "environmental emergency region" (El Universal, 2019; Clausing, 2019), since its greatest problems are evident in the severe reduction of the aquifer and the increase of toxic levels of arsenic and fluoride in the pumped water; in addition, poor rural communities and households often live with limited access to water for domestic and productive needs, while large commercial farmers, industry, mining and expanding cities can access large quantities of premium quality water (Hoogesteger, 2018; Tetreault and McCulligh, 2018).

The impact of this situation is evident and far from being a problematic managed by the government while the consequences keep increasing in the social, political, cultural, economic, and health spheres, as showed in Table 1 (Annex 1), who summarizes the problems considered as priorities. Nonetheless, this problematic has been assessed by different bottom-up organizations along this region, "Caminos de Agua" (Water paths) works with rural communities to implement Rainwater harvesting system as an alternative solution to the problem, providing immediate action in response to the negligence of the public sector throug a participative and educational strategy.

KEYWORDS water access inequality, rural deprivation, arsenic-fluoride, NGO assessment, adaptation practices

Poster Booth

Water Consumption Practices and Health Risks Among the Population of Baloum, Western Region of Cameroon

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More than 74% of the population in sub-Saharan Africa still does not have access to a safe source of drinking water with undeniable consequences for the health of the population. In the Baloum Community (West Region, Cameroon), water consumption practices are responsible for the presence of many cases of water relate diseases observed among the population. The objective of this study was to determine the water consumption practices and to evaluate the physical and chemical parameters in the drinking water sources of that community.

A semi-structured questionnaire and a checklist were administered, from June-august 2020 to 650 villagers randomly selected. Information, including socio-economic profile, consumption and utilization patterns was analyzed. Water collected from quarters in the village was analyzed for physical and chemical characteristics using standard methods.

This study revealed that the water used by villagers came from: streams (93%), wells (5%) and rainwater (100%). 95% of the water supply points were accessible by domestic animals. Almost all the people surveyed (98%) believed that the water they used for drinking is of poor quality. To avoid water wastage in households, the same water is used for laundry, dishes, and toilet. Barely 5% of this population is aware of the need to drink sufficient volume of clean water to be healthy. The presence of visible particles was observed in 96% of the samples. There was also a significant difference in the chemical composition (pH, N-NO3, minerals) of the water from the various collection points. The exploitation of medical records found in the village's Health Centre revealed the presence of cases of diseases related to water.

The results presented are sufficient to demonstrate the need to provide good quality water and to educate the people of this locality on the need of drinking sufficient volume of good quality water to avoid diseases.

Application of System Thinking Causal Loop Modelling for a Sustainable Integrated Water Resources Management

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Water is an essential and exhaustible natural resource which is fast depleting due to population growth and climate change. There is a growing consensus among the international community that water security is increasingly becoming one of the biggest environmental and development challenges of the century next to climate change. There are several forecasts depicting a future which represents fast depletion of freshwater resources making it difficult to meet even the basic human needs for survival. Many countries across the globe including both developed and developing countries are already facing severe water shortages accompanied by periods of prolonged and intense drought and are unable to meet their growing water needs. Wicked problems such as water insecurity is becoming highly complex and dynamic and thus relying on a traditional linear approach to address such complex issue do not necessarily solve the problem but only aggravate it leading to a new set of problems at later stage therefore stressing on the need for a circular and non linear approach. System thinking can be viewed as a language of communicating the various processes and interrelationship of a Complex Dynamic System (CDS) in a nutshell so as to aid effective decision making process. Causal Loop Diagrams (CLDs) is one of the most important and commonly used methods to understand system behavior. CLDs are based on balancing and reinforcing loops and helps to identify different variables that affect system behavior. Based on a systematic review of literature a series of CLDs are developed to understand water management challenges across agriculture, industry and domestic sectors in developing countries context. The proposed CLDs are categorized as water demand supply model, water governance model and water, economy and environment model. The paper highlights existing challenges in water sector and proposes a pathway for sustainable integrated management of water resources.

KEYWORDS water pollution, pesticides, Scendesmus sp., bio-sorbent, drainage water, Nile Delta

Poster Booth

Achieving Sustainable Groundwater Management in Water-Stressed Countries - Lessons from Jordan and Tunisia

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In the water-stressed, semi-arid to arid countries, groundwater is considered one of the primary water resources to cover the dramatic water requirement. Hence, this leads to putting more pressure on groundwater resources. Although expanding water stress and growing needs on groundwater resources are making groundwater management more sophisticated, they are also driving to creating of innovative management strategies that are pointed out in this work as beneficial patterns for managing groundwater resources. This paper highlights the approaches applied by Jordan and Tunisia governance to improve groundwater management. This work conducts critical analysis and review of the current established national policies in both countries. It also figures out the best practices and lessons extracted from Jordan's and Tunisia's experiences to inspire other countries. Each country has a unique and compelling journey in dealing with groundwater issues through implementing and testing a broad range of policies. In Jordan, the water authority has launched a series of policies and co-ordinated counter-measures to prevent groundwater extermination caused by illegal and erroneous users' activities. Those counter-measures include new water tariffs, controlling drilling companies, satellite imagery to handle extractions, destroying illegal wells, stopping land settlement processes, and raising awareness. For the Tunisian case, groundwater management is based on three approaches: technology, incentive/sanction, and awareness/capacity development. The technology approach used to increase water supply through the construction of dams, aguifer recharge, desalination and reuse of treated wastewater, and management of water use by improving irrigation techniques and crop productivity. Tunisia applied incentives and sanctions to monitor the number of wells and groundwater abstraction. Awareness and capacity development are used to knowledge diffusion, farmers' follow-up, decentralized, and communitymanaged groundwater systems. This work tracked the evolution of groundwater management tools and policies in two water-stressed countries and provided a set of recommendations and lessons that can benefit other regions.

KEYWORDS Groundwater management, Water governance, Water policy, Climate change

Sustainability in Mountain Basins: Irrigation Systems and Water Security

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Mountain basins, specifically within Andean ecosystems, present difficulties for their sustainable management, among other things, due to the scarcity of data from these geographical areas, which are often of limited access. The Andean ecosystems, specifically the paramo (generally above 3000 m.a.s.l.), are the major generators of drinking water for cities and irrigation systems; for this reason, hydrological conservation of environmental services, linked to how water is released in an ecosystem (hydrological regime), become relevant due to the biophysical characteristics to be protected and conserved.

It is here, where irrigation plays an important role as an influencing factor in this type of so-called regulation services; and where, the size of the parcel irrigation systems (small, medium, and large farmers) generates conflicts of various kinds, in the sense that on the one hand, the water serves for the reproduction of life, but on the other hand, for activities of production and consumption generated by the human being, the same ones that pressure so that their demands are met to the detriment of the others.

Therefore, the objective is to identify the socioeconomic characteristics of irrigation systems in mountain basins of the Andean area. For this reason, a detailed documentary review and review of previous works were carried out, to obtain the most relevant dimensions and variables for the application of a hydro-economic model in mountain basins, which represents a gap in knowledge in this area. These findings are relevant since the efficiency of water management through irrigation systems will be represented in a multidimensional approach, when dealing with economic, hydrological, and engineering aspects.

KEYWORDS Mountain basins, irrigation systems

Poster Booth

Cervical Cancer, Pesticides and Water Quality in an Agricultural State of the Federation: A Route of Imminent Hazards and Risks to Human Health in Mato Grosso do Sul

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The present work investigates the associations of cervical cancer (C.C.) with environmental sanitation and pesticides, in the municipalities of Mato Grosso do Sul, between 2013 and 2017, by Pearson's Determinant and distribution maps via QGIS. We identified that C.C. prevails in white women, between 30 and 34 years of age. The analysis on water guality, in SISAGUA data, revealed samples under the presence of heterotrophic bacteria (with results above 500 CFU / mL, highlighting the cities of Ladário, Jutí, Caarapó and Naviraí) and total coliforms (ex.: in Mundo Novo, Iguatemi, Campo Grande, Coronel Sapucaia, Caarapó, Naviraí and Tacurú). In addition, we identified water samples under guality standards above those recommended by Law No. 2,914/2011, for example, when leaving the treatment system, for fluoride (with values above 1.5 mg / L in up to 16 samples over Field Grande) and for free residual chlorine (CRL) (values between 2.0 and 5.0 mg / L, in up to 391 samples on Corumbá and up to 33 on Coronel Sapucaia). There was a high correlation between the disease and sanitation indicators, especially the extension of the water network (86.43%) and sewage (85.83%); the volume of water (produced = 85.72%, micro-measure = 85.3%, fluoride = 85.11% and consumed = 85.01%) and total expenses with water supply services (86.01%). As for its correlation with water quality, there was a 47.45% response to the number of samples for CRL with non-standard results. Correlation of 82.97% of C.C. to the number of sewage overflow records indicates possible exposure of the population to contaminated water. All correlations shown here at p-value <0.0001. More in-depth studies are needed to investigate in detail the relationship of this type of cancer to the effects of poor quality water for human consumption, especially regarding the misuse of pesticides in the environment.

KEYWORDS Cervical Cancer, Environmental Sanitation, Free Residual Chlorine, Pearson's Correlation Determinant, SISAGUA

Methodology Proposal to Develop Competencies for Sustainability. Case Study Based on Creating Water Management Model

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To achieve the sustainable management of water there is a set of previous needs. For example, the inter, multi and trans disciplinary approaches and their respective operationalizations. The three of them, represent the demand of people with the knowledge, skills, and attitudes (von Marriënboer, 2018), better said, competencies to live and solve sustainability issues embedded in complexity. The present proposes a methodology to develop systemic and critical thinking competencies, by creating scenarios on which the users must perform, and therefore, increase their competencies. From the outcomes of the performances, the levels of achievement can be inferred. The background of the present is a master thesis which emerged from an iterative process of conceptualization, design, test, and analysis of results. This last demonstrated the viability of the proposal to develop not just systemic and critical thinking but also, the interpersonal competence which enables the linkages and synergies needed to develop decisionmaking strategies. The presentation will exhibit a general methodology to develop educative experiential resources which can be adapted to multiple contexts and needs. From a wide perspective, it integrates six stages: 1) case selection, 2) systemic analysis of the case that integrates various sources of complexity, 3) identification of conflicts and their critical components: actors involved, scenarios and decision-making processes, 4) development of a narrative about the case, 5) schematization of a scenario from a simplified narrative, 6) assembly of the necessary materials and activities. Furthermore, the advantages of this kind of strategy will be explored through an example done by using two rivers as scenario: The Rhin in Europe and Rio Verde in Mexico. Finally, trial experiences from it will be shown and discussed.

KEYWORDS Educaction for Sustainability, Water management, competencies

Poster Booth

Everyday Hydrosocial Relations along Kolkata's River-Fronts

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The history of riverfront of Kolkata and particularly 'ghats'[1] on 'Gangardhaar'[2] (as called locally) has been guintessentially a montage of histories of a riparian village's transition to a megacity, its labour, livelihoods and political ecologies around a long, muddy, aqueous terrain. Thus, placemaking took place under the purview of colonial hydrological projects backed by the 'state hydraulic paradigm' (Gandy, 2004; Kaika, 2006; D'Souza, 2006; Legg, 2008) as well as postcolonial placemaking schemes. In an era of the rule of aesthetics (Ghertner, 2015), where cityscapes are produced as perfect visual artefacts, sites for best practices to build upon the image of the cities (Lynch, 1960), city's blue-green infrastructures often become critical sites of aesthetic transformation. This study aims to unravel the nuances of production of urban spaces along one such blue infrastructure, called the River Hooghly in Kolkata, through various historically rooted, placemaking processes - operating as a function of and in tandem with a gamut of characteristic social relations binding the city and its river. Therefore, ghats here provide us with a new optic to look into the water-society interfaces, the making and remaking of certain everyday waterscapes (Appadurai, 1996; Swyngedouw, 1999; Baviskar, 2007; Follmann, 2016; Stefanovic, 2019; Watson, 2019) redefining the specificities of 'hydrosocial relations' (Linton & Budds, 2014) between people, urban materialities, State and its governmentalities. An everydayness - that talks of the production of distinct relational spaces that are organic, performative, ritualistic, mundane yet socio-culturally politicised, pivoted around both subtle and blatant, material and symbolic contestations around power, inequality, meanings and values and which have contributed to a sustainable existence of the city for years.

[1] Flight of steps leading down to the river

[2] 'Dhaar' referring to 'edge of the river' or Riverfront. Here Hooghly being a tributary of the Ganga, riverfronts are often locally addressed as 'Gangar-dhaar'.

KEYWORDS River-front, Hydrosocial Relations, Blue Infrastructure, Urban Political Ecology
Healing Biotope: A Model of Living in Times of Sociopolitical and Economic Collapse

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A theoretical research of sustainable models of life is presented: the ecovillages, from their beginnings to the present time emphasizing in a model known as the healing biotope Tamera, located in Colos Portugal, structured in the principles of mutual care between people and the earth, performing the necessary activities to satisfy the individual and collective needs.

The Tamera model is explained from the concept of socio-ecological systems which includes the social, environmental, economic, and political dimensions, the involved stakeholders as well as the strengths, the limitations, and the aspects to be improved of this model. It was assessed through attributes and indicators based on evaluation methodologies adapted to this purpose, such as MESMIS (Framework for the Evaluation of Natural Resource Management Systems incorporating Sustainability Indicators) in conjunction with the Pressure-State-Response (PSR) framework.

Complexity maps are generated to evaluate the model and its relationship and performance in possible situations or scenarios like catastrophe (undesirable scenario), trend (current scenario), and becoming (desirable scenario). The obtained results for the current case of the healing biotope show the aspects to be improved (weak) and those that adequately maintain the system (stable), represented in an AMOEBA map. As a result, it is indicated that these emerging models are the product of a change in the current paradigm that requires greater efforts and understanding of natural systems by today's society, which allows to visualize and analyze their advantages and disadvantages concerning other conventional economic systems. However, the biotope model, since it does not present a final solution to many of the current problems, makes it possible to make a real approximation to what should be ideally achieved in several sectors of the society.

KEYWORDS Sustainability, socio-ecological systems, biotope, paradigm, society

Poster Booth

Modeling Current Hydro-Meteorological Variability in the Neelum Basin Using HBV-Light Model

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Pakistan is highly dependent on water resources originated from upper Indus Basin and Himalayan region. Proper monitoring and advanced studies on hydrological balance and impact of climate change on these resources are needed. For this purpose, HBV (Hydrologiska Byrans Vattenbalansavdeling) model was used. HBV-Light model is a semi-distributed conceptual rainfall-runoff model, consisted of three routines: snow and glacier, soil moisture and response function routine. It required daily discharge, daily precipitation, and daily temperature data as an input in addition to mean monthly potential evaporation values for simulation of stream flow on daily time step. HBV-Light model was used for the simulation of baseline streamflow. Model was calibrated and validated for the simulation of stream flows of Neelum River basin. Model performed well during both calibration and validation period. The results of this study could be useful for effective water management strategies and sustainable development for the future time period in that region.

KEYWORDS HBV

Forestry Solutions to Prevent Soil Erosion and Landslides in Ba River Basin

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Ba river is the largest river in Central Vietnam. Due to topographic and climate characteristics, the Ba river basin is often affected by multi hydro- meteorological hazards such as: flash flood, soil erosion and landslides. This paper aims to assess the current status of major forest types in the river basin portion lying in Kot Bang district of Gia Lai province. The indicators used to evaluate the protective capability are the structure, coverage and tree density of the forest. The results showed that the forest cover in this area is lower than the national average, tree density is not uniform. The protective capacity of the forest is not enough to cope with the risk of soil erosion and landslides. Therefore, it is necessary to improve the protective capacity of the forest management, forest restoration and reforestation. Besides, a model of watershed-based protective forest for soil erosion prevention was tested.

KEYWORDS The Ba river basin, Gia Lai province, forestry solution, erosion, landslide

Poster Booth

SWAT-Simulated Streamflow Response to Land Use, Climate Variability and Dam Management in the Mono River Basin, Togo-Benin, West Africa

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The sub-tropical regions of Africa are particularly vulnerable to the negative effects of climate change. Land use change and dam management additionally increase these vulnerabilities. The goal of this study was to simulate and compare streamflow using different land use and climate data in the Mono River Basin for the period before (1964-1986) and after (1988-2011) dam construction. The Soil and Water Assessment Tool (SWAT) which is using input data such as a digital elevation model, soil and land use, and daily climate data for the model set up was selected. Model sensitivity analysis, calibration and uncertainty analysis were performed based on daily observed streamflow using the Sequential Uncertainty Fitting procedure (SUFI-2) of the SWAT-CUP software. The SWAT model performance showed acceptable parameters value ranges during 1964-1986 and poor performances during 1988-2011 periods. The results of model performance and uncertainty analysis for the first period showed for the calibration periods the coefficient of determination R2> 0.50; the Kling-Gupta Efficiency KGE ≥ 0.60 and the absolute percent bias $|PBIAS| \le \pm 20$. Over validation periods, $R2 \ge$ 0.28; KGE \geq 0.40 and |PBIAS| \leq ±15 at each station. The simulated streamflow amplitude has decreased over the second period compared to the first period of simulations and differed from upstream to downstream stations. During the second period of simulation, the results indicate a good fitting of simulated streamflow with observations for the upstream station while in the downstream stations there was change in simulated streamflow compared to observations. This change showed that the construction of the dam in 1987 had affected the hydrological system of the watershed additionally to land use and climate variability impacts. The SWAT model can be used for streamflow simulation in the Mono watershed, although the model needs to be improved to account for the implementation of dam management.

KEYWORDS Climate variability; land use/cover; streamflow; SWAT model; hydrological modelling; Mono River Basin

Modeling Nutrient Distribution Patterns in Selected Coastal Lagoons in Ghana

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The Sakumono II and Gao lagoons are situated along the central coast of Ghana, West Africa. The lagoons provide a lot of services for these coastal communities. These services include fishing activities and also serve as habitat to some mangrove species. With the increasing rate of pollution these Lagoons cannot provide these services and are therefore affecting the livelihood of the people around these communities. This study sort to promote water security and hazard risks by modeling the levels of phosphate, nitrate, and ammonia in water from the Sakumono II and Gao lagoons. Data collected over six months was used in calibrating and predicting nutrient concentrations in the Sakumono II and Gao lagoons using the MIKE 3 model. Discharge rates measured were highest for Gao lagoon and lowest the Sakumono II, which may be linked to the width and depth of the lagoons. Sediment discharge rate results indicated that sediment nutrient concentration has a positive correlation with sediment discharge rate. Average sediment nutrient concentrations recorded for phosphate during the dry and rainy season for Sakumono II and Gao lagoon were (0.121 and 0.128mg/kg) and (1.42 and 1.22mg/kg) respectively. The average sediment nutrient concentrations recorded for ammonia during the dry and rainy season for Sakumono II and Gao lagoon were (37.18 and 25.85 mg/kg) and (4.58 and 4.31mg/kg) respectively. The average sediment nutrient concentrations recorded for nitrate during the dry and rainy season for Sakumono II and Gao lagoon were (14.54 and 11.55mg/ kg) and (3.83 and 3.46mg/kg) respectively. Average sediment discharge rates recorded in the Sakumono II and Gao lagoon for ammonia, nitrate and phosphate were (0.00000399 m3/s, 0.00000133m3/s and 0.0000000143m3/s) and (0.000021m3/s, 0.0000073m3/s and 0.0000000746m3/s) respectively. The results from this study will help inform managers on the current state of these lagoons and the need to protect these coastal waters.

KEYWORDS Ecological modeling, Lagoons, Discharge rates, Nutrients, Water quality

Poster Booth

Quantifying Teleconnection Pathways Leading to Low Rainfall Anomalies during Boreal Summer in Indonesian Borneo

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Teleconnections are sources of predictability for regional weather and climate, which can be represented by causal relationships between climate features in physically separated regions. In this study, teleconnections of low rainfall anomalies in Indonesian Borneo are analysed and quantified using causal inference theory and causal networks. Causal hypotheses are first developed based on climate model experiments in literature and then justified by means of partial regression analysis between NCEP reanalysis sea surface temperatures and climate indices (drivers) and rainfall data in Indonesian Borneo from various sources (target variable). We find that, as previous studies have highlighted, El Niño Southern Oscillation (ENSO) has a profound effect on rainfall in Indonesia Borneo, with positive Niño 3.4 index serving as a direct driver of low rainfall, also partially through reduced sea surface temperatures (SSTs) over Indonesian waters. On the other hand, Indian Ocean Dipole (IOD) influences Indonesian Borneo rainfall in through SSTs over the same area in the absence of direct link. This work informs the potential of a systematic causal approach to statistical inference as a powerful tool to verify and explore atmospheric teleconnections and enables seasonal forecasting to strengthen prevention and control of drought and fire multihazards over peatlands in the study region.

кеуwords Tropical teleconnections, Causal inference, Climate variability, Drought, Indonesia

Precipitation and Associated Extreme Storms Affecting Peninsular Malaysia in High-Resolution Global Climate Models

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Climate models are important tools to predict possible changes in storms and their associated precipitation and extremes under climate change conditions. This is particularly the case for Peninsular Malaysia where extreme precipitation can lead to flooding resulting in considerable economic losses and casualties. However, the ability of state-of-art climate models to simulate the storms and associated precipitation affecting Peninsular Malaysia and the impact of model resolution is not adequately understood. In this study, the ability of 19 global climate model (GCM) simulations from the CMIP6 HighResMIP models to simulate precipitation in Peninsular Malaysia is evaluated. The intercomparison among simulations at different model resolutions indicates that the GCMs with improved horizontal and vertical resolutions yield a better representation of the observed precipitation patterns in Peninsular Malaysia during both the Northeast and Southwest Monsoon seasons. Due to the close association between precipitation extremes and Borneo Vortices (BVs), an objective tracking algorithm of BV is used to evaluate the ability of the HadGEM3-GC31 (Hadley Centre Global Environment Model 3 - Global Coupled Version 3.1) simulations from HighResMIP to capture the climatology of BVs and associated precipitation. Compared with BVs identified in a climate reanalysis, the simulations at a relatively high horizontal resolution (N512, ~25 km) exhibit a better represention of the spatial distribution, lower-tropospheric structures and precipitation of BVs, compared to the lower resolution N96 (~135 km) and N216 (~65 km) simulations. The N512 simulation also exhibits an improved ability to reproduce the modulation of BV activity by the occurrence of northeasterly cold surges and active phases of Madden-Julian Oscillation in the region, including increased BV intensities, lifetimes and precipitation. A sufficiently high model resolution is thus found to be crucial to realistically simulate the present-climate precipitation extremes and their association with BVs and to study their possible changes in a warmer climate.

Poster Booth

Social-Economic Impacts of Sand Dam in Semi-Arid Agricultural Areas of Kenya

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About 80% of Kenya's terrestrial land is classified as Arid and Semi-Arid Lands, characterised by frequent, severe drought and climate extremes. A potentially simple and cost-effective mitigation measure against drought periods is sand dams. This little-known technology is designed to help farmers gain access to water for domestic and agricultural use during the dry seasons. They are concrete weirs built across seasonal river beds. The captured sand stores millions of litres of water upstream. It is estimated that there are over 2,800 sand dams in the South Eastern part of Kenya. On average, 350 people and 1,500 livestock units benefit from a single dam. However, very little systematic research has been done on sand dams. To assess their impact at farm level a "meta" impact assessment approach together with short field visits and own research is utilized. Results indicate that during the month of drought, the distance and time to fetch water have decreased at 67% and 46% respectively. The income, expenditure, and savings have increased significantly to 43%, 68%, and 37%, respectively. Farmers have also increased their assets in terms of number of bicycles (has risen with 240% since sand dam construction), radios increased with 107%. Based on an economic surplus model the rate of returns to the total cost of construction and maintenance of a single dam ranges from 130% to 189%. Even under highly unrealistic and extremely conservative assumptions on the conditions affecting the calculation of net social benefits, the investment is still highly justified. The study thus conclude that sand dams can potential mitigate drought events and have positive impact to the inhabitant of dry lands. Thus the number of sand dams should be increased especially in this era of climate change.

KEYWORDS Sand-dams Kenya Semi-Arid Economic Impact

When Low and High Streamflows are in Conflict: Using NMPSO to Provide a Multi-Objective Compromise Solution

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An adequate representation of the different hydrological processes of a catchment is of utmost importance in a changing climate, since decision making derived from such models can have large societal impacts. In this work a novel multi-objective optimization algorithm based on Particle Swarm Optimization (NMPSO) is used to calibrate the lumped TUWmodel hydrological model, with a focus on daily high, medium and low streamflows simultaneously - i.e. three different objectives - for the Currarrehue River Basin, located in southern Chile. Fourteen parameters of the TUWmodel were calibrated, using 19 (1995- 2016) and 21 (1980-1997 and 2017-2019) years for calibration and verification, respectively. Three goodness-of-fit (GoF) functions were used for calibration and verification: the well-known Nash-Sutcliffe Efficiency (NSE) to represent high flows, the modified Kling-Gupta Efficiency (KGE') to capture medium flows, and the NSE applied on inverse flow values (iNSE) to focus on low flows. Results obtained with NMPSO were compared against single-objective calibrations with each one of the three aforementioned GoF functions, using a state-of-the-art PSO algorithm. Results indicate that model parameters obtained with NMPSO are more robust than any of the individual parameter sets achieved with single-objective optimization. In particular, during calibration NMPSO gets a better and more balanced set of model performance, as shown by values of 0.86, 0.93, and 0.68 obtained for NSE, KGE' and iNSE, respectively; compared to the 0.86, 0.93, -1.01 obtained with single optimization of KGE'; 0.87, 0.89, 0.59 obtained with NSE; and 0.76, 0.87, 0.69 obtained with iNSE. Results obtained during the verification period follow the ones obtained during calibration. Therefore, the application of NMPSO as a multiobjective calibration algorithm is very promising to provide parameter sets able to represent different processes or different aspects of the same process which might conflict with each other.

KEYWORDS hydrological modeling, goodness of fit

Poster Booth

An Automated Drip Irrigation System for Watermelon Kaolack (Citrullus lantatus) Based on Climatic and Hydro-Physical Parameter Measurement and Control

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The experiment seeks to design a low-budget automatic irrigation system that allows for a more adequate way to nurture plants in the farm by implementing low voltage sensor technology in order to minimize wastage of water and manpower. This was achieved by implementing a sensing and actuating unit that comprise of moisture sensors that reads the moisture content in the soil, humidity sensor which measures the amount of moisture present in the atmosphere and the temperature sensor which measures the temperature of the soil. The microcontroller collects information from the sensors and then processes the data collected and then decide on whether to open or close the valve of the water pump based on the information received by the microcontroller. The data that is being read by the sensors is being sent to the user through an online Internet of Things (IoT) platform, displayed on the LCD and is also stored on an SD card within ranges of twentyfive minutes. However, it was discovered that when the automatic irrigation system is applied in real-life applications, for instance, on a larger scale of farming, it will result to high efficiency in nurturing plants to their maximum growth and produce on the farm or in the greenhouse system and this will result into maximum yields round the year for the farmers. The result was then collected for the period of one (1) week and there were variations for different days which were due to change in climatic conditions. The designed system worked optimally and is fully recommended for both small-scale and large-scale farmlands.

KEYWORDS Automatic irrigation system, watermelon, climatic and hydro-physical parameters, measurement and control

Lost Material Stock in Buildings due to Sea Level Rise from Global Warming: The Case of Fiji Islands

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This study developed a methodology to estimate the amount of construction material in coastal buildings which are lost due to climate change-induced sea level rise. The Republic of Fiji was chosen as a case study; sea level rise is based on predictions by the Intergovernmental Panel on Climate Change for the years 2050 and 2100. This study combines the concept of a geographic information system based digital inundation analysis with the concept of a material stock analysis. The findings show that about 4.5% of all existing buildings on Fiji might be inundated by 2050 because of an expected global sea level rise of 0.22 m (scenario 1) and 6.2% by 2100 for a sea level rise of 0.63 m (scenario 2). The number of buildings inundated by 2050 is equivalent to 40% of the average number of new constructed buildings in Fiji Islands in a single year. Overall, the amount of materials present in buildings which will be inundated by 2050 is 900,000 metric tons (815,650 metric tons of concrete, 52,100 metric tons of timber, and 31,680 metric tons of steel). By 2100, this amount is expected to grow to 1,151,000 metric tons (1,130,160 metric tons of concrete, 69,760 metric tons of timber, and 51,320 metric tons of steel). This study is a first attempt at quantifying the amount of materials rendered unusable by SLR. By explicitly quantifying the number of buildings and amount of materials that will be under water, policymakers have a valid dataset which can contribute to planning adaptation actions to climate change such as the estimation of demolition and recycling flows and the planning of resource demands. The present study's results could be additionally used on Fiji to create maps with secondary resources including an approximate date on which they would become available.

KEYWORDS island metabolism, material stock analysis, sea level rise, GIS

Poster Booth

Review of Textile Waste Water Treatment Using Constructed Wetlands

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Wastewater of industrial textile industries activities has the potential to pollute the environment. Textile wastewater contains organic pollutants and organic dyes which are difficult to degrade through simple processing. The quantity of textile wastewater varies greatly depending on the input of each production process. If these parameters exceed the environmental guality standards in accordance with the Decree of the Indonesian Minister of the Environment Number 51/1995 concerning Quality Standards for Industrial Wastewater, industrial activities are required to treat textile wastewater before it is discharged into water bodies. Various technologies for treating textile wastewater have been developed through several physical, chemical, and biological approaches. One of the operating units to control textile wastewater is constructed wetlands to reduce hazardous contaminants. Constructed wetlands are designed and built using natural processes that involve the relationship between plants, soil and microbes. This method is an alternative for treating textile wastewater because it uses less energy, low maintenance costs, and has high ecological value. The aim of this study was to describe the processing of constructed wetlands with the mechanism for processing textile waste through various operational parameters. The constructed wetlands can be used alternatively to optimize the appropriate planning criteria and operational variables such as initial pH, current density, and operating time.

KEYWORDS Constructed wetlands, industrial, organic, wastewater

A Proggram Framework for Collaboration on Sustainable Water Resources Management in Southeast Asia

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Global variability in temperature, evaporation, and precipitation associated with climate change will alter the hydrological cycle including the intensity, frequency, and timing of extreme hydrological events. It is expected to modify river flow regimes, irrigation requirements, and agricultural bio-ecosystem. In Southeast Asia, higher temperatures, pronounced drought, and precipitation are expected. Freshwater availability especially in big river basins is forecasted to decrease by 2050 while flooding, saltwater intrusion, and destructive typhoons are expected to threaten some of the region's populated deltas. The freshwater resources are already under increasing pressure from rising demands, wastewater pollution, and land-use change. Climate change will further exacerbate the risks and pressures on the water resources, which could lead to overexploitation of the resources. The key challenge for the region is managing competing demands in the context of climate change towards water- and food-secure future.

This paper presents a proposed program framework for collaboration for sustainable water resources management for water and food security in Southeast Asia with a focus on four themes namely, (1) managing high variability of water supply in agriculture; (2) integrated river basin management challenges and cooperation; (3) modernizing agriculture for improved crop and water productivity; (4) policy support to water security in agriculture. The themes are results from a regional consultation conducted by SEARCA aimed at developing a platform for strengthened collaboration on sustainable water resources management. Through this platform, key institutions and agencies can collaborate through research and development, knowledge management, and capacity building programs to address the needs and gaps in the current initiatives on water resources management in Southeast Asia and to further prepare for the uncertainties brought by climate change in the region.

KEYWORDS sustainable water resources management, integrated river management, water security

Poster Booth

Modelling Lahar Initiation from Rainfall: Reconstruction of 3rd December 2019 Maninila Lahar at Mayon Volcano

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Rainfall-triggered lahars are an important volcanic hazard. Forecasting and assessment of their hazard requires the integration of dynamic models of lahar flow with predictive models for their initiation mechanisms. This study explores the use of hydrological modelling to provide initial conditions for modelling rainfall-driven lahars, using detailed topogrgaphic and deposit mapping from a recent lahar in the Philippines to test this approach.

Early on 3rd December 2019, intense rainfall from Typhoon Tisoy remobilised ash from the 2018 Mayon eruption into a lahar which flowed down the Maninila river valley. The flow produced deposits up to 1.5 m thick, transported boulders up to 1.8 m in diameter, and damaged infrastructure and houses in an avulsion at San Francisco Barangay. Our field team from Philippine Institute of Volcanology and Seismology (PHIVOLCS) were able to compile a detailed dataset of deposit and flow observations, and pre- and post-event high resolution drone-derived digital surface maps (DSM).

We reconstructed the 3rd December 2019 lahar using the hydrological modelling framework DECIPHER at catchment scale to provide initial conditions for the dynamic lahar model LaharFLow. DECIPHER was implemented on a 5 m DSM of the catchment, using as input 10 minute rainfall measurements from nearby Guinobatan and Camalig stations. DECIPHER output was used to drive runoff and shallow landsliding inputs into LaharFlow, which was run on a combination of 5 m and 0.5 m drone DSMs. We found that this combined model approach can provide a reasonable reproduction of the observed flow conditions and deposits, but these are sensitive to modelled substrate erosion rates, which need careful calibration. In this presentation, we discuss data needs and challenges of initiating lahar flow models with hydrological models of rainfall.

KEYWORDS Lahar, Typhoon, Hazard Modelling, Hydrology, Risk Reduction

Preliminary Analysis of Effluent from Wastewater Treatment Plant for Indirect Potable Reuse in Overexploited Aquifer

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The artificial recharge with wastewater has been used as an alternative to counteract the overexploitation of aquifers and contribute to the availability of water. In this work, the effluent of the wastewater treatment plant of the municipalities of Zacatecas and Guadalupe (Mexico), called "Osiris" (22°46'31''N y 102°27'07''W) was evaluated for indirect potable use in an overexploited aquifer named "Calera", which is part of the system that supplies water to the conurbated zone of the Zacatecas-Guadalupe municipalities. This analysis was based on Mexican standard NOM-014-CONAGUA-2003, the analysis of water quality parameters request was the presence of pathogenic microorganisms, biological oxygen demand (BOD5) and those established by Mexican standard NOM-127-SSA1-1994 (except radioactivity). Alternatives were proposed to removal those contaminants and to improve parameters outside of the limits in the wastewater treatment plant.

The samples analyzed from wastewater treatment plant effluent gave results outside the limits only in terms of arsenic (0.12 mg / L), total dissolved solids (1,239 mg / L) and total fecal coliforms (152 NMP / 100 mL). In the case of arsenic, it is found in the compatibility with the native water of the aquifer, for which Mexican standard allows the recharge in that aspect. It should be reduced the amount of dissolved solids, for that, it is necessary to improve the maintenance of the secondary treatment due to the infiltration of a considerable quantity of sludge to the tertiary treatment. A change in the voltage of the UV lamp of disinfection was proposed to reduce the coliforms. These changes would make the water suitable to be recharged.

KEYWORDS Mexican standard, overexploited aquifer, water quality parameters, water artificial recharge

Poster Booth

Spatio-Temporal Assessment of Chlorine Residuals in the Water Distribution System of Dhaka City

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This study assesses the effectiveness of the baseline chlorination system adopted in a particular DMA 505 (District Metered Area) of Dhaka city by performing residual chlorine measurements at selected locations within the network by predicting the concentration of residual chlorine over space and time under various operating conditions using EPANET 2.0. The residual chlorine model was calibrated and validated using time-patterns of residual chlorine concentration data collected at several control points within the DMA and the sensitivity of the residual chlorine model were done over a variety of conditions. The bulk residual chlorine decay rate (kb) was found to be -0.2975 h-1 through laboratory experiments. The wall residual chlorine decay rate constant (kw) was found to be -0.0065 ft/s through calibration. Also, the residual chlorine modeling using EPANET 2.0 was carried out to simulate the residual chlorine in the water distribution network of the DMA as well as to determine the most optimum locations of chlorine injection points. It has been found that more than 50% pipes do not get any chlorine under the present chlorination scheme. Inclusion of additional chlorine injection points had increased the chlorine coverage area of the network. It was noted that 100% chlorine coverage was not obtained over 24 hours, even with all six injection points was used and therefore, additional protection measures to ensure water quality needs to be provided in certain sections of the network. EPANET 2.0 is a predictive tool that may be used for controlling the concentration of residual chlorine and assessing the effectiveness of the existing chlorination system spatially and temporally within a very short time in the different DMAs under DWASA (Dhaka Water Supply and Sewerage Authority).

κεγwords DMA; DWASA; Water distribution network; Residual chlorine; Bulk decay rate; Wall decay rate; EPANET 2.0; Calibration; Validation; Simulation

Mapping and Identifying Hot Spots of Research on Flash Drought: A Quantitative and Key-Word Biclustering Analysis

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Keywords are highly abstract topics, covering the core point of a paper, so keyword analysis is conducive to mining the research hot spots and the evolution of the hot spots. In recent years, research on the Flash drought has become an increasingly important scholarly focus. However, there have been no biclustering studies to date on hot spots of flash drought. A summary of the most frequently used keywords obtained from the title, author keywords and keywords plus analysis provided the clues to discover the current research emphases. The purpose of this study is to map the author keywords and explore research hot spots of flash drought. A biclustering analysis based on Scopus database was conducted to investigate the publication trends of authors keywords on flash drought. A bibliometric R package and VOS viewer software are used to study the trends and, biclustering analysis to detect the hot spots in the field of flash drought. A total of 44 publications were found in Scopus database from 2000-2019. Out of these 44 publications, 394 keywords plus and 109 authors keywords are observed. The top five keywords are "Evapotranspiration", "Flash Drought", "Drought", "Soil moisture" and "Agriculture". The network analysis of authors keyword highlights the five research hot spots: (1) Climate change impacts, adaptation, and risk assessment of extreme events, (2) Agriculture production and food security issues caused by flash drought events, (3) Indicators for the assessment of flash droughts-like evapotranspiration, soil moisture, and precipitation, (4) monitoring and the development of an early warning system for flash drought in the growing season of agriculture production, (5) Land atmospheric feedback mechanisms such as air temperature, hydrological cycle, and atmospheric-oceanic interaction. The major research hot spots could provide some hints for researchers to get a comprehensive understanding of the state-of-the-art research trends in flash drought.

KEYWORDS Flash Drought, Drought, Research Hotspot, Keywords Network

Poster Booth

Quantifying and Mitigating Climate Change Implications on Eco-hydrodynamics of Lake Burullus, (Egypt)

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Lake Burullus is a typical eutrophic shallow brackish lagoon lies totally inside the Nile delta featuring a restricted connectivity with the Mediterranean Sea via a narrow channel at its northeastern corner. The lagoon environment is prone to serious threats due to climate change and the resulting in sea level rise that act to bedevil the water exchange with the sea and accordingly boost spatio-temporal heterogeneity throughout its basin with consequences for ecological processes. The purpose of this work is assessing the feasibility of some advocated measures and discuss theirs possibility considering as mitigation management actions against likely anthropogenic-induced impacts. A two-dimensional (2D) finite element model has been employed to simulate the lagoon key eco-hydrodynamic traits, including water temperature, salinity, water renewal times as well as velocity, current fields within its basin, and fluxes through the inlet under observed meteorological and hydrological conditions. The simulations were fine-adjusted based on daily gauged water levels, seasonal measurements of salinity and temperature, and monthly exchange fluxes within the lagoon mouth. Forcing the lagoon calibrated model with bias corrected regional climatic projections estimated under three representative concentration pathways (RCPs) and corresponding local sea level projected offshore the Nile delta, dramatic alterations of the lagoon water budget, circulation pattern, residence time, water temperature and salinity have been obtained. Combined scenarios of climatic and land use changes take the system beyond the threshold of sustainability where the modified current dynamics and resulted prolonged residence time could affect the chemical composition of the lagoon waters and diminish fishing capacities in a significant way. The proposed management actions revealed considerable roles to enhance the lagoon adaptive capability. The case of the simultaneous dredging of new inlet and radial channels in the lagoon bed is the most effective where the e ects are accumulative and spread over the whole lagoon area.

KEYWORDS socioeconomic impacts, drought, river basin, Muriaé basin, rural area

Efficient Irrigation Management Based on the Data through Telemetry(TM) System In Vietnam

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Irrigation sector has been facing adaptation to climate change and degradation of aging facilities with limited budget, while it has been essential in food production. Now the irrigation sector in Vietnam needs to be more efficient and modernized as the new law on irrigation has been enforced.

Efficient management of irrigation requires measurement of data on water level, water volume and rainfall. These data have been collected by sight and recorded manually. Human errors and inaccuracy are common. The measuring facility used tends to be expensive and have data interruption.

With advancement of IT technologies, precise and low cost TM system is available. A new TM system sends measured data through mobile phone networks to cloud server, and show data on smart phones by the internet. Timely data collection, quick feedback and data sharing are possible for water management.

In the area of South Nghe An IMC, 36 water level sensors and 12 rainfall sensors were installed at major gates, main canals and main pumping stations in 2017 and 2019. The TM data have been transmitted without interruption.

Based on the TM data, the operation at TB16B pumping station has been improved to reduce electricity cost by shifting operation hours to less expensive charged hours. The relationship of the water levels between the main intake gates and pumping stations has been clarified by TM data so that the gates and the pumps will be operated efficiently in future.

KEYWORDS TM system, efficient irrigation management, IT

Poster Booth

Timing of Proper Paddy Planting Based on Wet and Dry Season Patterns in South Sumatra

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Timing of paddy planting in South Sumatra was necessary for adaptation to the season changes based on wet and dry season patterns. Pattern determine of the wet and dry seasons was done by analyzing rainfall data in South Sumatra for 10 vears from initial and latest data (1976-1985 and 2010-2019) was collected from the National Agency for Meteorology, Climatology, and Geophysics. Interpolation of rainfall and evapotranspiration (Hargreaves model) data was used to show the water balance. Timing of paddy planting was made with the consideration of data from wet and dry seasons pattern analysis, the growth phase of 140 days (imbibition-harvesting) and the assumption that the harvest was carried out 20 days after the start of the dry season. Rainfall data showed differences in the amount and period. The minimum monthly average rainfall for 1976-1985 occurred in August and for 2010-2019 occurred in July, with the average total rainfall from 1976-1985 < 2010-2019. Wet and dry seasons analysis showed that the dry season average for 1976-1985 and 2010-2019 started on 172 Julian day, while the dry season for 1976-1985 ended on 258 Julian day and for 2010-2019 on 269 Julian day and it was 10 days longer. Availability of water in the wet season of 1976-1985 < 2010-2019 and the water deficit in the dry season of 1976-1985 < 2010-2019. Timing of paddy planting was based on the results of wet and dry season patterns analysis started from 52 Julian day (imbibition) to 191 Julian day (harvesting).

KEYWORDS South Sumatra, Timing of paddy planting, Wet and dry season patterns

Assessment of Groundwater Nitrate Concentration in the Island Municipality of Panglao, Bohol, Philippines

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The study was conducted in the Municipality of Panglao, Bohol, Philippines to characterize the spatial variation of groundwater quality with emphasis on nitrate concentration, identify and assess the relative importance of anthropogenic and natural factors in influencing the nitrate concentration in groundwater, and recommend possible solutions to any existing groundwater-related problems in the area. A total of 81 wells were sampled for the water quality parameters such as pH, dissolved oxygen (DO), electrical conductivity (EC), total dissolved solids (TDS), sodium chloride (NaCl), temperature, and nitrate-N conducted during very dry season without precipitation. ArcGIS 10.6 and multiple regression analysis were used to analyze the data.

Results showed that about 40% of the study area's nitrate concentration exceeded the maximum contaminant level (MCL) of 10 mg/L as set by US EPA under the Safe Drinking Water Act. The water quality was poor mostly in barangays with high-density built-up and along the foreshore. On the average, pH was 7.44, DO was 4.27 mg/L, EC was 3954.82 µs, TDS was 3480.60 mg/L, NaCl was 4377.50 ppm, temperature was 29.36°C and nitrate was 11.05 mg/L.

The multiple regression analysis showed that nitrate is significantly predicted by well to shoreline distance and 2D IDW. The T-test results indicated that the level nitrate concentration differ significantly between the types of well which was found to be higher in shallow wells and lower in deep wells.

Based on the overall results, the following recommendations were drawn for the Municipality of Panglao to implement: a) install a wastewater treatment facility to address the unfavorable presence of nitrate and other contaminants in the groundwater, and b) enact relevant ordinances to stop the rising influences of nitrate concentration and other water contaminants of its groundwater which are detrimental both to its growing population and to the environment.

KEYWORDS Groundwater, Groundwater water quality, nitrate level, nitrate contamination

Poster Booth

Numerical Simulation of Residence Time for Different Floating Treatment Wetland Designs

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Floating treatment wetlands (FTWs) are becoming a relevant nature-based solution that promotes water, stormwater and wastewater treatment by using vegetation growing hydroponically on top of a floating mat. This way, not only treatment is achieved by the vegetation, but ecological benefits linked to the presence of floating vegetation are also obtained. In contrast to traditional constructed wetlands, FTWs do not require land space because they are installed directly on the water body's surface. The treatment is performed by the plants' roots and the biofilm that grows attached to the roots, which together absorb nutrients, pollutants and suspended solids. The treatment of a FTW is, among other factors, time-dependent, which means that the removal performance is partly controlled by the residence time of the above substances inside the FTW. Therefore, this study aims to numerically estimate the residence time of three different FTW designs displayed in a channel reach, in order to assess whether the designs significantly impact the residence time. In Design 1, three FTWs in series will be installed at the channel center. Design 2 will be formed by three FTWs in series, each one spanning the channel width. Finally, Design 3 will be formed by two FTWs displayed at each margin of the channel. The total FTW volume will remain constant for all designs. The simulations will be performed in Computational Fluid Dynamics (CFD), using a validated FTW model from laboratory experiments and a volumetric tracer test.

KEYWORDS wetlands, CFD, residence time, design

Application of the Flowforms for Urban Landfill Leachte Treatment

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With over 600 municipal solid waste landfill in Vietnam, there is an ongoing demand for approaches in landfill leachate treatment, which would avoid expensive investment and operating costs. A lab-scale research of application of flowforms and aerated lagoons for improving the quality of landfill effluent has been carriedout during the period of March and April, 2017 at the Laboratory of the Department of Technology and Environmental Management, National University of Civil Engineering, Hanoi, Vietnam. An experimental setup consisting of a cascade of 10 flowforms, followed by a reservoir, operating with recirculating flow was used for examining its ability in treatment of diluted leachate. Results of operation have shown that, despite being a static and simple solution, the flowform cascade was capable of increasing the concentration of dissolved oxygen (DO) to above 5 mg/L, while the processing efficiencies of the whole system were as high as 78%, 76% and 81% for COD, NH4+ and color, respectively. The results of this study showed that flowforms in tandem with aerated lagoons, as a low-cost treatment solution can be applied for improving quality of landfill effluent and contributing to control of the pollution from landfills.

KEYWORDS Landfill, leachate, pond, flowforms, dissolved oxygen

Poster Booth

Assessment of Water Shortage in Ba River Basin

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Water scarcity is a widespread issue in many parts of the world. Assessment of water shortage in various conditions is very essential for effective water resources management in basin scale. In this study, a water shortage assessment was performed for Ba river basin in several conditions. The different approaches were integrated to estimate water potential and water demand. Mike Nam mode model was simulated to identify the surface water potential, associate with groundwater survey information to define water potential. Cropwat mode was used to estimate water demand for agriculture, while other demands were defined by the statistical method. The water balance calculation is based on the WEAP model. The study divides calculated basins into small sub-basins to assess the temporal and spatial water shortage. The results show that, even under favorable conditions, the Ba river basin has certain areas of water shortage for a certain period of time.

KEYWORDS Water shortage, water resources management, MIKE NAM, CROPWAT, WEAP

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