Applying climate indices to map occurrences of droughts, floods, and heat waves in Sweden

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Background

Hydroclimatic hazards, including heat waves, droughts, and floods, are on the rise in frequency and intensity worldwide due to climate change, leading to significant consequences for the environment, human health, and infrastructure. European heat waves have been linked to increased mortality rates and the accelerated spread of infectious diseases like Covid-19. Droughts negatively impact agriculture, energy production, and water supply, while flooding causes severe damage to critical infrastructure, disrupting livelihoods and essential networks. The co-occurrence of these hydroclimatic extremes can amplify their impacts. Understanding spatial-temporal patterns is crucial for assessing risks and selecting effective adaptation measures. This study focuses on hotspots of hydroclimatic hazards, utilizing climate indices, and emphasizes the need for regional studies in developing adaptation strategies. The assessment involves daily air temperature, precipitation, river discharge, and associated climate indices, with the selection of indicators based on the receiver operating characteristic method for detection skill evaluation against extreme events.

Method

The study developed a comprehensive framework consisting of four main components: data collection and processing, validation and selection of indicators, single hazard mapping, and compound hazard mapping. The study focused on a 100-year period (1922-2021) in Sweden, which spans three distinct climate zones. The high availability of hydrometeorological data in Sweden made it a suitable case for investigating prolonged climate trends. The data collection involved retrieving environmental parameters from meteorological and hydrological observations, and the methodology included the application of standardized indices for heat waves, droughts, and floods. The study evaluated the performance of environmental parameters and indices against documented extremes using receiver operating characteristic curves to assess hazard detection skill. The optimal indicators and thresholds for each hazard were then utilized to map the spatial distribution of hotspots and trends of single and co-occurring extremes in Sweden. The Likelihood Multiplication Factor was employed to explore the dependence between co-occurring hazards and evaluate their compound impact potential. The study's findings contribute to a better understanding of hydroclimatic hazards in Sweden and provide valuable insights for developing effective adaptation and mitigation strategies at the regional level.

Conclusion

A novel multi-hazard mapping approach was developed to analyze floods, heat waves, droughts, and their co-occurrences in Sweden, utilizing environmental indicators derived from temperature, precipitation, and discharge data spanning a century. The study assessed indicator performance by comparing them to historical extreme events at a regional scale, identifying a heat wave index based on SMHI’s definition as the most suitable indicator for heat wave detection. Standardized Precipitation and Evapotranspiration Index with 12-month accumulation period and the Daily Flood Index were identified as the most effective indicators for droughts, and floods, respectively. Increasing trends in heat wave and flood hazards were observed, along with compound drought-heatwave and drought-flood hotspots. The study recommends future research on socio-economic risk models and early warning systems for hydroclimatic hazards. The findings provide valuable decision support for climate adaptation planners, highlighting critical trends and impact areas for prioritizing preventive measures.

Research Gaps and Priorities for Terrestrial Water and Earth System Connections from Catchment to Global Scale

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Background

The out-of-sight groundwater and visible but much less extensive surface waters on land constitute a linked terrestrial water system around the planet. Research is crucial for our understanding of these terrestrial water system links and interactions with other geosystems and key challenges of Earth System change.

Method

This study uses a scoping review approach to discuss and identify topical, methodological and geographical gaps and priorities for research on these links and interactions of the coupled ground- and surface water (GSW) system at scales of whole-catchments or greater.

Conclusion

Results show that the large-scale GSW system is considered in just a small part (0.4-0.8%) of all studies (order of 10^5 for each topic) of either groundwater or surface water flow, storage, or quality at any scale. While relatively many of the large-scale GSW studies consider links with the atmosphere or climate (8-43%), considerably fewer address links with: (a) the cryosphere or coastal ocean as additional interacting geosystems (5-9%); (b) change drivers/pressures of land-use, water use, or the energy or food nexus (2-12%); (c) change impacts related to health, biodiversity or ecosystem services (1-4%). Methodologically, use of remote sensing data and participatory methods is small, while South America and Africa emerge as the least studied geographic regions. The paper discusses why these topical, methodological and geographical findings indicate important research gaps and priorities for the large-scale coupled terrestrial GSW system and its roles in the future of the Earth System.

Federated Learning for Water Leakage Detection Using Prototype-based Models

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Background

In this work, we explore the important intricate trade-offs in intelligent systems: the efficiency of leakage detection tasks, the preservation of sensitive information, and the interpretability of the intelligent system. Through a comprehensive analysis of these interconnected domains, we aim to design a low-cost algorithmic solution that can efficiently learn from industrial data collected by distributed sensors while preserving sensitive information.
In particular, we mainly focus on proposing an efficient and low-complexity distributed solution for identifying potential leaks in water distribution networks (WDNs) in municipal areas while ensuring the privacy of the hydraulic data. To this end, we explore and extend existing theories and methods from prototype-based learning (PBL) and federated learning (FL). We consider a hydraulic dataset, which includes water pressure and flow measurements obtained from pumps within district-metered areas in Stockholm, Sweden.

Method

By implementing a centralized PBL method and proposing a distributed (federated) PBL method, we create realistic and compact sets to generate representative samples for leakage detection in the WDN. Firstly, we train a reduced number of prototypes to represent the observed hydraulic data into comprehensible subgroups. Then, we use the trained prototypes to process operational condition predictions. Finally, we compare the performance of the distributed and centralized approaches concerning the water leakage detection rates.

For each run, three steps of the proposed methodology are carried out: (i) canonical discriminant analysis of the training set for each pumping station; (ii) training of the matrix of prototypes; and (iii) evaluation of the clustering procedure. Specifically, we label each cluster according to the class that appears most frequently within it. At the end of each run, we evaluate the purity rate, which denotes the ratio of the correctly matched class and cluster labels to the total of data samples.

We examine our results through numerical simulations considering full sensor participation, i.e. all pumping stations participate in the distributed training. We consider a maximum of $T = 800$ global iterations to communicate with the sensors, and then 10 iterations locally at each sensor. For the FL results, we start by randomly selecting five normal samples and five leakage samples from a pumping station to build the initial local learning model. For the centralized framework, we randomly select normal and leakage samples from the dataset to build the initial centralized model.

Conclusion

The numerical results evidenced the viability and potential benefits of combining PBL and FL. Specifically, our experiments showed that the proposed learning method can obtain higher leakage detection rates at each station than the conventional centralized approach. We show improvements of purity rates up to 7.6% in one of the pumping stations, which increased the minimum values from 92.13%, obtained through centralized learning, to 99.11%, obtained via federated PBL. Although our analysis are constrained to a specific federated PBL method, we hope our insights can inspire future works on other distributed clustering methods for water leakage detection.

Humans, Water, and Climate change – Global analysis of Water Conflict and Cooperation

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Background

Over the past decade, water conflicts have risen, and cooperation has declined. Research highlights multiple factors driving this change, with climate change acting as a threat multiplier. Human activities, like dam construction and irrigation, and climate-induced hydro-climatic shifts, including extreme precipitation and prolonged droughts, contribute to the risk of increased water conflicts. Connections between water flows and conflicts remain unclear due to incomplete datasets on water-related conflict-cooperation events and poor understanding of socioeconomic and biophysical causes of such conflicts. Disentangling various drivers of water-related cooperation and conflict pathways, with more complete datasets on water-related conflict-cooperation events and a detailed understanding of socio-economic and biophysical causes of such conflicts, is necessary for resolving conflicts and building peace.

Method

As part of this study, we have compiled a new openly available global dataset on water-related conflict-cooperation events that extends to 2019, updating previous datasets that covered only up to 2008, yielding important new insights on cooperation-conflict trends. This allows us to investigate cooperation and conflict events worldwide in the last 70 years, together with climatic and socioeconomic factors, such as wealth, export dependency, demographics, water use, and hydro-climate trends. Relationships between investigated factors and cooperation are analyzed by combining panel data analysis and qualitative text content analysis of events. The results provide a deeper understanding of the factors behind why certain events are more successful in achieving conflict mitigation than others.

Conclusion

The new dataset revealed a worrying trend shifting the cooperation-conflict balance, with conflict events increasing and outnumbering cooperation events in 2017. Regional analysis shows connections with increased conflicts and long periods of drought in Africa, while shifts in Asia related to irrigation and dam construction. The trend towards less cooperation and more conflict highlights the need for effective water management adapted to local and regional drivers of change (climate or anthropogenic), focusing on forming collaborations based on current and projected water availability. Economic collaboration can be an effective tool for enhancing resilience in high-water stress areas, as cooperation between countries struggling with water-related challenges was found to reduce expected conflicts over the next five years while simultaneously improving economic prosperity. Understanding successful conflict mitigation factors can provide helpful insights to global policymakers and leaders in water management to avoid future conflict based on current and projected water availability.

Comparative Analysis of Multi-Agent Multi-Criteria Decision-Making Methods for Evaluating Management Scenarios for Enhancing Water Resources Carrying Capacity

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Background

Due to water scarcity on both global and local levels, promoting sustainable management approaches and enhancing water resources carrying capacity (WRCC) have progressively become an issue of paramount importance for decision-makers. WRCC refers to the maximum ability of water resources to supply water for economic development, human well-being, and ecological conservation. Studies have indicated that considering the collective preference of influential stakeholders and their role in decision-making processes can result in selecting more reliable management scenarios. Several methods have been introduced to find a collective solution that takes the preferences and benefits of different stakeholders into consideration, among which are Simple Additive Weighted (SAW), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), Complex Proportional Assessment (COPRAS), Evidential Reasoning (ER) approach, and Analytical Hierarchical Process (AHP).

Method

This study compares the results of four different MCDM methods for selecting the best scenario for ameliorating the WRCC, namely COPRAS, ER, TOPSIS, and AHP. First, using the Pressure-Support-State (PSS) framework, the WRCC of the Zarrinehrud river basin in northwestern Iran between 2020 and 2050 is evaluated. Then, the best management scenario is selected and compared under the following modes: 1) considering stakeholders and their hierarchical structure, 2) considering influential stakeholders without taking their hierarchical structure into account, and 3) not considering the stakeholders. Using the COPRAS method, all three modes are investigated for scenario selection, while ER and TOPSIS are conducted for the second and third modes, and AHP is implemented only under the third mode. COPRAS, by considering cost and benefit criteria under two different categories in the calculation process, aims to find the most preferable answer. The ER approach enables the consideration of the uncertainties associated with criteria assessment in the selection process. The TOPSIS method relies on the idea that the selected alternative should have minimal proximity to the positive ideal solution (i.e., the most favorable option) and maximum distance from the negative ideal solution (i.e., the worst option). AHP, a widely applied method, is built on the premise of humans' ability to compare pairs of options regarding a given criterion. Here, 128 carrying capacity scenarios (SC), generated from combining seven projects of water allocation from new resources (1), modern irrigation methods (2), facilitating and increasing inflow to the basin (3), improving drainage and irrigation network (4), low-cost (5), medium-cost (6), and high-cost agricultural improvement projects (7) in different orders were scrutinized using the methods mentioned above and decision criteria concerning carrying capacity (e.g., initial carrying capacity, average carrying capacity), and economic-based criteria (e.g., implementation cost, risk of lack of funding).

Conclusion

Employing COPRAS, the scenarios SC_{12356}, SC_{12356}, and SC_{123467} were identified as the best scenarios for the first, second, and third modes, respectively (the subscripts denote the project implemented in each scenario). The ER approach selected scenarios SC_{12356}, $SC_{12356,}$ and TOPSIS yielded for scenarios SC_{12356} and SC_{1247} under modes two and three. By employing AHP under mode three, scenario $SC_{1234567}$ was chosen. The selection of the same scenario by the COPRAS, ER, and TOPSIS approaches may be attributed to the modest variation in the relative weights of decision criteria according to different stakeholders and the rigorous structure of the proposed scenarios. Comparing the costs and average WRCC of the selected scenarios (which are $65, $50, $72, and $90 million for

SC_{1247}, SC_{12356}, SC_{123467}, and $SC_{1234567}$, respectively, and 0.74, 0.7, 0.74, and 0.7 average WRCC for the same scenarios), makes it evident that considering the stakeholders leads to more reliable solutions.

Distinctive Patterns of Water Level Change in Swedish Lakes Driven by Climate and Human Regulation

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Background

Covering over 2% of the Earth’s surface, lakes are important sources of freshwater for the agricultural and urban sectors and contribute to aquatic and terrestrial ecosystem services. Since climatic change and anthropogenic activities negatively impact their ecosystem functioning, lake water level monitoring can deliver information on the ecological status of a lake ecosystem and the drivers of change. Yet, lake water level changes are often overlooked; in-situ water level stations are unevenly distributed, and their number is declining worldwide due to expensive installation and maintenance and logistic difficulties, especially for small lakes and those in remote areas. In the case of Sweden, the more than 100,000 existing lakes extend over 9% of the country's surface area and are a central component of the hydrologic cycle and ecological systems, but to date, there is no comprehensive study on the variability and recent changes in lake water levels.

Method

Satellite radar altimetry (RA) is an alternative to conventional in-situ gauges to measure lake water levels. Radar altimeters measure water levels based on the travel time of an electromagnetic wave emitted in the nadir direction and backscattered by a water surface. Data from multiple altimetry missions can achieve high temporal resolutions over lakes and a long time series of water levels. We use and combine RA data in 106 lakes within 1995-2022 and from the following missions: European Remote-Sensing Satellite (ERS-2), Environmental Satellite (ENVISAT), Joint Altimetry Satellite Oceanography Network (JASON-1,2,3), Satellite with ARgos and ALtiKa (SARAL), Sentinel-3A, and Sentinel-3B. In addition to RA-derived water level observations, we use water level time series from 38 gauged lakes to generate a dataset for 144 lakes and analyze the annual and seasonal trends of water levels and their variability. Finally, we compare these changes with temperature and precipitation for each lake, surface area, lake type (regulated/non-regulated lakes), elevation, and volume to differentiate the contribution of each factor in lake water level trends and variabilities.

Conclusion

We find that during 1995-2022, around 52% of the 144 lakes exhibited an increasing trend and 43% a decreasing trend. Most lakes exhibiting an increasing trend were in the north of Sweden, while most lakes showing a decreasing trend were in the south. Regarding the potential effects of regulation, we found that unregulated lakes had smaller trends in water level and dynamic storage than regulated ones. The seasonal pattern of water levels in the lakes in the north of Sweden is similar in regulated and unregulated lakes. Instead, in the south, the seasonal patterns of water levels were substantially affected by regulation. This study highlights the need to continuously monitor lake water levels for adaptation strategies in the face of climate change and understand the downstream effects of water regulatory schemes.

Strategic Integration of Green Spaces for Sustainable Water and Energy Management in Rapidly Urbanizing Regions: A Case Study of the Kan River Basin

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Background

Unbridled urbanization's most profound consequence is the irreversible transformation of natural landscapes. Mitigating the cascading challenges necessitates a paradigm shift towards holistic, biocentric urban planning that prioritizes not only bolstering urban resilience against climate change and extreme weather, but also fostering biodiversity, purifying air, and crafting healthier, more livable spaces for all. By strategically weaving nature into the very fabric of our cities, we can create a tapestry of resilient, and vibrant communities for generations to come. Amidst the towering skyscrapers and bustling streets of urban landscapes, green spaces emerge as vital sanctuaries for people and the planet. They contribute to the aesthetic beauty, recreational enjoyment, heat island and noise pollution reduction, and environmental sustainability of cities, making them vital components of any thriving urban landscape.

Method

The Kan River Basin, west of Tehran, faces immense pressure from rapid urbanization, population growth, and water resources shortage. This paper investigates how strategically integrating green spaces within its five municipal districts can contribute to sustainability.

Green space distribution, composition, water requirements, and available irrigation sources, along with their energy consumption and carbon dioxide emissions, were the focus of the initial data collection. Energy usage and carbon dioxide emissions per unit of energy consumption were estimated based on equations and coefficients identified in the literature review. This comprehensive approach proved invaluable in subsequently guiding the analysis of urban water management strategies. The strategic identification of alternative plant types and plant vegetation texture formed the next step, focusing on species that minimize water consumption while offering a variety of aesthetic benefits, such as seasonal color variations, textural diversity, and harmonious integration with the architectural context.

The current dominant plants, sorted by coverage, are Pinus eldarica (13 %), Robinia pseudoacacia (10 %), Cupressus arizonica (9.4%), Platanus orientalis (8.4 %), Thuja orientalis L (7.2%), Morus alba (5.7%), Fraxinus excelsior (4.7%), Cupressus sempervirens (3.5%), Ulmus americana (3.5%) and proposed list of dominant plants, sorted by coverage, are Robinia pseudoacacia (13%), Pinus eldarica (10%), Celtis australis (9.4%), Cupressus arizonica (8.4%), Elaeagnus angustifolia (7.2%), Lagerstroemia indica (5.7%), Ailanthus altissima (4.7%), Fraxinus excelsior (3.5%), Morus alba (3.5%). Substituting high-water-demand plants with carefully chosen alternatives led to a 30.72% reduction in irrigation volume and a 30.70% decrease in average annual energy consumption and carbon dioxide emissions over an eight-year period, demonstrating the potential of strategic plant selection for sustainable water and energy management in urban landscapes.

Conclusion

The role of green infrastructure such as green spaces in making cities resilient to climate change is significant. Urban green spaces intertwine with the physical, psychological, social, and environmental aspects of citizens' lives, forming a fundamental well-being nexus. Preserving and enhancing urban green spaces is crucial, therefore, by choosing plants strategically can not only conserve precious resources but also create thriving, resilient green spaces that benefit communities.

To create sustainable and resilient landscapes, future research would delve into the interplay of native species, community acceptance, economic viability, maintenance requirements, and alternative water resources such as reclaimed wastewater.

Strategic Wetland Placement for Enhanced Hydrological Resilience: A Multifunctional Approach in Swedish Landscapes

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Background

Sweden is facing increasing challenges in water resource management due to the ongoing climatic change, with significant impacts on flood control and biodiversity conservation (Angelstam et al., 2023, Johansson, 2020). Traditional approaches often overlook the integration of Nature-Based Solutions (NBS) in landscape planning, resulting in underutilized wetlands for ecological resilience and hydrological management (Ferreira et al., 2021). The present research addresses this critical knowledge gap by focusing on the strategic placement of wetlands to optimize landscape connectivity and maximize related ecosystem services (Hansen and Pauleit, 2014). The study aims to combine biophysical research with societal needs, providing a comprehensive framework for optimizing the integration of designed wetlands into landscape planning for more sustainable development and climate change mitigation (Haase, 2017).

Method

The study focuses on assessing landscape hydrological connectivity under varying weather conditions, recognizing that the optimal level of connectivity depends on the specific purpose of each wetland. Using GIS (Costabile et al., 2022) and rainfall-runoff modeling (Futter et al., 2014), the research compares the efficacy of constructed wetlands in different-sized catchments for various ecosystem services and examines connectivity indices for identifying ideal constructed wetland locations. Topography, mainly represented by high-resolution Digital Elevation Models (DEMs), land use/land cover maps, and soil characteristics can inform these indices. For example, in designing a pond for freshwater conservation, a lower level of connectivity might be preferred to maintain water quality and reduce construction efforts and costs, contrasting with the higher connectivity required for effective flood mitigation. The study includes two catchment areas in Uppsala County, each about 160 km^2, applying different versions of the index of sediment connectivity (IC) (Borselli et al., 2008, Cavalli et al., 2013, Kalantari et al., 2017) to align constructed wetland placement with the desired ecological function. It also explores the potential of upstream forest water retention in improving water quality in downstream agricultural areas, highlighting the variable needs of hydrological interventions.

Conclusion

This research aspires to refine the understanding of multifunctional connectivity analysis in helping to determine the optimal locations of wetlands, recognizing that the desired level of hydrological connectivity varies based on the wetland's intended function and ecological requirements. The findings are expected to offer strategic insights for mitigating downstream hydrological extremes and improving water management, in the context of climate-induced precipitation changes. Collaboration with Mälardalen municipal stakeholders is anticipated to guide the implementation of flood mitigation strategies and the design of multifunctional wetlands, emphasizing the importance of context-specific approaches in NBS planning. The project underscores the significance of informed decision-making in NBS integration, empowering stakeholders to adopt tailored strategies for improved flood resilience and water management within the Mälardalen region, based on the specific ecological objectives and requirements of each wetland or water body.

Seasonal advancing heatwave prediction using machine learning approach

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Background

Heatwave poses a significant threat to ecosystems and societies, including but not limited to human health, agriculture, and wildfire severity. With climate change, the intensity and frequency of heatwaves are projected to increase and Europe is identified as one of the hotspots. Sweden has encountered a notable surge in heatwaves over the past decade, triggering cascading natural hazards such as drought and adverse health effects leading to excess mortality. Predicting heatwaves enables an effective and timely response targeting vulnerable populations and regions. However, the traditional deterministic methods have limitations in predicting beyond two weeks. Seasonal advancing heatwave prediction enhances preparedness and minimizes adverse impacts. This study aims to predict the occurrence of heatwave days during summer months in Sweden with a lead time ranging from 1 to 5 months, leveraging machine algorithms and remote sensing data.

Method

The formation of the heatwave is influenced by a combination of atmospheric variables and land surface feedback. To model the intertwined dynamics during heatwave formation, a comprehensive dataset comprising 21 atmospheric and land surface features was identified through the literature review and collected from Google Earth Engine. Preprocessing of the data included feature selection to eliminate the highly correlated data groups, feature scaling for normalization, and resampling to address the class imbalance effects. Five widely used machine learning classifiers (logistic regression, Gaussian Naive Bayes (NB), K-Nearest Neighbor (KNN), Random forest (RF), and Extreme Gradient boosting (XGBoost)) were developed for lead times ranging from 1 to 5 months. During the model development stage, hyperparameters and thresholds were fine-tuned to optimize the model performance. Subsequently, these models were systematically compared based on their heatwave prediction performance using accuracy and F1-score metrics. Furthermore, the SHapley Additive exPlanations (SHAP) technique was employed for the best-performing model in each lead time to interpret the model behavior and provide valuable insight derived from the modeling process.

Conclusion

All machine learning models demonstrated effectiveness in heatwave prediction across varying lead times from 1 to 5 months except for NB. XGBoost notably outperformed other models with a lead time of one month (F1-score = 0.63, accuracy = 0.81) and four months (F1-score = 0.54, accuracy = 0.79), while KNN excelled in predictive performance with lead times of 2, 3, and 5 months (F1-score = 0.63, 0.65, 0.49; accuracy = 0.77, 0.79, 0.78). Land features emerged as more critical predictors for longer prediction lead times compared to atmospheric features. Contributing factors to Swedish heatwaves included southerly and westerly winds, high temperature, high mean sea level pressure, low geopotential height, low precipitation, low evaporation, cropland, and flat terrain. These findings support the development of an early heatwave warning system for managing heatwave impacts in Sweden.

Digitalization of the Sea in Portugal: A Proposal for a Business Intelligence Solution with Open Data

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Background

The Sea increasingly presents itself as a window of opportunities, a territory open to the future, to innovation, but also to the appreciation of the past and culture through the promotion of traditional activities. Both in Portugal and in European Union, there have been initiatives that aim to promote to sustainable blue development. Nevertheless, the geostrategic position and the historical and emotional connection to the Sea can act as a driving force for Portugal's affirmation in this field. In this context, a relevant contribution for this national purpose can be made by aggregating available information about the Portuguese Sea within an easily accessible interactive tool. The designed solution should allow users, with an interest in the Marine sector, to increase their factual knowledge based on indicators, and leverage new insights, so that the Portuguese Sea, more than a legacy of the past, can be the Sea of the future.

Method

To accomplish this task of developing a proposal of an easily accessible interactive tool that gathers disperse relevant information about the Portuguese blue economy, the data used is exclusively open data and the methodology followed is that of a Business Intelligence (BI) project. This methodology encompasses six stages. The first phase is the cornerstone of the project, it is where the stakeholders are identified and the information needs are assessed and structured. To this end, a literature review of several articles, texts and documents directly related to the topic under study was used. Subsequently, in order to structure the desired information, a mental map was created where the main vectors and corresponding axes, dimensions and indicators that reflect the economic, social, geopolitical and sustainable potential of the Portuguese Sea were identified. The second stage is where the data sources are mapped, that is, the necessary data sets and their respective sources are located and framed into the tool's design. This is followed by the extract, transform and load (ETL) process, which is the third step, where the software is effectively connects to the data sources and where the data preparation, cleaning and processing process is carried out. The fourth stage is for data storage and data modelling which involves the creation of relationships between tables, the definition of hierarchies, the optimization of the data structure for analysis and the subsequent storage of data in a structured way, so that it can be accessed and used later. The fifth step, is the development of interactive visualization, where interactive and dynamic visualizations of dashboards are created with indicators, which will enable the generation of reports. Finally, on the sixth phase, the tool and its usage are analysed and disseminated to the potential users.

Conclusion

In conclusion, it is important to highlight that this BI solution is an innovative and pioneering proposal in Portugal, aggregating and organizing data about the Sea in different areas: economic, social, cultural, environmental, and geopolitical. Furthermore, the proposed solution aims to be an additional tool for the different stakeholders in the blue sector, particularly for policy-makers, contributing to a more sustainable and efficient management of the national natural and cultural heritage, taking into account the challenges and opportunities that the Sea represents for the socio-economic development of the country. This proposal also represents an advance in scientific knowledge and in the

dissemination of information about the Sea, allowing a better understanding of its importance and potential for Portuguese society.

Space competition – an agent-based-flood modelling system to analyse the land use conflict between blue-green infrastructure and housing

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Background

Damages from urban floods are expected to increase due to climate change and urbanisation. This is often remediated in a city by building blue-green infrastructure to delay and divert the water during the peak flood. Examples of these solutions are green roofs, rain gardens and detention reservoirs. However, in an urban environment, there is often a competition between green areas and housing for space and this competition could be further aggravated by extreme rainfalls in a changing climate. Therefore, there is a need to understand how authorities and individuals prioritise protection against floods during the coming decades when extreme rainfall becomes more likely.

Method

This study explores this competition of space in urban environments by coupling an urban flood model with an agent-based model to understand the land use decision-making process hit by recurrent yearly extreme rainfalls. The agent-based model consists of two types of agents, households and a governmental body. The household's location is determined by GIS data and at each timestep, a yearly maximum rainfall floods the neighbourhood. The households respond to the flood depending on the individual risk perception based on previous floods accordingly to the Protection Motivation Theory (PMT). In case of high risk perception, the household will complain to the government and can build private blue-green infrastructure. The government agent can build large-scale blue-green infrastructure to remediate the flood damages if there are many complaints. If there are almost no complaints the government will convert green areas into housing areas to increase urbanization. The flood is modelled using a 2d hydrodynamic tool, LISFLOOD-FP and is simulated on high-resolution topography data. The changes in the urban environment due to the decisions of the government and the households will feed back into the topography and runoff data in the flood model. Several scenarios can be modelled such as climate trend-adjusted rainfall, different blue-green infrastructure measures and changes in the initial state of the neighbourhood using this system.

Conclusion

This modelling system approach makes it possible to evaluate different scenarios of how households and municipalities prioritise blue-green infrastructure. It is also possible to understand how individual and governmental flood measures interact with each other in case of a flood. Also, agent emergence can occur where households can protect neighbours and decrease the global flood risk even when they are only interested in protecting themselves. The results are dependent on the parametrisation of the decision-making theories and location of blue-green infrastructure but can give insights into how we should prioritise urban land use and flood measures in a future climate.

High-resolution temporal sensor data test active-legacy source attribution model

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Background

The Shannon's Sampling Theorem states that to properly reconstruct a given signal the sampling frequency needs to be at least twice the higher frequency of such signal. When we translate this concept into studying pollutant sources and other drivers of water-quality, we understand that our ability to study such phenomena in their full complexity is limited by monitoring limitations in the time-resolution domain that do not match real-time dynamics. To improve this, technological advancements in high-resolution temporal monitoring of water-quality can be a great resource. Low-resolution temporal data for water-quality have so far provided support for a relatively simple mechanistic model implication of linearity between pollutant loads and water discharges as basis for differentiating between active and legacy source contributions to monitored water-quality dynamics. Here we aim to test this model-implied linearity against high-resolution temporal data for such dynamics, to assess down to which fine-resolution time-step such linearity may still emerge from observed data

Method

To this end, we combine water flow data with associated data for several water-quality indicators (variables regarding dissolved oxygen, blue-green algae, chlorophyll, and fluorescent dissolved organic matter content in water, along with oxidation-reduction potential, conductivity, Ph, and turbidity in that water body), measured with submerged sensors in Sweden's third largest lake, Lake Mälaren, a key freshwater supply for the country's capital, Stockholm. The model linearity to be tested by this data synthesis combines two types of source contributions to total pollutant load: a temporally stable average load contribution from active sources; and a temporally stable average concentration contribution from legacy sources, which yields a corresponding legacy load (product of concentration and water flow) that is linear in the water flow carrying the pollutant. Using linear regression across all load and flow data points, it is possible to identify from the data (i) the statistical significance and coefficient of determination (R^2) for the fitted regression lines, showing whether this linearity is supported by the data. Furthermore, if data support emerges for this linearity, the fitted (ii) line slope, and (iii) line intercept provide direct estimates of (ii) the legacy concentration contribution, and (iii) the active load contribution to total observed waterborne pollutant load and associated water quality variable(s). The water-quality variables investigated in this work are ones commonly measured with automatic sensors. These can also be used as possible good indicators of (or proxies for) various waterborne pollutants, such as metals or nutrients. Using the synthesized dataset with a time resolution of two hours, we find stable such relationships at this relatively fine temporal resolution. Furthermore, we can also investigate the fine-resolution temporal behaviors of these in relation to water flow (discharge).

Conclusion

The results for most of the studied water-quality indicators support the linearity hypothesis underlying the tested model down to the fine-resolution time scale studied here; e.g., R^2 values for fitted regression lines are close to unity. Among the investigated variables, only chlorophyll does not show linear behavior, and blue-green algae and turbidity show a mixed (weaker linear) response, in consistency with likely different types of hydro-biogeochemical source-sink and waterborne transport dynamics governing these compared to the other indicator variables. Overall, the automatic sensor data reveal the applicability of the tested legacy and active source distinction model for various water-quality indicators down to the studied fine-resolved time scales.

An Innovative Approach for Rare-earth Elements: Implementation of Enhanced Phosphorus Recovery for Phosphorus Mining from Eutrophic Sediments

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Background

The municipal technology for recycling phosphorus (P) from waste streams has been well established. The process of P removal/uptake relies on polyphosphate accumulating organisms (PAOs) under alternating anaerobic and aerobic conditions. However, the feasibility of applying relevant processes to mine P from marine sediments has not been investigated. Our previous batch reactor results exhibited that under anaerobic conditions, sediment, collected from the Baltic Sea region, prefers to uptake glucose/propionic acid and releases P. Therefore, to investigate the feasibility of adopting the enhanced biological phosphorus removal (EBPR) process for P recovery in marine sediment, as well as comparing the performance of sediment in P uptake/release under different carbon sources feeding; two mentioned carbon sources (glucose and propionic acid) were selected for running sequencing batch reactors (SBRs) based on an anaerobic/anoxic cycle operation. Additionally, sewage sludge inoculated SBRs were also set up as comparative groups.

Method

Four SBRs with 1.5 L working volume were operated with 8 h cycles, including an anaerobic phase (2 h), an aerobic phase (4 h), and a settling/decant phase (2 h). Initially, the reactors were seeded with marine sediment from the eutrophic Baltic Sea region and sludge from a wastewater treatment plant in Stockholm, respectively. Subsequently, both sediment- and sludge-inoculated reactors were operated using different carbon sources, propionic acid and glucose. Specifically, the SBR inoculated with sediment and fed with propionic acid is designated as R1, the SBR inoculated with sediment and fed with glucose is designated as R2, the SBR inoculated with sludge and fed with propionic acid is designated as R3, and the SBR inoculated with sludge and fed with glucose is designated as R4.

The reactors were operated with a hydraulic retention time of 24 hours and a PO_4-P loading rate of 45 mg P per day. During each cycle, in the feeding phase, 0.5 L of a fresh solution containing gradually increased carbon (calculated based on chemical oxygen demand, COD) was fed. In the acclimation phase, the concentration of the carbon source was progressively increased, following a sequence of 50 mg/L, 100 mg/L, 200 mg/L, and 400 mg/L of COD. The synthetic water used in this study was referenced from the research of Guisasola et al. (2019). The first cycle on sampling days was dedicated to measure the P concentration in the supernatant and sediment/sludge at the end of different SBR operation stages. Sampling was conducted three times per week, and volatile suspended solids (VSS) was determined weekly. The SBRs were operated for a total of 119 days.

Conclusion

Our long-term continuous SBR confirmed that EBPR can be effectively applied as a biological engineering approach for P recovery from marine sediment. After a 56-day acclimation, reactor inoculated with sediment demonstrated a satisfactory P release rate of 3 mg P/g VSS•h^{-1}; while the corresponding rate for sludge-inoculated SBR was 2.6 mg P/g VSS•h^{-1}. The obtained high P-containing (>78 mg/L) solution will be utilized for P precipitation subsequently, aiming at P recovery.

Production of bio-based superabsorber absorbent from collagen obtained from Jellyfish (Aurelia auretia), an invasive species in the Sea of Marmara, Türkiye

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Background

Bio-based products stand out in line with the Paris Agreement and the goal of reducing the carbon footprint. However, research has shown that not every material made from biomass is biodegradable and reduces the carbon footprint. The conversion of lands into agricultural areas due to increasing agricultural pressure causes deforestation, desertification, loss of biodiversity and habitat, and increased pressure on limited water reserves. These situations make the carbon footprint high according to the Life cycle assessment methodology (LCA). This study aims to obtain marine-derived chitosan from gelatin and collagen obtained from jellyfish (*Aurella aurita*), the majority of which is densely found in the marine ecosystem in the Sea of Marmara, where organic load is intense, and to synthesize fully or partially biobased super absorbents by using chitosan and commercially used acrylic acid. After that, biobased superabsorbent absorbents were synthesized, characterized, and their water absorption capacities were determined.

Method

Jellyfish were collected from Haydarpaşa Port in the Sea of Marmara. Jellyfish were washed 1-2 times with distilled water and then cut into 1-1.5 cm pieces. After that, they were washed 3 times with 1:1 (w:v) 0.1 N NaOH to break down the protease enzyme. They were washed again with distilled water 1-2 times to remove water-soluble proteins. After adding 0.5 M Acetic acid, the mixture was mixed for 15 minutes at +4 °C using a sonicator (ultrasonic bath) in a mechanical mixer. The dissolved fraction was dialyzed with 0.02 M phosphate solution (Na_2PO_4) at +4 °C until neutral pH (pH 7.2) was reached. If there was a lot of residues, this part was dissolved in 0.5 M Acetic acid and 0.9 M NaCl. Dialysis was performed again with 0.1 M and 0.025 M acetic acid. They were then frozen and lyophilized. Chitosan - acrylic acid, collagen-acrylic acid and acrylic acid synthesized by radical polymerization with ammonium persulfate and N, N'-methylenebisacrylamide were characterized by FT-IR.

Conclusion

The water retention capacity of the polymer obtained from the polymerization of acrylic acid and collagen was measured and it was determined that it retained approximately 100 times its weight in water within the first 5 minutes, and within 70 minutes it retained approximately 120 times its weight in $9\%_0$ NaCl solution. It has been observed that the polymer made with chitosan, among other polymers, retains 30 times more water than that made with acrylic acid alone. In addition, approximately 47% of the dry weight of jellyfish was obtained from collagen. In this study, it was determined that water retention capacity can be increased by changing the cross-linking ratio. As a result, it was concluded that a biocomposite containing collagen with high water retention capacity could be synthesized by increasing the collagen ratio and optimizing the cross-linker.

Forest System Exploitation and Management from the Perspective of Game Theory Application

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Background

Facing conflicts in the management of large-scale natural resources systems is possible where various stakeholders with different interests and desires are involved in the system. In this case, competition, negotiation, and cooperation are grounded in the field of multi-decision-maker problems such as the management of natural resources. In common resources management, mostly the benefits of using natural resources are for stakeholders and the costs for all the others. This condition is named as the tragedy of commons. Given the critical role of the forest system in climate mitigation, it can be said that any local forest system has a global impact.

Method

Forest systems are large-scale and involve various stakeholders whose decisions affect others' payoff. In this situation, employing approaches such as game theory can be beneficial for studying the forest system management and resilience can be considered. Game theory can be helpful in studying complex situations in which various stakeholders are involved and make interdependent decisions. In this paper, the management and exploitation of the forest system are studied in a strategic environment using a game theory approach. First of all, the forest system is defined in terms of common resources. Subsequently, the paper identifies both the stakeholders who influence the management and exploitation of this forest system and those who are impacted by the management of the forest system. Then, the main aspects and main issues that should be considered to study the problems through the lens of game theory are identified. As the mentioned problem is a large-scale and complex issue, various game theory-based games and examples are determined for the game abstraction of the main problem. In other words, some games are applied to reduce the complexity of the main game of forest resources management.

Conclusion

Analyzing and exploring any scenario aimed at enhancing the conditions for managing and utilizing a natural resource can be overly simplistic and potentially unfeasible without taking into account the strategic aspects of the problem. This perspective emphasizes the importance of understanding and incorporating the interactive and strategic behaviors of all involved stakeholders to ensure a more comprehensive and realistic approach to resource management. Hence in this paper, the main algorithmic issues that must be considered in the management of the forest system are defined and presented. Finally, the main games that can be named as the abstraction of the main problem are presented using hypothetical examples, and the benchmarks in the forest system such as the Nash Equilibrium are defined based on the answers and outputs of the examples. The main road for future studies at the global scale is also determined considering these hypothetical examples.

Understanding the Impact of Social Attachment in Managing Large-Scale Water Resources System

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Background

In the management of large-scale systems, it's crucial to consider a variety of factors including physical conditions, social dynamics, and behavioral patterns which are equally important in understanding their relations and interactions in the management of the system. In a large-scale system, a variety of stakeholders are involved forming a diverse community. The management of water resources systems is influenced significantly by the actions of the stakeholders and their behaviors. These behaviors are often shaped by the community to which the stakeholders belong, highlighting the importance of social dynamics in resource management. The emphasis of the previous water resources solutions was primarily on structural approaches, physical simulation models, and more recently, robust optimization techniques. Despite advancements in traditional methodologies, there remain numerous unresolved challenges in the field of water resources management. A significant portion of these challenges arises from neglecting social considerations and attachments in water resources management.

Method

Integrating social-based approaches into engineering sciences is a challenging issue. This article investigates the significance and role of social-based approaches within water resources management and engineering. First, we will define the concept of socio-hydrology and elucidate its application in the context of water resources management. Then, using simple examples involving the exploitation of shared water resources, we will demonstrate the role of considering social attachments in this field of study. Furthermore, this article will present and examine some key methodologies derived from social science approaches in the context of water resources management and engineering. After that, we will introduce an algorithm to facilitate the application of social attachments and consideration in the field of water resources management and engineering.

Conclusion

The outcomes of this article can be presented in various aspects. First, after redefining socio-hydrology thermology, its position and function within water resources engineering and management through simple, clear, and related examples are presented. Then, the role of social attachments in the field of water resources management is presented in comparison with traditional methodologies. Afterward, some of the main social-based approaches such as the Social Network Analysis (SNA), Stakeholder Analysis (SA), and Social Learning (SL) are reviewed and the role of each of them in the field of water resources management is presented. After the review of the mentioned approaches, an algorithm is presented to help a fresh researcher in the field of water resources management to apply the mentioned algorithms. The presented article can be considered a review paper on the definition, role, and application of social-based approaches in the field of water resources management.

Exploring the Production of Algae-Based Cheese Analogue

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Background

Due to their exceptional resource efficiency, algae have emerged as a potential solution to address contemporary challenges in food production. Their biosynthetic property yields a diverse array of bioactive metabolites and valuable biological components, including proteins, carbohydrates, lipids, and omega-3 fatty acids. Notably, certain algae-derived compounds exhibit unique biological activities and health properties, such as antiviral, antihypertensive, and anticoagulant capabilities. This facilitates the use of algae in enhancing food quality through functional enrichment. Furthermore, the inherent CO2 sequestration capacity of algae contributes to their environmental sustainability by mitigating their carbon footprint. Consequently, algae-based food products present a persuasive option for individuals adhering to vegan or flexitarian dietary patterns. Interest in cheese alternatives is also growing in animal-free products.

Method

The proposed method for cheese analogue production utilizes a two-step coagulation process involving enzymatic and ionic interactions. This approach aims to replicate the textural characteristics of traditional cheese curds without the use of animal rennet or casein. Cheese analogue formation process commences with the acid-coagulation of an algal-based emulsion mainly containing lipids and proteins, facilitated by the addition of animal-free rennet. Prior to rennet addition, complex carbohydrates, such as sodium alginate, are incorporated into the algal liquid to initiate synergistic gelation. This process is followed by the controlled introduction of calcium carbonate, an inorganic salt, further promoting the cross-linking of the polysaccharide network. The alginic acid present in sodium alginate interacts with divalent cations, typically calcium ions, present in the algal liquid. This forms an initial network of weak gels, providing a structural foundation for further coagulation. Following alginate pre-coagulation, rennet is introduced. This enzyme cleaves specific peptide bonds, leading to their aggregation and further strengthening of the gel network. The mixture is maintained at a controlled temperature (specify range) for a predetermined period (18-72 hours) to allow complete rennet action and curd formation. Upon achieving the targeted curd structure, the mixture is subsequently transferred to molds and subjected to gentle pressure to remove excess whey and achieve the desired final shape.

Conclusion

While contemporary advancements in algae-based food products largely focus on enriching existing, traditional, or plant-based options with algal ingredients, this research aims to break new ground by developing cheese analogues predominantly sourced from algae and macro algae derivatives. With the goal of creating cheese analogues that are both functional and appealing in terms of texture and sensory experience, there is potential for a more sustainable approach to food production and consumption. Hence, the future prospects of algae-based cheese seem promising.

Drought Vulnerability Concepts and User-Endorsed Factors in Forested Ecoregions in Cold and Continental Climates

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Background

In a changing climate, the assessments of drought risk and vulnerability are becoming increasingly important. Responding to the global call for a proactive approach to drought risk management, there is now a growing emphasis on drought vulnerability assessments within the drought research community. Since the manifestation of drought vulnerability depends on the social, ecological, and hydroclimatic context in which it unfolds, recognising vulnerability factors specific to particular climatological and ecological regions could enhance the accuracy and reliability of vulnerability assessments. However, a holistic overview of factors affecting vulnerability in polar and cold climates is currently lacking, although these regions accommodate extensive socio-hydrological systems, encompassing urban areas, energy infrastructures, agricultural practices, and vast boreal forests.

Method

Through an interdisciplinary and systematic exploration of existing literature, we identified the manifestation and conceptualization of drought vulnerability for forested ecoregions in the Köppen–Geiger D and E climates. The various definitions, conceptualization and methodological approaches in the literature gave rise to numerous potential factors that are described or used as measures of drought vulnerability. Three main dimensions of vulnerability could be portrayed, representing the on-site water dependent sectors of society, the socio-economic and cultural characteristics and the structure of governance and availability of policies and plans. Factors contributing to vulnerability, as delineated by several scientific disciplines, were identified and synthesized into a novel conceptual framework that categorizes vulnerability factors by their location in a socio-hydrological system, and their relation to blue or green water sources (Stenfors et al., 2023, https://doi.org/10.1002/wat2.1692). To further assess their relative importance in cold and continental climates, a survey with more than 100 respondents from various sectors (e.g., agriculture, forestry, energy, water supply, environment, etc.) and different governance levels in Sweden was conducted to validate and rank the identified sectorial (linked to a specific sector) and societal (i.e., linked to governance and society) factors. Thus, we provide a list of user-endorsed sectorial and societal drought vulnerability factors that allows to identify systemic vulnerability patterns in high latitudes such as Sweden.

Conclusion

Through a user-validation process, our study identified key sectoral and societal vulnerability factors for drought vulnerability assessments in cold forested areas, incorporating novel factors suggested by end-users. Among the 75 identified sectorial vulnerability factors, soil water holding capacity received the overall highest ranking, followed by availability of relevant data regarding drought, the presence of land area covered by wetlands/lakes/ponds, and water stress. Out of 32 identified societal factors, the highest-ranked factors included the access to public drinking water services, the presence of groundwater monitoring, and the availability of long-term supply & demand assessments. Variations in ratings were observed across respondents from different sectors, with forestry respondents standing out. Additionally, differences emerged based on the type of organization and geographical location (northern vs. southern Sweden). These findings underscore stakeholder diversity and regional nuances in drought vulnerability assessment.

Evaluation of water resources and environmental management scenarios based on biological capacity and ecological footprint indicators

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Background

The ecological footprint refers to the land area required to support human life and activities such as providing food, clothing, construction, and services while absorbing the waste produced by these activities. On the other hand, biological capacity refers to the maximum land area of a region that has desirable capabilities for biomass production and waste absorption. Thus, the biological balance of the region is maintained when resources are used up to their maximum biological capacity. Biological capacity and ecological footprint are two main indicators for understanding the sustainability of ecosystems. Due to the intensification of the exploitation rate of water resources, the balance between supply and demand has been disrupted in many regions. Therefore, sustainable resource management and increasing efficiency in water consumption are necessary to maintain a balance between water demand and supply.

Method

This paper presents an approach for assessing biological capacity and ecological footprint indicators, which is used to evaluate water resources and environmental management scenarios and quantify the carrying capacity of water resources. The effectiveness of this approach has been evaluated in the Zarrinehrud River Basin (ZRB) in Iran. Initially, the biological capacity and ecological footprint are calculated for the current conditions. In the next step, several management scenarios are defined to improve the water and environmental resources conditions in the study area if the current condition is not desirable. These scenarios are a combination of seven projects, including supplying water from new resources (1), using modern irrigation methods (2), facilitating and increasing inflow to the basin (3), improving drainage and irrigation networks (4), implementing low-cost agricultural improvement projects (AIP) (5), implementing moderate-cost AIPs (6), and implementing high-cost AIPs (7). The performance of water resources in the Zarrinehrud watershed under each of the 15 management scenarios is examined by calculating biological capacity and ecological footprint for energy, food, and construction sectors, under the impacts of climate change in 2050. Finally, a scenario that leads to the sustainability of the region's water resources is selected by reducing the ecological footprint and increasing the biological capacity.

Conclusion

Based on the results, the biological capacity of the ZRB in 2018 was 0.77 hectares globally per capita, which is almost half of the global average. Of the total biological capacity of the watershed, 79.5%, 15.8%, and 3.9% are, respectively, related to croplands, grazing lands, and forests. Moreover, the biological capacity in the region is less than its ecological footprint. This shows that the consumption of natural resources in this region exceeds its production capacity. Hence, the watershed is in an unstable state. The superior management scenario emphasizes increasing productivity and reducing water consumption in the agricultural sector. This scenario aims to create a balance between the supply and demand of water resources, improve productivity, and reduce environmental impacts. Furthermore, based on biological capacity and ecological footprint indicators, the carrying capacity of water resources was estimated, which can be used as a basis for sustainable development plans in the region.

Analysis of solute transport with groundwater in rock fractures using a time-fractional transport model

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Background

Mechanism of solute transport with groundwater in fractured aquifer can provide theoretical support for disposal radioactive waste and prediction of soluble contaminants. However, the uneven stress distribution underground and heterogeneous mineral distribution within rocks contribute to the complex geometry of fractures, posing challenges in predicting flow and solute transport within them. To elucidate the solute transport dynamics within fractures, fractional operators have been introduced, giving rise to promising fractional models. Nevertheless, the parameters linking the surface geometry of fractures to the model remain ambiguous. The aim of this study is to analyze the influence of surface roughness on solute transport process and explore the underlying correlation between geometrical and transport characteristics and the fractional model parameters.

Method

In this study, six rough-walled rock fractures with different relative standard deviations (RSD) are created using a digitalized surface from a granite sample and they are used to conduct numerical experiments on fluid flow and solute transport with different Péclet numbers by direct solving the Navier-Stokes equations and the advection-diffusion equation (ADE). The solute breakthrough curves for all fractures with increasing RSD are compared and the impact of Péclet number and surface roughness on the solute transport process are analyzed. Furthermore, time fractional mobile-immobile model (tFMIM) is employed to analyze the transport process. The accuracy of the model is tested and the physical meaning of the parameters are discussed.

Conclusion

The results show that the channeling effect becomes more pronounced with the increasing Péclet number, resulting in distortion of residence time distribution (RTD) curves with heavy tailing. In general, surface roughness plays a significant role in the development of channeling and recirculation zones in rock fractures, thereby contributing to the heterogeneous distribution of concertation fields. The tFMIM can well capture the tailing behavior of RTDs. The findings from this study can improve the understanding of solute transport mechanisms in natural rock fractures, which lays the foundation for further upscaling analysis of solute transport in fractured rock masses.

Enhancing Water Quality by Rewetting Drained Peatlands in boreal regions

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Background

Peatlands, which account for roughly 3% of the Earth's land surface, are unique ecosystems that are endangered by climate and land use change. Among their potential ecosystem services is the improvement of water quality. However, many peatlands have been drained, mainly for forestry purposes, in boreal regions of Europe and groundwater levels will be further lowered due to increased evapotranspiration as a result of global warming. These factors combined could transform peatlands from an anaerobic to an aerobic state, likely accelerating peat decomposition and reducing the quality of water exported from peatlands.

Method

Our research focuses on the consequences of a moderate future climate change scenario and different drainage management approaches on peatland water quality: a) active drainage, b) historically drained but left unmanaged, and c) rewetting through ditch blockage. We conducted a mesocosm experiment in climate-control rooms to simulate the present (2022 growing season) and a moderate future representative concentration pathway (RCP) climate scenario, RCP 4.5. Additionally, the peat cores in the mesocosms were exposed to simulations of the various drainage management strategies.

Conclusion

We found that while short-term climate change had no significant effect (p>0.05) on the water quality of peatland mesocosms, drainage management had a strong impact. The effect of drainage management as a main factor was significant for $SUVA_{254}$ as a proxy for the quality of organic carbon, nitrate, A_{254}/A_{365} as a proxy for bioavailable organic carbon, as well as total nitrogen. Our findings emphasize the importance of rewetting drained peatlands to effectively control the detrimental effects of recalcitrant and aromatic organic carbon and nitrogen release to the downstream aquatic systems from actively and historically drained peatlands.

Mapping Phenoregions and Phytoplankton Seasonality in Northeast Pacific marine coastal ecosystems via a satellite-based approach

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Background

The coastal waters of British Columbia support diverse food webs and provide habitats for various species of Pacific salmon, which are of vital importance to the regional economy and for First Nations culture and subsistence. To effectively monitor marine environmental health of these regions and any changes thereof, it is necessary to employ ecological indicators to provide objective and quantitative metrics upon which to evaluate the state of the ecosystem and their response to environmental and climatic perturbation. Phytoplankton phenology is an important ecological indicator that characterises the timing of annually occurring phytoplankton growing periods and has been typically synthesized into a set of indices encompassing the timing, duration, and magnitude of bloom events. Observing changes in phytoplankton phenology in this region requires vast spatial coverage and short temporal frequencies, which is achieved through ocean colour satellite imagery.

Method

This study used satellite chlorophyll-a data from 1998 to 2020 and the Hierarchical Agglomerative Clustering method to define phenoregions based on phytoplankton phenology spatial patterns over the British Columbia and Southeast Alaska coastal oceans. Phytoplankton phenology and its underlying drivers are spatially variable, and the study of its patterns over heterogenous regions benefits from a delineation of regions with specific phenological properties. The defined phenoregions were used to simplify and, thus, better describe phytoplankton seasonality across the target area. As a first step, the GlobColour interpolated product in British Columbia coastal waters was evaluated via a statistical match-up analysis and a qualitative analysis to determine whether the data reflect the region's large-scale seasonal trends and latitudinal dynamics. The statistical performance of the GlobColour interpolated product was compared to the original GlobColour and Ocean Colour Climate Change Initiative merged chlorophyll-a products based on in situ observations. A suite of phenological indices were then derived on a pixel-by-pixel basis, and used to partition the study area into phenological bioregions using the Hierarchical Agglomerative Clustering method. The delineated bioregions described region-specific phytoplankton phenological patterns associated with bloom magnitude, frequency, duration, and timing. Moreover, the interannual variability of the spring bloom initiation was evaluated considering interactions between sea surface temperature (SST) anomalies and the El Niño Southern Oscillation Index (ENSO).

Conclusion

The GlobColour interpolated product performed relatively well and was comparable to the best performing product for each water type (RMSE = 0.28, r2 = 0.77, MdAD = 1.5, BIAS = 0.90). The cluster analysis allowed the delineation of four coherent regions: two coastal regions and northern and southern shelf/offshore regions. Results showed that each phenoregion had distinguishable phytoplankton phenological characteristics likely due to different physical forcings acting on these areas. Early spring blooms were associated with positive SST anomalies and El Niño conditions; conversely, average or late spring blooms occurred in years with negative SST anomalies and La Niña conditions. This study may potentially aid in improving fisheries management and conservation efforts by offering insights into the correlation between the timing of spring bloom events and SST anomalies in relation to the ENSO

index.

Production of Functional Bread with Plant and Algae-based Sources

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Background

Due to global population, growth and increased consumer awareness of healthier food is driving the growth in the functional food market. Bread is the staple food of the diet worldwide which is crafted from a dough of flour, salt, sugar, yeast, and water, often by baking. The functional bread market is expected to increase every year and reach $350.17 billion by 2030. Different kinds of flours can be used to access health benefits and to produce fortified and functional breads. Alternative flours such as chickpea flour, einkorn flour, almond flour, etc. have been used as a wheat replacement in bread formulations to induce functional properties and have a great potential in reducing the risk factors associated with diet-related diseases. Microbiota-based precision nutrition can be used in the design of healthy and functional bread.*Chlorella vulgaris* is a green microalgae that is used in several food products to improve nutritional value and provide health benefits.

Method

Bread formulations were developed using different types of flours such as almond flour, chickpea flour, and einkorn flour enriched with *Chlorella vulgaris* microalgae. Flour, salt, water, yeast, sugar, and microalgae have been mixed and baked for 30 min at 200°C. After cooling to room temperature, samples were sliced and analyzed. Formulations were prepared in triplicate. Three bread formulations have been evaluated according to their protein content, color, pH, moisture, taste, texture, and overall sensory acceptances. Protein content was determined by using Kjeldahl method. The microbiological analyses were performed in three bread formulations on 1, 3, and 5 days. To prepare for the analysis 25 grams of each sample were added to 225 mL of sterile peptone water (0.1%) and homogenized in a stomacher for 2 min. After that decimal dilutions were prepared for microbial enumeration of total aerobic mesophilic bacterial counts, yeast and molds. Analysis of Variance (ANOVA) one-way was used to compare the nutritional and physicochemical characteristics of the different bread formulations.

Conclusion

This research resulted in the development of three novel, innovative, high-protein functional bread formulations enriched with *C. vulgaris* that met the requirements of "rich in proteins" (the protein provides at least 20% of the energy value) claim. According to the results of shelf-life analysis; the microbial safety was confirmed for at least five days of storage at room temperature. These formulations are promising that have been used to produce functional, novelty and healthy fermented breads using microbiome, sustainable, innovative techniques.

Removal of nitrogen compounds and fluoroquinolone compounds group antibiotics from Waste water with MBBR system

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Background

Pharmaceutical (PhACS) compounds are now one of the issues in wastewater, and their residues remain in the water for extended periods. PhACs can be grouped into various categories, the most notable of which are the fluoroquinolone antibiotics, which are typically found in waste streams and include ciprofloxacin (CIP), ofloxacin (OFL), and norfloxacin (NOR). The primary sources of these PhACs are domestic water and hospital water. With only minor changes to their physicochemical characteristics, i.e., molecular structure, molecular size, hydrophobicity or hydrophilicity, solubility in water, concentration in water, an affinity for different solids, as well as their electrochemical and chemical properties, such as surface charge, medium pH shows a wide variety of toxicity levels and causes. However, removing fluoroquinolone antibiotics by traditional activated sludge (CAS) treatments is highly challenging since it creates residual waste sludge.So it is important to remove these PhACs from the wastewater effectively.

Method

Moving bed biofilm reactors (MBBR) have recently been found to be a potential biological treatment alternative for higher PhAC removal because of their strong removal inhibitions compared to conventional CAS reactors. The MBBR uses biofilm carriers or media, which are generally constructed of plastic with high surface area-to-volume ratios. These carriers serve as a substrate for the attachment and development of microorganisms, including bacteria that can degrade PhACs.When the wastewater moves through the reactor, the biofilm carriers are colonized by a variety of microbial communities, including those able to degrade pharmaceuticals. The MBBR promotes various microbial activities by moving between aerobic and anoxic conditions. During the aerobic phase, oxygen is introduced into the reactor to assist in the aerobic breakdown of organic materials and medicinal compounds by microorganisms. In the anoxic phase, oxygen is restricted or absent, making conditions ideal for activities such as anaerobic ammonium oxidation (anammox), which can help with nitrogen removal and possibly remove pharmaceuticals. Various bacteria species in the biofilm use enzymatic processes and metabolic pathways to degrade or convert pharmaceuticals. Aerobic bacteria and anammox bacteria are able to degrade certain antibiotics among the microorganisms that may be present. In the MBBR, it is also possible to remove the nitrogen compounds such as NH4+-N, NO2--N, and NO_3^--N.The piperazinyl ring of fluoroquinolones in a variety of substitution and breakdown processes. Deethylation and deamination processes are principally responsible for breaking the piperazinyl ring.Deamination, which is catalysed by deaminases in the presence of ammonia-oxidizing microorganisms, as well as the formation of hydroxyl radicals from hydroxylamine during ammonia oxidation, may accelerate the conversion of CIP to NOR.It basically indicates the capacity of the nitrifying bacteria to break down the antibacterial activity of the PhACs.

Conclusion

Antibiotic contamination causes a significant risk to the anammox process. According to previous studies, they can alter community structures, reduce anammox process activity, and influence anammox biomass properties. But in MBBR system it shows that nitrogen and PhACs were effectively eliminated. The greatest TNRE of 93 ± 5.02% was achieved over the 917-day operational period. The specific examination of fluoroquinolone antibiotics (CIP, NOR, and OFL) revealed a substantial correlation between PhAC concentrations and removal efficiencies. While OFL removal rates were rather low (39%), rising PhAC concentrations resulted in higher CIP(71.2 %) and NOR(72 %) elimination rates. *Candidatus Brocadia, Candidatus Kuenia*, and *Planctomycetes* species were found in the anammox culture at an amount of 0.5% during the non-starvation phase and 0.3% during the

Using modelling to understand the role of blue-green areas in carbon neutral cities

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Background

Cities around the world have a pressing need to reduce their contributions to climate change, and many have committed to achieving some kind of "carbon neutrality" in the coming decades. Achieving this will require significant changes, even in cities which are often considered to be leaders in climate action, such Stockholm, Sweden. Blue-green areas could potentially play important roles in urban carbon cycles, but their potential is not fully understood in this context, and they are frequently excluded from urban carbon accounting exercises. Nature-based solutions could potentially be an additional tool for reducing greenhouse gas emissions in urban regions, but this potential needs to be better understood and quantified in order for them to be used effectively in climate action planning.

Method

We use a systems breakdown modelling approach to better understand the role of blue-green areas (and particularly water bodies) in urban carbon cycles with a case study in Stockholm, Sweden. Following this, we use land use modelling to assess the potential for nature-based solutions to reduce the net greenhouse gas emissions from an urban region, and apply this to cities across Europe.

Conclusion

In both cases, we find that modelling can help us to understand and quantify the roles of blue-green areas in reducing greenhouse gas emissions in urban areas, and how they can and should be considered by cities when striving to achieve carbon neutrality and other climate action goals. In particular, we find that a better understanding and accounting of carbon in urban water bodies is needed as these could contribute significantly to a city's emissions. We also find that nature-based solutions could contribute significantly to reducing greenhouse gas emissions and achieving climate action goals when implemented at a city scale.

Assessing the climate change impact on rainfed barely in the Mediterranean basin. The Almeria province case study

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Background

The Mediterranean basin is recognized as a climate change hotspot, with climate models projecting increasingly warmer and drier conditions that will affect local ecosystems and communities. Reduction in water availability is one of the expected and most relevant impacts of these projections, posing a significant threat to the agricultural sector. One of the most resilient crops to limiting and stressful conditions is barley, often sown in areas where other crops and cereals would struggle. This work analyzed the impacts of climate change on rainfed barley using the province of Almeria as a case study. This is one of the most arid areas of the Mediterranean basin, where agriculture is among the main economic resources, and where barley is the main crop produced outside greenhouses. Here, adapting rainfed barley cropping to climate change is crucial to enhance rural development and diversify the province's economy. In doing so, water plays a crucial role.

Method

Barley growth was modeled using the FAO AquaCrop model in its Python implementation, AquaCrop-OSPy. Setting the model up to avoid local re-calibration of the barley parameters and to capture multi-year trends in productivity change, rather than its interannual variability. This was achieved by evaluating the minimum time span that needed to be analyzed to obtain meaningful information from the model. To do so, a rolling average operator with an increasing window size was applied while comparing modeled and historical observed data for a baseline period (1985-2014). This analysis was based on correlation (Pearson and Spearman correlation coefficient), error (relative Root Mean Squared Error, Root Mean Squared Error), and similarity (p-test); and provided the domain of applicability of the proposed approach. Also, it allowed to select a reference initial soil water content to develop future projections and account for possible decreases in water availability in the soil.

The study focused on two 30-year time periods: mid-century (2041-2070), and end-century (2071-2100); and on *Shared Socioeconomic Pathways* scenarios SSP1-2.6, SSP2-4.5, and SSP5-8.5. For each time period and SSP scenario, the research also evaluated three sub-scenarios of soil water content at sowing: with the parameter set respectively at 10%, 20%, and 30% of the Total Available Water (the water present in the soil available for the crop to sustain its life). Having estimated the climate change impact, the research analyzed different adaptation pathways (irrigation, the application of mulches, and the change of sowing date), to evaluate their performances for climate change adaptation in the area.

Conclusion

The results indicate the importance of soil water content for maintaining good yield, reducing losses, and planning adaptation. The average yield change is indicated to be between +14% and -45% at mid-century, and between +12% and -55% at end-century. The greater variability in productivity is associated with the soil water content at sowing. Regarding irrigation, the study indicates that for adaptation purposes an optimal threshold to trigger irrigation can be found between 0% and 20% of the Total Available Water. Overall, the irrigation needs might be up to 3% of the province's superficial water resources, indicating that adaptation through irrigation can be viable. The work suggests the effectiveness of mulches as an adaptation strategy to optimize water use in the future. Also, it suggests that maintaining

a high level of soil water content allows for reduced variability in yields.

Life Cycle Carbon Footprint and Water Footprint Analysis in Stockholm Royal Seaport

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Background

The urban population growth is accompanied by significant resource consumption and environmental problems. One of the key challenges is to quantitatively assess the allocation of materials and energy flows during the urbanization process. Water and energy play crucial roles in socioenvironmental sustainability. Since water, energy, and carbon (WEC) represent the paramount resources and environmental impact factors in the socioeconomic development system, a quantitative depiction of these factors can aid in uncovering the relationships among them and in enhancing the development and optimization of WEC. Carbon and water footprint assessment are two pressure indicators, which are used to measure human use of natural resources and anthropogenic emissions and can be used to guide mitigation policies. The main purpose of study is to evaluate the accounting of material flows and life cycle carbon and water footprint in two urban neighborhoods in the Stockholm Royal Seaport, Norra 1 and Norra 2, in 2016.

Method

An urban socioeconomic system model was developed to present the development of the urban metabolism (UAM) in the Stockholm Royal Seaport (SRS) district, employing a combination of material flow analysis (MFA) and life cycle assessment (LCA). The model was utilized for the accounting of material flows in two urban neighborhoods in the northern part of SRS, Norra 1 and Norra 2, and was executed in MS Office Excel. The system's external environment encompasses the national and global socioeconomic systems, along with the natural environment. Inputs to the system consist of materials imported from the two socioeconomic systems, as well as natural inputs extracted from the environment. Economic activities within the system transform nationally and internationally the imported materials into products, which are either locally consumed by economic activities or households, exported to the national or global socioeconomic systems, or accumulated in stocks. Residuals from local consumption may be recovered and serve as inputs to economic activities within the system, or they flow out of the system for reuse, recovery, recycling, or treatment and disposal. The ReCiPe 2016 method was employed to estimate the water footprint and carbon footprint in an LCA.

Conclusion

The results of the study showed that the total input including products, energy, and natural materials, is about 155470 tons, and the output is about 79900 tons, which includes solid waste, sewage, and air emissions. The water footprint related to material flow analysis was around 1.17 million M3, which consumption of products had the largest share with 46%, while the carbon footprint was 85 million kg CO2-Eq and the consumption of natural materials had the largest share of 47% in the carbon footprint. Among the different activities, construction has the largest water footprint and carbon footprint with 71% and 40%, respectively. After the construction activity, households with 34% and Sewerage with 18% had the largest contribution in water and carbon footprints, respectively.

FLOATING WETLANDS FOR MITIGATING MARINE EUTROPHICATION: LESSONS LEARNT FROM THE PILOT APPLICATION IN UTÖ

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Background

The Baltic Sea, which serves about 85 million people as a home, is the most polluted sea in Europe suffering from biodiversity loss, climate change, eutrophication and anthropogenic pollution. Presently, eutrophication affects 97% of the Baltic Sea, leading to decreased oxygen levels[1]. Furthermore, the economic loss in terms of citizens welfare in the Baltic Sea Region due to severe eutrophication is 3.8-4.4 billion euros per year[2]. Thus, immediate measures are needed to mitigate the deleterious impact of eutrophication on both ecosystem and human well-being within the region. Nature-based solutions emerge as a promising and environmentally friendly approach for bioremediation of eutrophic marine environments by capturing excess nutrients from the water

[1] https://ec.europa.eu/commission/presscorner/detail/en/ip_23_4683

[2] https://helcom.fi/wp-content/uploads/2019/12/BSEP160.pdf

Method

The vertECO® prototype included a raft equipped with two vertECO® treatment wetland basins aligned stepwise above each other and one polishing tank filled with a sorbent (magnesium hydroxide coated biochar) for the capturing nutrients and a solar panel to provide energy for the feed pump for the inflow water and aeration pump for aerating bottom of the vertECO® basins. The vertECO® basins were filled with a mixture of substrates such as expanded clay and species tolerant to brackish water conditions (*Bolboschoenus maritimus*, *Schoenoplectus tabernaemontani*, *Lythrum salicaria L.*, *Juncus inflexus*, *Spartina pectinate*) were planted. The system works as a horizontal subsurface flow (HSSF) treatment wetland and with an inflow of 500L/d the hydraulic retention time is 12.5 hours. The vertECO® system started to operate on May (2023) and the samples were collected until October (2023). The samples were collected from the inlet, after vertECO® basins (i.e. before the biochar tank) and after the biochar tank (outlet), and were analyzed in terms of pH, salinity, total dissolved solids, conductivity, chemical oxygen demand, phosphate, nitrate as well as other anions and cations.

Conclusion

The pilot application of the vertECO® raft system was able to treat nutrients significantly during algae blooms, resulting in outflow phosphate and nitrate concentrations similar to surface water concentrations during non-bloom periods. However, in- and outflow nutrient values were always above the stringent eutrophication threshold limits set by HELCOM. Hence, the authors recommend testing further sorbents to be able to achieve the relatively low outflow nutrient thresholds set by HELCOM after the sorbent chamber. For the plants in the vertECO® basins, the nutrient concentrations are relatively low during non-bloom periods, nevertheless the plants were able to survive with relatively low growth, also showing the adaptability of the system and plants during the fluctuating conditions. This study showed that this prototype can be a model as a sustainable solution to reduce eutrophication in the Baltic Sea, especially during algae bloom or other extraordinary pollution.*This project is funded by Nordic Council of Ministers.*

MASSA Lagu – Innovative methods and design processes transforming residue to reef

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Background

Rapid urbanization and infrastructure development in Stockholm generate large quantities of surplus stone materials, posing both a challenge and an opportunity for sustainable urban planning. The MASSA project emerges as a pioneering initiative, aiming to repurpose these stone remnants creatively while addressing urban ecological challenges. By fostering a unique collaboration among architects, artists, engineers, and ecologists, the project seeks to redefine the relationship between urban development and environmental stewardship, emphasizing the role of artistic processes in achieving sustainable metropolitan transformations.

Method

This study employs a mixed-methods approach, incorporating design as a core research tool to address complex urban challenges. It emphasizes the creation of prototypes, models, and design concepts to probe questions and hypotheses, fostering a cycle of iterative experimentation. Key methods include tactical urbanism for low-cost, temporary urban enhancements, and strategic design interventions like waterfront landscaping and the development of new habitats to bolster urban biodiversity and resilience. These methodologies aim to create sustainable urban environments by balancing ecological integrity with aesthetic and functional considerations, using surplus materials from infrastructure projects for ecological restoration. The project methodology involves constructing protective reefs and lagoon landscapes, focusing on enhancing ecosystem balance. Key initiatives include Isbladslagunen, a collaborative effort among the MASSA project, WWF, and Royal Djurgården, designed to forge a distinctive recreational and habitation zone for both aquatic and avian species, alongside visitors.

Conclusion

Preliminary findings from the MASSA project illustrate the significant potential of creative reuse of stone materials in promoting sustainable urban transformations. This approach enhances urban ecological health and methodically reestablishes a community-driven management, fostering a connection to the local landscape. This, in turn, deepens community involvement in the urban planning process. By highlighting the synergy between art, ecology, and urban development, the project advocates for a holistic approach to city planning that prioritizes sustainability and resilience. The research underscores the importance of multidisciplinary collaborations across organisations in addressing complex urban challenges, offering a novel paradigm for future development projects.

Keywords: Urban Transformation, Artistic Intervention, Stone Material Reuse, Biodiversity, Climate Resilience, Sustainable Urban Planning.

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Persistent Organic Pollutants in Marine Sediments Under the Effect of Industrial Sources

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Background

Persistent Organic Pollutants (POPs) are a class of chemicals with unique characteristics, such as environmental stability, bioaccumulation potential, and toxicity to humans and the environment. POPs originate mainly from industrial activities and may also be produced unintentionally. During their industrial production, use in manufacturing products, and waste management of POP-treated products, they are emitted in the environmental media. When they enter into aquatic systems, they accumulate in the sediments due to their hydrophobic properties and persist there for long periods. POPs pose a significant risk to aquatic life as a continuous source in the sediments. Hence, identifying the POPs' concentrations in the sediments, especially under the influence of industrial activities, is essential to understanding and managing their environmental risk.

Method

Surface sediment samples were collected from 16 points in the Aliağa Region, İzmir, Türkiye. The sampling points reflected the influence of industrial sources, such as the petrochemical industry and ship dismantling facilities. The collected sediments were stored at -20 °C until their analysis for polychlorinated biphenyls (PCBs) and polybrominated diphenyl ethers (PBDEs). Freeze-dried sediments were taken into glass vials and mixed with anhydrous sodium sulfate to remove any remaining moisture. Then, sediments were spiked with surrogate standards for PCB and PBDE analysis and ultrasonicated twice for 30 minutes with n-hexane:acetone (1:1, v:v) solvent mixture. All the solvents were evaporated to 3 mL using a rotary evaporator. The extracts were treated with sulfuric acid and then eluted from an alumina column to remove possible interferences during analysis. Lastly, the extracts were evaporated under high-purity nitrogen until 1 mL. The final samples were analyzed in gas chromatography coupled with mass spectrometry in EI mode for PCBs and in NCI mode for PBDEs.

Conclusion

The total concentration of 46 PCB congeners ranged from 5 ng/g dry weight (dw) to 4750 ng/g dw. The total concentration of 23 PBDE congeners ranged from not-detected to 5053 ng/g dw. The sediment samples showing the lowest PCB and PBDE concentrations were from the coasts of residential areas in the region. In contrast, the highest concentrations were observed in the samples taken from ship dismantling facilities and near heavy industrial activities. The dominant PCB congeners in the highly contaminated sediments differed between ship dismantling (PCB-153) and petrochemical industrial areas (PCB-28), while in all sediments, the dominant PBDE congener was BDE-209. These findings indicated the wide usage of deca-BDE in all areas and the usage of varying PCB mixtures for specific purposes. Since PCBs and PBDEs have several adverse effects on organisms, such as endocrine disruption, their concentrations in marine sediments highlighted the potential risk posed to the marine ecosystem.

Co-creation and transdisciplinary knowledge on the river in the Pacífico Econavipesca Project

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Background

The objective of the Pacífico Econavipesca project is to develop a sustainable artisanal fishing model that reduces the environmental, social, and economic impacts on the ecosystem in the municipality of Guapi, Cauca, in Colombia. A major challenge is to reduce dependence on fossil fuels for the fishing boats and engage in dialogues with the local community about ways to create social entrepreneurship to make fishing activities more sustainable long-term. The study focuses on transdisciplinary co-creation, thereby taking advantage of both traditional knowledge of local communities and scientific knowledge from several different disciplines. Thus, acknowledging that local knowledge is key to achieve climate strategies and environmental objectives (IPCC, 2022). The KTH field study started in October 2022 focused on i) understanding community engagement, co-creation strategies and actor interactions to identify challenges and opportunities for sustainability and ii) to explore methods for local community capacity building.

Method

The project's main methodology is transdisciplinary co-creation, that includes the local community and their traditional knowledge as part of the team together with researchers from different disciplines. Fieldwork activities were designed to create room for dialogues and mutual learning rather than importing or imposing certain technology or ways of thinking to any local community. The KTH team focused on co-creative activities engaging in dialogues between academics and local community representatives where local knowledge, culture and values are considered important together with scientific knowledge in co-production of new solutions and for input to policy. This included using methodologies of observational studies, interviews, actor-network mapping, co-creative activities, and reflective workshops together with the local community. Themes of activities included local and ancestral knowledge, inter-generational knowledge sharing, roles of key change-makers and other actors in the project, interaction between humans and the environment, importance of hands-on learning, and sharing of culture through food. One co-creative field activity took place on the river, using ancestral knowledge of sail-making and testing the sails on the river. This was complemented by a workshop (combining perspectives from anthropology, socio-technical understanding of narratives of change) to understand what the activity of sailing meant for community members. Methods enabled crafting recommendations for local policy makers and material for discussion in the local community. Key themes for policy recommendations included: 1) Make use of specific historical, geographical, social, and environmental context and local knowledge; 2) Include local representatives in transdisciplinary collaboration; 3) Incorporate time for developing knowledge and skills of the local community; 4) Acknowledge interlinkages between ecological, social, and economic factors; and 5) Enable synergies between UN Sustainable Development Goals in your local environment. For local capacity building, discussion material for local community was anchored in river narratives.

Conclusion

Experiences from the KTH field study highlight transdisciplinary co-creation as a useful method for understanding both the knowledge of the locals but also their notion of change, development and innovation. Furthermore, co-creation results not only in material solutions, but also cognitive development and capacity building of actors. Workshop activities improved our understanding of inter-generational knowledge. This is relevant since sustainable development, coined in the Brundtland Report "Our Common Future" (1987), implies not compromising possibilities of future generations. The study shows that local community values and narratives of change can influence knowledge transferred to the next generation. Thus shaping sustainability outlooks and local communities' relations with the river.

Flood and flow modulation potential of small constructed wetlands

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Background

Wetlands may function as nature-based solutions to store water, mitigate flooding of downstream areas and improve water quality. However, such ecosystem services of wetlands have often been studied in individual wetlands, while large-scale studies of the functions of interconnected wetlands in entire catchments (wetlandscapes) are relatively few, despite the necessity to implement solutions at larger scales to face current societal challenges. We acknowledge that there is a large heterogeneity in the function of wetlands, depending on size, ambient hydro-climatic conditions, land-use, water use, other catchment characteristics, and topographical position. Notably, constructed wetlands can be numerous in some regions, not least in the more populated parts of Sweden, although they are often much smaller than natural wetlands. We here aim at investigating the large-scale net effect of constructed wetlands on water storage and downstream flood and flow modulation (buffering), investigating also landscape controls on buffering capacity.

Method

We have monitored daily water levels and water storage of >100 constructed wetlands in Halland, SW Sweden, from the spring period of 2020 to the winter period of 2023. The detailed wetland bathymetry, inlet/ outlet solutions, upstream drainage areas and catchment characteristics, as well as downstream flows were quantified. The monitored characteristics of constructed wetlands were furthermore compared with corresponding characteristics of much larger, natural wetlands in Vattholma, NE of Stockholm and Uppsala. More specifically, we define flow buffering as the (positive) water storage in wetlands that increase the wetland water levels, while also contributing to downstream flow and flood risk reduction. We distinguish between different type behaviors of wetland flow buffering, including wetlands that change volume and area in response to individual rain events, those that predominantly have seasonal storage cycles, and those that are essentially hydrologically unresponsive. We furthermore quantify the larger, landscape-scale effect of the constructed wetlands by evaluating how large fraction of the landscape's total water flows that actually will pass one or several constructed wetlands along the flow pathways to the coast.

Conclusion

Results showed that the small constructed wetlands together buffered (modulated) a notable share (3-17%) of the runoff of their upstream catchment areas, which e.g. is en par with the (10%) buffering of natural wetlands in Vattholma. There was furthermore a clear positive trend between buffering and wetland catchment area. The relatively strong correlation was partly unexpected, as small constructed wetlands with large catchments could fill more quickly, remain at maximum capacity, and thus buffer less effectively. We can therefore conclude that the predominant technical design of the constructed wetlands gives them good buffering capacity despite high hydrological load. On the landscape scale, around 50% of the region's coastal flows passed at least one constructed wetland. Our results furthermore show that there is potential to considerably improve buffering of the existing wetlands by utilizing wetland engineering mechanisms, in particular the emptying possibilities and controllability of the outlet structures.

The potential of nature-based solutions in flood regulation within urban areas

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Background

There has been an increasing frequency and severity of floods, a trend that is expected to continue in the future due to climate change impacts and increasing urbanization. Traditional responses to flood risk reduction have typically involved "grey" infrastructures for stormwater management (e.g. dams and dikes). However, over the past years, there has been a growing interest on nature-based solutions (NBS) for flood management since they are more cost-effective and multifunctional. NBS intends to re-establish hydrological conditions before urbanization, i.e. reducing and delaying runoff, through the incorporation of green and blue elements that increase infiltration, evaporation and retain water. However, there is a general lack of knowledge regarding the effectiveness of NBS in flood mitigation which have been impairing their large-scale implementation. This paper aims to understand the potential impact of NBS on flood mitigation and how to move towards more effective implementation of NBS for flood risk reduction.

Method

The paper presents several case studies in central Portugal where the impact of different types of NBS have been investigated through both field measurements and modelling. For example, the role of three distinct forests patches (i.e. semi-natural oak stand, sparse eucalyptus stand and dense eucalypt plantation) on overland flow processes in a small catchment were assessed based on runoff plot measurements. The results show that although the three types of forest produced limited overland flow (<3% of the overall rainfall), the semi-natural forest provides a higher potential to promote infiltration, whereas the dense eucalypt stand generated twice high overland flow due to soil hydrophobicity. The study stresses the relevance to incorporate forest patches in any urban planning to reduce total runoff-generating areas and to provide sinks for overland flow from upslope urban surfaces. Based on hydrologic and hydraulic modelling, the role of retention basins was also investigated in different locations within a small peri-urban catchment. The study revealed that placing a retention basin downslope lead to 5-10 times higher decrease in the water depth at catchment outlet than upslope. Combining both upslope and downslope retention basins provides a marginal additional impact in reducing water depth. Another study focuses on the impact of coupling both green and blue elements with grey infrastructures to mitigating pluvial floods, based on field surveys and runoff estimates through the widely used Curve Number (CN) method. The use of grassed areas and ponds integrated with a spillway infrastructure which controls the runoff storage capacity of the semi-natural elements have the capacity to cope with runoff driven by rainfalls with recurrence up to 20 years, providing runoff storage near to its source and a slow release of runoff which delays the peak flow into downslope urban areas.

Conclusion

These findings demonstrate that incorporating green infrastructure in urban design can be an important strategy to manage urban floods and alleviate flood risk. Generally, the effectiveness of different NBS on stormwater management

are influenced by design and placement aspects, but a network of connected NBS elements can improve flood mitigation and enhance urban resilience. Stronger evidence of the advantages of NBS, however, is still required to overcome the current challenges and barriers impairing their wider implementation in urban areas.