# Abstracts in Poster Session

## P01 Bayesian Spatiotemporal Modelling of Extreme Rainfall Frequencies in Denmark

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Changes in the characteristics of extreme rainfall events have been observed globally. In the context of ongoing climate change, it is crucial to link these changes to known sources of climate variability. Here, we apply Bayesian hierarchical spatiotemporal models to analyze extreme rainfall data with a computationally efficient setup. The fixed part of the model includes climate and physical factors, such as atmospheric moisture, vertical stability, and large-scale atmospheric flow patterns. Due to the complex coastal geography of Denmark, we also account for the distance to the sea. The technique explicitly models the spatiotemporal correlation structure inherent in the data by incorporating Gaussian Random Fields (GRFs) into the model structure. This allows for the inclusion of uncertainties resulting from sampling bias and extreme rainfall variability across both space and time, such that it is straightforward to obtain posterior predictive probability distributions for non-sampled areas. We tested multiple statistical models and found that negative binomial models performed best for extreme rainfall frequencies in Denmark. The full model highlights clear geographical variations in extreme rainfall frequencies across the country. Despite accounting for various climate and physical factors, we still find a positive trend in extreme rainfall frequencies over the past 45 years. We find a strong decrease in the posterior spatial correlation range of the spatial random field as we increase the threshold for extremes from 10mm/h to 15mm/h, suggesting that 15 mm/h exceedance is dominated by local, convective events, while 10 mm/h events include larger-scale precipitation structures.

## P02 Nationwide assessment of groundwater redox conditions in Estonia

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Oxidation-reduction (redox) processes significantly influence groundwater quality by controlling the mobility and transport of naturally occurring and anthropogenic components, such as iron, arsenic, and nitrate. Understanding the spatial patterns of redox conditions is critical for assessing groundwater vulnerability, predicting contaminant behavior and developing sustainable water management strategies. While advanced modeling techniques have been successfully applied worldwide to analyze large-scale redox conditions, Estonia currently lacks a comprehensive national assessment of its groundwater redox status. With climate change impacting groundwater systems and their geochemical dynamics, understanding the spatial distribution of redox conditions is crucial for assessing groundwater vulnerability and developing sustainable water management strategies.

This study aims to characterize and predict the spatial distribution of redox conditions in Estonia's groundwater systems through the development of a nationwide redox zonation. This is achieved by integrating groundwater quality data from Estonian national databases with environmental and geological

predictors, such as land use, aquifer type, and water table depth. Advanced modeling techniques are applied to classify redox zones and identify the key geochemical and spatial drivers influencing groundwater quality across Estonian groundwater systems. The resulting redox zonation will provide a valuable resource for assessing groundwater quality risks associated with contaminant mobility and supporting sustainable groundwater management strategies.

## P03 Comparison of streamflow simulation accuracy using hydrological model and machine learning methods: application to the Kävlinge river basin in Sweden

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Streamflow simulation plays a critical role in flood monitoring and early warning system, and it is also affected by biases and uncertainties arising from nonlinear processes, model parameterization and errors in meteorological forecast. In this study, we compared the streamflow simulation accuracies using the QSWAT+ hydrological model and Long Short-Term Memory (LSTM) method in the Kävlinge River basin in Sweden. The hydrological model was driven by observed hydro-meteorological data from the Swedish Meteorological and Hydrological Institute to simulate flood peaks. Meanwhile, the LSTM used precipitation and runoff data to simulate the streamflow. The results show that both methods can simulate the streamflow effectively. The physics-based hydrological model, observed hydro-climatic data, and LSTM method improve streamflow simulation for flood magnitude and timing, which is valuable for developing flood early warning systems in Sweden.

## P04 Enhancing terrestrial evapotranspiration modeling using a deep learning method: integrating spatial heterogeneity with temporal dynamics

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Evapotranspiration (ET) plays an important role in terrestrial water and energy cycles. However, accurate and spatially continuous ET modeling remains a significant challenge due to the complex interplay of environmental factors and inherent spatial heterogeneity. In this study, we employ a data-driven approach utilizing the Entity-Aware Long Short-Term Memory Network (EA-LSTM) to improve ET simulations. The EA-LSTM integrates meteorological time-series data with carefully selected static site attributes (including vegetation indices, soil properties, and topographic characteristics) across 103 flux towers worldwide, encompassing 10 distinct vegetation types. This integration allows the model to explicitly account for spatial heterogeneity while simultaneously capturing the temporal dynamics of the ET process within a deep learning framework. Furthermore, the sensitivities of ET simulations to these static attributes are systematically analyzed. Our results show that the EA-LSTM outperforms the traditional LSTM, with the mean and median Nash-Sutcliffe Efficiency (NSE) across all sites reaching 0.65 and 0.87, representing increases of 0.10 and 0.08, respectively. Notably, the model's superior performance in leave-one-out cross-validation experiments underscores its enhanced spatial transferability compared to traditional LSTM approaches. The EA-LSTM model demonstrates the ability to extract key regional similarity features from limited observational data and leverage additional vegetation characteristics for enhanced ET simulation. This study represents a robust deep learning-based approach for ET modeling, offering improvements in spatial transferability and predictive accuracy.

## P05 Recent changes in ice climate in the Estonian coastal waters and its influence on coastal hydrodynamic and geomorphic processes

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The year 2024, the hottest on record globally, was the second hottest in Estonia, with an average temperature of 8.1°C, 1.7°C warmer than the climatic norm from 1991–2020. It is well known that in northern Europe, warming has been faster than the global mean. For instance, air temperatures at Estonian coastal stations have increased by approximately 2.5°C between 1950 and 2024. As a direct result of this warming, the duration of winter ice cover in the Estonian coastal sea has decreased by 30–50%. This decline has been suggested to play a crucial role in the intensification of coastal processes. Based on visual observations at Estonian coastal stations and analyses of ice charts provided by the Estonian Environment Agency and the Swedish Meteorological and Hydrological Institute, this presentation reviews and updates the time series of ice conditions in the Estonian coastal sea over the past 75 years. The revealed tendencies in Estonian coastal stations are compared with long-term variations in the Baltic Sea's annual maximum ice extent and are analyzed alongside air temperature data and the NAO index. The discussed influences of the decrease in ice cover include the interfering with wave statistics (due to the shortening of fetches or the complete elimination of waves in fully ice-covered conditions), the impact on wind-driven surface currents, and the influence on long-term sea level statistics. The geomorphic influence on coastal erosional-accretional processes is analysed on the basis of Järve and Valgeranna case studies with coastal records starting from the 1950s.

## P06 Urban hydrology for waste management

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Urbanization and population growth contribute to increasing waste disposal, posing risks to human health and environmental safety. Landfills are dynamic systems that require careful and strategic management due to their potential hazards. While numerous studies have explored landfill emissions, including leachates and methane, there remains a need for deeper insights into landfill hydrology and the risks associated with climate change and shifts in the hydrological cycle. Although urban hydrology has been extensively studied, its application to landfill management remains incomplete and inconsistent.

Over the long term, landfills influence the hydrological cycle, yet questions persist regarding how urban environments impact water balance components. We aim to outline the fundamental principles of landfill hydrology within the urban hydrological response unit framework. Additionally, it evaluates environmental and health risks linked to landfill geomorphology and water balance under changing climate conditions. While landfill hydrology shares similarities with urban hydrology, it also includes specific elements such as irrigation, leachate recirculation, and total leachate production. A better understanding of these factors is crucial for improving landfill management and mitigating environmental impacts.

## P07 Impact of 2-stage channels on sediment and nutrient loading as measured by automatic monitoring systems

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Sediment and nutrient loading from catchments to water bodies has traditionally been monitored based on water samples collected at varying frequency. However, this approach leaves long periods between

sampling events, during which water quality can vary significantly, increasing the uncertainty of load estimates. Automatic monitoring systems with continuously recording sensors provide a feasible option to obtain more reliable loading estimates. At the Uuhikonoja site in Tammela, southern Finland, we investigated the effects of agricultural drainage renovation realized by replacing the conventionally dredged ditch by a 2-stage channel (TSC). Continuous water quality monitoring was conducted for three years before and during the renovation (November 2018 – November 2021) and for two years after (February 2023 – February 2025). The measurements took place downstream of the TSC in the implementation area and, during the same periods with similar devices, in a channel in a similar-sized reference area where no excavation was done. The results based on sediment and nutrient loading ratios (implementation/reference) clearly revealed the increased loading during and right after the excavation. However, reductions in loadings, to even below the pre-excavation levels, were observed in the years following the renovation. The main reason for decreased loading was likely the vigorous development of vegetation on the excavated floodplain TSC during the 2$^{nd}$ and 3$^{rd}$ years after the construction. These findings highlight the positive, load-reducing effects of TSCs. Together with other nature-based solutions, these channels are crucial for addressing challenges such as increased wintertime loading and flood risks associated with a changing climate.

## P08 Climate Change and Permafrost Thaw Impact on Drinking Water Quality in Greenland

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Permafrost underlies 22% of the Northern Hemisphere's exposed land surface and is thawing at an alarming rate as a direct consequence of climate change. Permafrost thaw releases large quantities of organic matter and contaminants into the environment. Contaminants, including heavy metals, persistent organic pollutants and microbiological agents locked in permafrost, are a risk for both human and animal health. To evaluate the impact on drinking water quality in Greenland different sites spanning the west coast has been selected. Since most of the Greenlandic communities are supplied with drinking water from lakes, the sampling focus is evolving around this. Water and sediment cores will be collected from several lakes used to supply the communities with drinking water along with references outside of supposed local pollution. These will be analyzed for organic long-distance contaminants such as poly chlorinated bisphenols and poly aromatic hydrocarbons, but also for oil contaminants stemming from local activities. Alongside the chemical assessment, a microbial evaluation of presence of cyanobacteria will also be performed by laboratory analysis and remote sensing. The acquired data will be used to describe the status of Greenlandic drinking water in a changing climate. Similar chemical analysis will be performed on permafrost cores and above-lying active layer in order to describe a possible connection between pollution in permafrost and degenerating drinking water quality.

## P09 Hydromorphological Quality of Lowland Rivers and Key Influencing Factors

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Hydromorphological quality is one of the key elements for river ecological status assessment. Hydromorphological degradation caused by hydrological and morphological alterations often causes deterioration of biological diversity of aquatic flora and fauna and leads to downgraded ecological status. The aim of this study was to test links between hydromorphological quality parameters and macroinvertebrate indices used in routine monitoring and to find out hydromorphological parameters which are most sensitive to predict biological quality of a river. During LIFE GoodWater IP project hydromorphological status of four rivers was assessed in field using River Habitat Survey. Total assessed length was ~200 km. Additional macroinvertebrate sampling was done to validate ecological response of

hydromorphological degradation. The results obtained in the project were supplemented with the national monitoring data from 2010-2023. Mann–Whitney–Wilcoxon U tests, linear regressions and boxplots were used to select the best combination of hydromorphological variables to explain diversity of selected benthic macroinvertebrate indices. We found significant links between biological and hydromorphological quality. It was found that river bed slope, percentage of akal bed substrate, channelization intensity and agricultural land area were key hydromorphological variables affecting selected macroinvertebrate metrics. There were clear differences between hydromorphological response of rithral and potamal rivers, with rithral rivers showing better connection to hydromorphological variables while the ecological status of potamal rivers was more related to eutrophication pressure. Results of this research can be used to support ecological status assessment of water bodies without field monitoring.

## P10 Prevalence and applicability of PAHs as markers in the groundwater of an industrial region in Estonia

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In northeastern Estonia, oil shale mining and processing have been ongoing for over a century, leading to the degradation of groundwater and surface water quality. This pollution is primarily characterised by toxic phenols and polycyclic aromatic hydrocarbons (PAHs). While phenol contamination has declined in recent decades, PAHs remain detectable in all groundwater systems. This study aimed to identify PAH sources and delineate their distribution. To achieve this, water samples were collected from 120 boreholes, and historical surface water datasets were analysed.

PAH concentrations in northeastern Estonia reached up to 10.8 µg/L (median 0.08 µg/L), with a distinct division into northern and southern groups, each exhibiting different PAH compositions. In the north, PAHs were strongly linked to industrial residual pollution sites, whereas in the south—where glacial-origin groundwater dominates—PAH concentrations remained below 0.04 µg/L, which seems to be their natural level. The highest concentrations were detected at depths of up to 20 metres, corresponding to the fractured limestone zone. Below this depth, PAH levels declined rapidly, with a shift towards lower molecular weight PAHs.

PAH data from rivers and mine drainage showed seasonal variations. During the spring flood, riverine PAH composition differed significantly from that of groundwater, reflecting surface runoff influences. In contrast, during low-flow periods, riverine PAH composition closely resembled groundwater signatures. Based on a comprehensive dataset, PAHs emerge as promising hydrogeochemical markers for identifying pollution sources and monitoring groundwater–surface water interactions.

## P11 Intercomparison of hydrological models and calibration objective functions for evaporation estimates in unregulated Norwegian catchments

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Hydrological models are commonly used tools to estimate evaporation (ET) at the catchment/regional scale. Due to lack of direct measurement of ET, hydrological models are usually calibrated against river discharge without having constrain on other hydrological processes. Therefore, ET estimates vary with hydrological model, input data and model structures. In addition, the choice of objective functions used for calibration is crucial. However, the effect of the choice of objective functions on ET estimates have been rarely documented in literature. In this study, we aim to compare the ET estimates for 66 unregulated Norwegian catchments using three hydrological models (HBV, LISFLOOD and Shyft) and three objective functions (KGE, KGE+LKGE, and KGE+BoxcoxKGE). The selected catchments differ substantially in

climatic and hydrological characteristics and span five hydrological regimes (Atlantic, Mountain, Inland, Baltic, and Transition). The three hydrological models are calibrated against daily discharge in 1981-2000 and validated in 2001-2020 using six criteria: KGE, LKGE, BoxcoxKGE, percent Bias (PBias), and KGE and PBias in the snow free period. The snow free period is identified for each catchment and year based on a daily fractional snow-covered area data at 500m spatial resolution produced from a combined MODIS dataset from Aqua and Terra satellites. The calibration and validation results show that the three hydrological models need different objective functions to achieve the best model performance for each hydrological regime and target variable (discharge and ET). The uncertainty of ET estimates from different hydrological models is generally larger for mountain and inland regimes than for other regimes.

## P12 Hydrological modeling for Reola basin Estonia using GR4J-Cemaneige and LSTM models

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Almost half of Estonia's land is covered by hemi-boreal forests, crucial for its economy and ecology. Estonia ranks fourth in the EU in forest area per capita (1.70 ha/capita). Over the past century, forested areas have tripled, making hydrological forecasting vital for water resource management.

This study focuses on the 237 km² Reola Basin, which drains into the Emajõgi River. It aims to improve hydrological modeling using big data, such as radar precipitation and satellite evapotranspiration. Data were sourced from meteorological stations (Tartu-Tõravere, Võru), EURADICLIM radar, and the Reola hydrometric station. Evapotranspiration data came from MODIS (Terra satellite) and SMEAR Estonia, with MODIS values corrected using SMEAR $H_2O$ fluxes via the Eddy Covariance technique.

The GR4J-Cemaneige conceptual model and the Long Short-Term Memory (LSTM) machine learning model were compared using precipitation, evapotranspiration, and temperature inputs. Nash-Sutcliffe efficiency was assessed for three precipitation scenarios: pluviometer data, uncorrected radar, and radar corrected via the Double Mass Curve method. The GR4J model performed best with pluviometer data (0.8025), while LSTM excelled with corrected radar data (0.7240). Including the previous day's flow improved LSTM results significantly (0.9450).

The findings showed that LSTM excelled with radar data, whereas GR4J outperformed it with pluviometric data. The double mass curve method significantly enhanced the quality of radar-derived precipitation data. This research contributes to a better understanding of water balance dynamics in hemi-boreal ecosystems, which are altering their hydrological response due to climate change.

## P13 Hydro-Meteorological Drought in the Baltic Region: A Regional Perspective

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The Baltic Region is characterised by a humid climate in which annual precipitation generally exceeds evaporation, suggesting that droughts should be rare. However, this study analyses the spatial and temporal characteristics of droughts in the region, which includes Sweden, Finland, Lithuania, Latvia and Estonia. To assess the variability of droughts, two indices — the Standardised Precipitation Index (SPI) and the Streamflow Drought Index (SDI) — were analysed over several accumulation periods. Daily

precipitation and streamflow data served as the basis for the assessment of drought trends. Spatial and temporal assessments and a decadal analysis of drought classifications were performed to determine changes in frequency and distribution over time. Pearson correlation analysis was applied to determine the relationship between meteorological and hydrological droughts. The results indicate that locations where short-duration SPI or SDI events occur frequently tend to have fewer long-duration events and vice versa. In the western Baltic states and at several hydrological stations in Sweden and Finland, an increase in SDI-defined drought events (SDI ≤ –1) was observed from 1991 to 2020 compared to 1961–1990. In contrast, drought trends based on the SPI remained largely stable, except for some signs of change in central Estonia and southern Finland. The 6-month accumulation period proved to be a critical indicator of prolonged and widespread drought conditions, while the 9- and 12-month periods showed similar patterns in terms of drought duration and severity. The strongest correlations were found between SPI12-SDI9 and SPI12-SDI12, emphasising the links between meteorological and hydrological drought processes.

## P14 Projected Changes in Annual Maximum Flows in Northern Lithuanian River Basins: A Focus on Extreme Events

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Climate change is significantly altering river flow patterns. Extreme hydrological events are becoming more unpredictable, with rare but devastating flash floods (1%, 0.5%, and 0.1% probability thresholds) causing severe damage, as seen in Poland and the Czech Republic in 2024. Projecting annual maximum flows (amaxf) is crucial for improving hazard management.

This study investigates future changes in amaxf in two northern Lithuanian river basins (Mūša and Lėvuo) using global climate models (GCMs) projections to better understand extreme hydrological events and their impact on regional water systems. The projections were made for three future periods: near (2021-2050), mid (2041-2070), and far (2071-2100).

The study used a hydrometeorological database, GCMs data under Shared Socioeconomic Pathway (SSP) scenarios, probability distribution fitting and hydrological modelling. Analysis of Mūša and Lėvuo amaxf (1958-2022) showed they follow a Generalized Gamma (4P) distribution. Hydrological models of these rivers were developed using the HBV model. River flows were projected using an ensemble of 12 GCMs under SSP245 and SSP370 scenarios. A detrended quantile mapping bias correction technique was used to recalculate meteorological parameters from the GCMs grid into the places of meteorological stations.

The results indicate amaxf will increase from 2% to 67% (SSP245) in the 2021-2050 but may decrease from 2% to 28% (SSP370) in the 2071-2100, compared to the reference period (1985-2014).

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## P16 Replacement of meteorological data by interpolation methods for hydrological modelling in low land catchments

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Modelling of small river basins often entails several challenges, including the lack of basic meteorological data (temperature and precipitation), gaps in the time series, and the location of the weather station at a considerable distance from the study area. Thus, this study aims to investigate the possibilities of using interpolation (Kriging and Spline) and ERA5 database for hydrological modelling of low land basins.

For the analysis, 14 meteorological stations with data set for 60 years (1961 -2020) were used, additionally, data from 20+ meteorological stations with significant data gaps were also used for interpolation. The ERA5 data were downloaded from https://open-meteo.com/en using the meteorological station coordinates. The study was divided into 2 stages, where the first stage analysed the station-by-station error between real and simulated data. Interpolation was performed by monthly and was done in ArcGIS, with a raster output cell size of 100x100 metres and the station coordinates were used to download data from package of 720 rasters (for each station). Root Mean Squared Error and percent Bias were used to investigate the error of received data. At the second stage, 3 catchments in Lithuania were selected to create hydrological models in the HBV software. The models were calibrated and validated using historical meteorological data, after that data from interpolation and ERA5 were used in the model.

According to the results, Kriging method shows the smallest error in precipitation compared to real data, and for temperature, ERA5 and Kriging method are almost similar to historical data.

## P17 Water balance of Sweden – comparing the standard normal period (1991-2020) to the reference normal period (1961-1990) to determine temporal changes

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The water balance of Sweden has been determined for the current climatological standard normal period (1991-2020) through hydrologic modelling using the S-HYPE model and a national geographical setup consisting of around 26 000 subcatchments. The calculated variables comprise precipitation, evapotranspiration and runoff. These results show geographical differences of the hydrological variables over the country, and provide useful basis for urban and rural planning, for environmental needs as well as for construction of for example infrastructure.

In addition to launching an updated version on longterm average values on these variables, the same modelling version and geographical setup has been used on the previous 30-year period (climatological reference normal period 1961-1990), which facilitates comparisons regarding the trends in runoff variables . Comparing the time periods, we see an increase in precipitation in large parts of Sweden, although the findings are spatially variable. However, also the evapotranspiration seems to increase in large parts of the country. The results in runoff shows a somewhat scattered and variable change. In most parts in the southwest and north, the runoff is shown to increase over time, whereas particularly parts of southeastern Sweden is shown to generate less runoff when comparing the two time periods.

Further analysis is to be performed, but having the current climatological standard normal period 1991-2020 as well as the climatological reference normal period 1961-1990 available using the same modelling and geographical setup provides a useful tool for drawing conclusions regarding how the water balance of Sweden has changed during the recent decades.

## P18 Developing smart irrigation framework to Mitigate Climate Change Impacts on Sub-Arctic Agriculture

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Climate change, with its rising temperatures and increasing weather extremes, challenges agricultural water management and productivity. In northern Europe, prolonged growing seasons and the cultivation of alternative crops are expanding due to warmer temperatures. However, hydrological extremes such as droughts and intense rainfall threaten productivity, particularly in areas lacking established irrigation systems. This study focuses on developing a smart irrigation modeling framework to optimize water management for agriculture under these changing conditions. The model simulates daily water storage dynamics across a sub-Arctic region by integrating high-resolution climate data. The model identifies spatial and temporal patterns of water deficit and excess, enabling precise calculations of water reservoir capacities needed to address summer droughts. These insights are applied to design an intelligent irrigation control system that automates water distribution and drainage operations. The proposed system adapts in real time to flash droughts and heavy rainfall, providing a flexible and efficient solution to climate-resilient agricultural water management.

## P19 Climate change impacts on ecologically sensitive species and management challenges in regulated rivers

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Climate change is negatively affecting ecologically vulnerable fish species in regulated rivers. Such species are bullhead (*Cottus gobio*), river lamprey (*Lampetra fluviatilis*), brook lamprey (*Lampetra planeri*) and salmonids such as Atlantic salmon (*Salmo salar*) and grayling (*Thymallus thymallus*). All these species are of high conservation priority under the Habitat Directive.

Rising temperatures, reduced summer water flow, prolonged low-flow periods create challenging conditions for these species. Additionally, human-induced alterations in rivers, including hydropower plants, straightening and migration barriers, increase negative impacts. The combined effects of climate change and human activity are putting vulnerable river fish species at great risk, potentially causing severe population declines or even local extinctions.

As part of the LIFE GoodWater IP project, a 200 km stretch of regulated rivers in four river basin districts was assessed. The findings revealed that hydromorphological alterations are the most important pressure overruling also the impact of eutrophication. To reduce these adverse effects, several mitigation measures were identified, including the removal of migration barriers and ensuring sufficient ecological flow. However, their implementation is often hindered by legal gaps and outdated regulations.

Our findings indicate that without adaptive management approaches and legislative improvements, the situation for ecologically vulnerable species is expected to face further decline. Immediate action is required to modernize management strategies and ensure the long-term survival of freshwater biodiversity.

## P20 "Advancing Flood Forecasting in Ireland: Development and Implementation of an Operational Fluvial Forecasting System"

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In response to significant flood events, the Irish Government initiated the development of a national flood forecasting service in 2016. A key milestone in this initiative is the establishment of the Flood Forecasting Centre (FFC) within Met Éireann, which provides critical flood forecasting and advisory services to local authorities and emergency management stakeholders.

Met Éireann is currently advancing an operational fluvial flood forecasting system. The system integrates the HYdrological Predictions for the Environment (HYPE) model, developed by the Swedish Meteorological and Hydrological Institute, with the Delft-FEWS platform. Hosted on Microsoft Azure's cloud computing service, this system utilizes real-time observational hydrometeorological data and ensemble Numerical Weather Prediction (NWP) forecasts from Met Éireann (Harmonie) and the European Centre for Medium-range Weather Forecasts (ECMWF). These ensemble forecasts enable the generation of probabilistic river discharge forecasts at multiple locations with lead times of up to seven days.

This poster highlights the core components of the fluvial forecasting system, detailing the development, calibration, and real-time operational workflow. Additionally, it explores system outputs, the role of ensemble forecasting, and future advancements, including the development of a robust verification system to evaluate forecast performance. This work represents a critical step forward in enhancing Ireland's resilience to flood risks through robust and actionable forecasting capabilities.

## P21 GRANDE-U: Advancing Transboundary Groundwater Resilience Assessment with Satellite Data Downscaling and Data-Driven Approaches

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Transboundary aquifers supply a significant share of drinking and irrigation water worldwide, yet the lack of standardized international practices for their assessment and management threatens groundwater sustainability. Over-extraction in these shared systems is a growing concern, exacerbated by fragmented data collection, inconsistent monitoring, and limited cross-border coordination. Effective groundwater management requires integrated observations, models, and shared assessments to ensure transparency and informed decision-making.

The GRANDE-U (Groundwater Resilience Assessment through Integrated Data Exploration for Ukraine) project unites researchers from six countries - the U.S., Ukraine, Poland, Latvia, Lithuania, and Estonia - to enhance groundwater resilience assessment in regions facing data gaps, incompatible hydrogeologic descriptions, and governance challenges.

Building on the US NSF-funded AccelNet Transboundary Groundwater Resilience project and the European EU-WATERRES initiative, GRANDE-U integrates hydrogeologic models with satellite and ground-based data to refine predictions of groundwater storage and flow across borders. This includes downscaling GRACE-FO satellite data and developing a spatial database of key groundwater characteristics. Additionally, machine learning models will be applied to improve groundwater resilience assessments, addressing both quantity and quality concerns.

This approach is particularly critical in Ukraine, where western regions face rising water demand due to war-driven population displacement and emerging pollution risks. By enhancing data integration and predictive capabilities, GRANDE-U aims to support sustainable transboundary groundwater management and resilience in vulnerable regions.

## P22 Flood Modeling of an Extreme Rainfall Event in Norway Using Partial Differential Equations

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Public availability of large high-resolution datasets and advancements in computational capabilities have made the use of partial differential equation based numerical models in hydrology an effective tool for predictions of extreme events and management of water supplies. These developments combined with climate change driven increases in extreme hydrologic events, such as flooding, has generated a need for more accurate and informed water management and prediction tools. As a test case, Hans an extreme storm event in 2023, that saw 100-139 mm of precipitation over a large interior area of Norway in a short time frame was modeled. The event caused widespread damage of infrastructure and property from flooding and landslides, particularly in the area of Nesbyen where the model is focused. To improve future responses and preparation to these types of events this study aims to create more accurate and informed runoff model based on finite element discretizations of surrogates to the shallow water equations.

In the present work, our aim is to implement a finite element model of the diffusive wave approximation. The model will use available data, such as elevation and landcover data for the Nesbyen catchment and precipitation data from the Hans event as input and model data.

## P23 Seasonal and Spatial Variability of Microplastic Pollution on Latvian Marine Beaches

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Despite increasing research on microplastic contamination in beach environments, the factors influencing its distribution remain poorly understood. This study addresses this gap by examining microplastic pollution across 11 marine beaches in Latvia (northeastern Europe), characterized by a four-season climate and influenced by the Gulf of Riga and the Baltic Sea. Site selection was based on previous research (Dimante-Deimantovica et al., 2023), with data collection conducted from autumn 2022 to summer 2023.

Microplastic samples were collected seasonally - autumn, winter, spring, and summer - across three distinct 100-meter transects at each beach: the waterline, mid-section and the area near vegetation or bluffs. The findings reveal sseasonal variations, with higher microplastic concentrations observed in autumn and winter compared to spring and summer. Additionally, distribution patterns varied across the transects, with vegetation occasionally acting as a barrier for microplastic accumulation. Rounded particles, transported by wind, tended to accumulate near vegetation, whereas elongated particles were predominantly found in the first transect near the sea. This study underscores the necessity of year-round sampling for accurate pollution assessments in highly seasonal environments.

The research is supported by GRANDE-U “Groundwater Resilience Assessment through iNtegrated Data Exploration for Ukraine” (NSF Awards No. 2409395/2409396) and Latvian Environmental Protection Fund project No. 1-08/37/2022.

Dimante-Deimantovica, Inta et al. (2023) The baseline for micro- and mesoplastic pollution in open Baltic Sea and Gulf of Riga beach. Frontiers in Marine Science.

## P24 CRYO-RI: improving the cryospheric monitoring network for Northern Finland

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The CRYO-RI project develops and tests modern monitoring technologies and infrastructure for academic and operative use. The project focuses on Northern Finland, which is experiencing rapid changes due to the warming climate. The consortium is lead by the University of Oulu, with the Finnish Meteorological Institute (FMI), the Finnish Environment Institute (Syke), and the Geological Survey of Finland (GTK) as partners. The outcomes of the project are provided as open access-data and measurement infrastructure.

This presentation gives an overview on the project activities, focusing on the development activities on operative hydrological monitoring. The presented work includes testing lake ice thickness monitoring using SIMBA instrument and the newly developed temperature spears, improving the river ice formation modelling of Sykes River Ice Model at river Kiiminkijoki and lake temperature profile measurements using Starr-oddi loggers. We will also introduce plans on testing GNSS based instrumentation for continuous snow water equivalent monitoring and building a drone-based data set on fractional snow cover for in situ snow course measurement and EO product validation.

## P25 The restoration of an urban eutrophic lake - preliminary results of the first aluminum treatment in the Baltic States

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Lake Velnezers is a small, dimictic lake located in Riga, Latvia. Decades of anthropopressure impacted the nutrients dynamics of the lake, leading to its gradual eutrophication. Nowadays external input has been reduced, still, the vast amount of phosphorus deposited in the sediment has prevented the recovery of the lake. Monthly monitoring conducted since July 2023 revealed total phosphorus concentrations reaching up to 0.11 µg/L in the surface water and 1.15 µg/L in the hypolimnion, resulting in excessive algal blooms and a critically low oxygen bottom layer (< 0.5 mg/L) prevalent during the times of stratification.

In October 2024, in an effort to reduce internal phosphorus loading, Lake Velnezers underwent a chemical treatment involving the addition of a polyaluminum chloride solution into the sediment. The restoration marked the first application of the aluminum treatment method in the Baltic States. A comprehensive assessment of the sedimentary mobile phosphorous pool determined the appropriate aluminum dosage of 56 g/m$^2$, aiming to reduce the internal phosphorus loading to natural levels of around 0.3 mg/m$^2$/day.

The preliminary results of post-treatment monitoring revealed an upsurge in water turbidity, and a significant decrease in surface water total phosphorus levels compared to the same months of the previous year. Ongoing studies will determine whether the water quality improvement achieved by the reduction of internal phosphorus loading in Lake Velnezers will be reflected in species richness and

diversity of plankton, and overall improvement of the lake's ecological health. The study was supported by Interreg Baltic Sea Region project TRUST ALUM.

## P26 Nordic approach to drought risk management: Risk assessments

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The Nordic approach to drought risk management is part of a broader European effort to address increasing drought challenges. Recent severe droughts have highlighted deficiencies in drought risk management in the Nordic Countries, prompting calls for improved understanding of the risk. This study examines the Nordic approach to drought risk management, focusing on comparing drought risk assessments in Finland and Sweden to identify their similarities and differences. In this context, we aim to analyse the applied methodological framework and the utilized concepts of drought risk, complementing the authors' study on drought policies.

Preliminary insights suggest that, although Finland and Sweden have historically lagged behind southern European countries in drought risk assessments, they have recently increased their focus on drought, mainly due to its growing negative impacts. Notably, their efforts often concentrate on distinct aspects of drought risk, such as hazard and vulnerability. The approach to drought risk assessments in Finland and Sweden differs, not only due to varying conceptualizations of drought risk but also because of the complex nature of the disaster, which spans multiple sectors of society, causes cascading effects, and results in impacts that can vary greatly across regions.

The next steps involve expanding the analysis to include other Nordic and Baltic countries, emphasizing their respective drought assessment approaches, challenges, and key similarities or differences. The authors encourage drought researchers from these regions to collaborate, broadening the study's scope and relevance. The goal is to develop a comprehensive regional evaluation and provide valuable recommendations for stakeholders and policymakers.

## P27 Soil amendments in mitigation and management of nutrient losses from agriculture in changing Nordic climate

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Soil amendments as a mitigation measure to reduce diffuse loadings from agricultural sites show prominent effects. The effects of gypsum, structure lime and pulp mill sludge applications on clayey soils have been investigated in catchment scale and lysimeter studies in Finland.

In the catchment scale study, water quantity and quality were measured using in-situ high frequency instruments and grab samples in a gypsum treatment and a control catchment stream. The analysis period 2020-2024 also includes extremely wet dormant seasons, which allowed us to highlight the effect of climate change induced warming winters on nutrient leaching.

The lysimeters were filled with clayey soil and treated either with gypsum, pulp mill sludge or structure lime with untreated control for comparison. Percolation water samples were taken through the summer

and autumn of 2024. The initial results clearly show the impact of these soil amendments on leachate quality in the short-term.

The results showed that the soil amendments had positive, negative or no effect on water quality depending on monitoring period after treatments and the variable analysed. Crucial is that the long-term overall effect of the soil amendments applied is positive in terms of soil balance and nutrient leaching, both agronomically and economically. We present the preliminary results and the studies will continue throughout the year 2025.

These studies are part of KIPSI and AIN3 projects and funded by the Ministry of the Environment.

## P28 Ecological classification for monitoring of the status of coastal waters in Iceland according to the Water Framework Directive (2000/60/EC)

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Extensive agricultural land use and human population growth have had a profound impact on the aquatic environment in the Anthropocene, mostly through intensification of nutrient fluxes from land causing structural and functional changes in aquatic ecosystems with persistent repercussions for water quality. In marine ecosystems, destruction of seagrass communities, harmful algal blooms, increased hypoxia and anoxia in deeper waters, and declines in harvested species, are a few of the problems that have been linked to nutrient overenrichment. Coastal ecosystems, in particular, are considerably affected due to their proximity to the pollution, and need to be protected and monitored.

To counter this degradation of aquatic ecosystems and restore them to a healthy state, several legislations have been adopted around the world. In Europe, the Water Framework Directive (WFD, 2000/60/EC) was established to ensure sustainable management of groundwater, freshwater and marine water in the European Union. To this end, the WFD states that water bodies should be classified based on their ecological status, according to a prioritised list of biological, chemical, physio-chemical, and hydromorphological elements. Hence, in Iceland, the Icelandic Water Management Act (36/2011) and Regulation 535/2011 have been implemented by the Environment Agency.

Here we present ecological classification elements and quality indices that have been developed by the Marine and Freshwater Research Institute for monitoring coastal waterbodies in Iceland. Biological quality elements currently utilised are phytoplankton biomass (chlorophyll *a*), soft bottom invertebrates (diversity index *NQI1*) and hard bottom macroalgae (community composition), and the physiochemical quality element of winter nutrient ($NO_3$,$PO_4$) concentration.

## P29 Bed-form scale changes in a sub-arctic meandering river: geomorphological evolution under different hydrodynamic conditions

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Understanding changes in meandering rivers is crucial for assessing how rivers respond to changing hydrological conditions, especially in high-latitude environments. The study examines geomorphic changes in a sub-arctic sand-bed meandering river, in northern Finland over a nine-year period (2015–2024). Using high-resolution LiDAR derived digital terrain models (DTMs) and orthophoto mosaics, we examine adjustments of point bars, channel thalwegs, and floodplains in response to varying hydrodynamic conditions, incorporating flood magnitude data.

We quantify these with the help of GIS based spatial analysis for channel migration rates, elevation differences, and sediment redistribution. Orthophotos are further analyzed to quantify vegetated versus unvegetated areas, enabling us to investigate the role of riparian vegetation on sediment stability and

flood resistance. Integration of DTMs with seasonal orthophoto data will enable us to visualize maximum inundation extents and changes in sediment transport patterns.

Preliminary findings indicate significant morphological changes at point bars, where seasonal flooding has led to the redistribution of sediment downstream. Areas with well-established vegetation appear to experience less erosion, while bare or sparsely vegetated zones show greater susceptibility to sediment displacement.

By using high-resolution temporal data, we are able to track even slight changes that can still be statistically significant in the river system. This information adds to the knowledge of meandering river dynamics and helps develop management policies within river systems under ever-changing hydrological regimes.

## P30 From biweekly to real-time: How high-frequency groundwater monitoring improves hydrological assessments in cold climate regions

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Groundwater level monitoring is a fundamental tool for understanding aquifer dynamics, detecting droughts, and supporting sustainable water management. In Finland, national groundwater data also plays a key role in the simulations and calibration of our river basin level hydrological model. This study examines the benefits of high-frequency, real-time groundwater level data by comparing it to conventional biweekly monitoring in Finland's national groundwater observation network. We investigate (1) whether groundwater level fluctuations appear differently in high-resolution (hourly interval) versus biweekly data, particularly in large and small aquifers, and (2) how local hydrogeological variability is captured in real-time monitoring by comparing multiple wells at the same station.

Finland's groundwater monitoring network has operated since the 1970s, transitioning from manual biweekly observations to fully automated real-time data collection in 2022. This study uses long-term and high-frequency datasets to evaluate how measurement resolution affects interpretations of groundwater behavior. By analyzing spatial and temporal groundwater variability at different scales, we aim to refine hydrological models and improve groundwater resource assessments in cold climate regions.

## P31 Real-time sediment load monitoring using ADCP and hybrid machine learning approaches in Finnish rivers

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Sediment transport in Finnish rivers is influenced by hydrological variability, land-use changes, and climate change, all of which influence erosion patterns and sediment supply dynamics. Traditional sediment monitoring methods are based on field sampling, which restricts their spatial and temporal cover. This study aims to develop a robust framework for real-time sediment load monitoring in Finnish rivers by coupling Acoustic Doppler Current Profiler (ADCP) backscatter signals with a hybrid machine learning method through multiple case studies. The framework is structured into four key stages—data acquisition, signal correction, model development, and real-time implementation. To begin with, ADCP backscatter signals are extracted and corrected for geometric spreading, water absorption, and sediment attenuation to ensure accurate acoustic measurements. Concurrently, water and sediment samples are collected from selected rivers to determine suspended sediment concentrations. These measured values will serve as ground truth data to establish a quantitative relationship between corrected backscatter signals and suspended sediment concentrations, enhancing the predictive capability of ADCP measurements. Afterward, an integrated machine learning approach is utilized, where support vector

regression models are trained using backscatter signals, flow rate, and water level, while a feature selection approach is applied to identify the most relevant model inputs. Model optimization is implemented to enhance predictive accuracy and robustness. Ultimately, the optimized model is incorporated into a real-time monitoring system to enable suspended sediment concentration estimation from real-time data. This study is ongoing, and further analyses will refine the methodology and provide results as the research progresses.

## P32 Combined effects of weather extremes and land use on long-term nutrient trends in Aurajoki river basin, South-West Finland

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The deterioration of water quality in rivers is a growing global concern. Nutrients, particularly nitrogen and phosphorus, play a key role in this degradation. The concentration of these nutrients in rivers is significantly affected by the increasing frequency and intensity of weather extremes (flood and drought) coupled with intensified land use (such as agriculture). However, the combined impact of weather extremes and land use on water quality in rivers is understudied. Therefore, it is critical to assess and deepen the understanding of the dynamics of nutrients under the influence of land use and climate change. This study aims to evaluate the long-term trends (over 30 years) of total phosphorus (TP) and total nitrogen (TN) loads, and to investigate the combined impact of flood, drought, and land use on the nutrient trends within Aurajoki river basin, South - West Finland. The utilized data will consist of long-term monitoring records of nutrient concentrations, discharge, temperature, precipitation, and CORINE Land Cover dataset. The data will be analyzed using Mann-Kendall statistics to assess trends, source apportionment to determine the contribution of land use to nutrient levels, and statistical modeling to evaluate the impact of both land use changes and weather extremes on nutrient loads. The findings will inform targeted interventions to protect and improve water quality in river ecosystems under changing environmental conditions.

## P33 DemoField for controlled drainage- to improve water management and yield stability in Swedish agriculture

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A major challenge facing agriculture is managing both water excess and deficit, issues that are exacerbated by climate change, while simultaneously reducing eutrophication. Controlled drainage (CD) has the potential to address these challenges and enhance yield stability. Despite the clear benefits of CD and state subsidies for its installation, its adoption among Swedish farmers has been exceedingly low. To address this, we are establishing a CD demonstration field at one of Sweden's largest agricultural fairs, Borgeby Fältdagar, to communicate the productivity, economic, and environmental benefits of CD to farmers, address their concerns, and identify knowledge gaps. Field experiments with different crops are being conducted at the Demofield, where free drainage is compared with CD systems featuring various groundwater level strategies. Crop-specific recommendations for farmers using CD systems are therefore, being provided. Additionally, the project explores the benefits of installing soil moisture sensors in CD systems, paired with user-friendly data management tools, to help Swedish farmers easily manage their CD systems. Surveys of farmers and advisors indicate a lack of knowledge regarding CD operation and its potential benefits, leading to skepticism among farmers. This project, running over three years, employs a multidisciplinary research approach, involving researchers at RISE, farmers, sensor experts, advisors, and representatives from the Swedish Board of Agriculture.

## P34 Impacts of Ferry Traffic in the Finnish Archipelago Sea

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The Finnish Archipelago Sea is the largest archipelago in the world by number of islands and has complex channel geometry and current patterns. Ferries over 200 meters long travel daily between Turku and the Åland Islands, transporting up to 3,000 passengers per vessel. These ferries can influence flow characteristics by causing fluctuation in water level and increasing turbidity, wave height, and sediment resuspension. Although the Turku-Stockholm ferries have hulls that are hydrodynamically optimized to minimize wave formation, the large size of these vessels can result in considerable water displacement and drawdown, particularly in narrow and shallow straits. These ship-induced waves and disturbances to flow can increase the resuspension of seabed and nearshore sediments and be harmful to sensitive species.

This study aims to identify locations in the Archipelago Sea where ferry traffic has a high potential impact on flow and to select comparable low-impact locations based on geospatial data. Site selection will be based on factors influencing ship-induced waves and flow (i.e., water depth and distance from the fairway) as well as wind-induced dynamics (i.e., wind speed and direction, wave exposure, and turbidity). Clustering techniques will then be applied to statistically assess the similarity between high- and low-impact sites. These selected sites will serve as the foundation for future field campaigns investigating the impact of ferry traffic on flow characteristics, sediment dynamics, and ecology.

## P35 Mesocosms vs. pilot-scale rain gardens - do results hold up across scales?

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Rain gardens are widely used nature-based solutions for stormwater treatment, but their performance varies with scale, hydrological conditions, and monitoring approaches. This study compares pollutant removal in 100L column mesocosms and 1m³ pilot-scale gardens with identical design configurations and 80cm packing depth. Three different media mixtures were tested: (1) a baseline mix of pumice and coconut fibers, (2) the baseline mix amended with crushed concrete, and (3) the baseline mix amended with iron-coated sand. Each media mixture was tested in triplicate mesocosms and a single pilot-scale pallet tank system. All setups were vegetated with *Carex apressa*.

For four months, the systems were irrigated with synthetic stormwater runoff spiked with phosphorus, copper, zinc, and nitrate. Three rain events per week were simulated, each delivering 4.3 mm of rainfall over 10 minutes. Effluent sampling methods differed: in the mesocosm columns, the entire outflow over a two-hour drainage period was collected and sampled. In contrast, pallet tanks were sampled using a flow-weighted composite approach over the first hour of draining, which captured the rise, peak, and fall of the outflow hydrographs. Statistical analysis revealed no significant differences between the two experimental scales for most measured pollutants.

These findings suggest that column mesocosms can provide reliable estimates of rain garden performance while also demonstrating the effectiveness of flow-weighted sampling in capturing pollutant trends over time. This study contributes to the ongoing discussion on the scalability of stormwater treatment research and the development of cost-effective experimental methodologies.

## P37 Temporal dynamics and hydrological impacts of snow-atmosphere vapor exchanges in a high-altitude catchment

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The evolution of the snowpack is strongly influenced by turbulent fluxes, where water vapour transfer alters the snowpack water equivalent through processes such as snow sublimation and deposition, in addition to changing the cold content and structure of the snow. In alpine regions, the contribution of sublimation to the water balance varies widely, with results indicating only a negligible part of snowfall is sublimated (Groot Zwaaftink et al. 2013), to up to 90% locally at high altitudes (Strasser et al. 2008). To improve our understanding of these dynamics, this study integrates small-scale measurements from a micrometeorological station with catchment-scale modelling, enabling a multi-scale analysis of snow-atmosphere water vapour exchanges and their impacts on the snowpack water balance in a high-altitude catchment in southern Norway.

We will outline preliminary insights into the temporal scales governing water vapour fluxes and its linkage to environmental drivers, using data from an eddy covariance tower. To evaluate the broader hydrological impacts of sublimation and deposition fluxes, we also plan to present results from a snow model framework over the whole catchment and contrast the annual variability between dry and wet winters. Our findings are expected to contribute to a deeper understanding of sublimation and deposition processes in Nordic regions, and how they may change in a future climate. By combining field measurements and modelling approaches, these insights can be used for advancing the parametrisation of winter vapour fluxes for applications in snow hydrology.

## P38 A new protocol to define groundwater inflow on small water bodies (SWB)

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Man-made water bodies often receive inflows from either runoff, rivers or groundwater. Over the years, various uses for these small water bodies (SWB) have become well-established. For some, the primary use is irrigation. In this context, French regulations differ significantly depending on whether the SWB is supplied by groundwater or runoff water. For instance, if the water body is supplied by groundwater, the owner must adhere to numerous irrigation restrictions and guidelines as stipulated by the Water Framework Directive. However, in many cases, the origin of the water supply is unknown or unclear, making it challenging to determine the source and therefore the way it is managed.

While numerous studies have focused on groundwater-river interactions, few have examined groundwater-lake interactions. Those that do typically concern large lakes or enclosed small lakes with well-documented groundwater supplies. Currently, there is no established protocol for SWB allowing to determine if they are supplied by groundwater and to locate the springs within the lake.

We began by measuring an Estonian lake with a well-known groundwater supply using a new methodology to locate the springs. Then we tested this methodology on SWB with unknown supply origins and used for irrigation. Our approach enabled us to determine the water supply based on temperature and conductivity measurements taken throughout the water body, from the surface to deep water.

## P39 Hydropower Resiliency, Regulated Rivers, and Climate Adaptation: RE-HYDRO

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Modernizing hydropower is increasingly recognized as a key strategy for restoring the biodiversity of rivers. However, factors beyond ecological benefits often influence decisions regarding hydropower operations and management. Historically, the needs of local populations and environmental considerations have not been prioritized. Modernising hydropower is inherently transdisciplinary, requiring a balance of multiple objectives. In our new RE-HYDRO project, we are developing an integrated framework to address these complex challenges for case studies in Finland and Sweden. This work involves not only hydrological and hydraulic modelling of regulated rivers but also a) assessing the faunistic biodiversity in the rivers and their riparian zones affected by hydropower and b) examining the effects of hydropower on local identity and the cultural environment. We employ various methods to collect data, including camera trapping, bioacoustics, insect trapping, and eDNA sampling of soil and water. This comprehensive approach would allow us to evaluate the biodiversity dynamics and explore the potential for habitat restoration in these regulated rivers while updating the hydropower management with climate change.

## P40 Measuring Lake Ice Thickness with SIMBA

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SIMBA – Snow and Ice Mass Balance Apparatus – (Sams Ent.) is a temperature profiling device that can be used for hydrological lake ice and snow monitoring. Its working principle is based on temperature and heat pulse measurements as a vertical profile, revealing the surfaces and thicknesses of snow and ice. Measurements can be made continuously with adjustable temporal resolution, i.e., every six hours, which is not possible with traditional methods. We have tested the feasibility of SIMBA for operational lake ice monitoring in Lake Pallasjärvi for winter 2023/2024 and the testing continues this winter 2024/2025 in Lake Kuivasjärvi, Oulu. The presentation introduces the SIMBA instrument, its working principle, and the developed method for determining ice thickness and snow depth based on the SIMBA temperature and heat pulse data. Results from winter 2023/2024 are discussed, along with preliminary results for the winter 2024/2025. SIMBA data combined with the developed data analysis method provided good estimates of lake ice thickness and its evolution during winter. Snow depth estimation was found to be more uncertain. The robustness of the SIMBA measurements, data delivery, and instrument deployment show potential for providing continuous real-time information on ice thickness, supporting lake ice monitoring in changing subarctic climate conditions. This experiment is part of the CRYO-RI project which develops and tests modern monitoring technologies and infrastructure for academic and operative use.

## P41 Lake Tjörnin: cleaning up a polluted urban waterbody

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Tjörnin is a lake, in the heart of Reykjavík's centre, standing by the cradle of settlement in city and the earliest urban development in the area. Since the first settlers, Tjörnin has been drastically transformed from a coastal lagoon into a freshwater lake and over the years been polluted due to various reasons.

Currently, the water quality is defined as having ‘bad’ chemical status by the European Water Framework Directive. Tjörnin and its catchment area, are not only important for recreation, but also for wildlife and birds. With elevated levels of seven ‘forever’ pollutants and five PaH’s, actions need to be taken.

The City of Reykjavík is a part of LIFE ICEWATER project, along with 21 other participants, that work towards the implementation of the Icelandic River Basin Management Plan. Lake Tjörnin is a demonstration site within the LIFE ICEWATER project, where the aim is to improve the chemical status of Tjörnin.

Actions will include better monitoring of water levels as well as chemical and ecological status to trace the sources of pollutants. Nature Based Solutions will be implemented to increase water quality where:

i.) vegetation and islets will be added to increase biodiversity,

ii.) runoff and return water from local heating will be treated, using blue green solutions, before being discharged into the catchment area.

Further, the catchment area of Tjörnin will be better delineated within the city master plan regime and surveillance increased with contractors ensuring their compliance with guidelines related to building blue-green infrastructure.

## P42 Urban Lake Dissolved Oxygen Variability in Cold Climates: A Monitoring Approach

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Oxygen depletion during the ice-on period is one of the main problems in many seasonal ice-covered lakes in Nordic regions, impacting aquatic life and water quality. Therefore, monitoring oxygen levels and their response to hydrological changes is essential. In this study, we examined two interconnected urban lakes, Kuivasjärvi and Pyykosjärvi, in Oulu, Finland, experiencing oxygen depletion, as evidenced by previous monthly oxygen level measurements. To address this issue, the municipality of Oulu has implemented a continuous inter-basin freshwater transfer from a nearby river. Using cutting-edge sensors, we monitored hourly changes in dissolved oxygen (DO) and water levels over a six-month period, encompassing both ice-on and ice-off conditions, to assess whether the water transfer effectively prevented low oxygen conditions (hypoxia and anoxia). Additionally, we investigated the relationship between DO levels and lake water level fluctuations. Our findings indicate that, despite the freshwater transfer, both lakes still suffer from oxygen depletion, particularly in late winter. Furthermore, statistical analysis of the observed data revealed a significant correlation between water level changes during the snowmelt season and increases in DO, with a specific time lag. These insights provide valuable information for reevaluating the effectiveness of the water-transfer strategy.

## P43 Compound coastal flooding on the Finnish coasts

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Simultaneous peaks in sea level and streamflow can lead to unpredictable extreme flood events in estuaries. These events are often linked to low-pressure storms, which are expected to become more intense and frequent due to climate change, making it essential to understand their behaviour. Existing flood hazard maps treat sea level and streamflow as separate flood drivers, and may therefore underestimate their combined effects in estuaries. This study aims to enhance understanding of compound coastal flooding along the Baltic Sea coast in Finland to support informed decision-making.

We combine analyses on water level records and remote sensing data to provide a detailed account of compound flood events and frequencies along the Finnish coastline. Specifically, we identify compound flood events – co-occurrences of extreme sea level and streamflow – using data from 14 pairs of Finnish mareograph and hydrological station records. We then determine event frequencies and trends for estuaries. To map water surface extent variability and flood extents during recorded compound events, we utilize open multispectral (Landsat 1985–2025; Sentinel-2 2018–2025) and radar (Sentinel-1 2014–2025) satellite imagery. By combining these extents with the national digital elevation model and water level records, we estimate compound flood hazard areas.

Ultimately, this study estimates the severity of compound coastal flood hazards in Finland, and identifies most vulnerable areas, e.g., due to differences in relative land uplift rate. This supports taking compound events into account in spatial planning, environmental management and rescue services.

## P44 Bathymetric mapping for better management of water resources

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In changing climate patterns, especially in precipitation, water resource management needs heightened attention. Although the overall precipitation is predicted not to decrease, rather the rains become more heavy but less frequent, it becomes essential to correctly manage the water supply. During the last decade there have been two summers when backup water reservoirs were significantly needed in order to maintain the water level in the main drinking water reservoir (Lake Ülemiste) of Tallinn, the capital of Estonia. The excessive draining of the reservoirs can lead to deterioration of the reservoir's ecosystem and therefore decline in water quality. High detailed bathymetric mapping of the water bodies gives the basis for better management of water resources and lowers the risk of harming the ecosystems of lakes and reservoirs. Additionally to water bodies from Tallinn water supply system we have mapped ca 60 lakes that are under national monitoring program. Also around 200 historical bathymetric maps from the previous century have been digitized. All this data provides a basic overview on the freshwater resources in lakes. Bathymetric maps with great detail compared with older maps allows us to validate the accuracy of historical maps and both together provide an opportunity for calibrating models on predicting lake bathymetry based on surrounding landscape

## P45 Glacial streams in Iceland as CO2 sinks

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Glacial streams transport organic matter (OM) from various sources, including atmospheric deposition, overridden soils and in situ microbial production. Glacial autochthonous OM has the potential to be rapidly metabolized by the microbial community in the stream, leading to $CO_2$ emissions.

However, our study reveals that the glacial river Virkisá in Iceland, acts as a carbon sink, sequestering $CO_2$. This contrasts with most inland freshwater systems, which typically function as net $CO_2$ sources.

Using self-constructed, low-cost $CO_2$ chambers, we measured $CO_2$ fluxes between the river and the atmosphere at 7 sites along a 3 km transect from the glacier terminus. Across four seasons (117 measurements, March 2023 until July 2024), $CO_2$ fluxes ranged from an average of -94.2 mg $m^{-2}$ $h^{-1}$ directly at the glacier outlet to -18.3 mg $m^{-2}$ $h^{-1}$ further downstream, with the strongest $CO_2$ uptake in spring and the weakest in autumn and winter. Measurements from four additional glacial streams (Skaftafellsá, Svínafellsá, Kvíárjökull, and Fjallsá) confirmed that they also act as carbon sinks.

A significant correlation with pH suggests that negative $CO_2$ fluxes are primarily driven by enhanced chemical carbonate and silicate weathering. The abundance of freshly eroded, reactive basaltic

sediments makes them highly susceptible to weathering, leading to $CO_2$ consumption that overrides typical biological and abiotic processes found in non-glacierized watersheds.

These findings emphasize the role of glacial streams as carbon sinks and highlight the need for further research on this phenomenon, particularly in the context of retreating glaciers and increasing glacial melt rates in summer.

## P46 CrowdICE: Bridging Citizen Science and Technology for River Ice Monitoring

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Ice is a prominent feature of Nordic rivers, playing crucial role in hydrodynamics, sediment transport, and aquatic habitats. While river ice processes provide environmental and economic benefits, they pose significant risks where ice is essential for transportation, recreation, and fishing. However, climate change accelerates shifts in river dynamics, increasing the frequency of ice jams and associated flooding. These changes present growing challenges for riverbank communities, infrastructure, and environmental management. Despite the critical need for accurate ice monitoring in resource management and long-term planning, traditional in-situ measurement methods remain resource-intensive, time-consuming, and often hazardous. Remote sensing offers valuable insights but is limited by low resolution, cloud cover, and infrequent satellite passes. These limitations hinder real-time ice condition assessments, challenging prediction, and risk mitigation. To enhance ice monitoring, we propose utilizing crowd-sourced data as a supplementary resource to predict river ice-related features. In our citizen science project, the public participants from the Kiiminkijoki River in Finland record real-time and historical images of frozen rivers. At the same time, participants share their experiences and opinions about the past, present, and future of river ice. These initiatives tap into people's passion for science, giving researchers valuable hands-on experiences, strengthening community connections, and fostering collaboration to enhance the community's resilience to the impacts of climate change on the future of ice. We aim to use this data to validate and improve remote sensing observations, integrating it with real-time data and advanced machine learning techniques to predict ice formation, breakup dates, and ice jams.

## P47 Monitoring of rivers and lakes in Iceland and ecological classification according to the EU Water Framework Directive

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The EU Water Framework Directive (WFD) aims to protect and enhance water quality across Europe by establishing a comprehensive framework for water management. Although Iceland is not an EU member, it is linked to the EU through the EEA agreement and has incorporated the WFD into its national laws through the Water Management Act (no. 36/2011), aligning the country’s water management practices with the WFD's goals to demonstrate its commitment to maintain high water quality standards and promote sustainable water use. As a part of the implementation process, a classification system has been developed to assess the ecological status of rivers and lakes in Iceland. That includes the establishment of reference values and category boundaries for a five-class system, covering the biological quality elements for phytoplankton biomass (chlorophyll *a*), benthic invertebrates (abundance and diversity) and phytoplankton (Trophi Index, TIc). It also includes physico-chemical quality elements like pH and annual average nutrient concentration. Based on this framework, monitoring has been conducted in several lake and river water bodies in Iceland to determine whether the measured values are in accordance with reference values of the classification system. Additionally, monitoring of water bodies under manmade pressure has been used to assess the system’s sensitivity to human impact. Here we present the

classification system and the monitoring results of water bodies with respect to their ecological classification.

## P48 Long-Term Assessment of Snow Drought across Finland

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Snow is a crucial component of the hydrological cycle in cold climates, influencing river discharge, groundwater recharge, and ecosystem dynamics. Snow droughts, characterized by diminished snow accumulation and shorter snow cover duration, have substantial hydrological and ecological consequences, particularly in high-latitude regions such as Finland. This study investigates snow drought occurrences across 13 snow measurement stations in Finland over the period 1961–2020, utilizing snow water equivalent (SWE) as the primary variable to assess changes in snow storage. The selected stations are located upstream of major Finnish rivers to capture snow budget variability in headwater regions, which is essential for downstream water availability. An annual snow budget index was derived using weekly SWE measurements during the snow year (October–May) to evaluate snow drought frequency, intensity, and spatial distribution. Additionally, a monthly Snow Drought Index (SDI) was employed to identify drought characteristics at finer temporal scales. Long-term trends in SWE and snow droughts were assessed using the Mann-Kendall test and Sen's slope estimator, enabling robust quantification of temporal and spatial variations. The results indicate a statistically significant declining trend in SWE across Finland at the 95% confidence level, with an average trend slope of -0.33 mm/year in the northern and -0.52 mm/year in the southern regions. These findings highlight substantial reductions in winter snowpack, with critical implications for water resource management, ecosystems, and winter tourism. Understanding these trends is essential for adapting to future climate variability and ensuring sustainable hydrological planning in Finland.

## P49 Systematic Inventorying of Socio-environmental Relationships in the Oulujoki Catchment

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Hydropower management and operation involve managing a network of diverse stakeholders. Hydropower projects may supply clean and affordable energy sources but remain a potential source of conflict. River encroachment, for example, leads to conflicts between the riverside residents and hydropower companies, as hydropower and reservoir development impact the local culture, livelihoods, and the river's recreational and amenity values. For hydropower projects, it is particularly difficult to balance conflicting local interests and values towards water use, recreation, biodiversity, nature conservation, fish protection and land use. Integrating local views into the decision-making is therefore crucial for increasing public acceptance and understanding public interest in modernizing the existing hydropower. The novelty of this work resides in considering hydropower as a component of a socio-environmental system in which people interact with a vast variety of environmental and engineered factors. This research examines the ways hydropower plants are changing or reorganizing human-nature relations and aims to identify subtle relationships that may make us reconsider our previous knowledge about the sustainability and social acceptance of hydropower.

## P50 Hydrologic -hydraulic modelling chain for impact based forecasting

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The Norwegian Water Resources and Energy Directorate (NVE) aims to provide impact-based flood forecasts for Norway by closing the gap from forecasting how high the streamflow might be to forecasting what the high flows might do. NVE has started a 4-year pilot for four selected catchments in Norway, and this presentation will focus on hydrological and hydraulic modelling approaches for impact-based forecasting of riverine floods.

A first challenge is to provide streamflow forecasts where the flood might have an impact, i.e. the hydrological models are applied at ungauged locations. To solve this challenge, we use a distributed version of the HBV model that is calibrated to several streamflow gauging stations within selected sub-regions and can provide consistent streamflow forecasts along a river network.

Subsequently, hydraulic models are used to estimate water levels and depths in susceptible areas. We evaluate two approaches. The first approach is to configure hydraulic models to sub-reaches of the rivers for well defined up- and downstream boundary conditions and produce maps of water level and depths for different streamflows and downstream boundary conditions. During a forecasted event, the relevant map(s) are retrieved from the database using a lookup function using the forecasted streamflow and boundary conditions as input. This reduces computing time during flood warnings as the maps dont need to be recalculated. The second approach is to apply a dynamic hydraulic model that represents the attenuation of a flood event in rivers and lakes. The performance of the two approaches will be compared.

## P51 Evaluating land management and nature-based solutions for water retention and climate adaptation through modelling and stakeholder participation

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Climate change causes frequent extreme weather events, including droughts and heavy rainfall, which disrupt local water balance. These changes pose a significant challenge for agriculture by reducing crop yields and causing floods and nutrient runoff from agricultural fields, contributing to the eutrophication of receiving waterbodies. Addressing these challenges requires effective water management strategies and catchment level collaboration.

Nature-based solutions (NBS) are recognized as a potential solution for climate change adaptation, and multiple benefits of these solutions for water management extend from flood and drought reduction to nutrient retention. While NBS are increasingly promoted, mainstreaming the use of these solutions requires more evaluation of their impacts and effectiveness across various environments and together with other agricultural management practices.

This study uses a novel approach to examine the effects of land use and nature-based water management practices on climate resilience of an agriculture-dominated watershed in Southwest Finland. We combine computational watershed modelling (SWAT+) with participatory mapping of climate change vulnerable areas to assess how management practices influence water balance in the catchment area. We investigate how different land management scenarios with NBS could mitigate flooding, drought and erosion especially in areas highlighted in landowner participation. The findings contribute to a deeper understanding of the role of land and water management practices together with NBS in sustainable water management, offering insights into their potential for enhancing agricultural resilience both now and in the future.

## P52 Sustainable Valorization of Wine Production Waste: Unlocking the Potential of Grape Pomace and Lees

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The wine industry produces significant quantities of waste that remains underutilized as a potential raw material. Typically, this waste is either discarded in the fields or incinerated, leading to environmental concerns. By-products of wine production, like lees and grape pomace, are readily available at relatively low costs and hold promise as raw materials for biochemical conversion into valuable products. Reusing these waste materials is crucial, not only for reducing environmental impact but also for enhancing profitability.

The main objective of this project is to study the sustainable valorization of grape pomace and lees from the production of DOC Vinho Verde. Extraction tests were performed to obtain high-value compounds, targeting phenolic compounds from grape pomace and protein-rich extracts from lees. An environmentally friendly technique, microwave extraction, was used for this process. This method is not only efficient but also aligns with the principles of green chemistry, reducing the use of harmful solvents and minimizing energy consumption. The findings from this study have the potential to open new revenue streams for the region's wine producers while promoting environmental sustainability.

The optimal conditions for extracting proteins from lees involve the use of NaOH at 150ºC. Regardless of the solvent employed, the ideal temperature for obtaining extracts rich in polyphenol compounds and exhibiting strong antioxidant activity is also 150ºC. For grape pomace, extracts with a high concentration of polyphenols and significant antioxidant properties were obtained at 210ºC. However, the highest total tannin and flavonoid concentrations were achieved at 150ºC and 170ºC, respectively.

## P54 Valorization cascade approach of fish by-products towards a zero-waste future – a review

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Following the exponential growth of human population, a remarkable increase in the amount of fish waste has been produced worldwide. Fish processing industry generates a considerable amount of by-products which represents a considerable environmental problem. Accordingly, reuse and valorisation of these by-products is a key process for marine resources preservation. The significant volume of fish waste produced worldwide, along with its environmental impact, underscores the urgent need for the adoption of sustainable practices. The transformative potential of utilizing fish processing waste to create industrial value is gaining recognition. The substantial amounts of wastes generated by fish processing industry, present both environmental challenges and economic inefficiencies. Different added-value products can be recovered by the valorisation industries whereas fishing companies can save costs associated with the management of those wastes, with associated advantages, not only in terms of economic income, but also considering the environmental impacts. Fish processing by-products have numerous applications, the target portfolio of products will be fish oil, fish protein hydrolysates, bacteriocins, pigments, vitamins, collagen and calcium-rich powder, targeting food products, additives, supplements and nutraceuticals.

This literature review focuses on the main valorisation ways of fish wastes and different compounds with high commercial value obtained by fish by-products, and their possible applications in different fields. Highlighting its potential in sustainable resource management strategies can play and important role in reshaping the fish processing industry, driving it towards circular economy and consequently more sustainable future.

## P55 A Snapshot of Agricultural Waste in the European Union

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In the current global context, we face a significant challenge: the rapid population increase combined with the pressing need for sustainable management of agro-industrial waste. Beyond understanding how population growth impacts waste generation, it is essential to first identify the primary types of waste produced and the countries responsible, to guide targeted actions. This study presents key statistical data on waste production from the agriculture, forestry, and fishing sectors across the European Union, alongside information on the agricultural areas dedicated to crop production in each European Union country. These insights will form the basis for future research into waste production by crop type and country, to improve waste management practices and promote recovery methods that are vital for environmental sustainability. The agricultural sector must stay at the forefront of scientific and technological advancements to meet climate change challenges, protect the environment, and ensure food and health security.

EUROSTAT data shows that, in 2020, the agriculture, forestry, and fishing sectors produced over 21 million tons of waste. Spain emerged as the largest producer, contributing nearly 30% of the EU's total waste in these sectors. Furthermore, five countries—Spain, the Netherlands, France, Sweden, and Germany—were responsible for producing more than two-thirds of the waste from these sectors.

The data presented in this study highlights the urgent need for action in managing agricultural waste in the EU. As population growth continues to drive up demand for agricultural products, waste generation will inevitably rise unless significant changes are made in managing of agro-industrial waste.

## P57 In-situ Woodchip Reactor in Urban Stream

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Citizens, nature and industry all need healthy rivers and lakes, groundwater and bathing waters but only 38% of EU surface waters are in good or better ecological status. One of the main reasons is the nutrients from agricultural activities, waste water treatment and ohter sources. It has been demonstrated that woodchip bioreactors are a cheap solution for removing nitrates compared with alternative methods (Sarris and Burbery, 2018; Schmidt and Clark, 2012). So far, most of denitrifying woodchip bioreactors have been installed in the agricultural catchment areas (e.g., Maxwell et al., 2022; Sarris and Burbery, 2018; Elgood et al., 2010). Mitigating non-point source pollution in urban area is limited by negligible possibilities to induce substantial land use changes in a short-term period, thus the in-stream solutions present an alternative option for urban stream restoration. To test it research was conducted during LIFE IP CleanEST project. A pilot scale in-stream woodchip reactor was installed in to small stream Soolikaoja in town Rakvere. Preliminary results show that an average NO3-N removal rate was 43.7gN $m^{-3}d^{-1}$ and an average removal efficiency was 43.6±18.8%. The nitrate removal efficiency is dependent on the dissolved oxygen concentration and is limited by photosynthesis and eutrophication. In-stream woodchip

bioreactors can offer a valuable option for cleaning nitrate polluted surface waters in areas where the land usage is limited. However, our study showed that in case of eutrophic waters the dissolved oxygen produced during the photosynthesis can temporarily limit the performance of the reactor and complicate the system efficiency assessment.

## P58 Exploration of the performance of the DDD model in a small urban catchment for better stormwater management in the city of Tallinn, Estonia

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There are fifteen urban rivers on the territory of the city of Tallinn. Often these rivers are part of stormwater system of the city. The paucity of knowledge on the dynamics of urban riverflow leads to poor planning of stormwater systems, mismanagement of blue and green areas, and vulnerability to floods in Tallinn.

Mähe stream is situated on the outskirts of the city with no historic runoff data. The stream catchment is 3.2 $km^2$. The proportion of impermeable and permeable surfaces is 22 and 78% respectively. The depth of the water table varies seasonally but tend to be high throughout the year.

We set up the DDD model (Skaugen and Onof, 2014) which allows prediction of runoff at high temporal resolution. The DDD model is designed for use in catchments with quite shallow subsurface storages. Stream gauging started in June 2024. Stage-discharge relationship is created and calculated runoff is used for model calibration. Precipitation and air temperature are measured 1 km away from stream gauge station. The model was warmed up rainfall and air temperature data dating prior to the runoff measurements.

First measurement results show that the Mähe stream has a substantial baseflow together a flashy response to precipitation. To improve model performance and account for a high baseflow component, a Dupuit-Forchheimer assumption to the subsurface response module was tested. Preliminary results will be presented.

Reference: Skaugen, T. and Onof, C. A rainfall-runoff model parameterized from GIS and runoff data. Hydrol. Process. 28, 4529-4542 (2014), DOI. 10.1002/hyp.9968.

## P59 Hydromorphological classification system for rivers and lakes

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Implementation of the EU Water Framework Directive 2000/60/EC (WFD) was transposed into Icelandic regulation (No. 36/2011) which now represents Iceland's water management. The main purpose of the WFD is to protect waters and aquatic ecology, hinder deterioration, improve water quality and enable sustainable use of water. Since then, various projects have been carried out to assess the status of water and how to protect water resources for the future. Iceland is currently in its first River Basin Management Plan (RBMP), and the LIFE Icewater project will accelerate the implementation of the next RBMP which begins in 2028.

Specific quality elements (biological, physio-chemical, and hydromorphological) are used to assess the condition of water bodies and whether they meet the environmental objectives set in the RBMP. Hydromorphological quality elements, which focus on identifying changes in hydrological regime, continuity and morphology, have already been defined in Iceland. The classification system is based on a

Norwegian model, adapted to Icelandic conditions, and has been tested on different types of rivers and lakes.

Hydromorphological pressures in Iceland are primarily caused by hydropower plants and related constructions, and specific indicators have been selected to evaluate these pressures. The results show that the system effectively detects changes in hydromorphology caused by such pressures, that can provide indication of pressure on the aquatic ecosystems. The classification system and testing on waterbodies under pressure will be presented and analysed to explore if varying assessment factor weights and calculations can impact the results.

## P60 Effectiveness of gypsum treatment to reduce phosphorus losses from soil - experimental results from Latvia, Lithuania, and Poland

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Agricultural phosphorus (P) runoff is a significant contributor to eutrophication in the Baltic Sea region. The Interreg Baltic Sea Region project GYPREG aims to promote the use of gypsum as a mitigation measure to reduce P losses from agricultural soils. This study presents the results of pot/laboratory experiments conducted in Latvia, Lithuania, and Poland, where different soil types were treated with gypsum to evaluate its impact on P leaching before piloting gypsum treatment on agricultural fields.

In Lithuania, soils Cambisol, Luvisol, and Retisol were tested while in Latvia predominant Phaeozems and Luvisol were analyzed. The preliminary results demonstrated that total phosphorus (TP) concentration in leachate depends on the soil and treatment type. In Lithuania preliminary results show that application of phosphogypsum reduced TP leaching from soil. The greatest effect was observed in Retisol. In Latvia TP concentrations in leachate did not differ much between control and treated samples, while differences increased with time. In Poland loam and silt loam soils were used, and similarly TP in leachate was higher in control than in treated pots for both soils.

Across all experiments, gypsum application to certain extend also influenced conductivity in leachate, with effects varying based on soil and gypsum used. The findings confirm that gypsum can be a promising method for reducing P losses from agricultural land, supporting its broader adoption in the Baltic Sea region. Further research is needed to optimize application strategies across different soil types and climatic conditions.