NC Internship Programme 2026

NC Programme

Hydro-JULES

Project Title

Coupling the regionalized hydrologic projections with climate and physiographic characteristics for ungauged catchments under changing climate.

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Project Overview

Regionalization approaches have been routinely demonstrated as a solution for river flow prediction and flood frequency estimation in ungauged catchments. Recently, studies related to regionalization and climate change research have emerged as an attractive topic for the water sector (both academic and industrial) due to the substantial impact climate change has on ecosystems, and water resources. Here we propose a catchment-first approach by developing statistical methods as a possible solution for estimating flow regimes at ungauged catchments.

A data-first approach to regionalization underlines the use of hydroclimatic and physiographic features through hierarchical clustering approach to predict flow regimes in ungauged catchments. This could relate to empirical methods to develop a link between the climate projection indices, physiographic features and hydrological signatures at gauged area and transferred into ungauged catchments. Therefore, we aim to develop a linkage between catchment descriptors and future climate variables using machine learning and statistical regression methods to simulate future changes in high, mean, and low flow regimes in ungauged catchments. Similarly, such cascade processes are subject to significant uncertainty due to climate ensembles and empirical models. Hence, we will identify the main associated sources of uncertainty in flow regime prediction, which is a current priority for policy and decision-makers.

This intern project will investigate the use of projected hydroclimatic data (using data from the CANARI large ensemble and HBV hydrological model) for regionalization using K-means clustering, decision tree models and multiple regression to improve estimates of peak flow in ungauged catchments based on observed and projected climate data, and physiographic features. To begin with, the project will look to understand the available data and the underlying processes. A review of relevant literature will complement this on-boarding phase. Using this understanding, the main focus will be on different flow regimes (5th, 50th, and 95th percentiles of flow) and the associated uncertainties, developing statistical and ML models across a range of gauged and ungauged catchments.

This scoping study could highlight possible approaches that, with further research, will help to improve water management and policy making and increase the reliability of the water system in the future. Assessing the impact of climate change on extreme hydrological characteristics is crucial for creating climate resilience water systems in the GB. However, most of the recent catchment-scale studies have emphasized on assessing the climate change impact on gauged catchments or through inter-model comparison. Therefore, in this work we will develop the climate impact on ungauged catchments. This also gives an opportunity to scope out possible machine-learning approaches in a “safe” setting before applying them to larger, more pressing projects.

Key tasks

- Analyse pre-prepared hydroclimatic projections for selected stations and understand the hydrological processes
- Review current regionalization approaches and hydrological models for suitability in assessment of the impact of climate change in ungauged catchments,
- Develop a prediction model using modelled and regionalised indices to forecast the change in mean, high and low flow regimes (5th and 50th percentiles of flow (Q5 and Q50)) in ungauged catchments,
- Identify how much uncertainty is introduced to Q5 and Q50 estimates by the choice of climate models, hydrological models, and regionalization approaches.
- Present the findings at group/science area meetings.

Expected Outcomes

- A presentation of the findings at group/science-area meetings.
- A short report summarising key findings and learning outcomes.

Required Skills and Background

Master student or PhD student

Essential skills and experience

- Strong mathematical and statistical skills,
- Good problem solving and critical thinking abilities

Desirable skills

- Good knowledge of the hydrological system, and environmental influences.
- Knowledge of basic machine learning approaches Technical and Transferable skills

- Experience in using a scientific programming language for mathematical formulation, (E.g. R or Python).
- Experience in handling spatial data
- Basic understanding of data visualization

Benefits this internship offers for the intern

- Machine Learning: You will gain practical experience applying advanced techniques—including K-means clustering, decision tree models, and multiple regression—to solve complex environmental challenges in a "safe" experimental setting.
- Climate Change Expertise: You will learn to work with large-scale climate ensembles (CANARI) and hydrological models (HBV) to predict how future climate variables will impact water flow regimes (high, mean, and low flows).
- Specialized Hydrological Problem Solving: You will develop a "catchment-first" expertise, specifically learning regionalization approaches to estimate flow in "ungauged" areas (rivers without physical sensors), a major priority for the modern water sector.
- Uncertainty Quantification: You will gain highly sought-after skills in uncertainty analysis, learning to identify how different climate and empirical models influence the reliability of forecasts—a critical factor for government policy and decision-making.
- Professional Communication: Beyond the technical work, you will refine your ability to communicate complex scientific findings by presenting your research to professional science and group meetings.