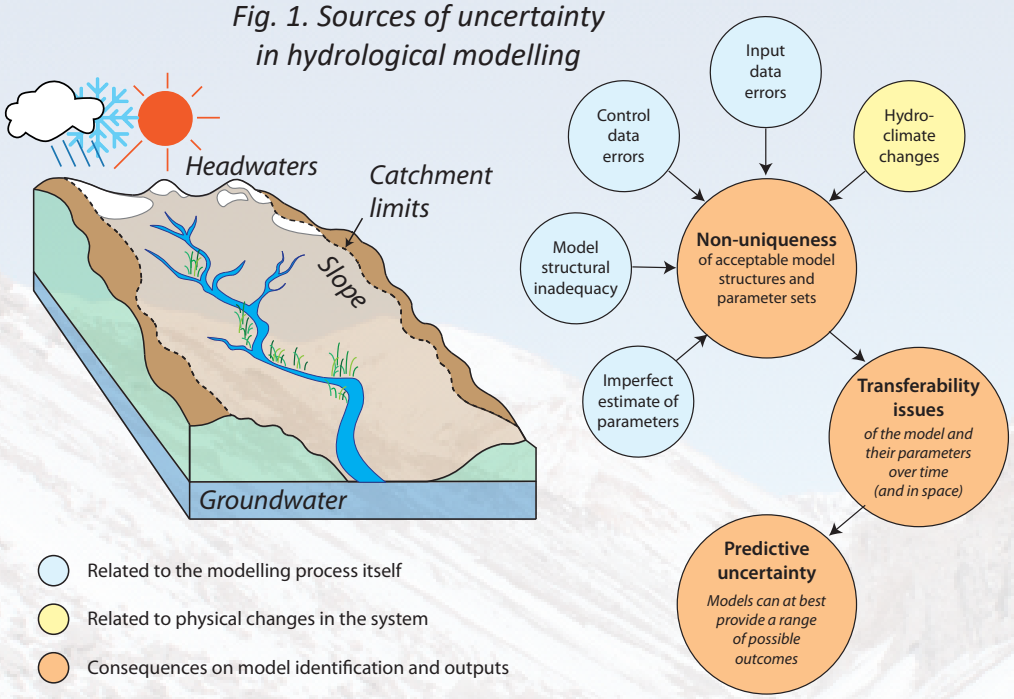
INTER·DISCIPLINARY & IN·LAB GRADUATE PROGRAM

# Improving the robustness of hydrological models under changing climate conditions

## 1 Context and background

The well-known lack of robustness of the hydrological models under changing climatic conditions points to the dependence of the optimal parameter set on the climate characteristics of the calibration period. This leads to increased uncertainty in estimating the hydrological impacts of climate change (see Fig. 1).

*Fig. 1. Sources of uncertainty in hydrological modelling*




## 2 Objectives

This study aims to develop an approach to enhance model transferability under climate variability. It seeks to exploit the dependence of the model parameter sets on the climate conditions in order to better account for changes in the catchment behaviour.

## 3 Methods

Several conceptual models differing in their time step (annual to daily) and complexity will be used in the modelling experiment. Their increasing degree of complexity will allow testing the parametric climate-dependency from annual to seasonal time scales. The models will be calibrated according to sliding-time windows in order to identify the relationship between the optimised parameters and the characteristics of precipitation, temperature and evaporation. This relationship will be analysed to propose a method to make vary the parameters over time. The proposed calibration approach will be developed and tested as a proof of concept in several catchments with long streamflow measurement chronicles in France.

## 4 Short bibliography


Dakhlaoui, H., Ruelland, D., Tramblay, Y. (2019). A bootstrap-based differential split-sample test to assess the transferability of conceptual rainfall-runoff models under past and future climate variability. Journal of Hydrology, 575, 470–486.

Fowler, K., Peel, M.C., Western, A.W., Zhang, L. & Peterson, T.J. (2016). Simulating runoff under changing climatic conditions: Revisiting an apparent deficiency of conceptual rainfall-runoff models. Water Resour. Research, 52, 820–1846.

Merz, R., Parajka, J., Blöschl, G. (2011). Time stability of catchment model parameters: Implications for climate impact analyses, Water Resour. Res., 47.

Royer-Gaspard, P. (2021). De la robustesse des modèles hydrologiques face à des conditions climatiques variables. PhD thesis, Sorbonne Université, 392 pp.

Singh, R., Wagener, T., van Werkhoven, K., Mann, M. E., Crane, R. (2011),.A trading-space for-time approach to probabilistic continuous streamflow predictions in a changing climate–accounting for changing watershed behaviour. Hydrol. Earth Syst. Sci., 15, 3591–3603.

Stephens, C. M., Marshall, L. A., Johnson, F. M. (2019). Investigating strategies to improve hydrologic model performance in a changing climate. Journal of Hydrology, 579.

Vora, A., Singh, R. (2022). Improving rainfall-runoff model reliability under non-stationarity of model parameters: A hypothesis testing-based framework. Water Resour. Research, 58.

Zhang, X., Liu, P. (2021). A time-varying parameter estimation approach using split-sample calibration based on dynamic programming. Hydrol. Earth Syst. Sci., 25, 711–733.


### Required profile

- General knowledge in hydrology/climatology
- Sensitivity to modelling approaches
- Good skills in programming (R, Matlab) and GIS softwares (ArcGis, Qgis)
- Scientific and technical English
- Organizational and editorial skills, taste for teamwork, autonomy

### Structure/Location

HydroSciences Montpellier

### Training period

6-month internship in the first half of 2024 (ideally starting in February)

### Intern conditions

Allowances of ~600€ gross/month

### How to apply

Applications (CV + cover letter) should be sent by e-mail before 15 Dec. 2023 to Denis Ruelland (**denis.ruelland@umontpellier.fr**)