# Exciting PhD opportunities at the University of Melbourne

*Environmental Hydrology and Water Resources Group,*
*Department of Infrastructure Engineering*

Three exciting PhD projects are available for motivated and suitably qualified candidates to undertake original research in the hydrologic sciences, at one of the world's top universities (#13 in QS world rankings). You will work with a dynamic and industry-aligned team to explore interrelated issues of water availability, drought and climate change. Your findings will inform water managers and contribute to the international body of knowledge. Upon selection, applicants will then need to obtain University of Melbourne scholarship funding through standard competitive scholarship selection processes (see here). Successful applicants will receive a stipend of approximately $38,000 (AUD) p.a. tax-free plus an additional $5,000 p.a. top up scholarship. PhD candidatures run for 3 to 4 years full time, and candidates are given considerable intellectual freedom and the opportunity to present findings at international conferences. If you are interested, please send a cover letter, response to selection criteria, CV and certified transcript from all University degrees, to Dr Keirnan Fowler at fowler.k@unimelb.edu.au by 21st March 2025. In the cover letter, please state project preferences. Please do not apply directly with the university.

**Selection criteria:** 4-year degree or masters in relevant discipline with weighted average over final two years of >79% (domestic applicants) or >85% (international applicants); outstanding written and oral communication skills; demonstrated competency in scientific programming, statistical techniques and/or mathematics. Industry experience preferred.

**Project 1: New methods for selecting rainfall-runoff models using multivariate data.** Water resource managers rely on rainfall-runoff models to project the volume of water flow in rivers, including under climate change. Although many models are available, we still have a poor understanding of which model is best under which circumstances, and we need more stringent tests to decide between models. The central hypothesis of this PhD is that multi-variate calibration presents new opportunities to distinguish between models, relative to single-variate (streamflow-only) calibration. This project will have a particular focus on data from remote sensing, such as evapotranspiration and gravity-based water storage estimates (GRACE). By allowing water managers to make more informed modelling choices, this PhD will aid reliable and robust water planning.

**Project 2: The value of non-streamflow data for robust rainfall-runoff modelling under climate variability and change.** Recent severe droughts have shaken our confidence in rainfall-runoff models, because models calibrated only to wetter times provide biased simulations during the severe droughts. This casts doubt on the use of these models in water resource planning, particularly for simulation during climate change scenarios that include droughts that are more severe than in the past. To fix this problem, recent research has identified several promising avenues to improve model structures (i.e. their underlying equations). However, an unsolved problem is the calibration of these new models so that they can correctly anticipate the extreme swings in water availability resulting from multi-year droughts. The central idea of this PhD is that incorporating multiple variables in calibration will make model simulations more realistic and thus more robust to changing climatic conditions. A key focus will be on improved selection and pre-processing of remotely sensed information (e.g. vegetation water use; GRACE water storage estimates).

**Project 3: Applying machine learning for new insights into hydrological non-stationarity.** While machine learning represents a new frontier in hydrology, we have yet to fully probe its value in generating new knowledge about hydrological processes. This project focusses on hydrological non-stationarity, a poorly understood phenomenon whereby the relationship between rainfall and runoff changes with time. Our lack of understanding of this phenomenon is a significant barrier to robust and defensible water resource planning. Non-stationarity has been observed in Australia (triggered by the 13-year "Millennium" drought) and in the Sahel region in Africa (known as the "Sahelian paradox"), and this project will examine both examples. Using the best available at-site and remotely sensed data, this project will apply Machine Learning to explore which information is most relevant to the non-stationarity phenomenon. This will generate insights into underlying physical processes that govern hydrological change, in addition to a prediction model relevant to water resource planning. This project will be undertaken with a local partner in the Sahel region.