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EXTENDED ABSTRACT ONLY

Large sample and high-resolution hydrological modelling studies to tackle a rapidly changing world

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Abstract: We are living in a rapidly changing world, with geophysical datasets being created at fast increasing rates. How to better use these datasets for understanding hydrological processes in various climate, vegetation and anthropogenic-influenced regimes has become a challenge and an opportunity. This is particularly pressing for the hydrological community who have relied on lumped rainfall-runoff modelling for hydrological simulations/predictions over the last several decades.

This talk first discusses major challenges in catchment and large-scale hydrological modelling and predictions, including: (1) quantification of uncertainty in hydrological modelling related to model inputs, model structure and parameterization; (2) extrapolation of hydrological parameters for predictions in different periods of time, when land cover conditions and climate change rapidly; and (3) use of large sample and high resolution available data for insightful understanding and skilful predictions on water information. The talk then touches on opportunities for hydrological community for better and smartly use of large sample and high-resolution datasets for improving hydrological simulations and predictions. Incorporating the work conducted in the last decade, the author introduces and discusses following four topics:

1. Use of the Google Earth Engine platform. The author and his team used the Google Earth Engine platform developing PML-V2 model for estimating up-to-date 500 m and 8-day resolution actual evapotranspiration and gross primary production products across global land surface. This allows researchers to have comprehensive analysis on land cover change impacts on water and carbon fluxes from patch to global scales;
2. Developing state-of-the-art model-data fusion techniques for predicting runoff in ungauged catchments. The author explores the potential for using parameter values from hydrological models calibrated solely against readily available remotely-sensed ET data to estimate runoff time series. The advantage of this approach is that it does not require observed streamflow data for model calibration and is therefore particularly useful for runoff prediction in poorly gauged or ungauged regions. The modelling experiments are carried out using data from 222 catchments across Australia. The results from the runoff-free calibration are encouraging, particularly in simulating monthly runoff and mean annual runoff in the wetter catchments;
3. Modifying rainfall-runoff modelling structure for better incorporating remote sensing data. Since traditional rainfall-runoff models do not have structure to simulate impact of land use and land cover change (LUCC), they are not reliable to simulate hydrological processes with rapid LUCC. The author leads a team modifying traditional rainfall-runoff models by changing their submodule for describing soil moisture and actual evapotranspiration processes. The modified rainfall-runoff models improve hydrological simulations noticeably in the bushfire impacted catchments and other catchments experiencing rapid land cover changes; and
4. Using machine learning techniques together with large samples to improve predictions of various hydrological variables and hydrological signatures. Using a large sample dataset from 605 catchments across Australia, the author and his team explore the potential to use a machine learning approach (regression tree ensemble) for predicting 13 runoff signatures. The machine learning approach is then compared with three conventional approaches (multiple linear regression, multiple log-transformed linear regression and hydrological modelling). Results demonstrate that the machine learning approach performs best and offers significant potential, being able to predict most of the runoff signatures very well.

Keywords: *Hydrological modelling, remote sensing, large sample, high resolution, model-data fusion*