EGU21-9888, updated on 28 Sep 2021
https://doi.org/10.5194/egusphere-egu21-9888
EGU General Assembly 2021

On the relationship between the variability of catchment hydroclimate and physiography, and the uncertainty of runoff generation hypotheses

Sina Khatami[1,2], Keirnan Fowler[2], Murray Peel[2], Tim Peterson Peterson[3], Andrew Western[2], and Zahra Kalantari[1]

[1]Stockholm University, Physical Geography, Stockholm, Sweden (sina.khatami@natgeo.su.se)

[2]University of Melbourne, Department of Infrastructure Engineering, Parkville, Australia

[3]Monash University, Department of Civil Engineering, Wellington Rd, Clayton, VIC 3010, Australia

Question #20 of the UPH aspires to disentangle and reduce model prediction uncertainty. One feasible approach is to first formulate the relationship between variability (of real-world hydrological processes and catchment characteristics) and uncertainty (of model components and variables), which links the UPH theme of “modelling methods” to “time variability and change” and “space variability and scaling”. Building on this premise, we explored the relationship between runoff generation hypotheses, derived from a large ensemble of catchment model simulations, and catchment characteristics (physiographic, climatic, and streamflow response characteristics) across a large sample of 221 Australian catchments. Using ensembles of 10^6 runs of SIMHYD model for each catchment, runoff generation hypotheses were formulated based on the interaction of 3 runoff generating fluxes of SIMHYD, namely intensity-based, wetness-based, and slow responses. The hypotheses were derived from model runs with acceptable performance and sufficient parameter sampling. For model performance acceptability, we benchmarked Kling-Gupta Efficiency (KGE) skill score against the calendar day average observed flow, a catchment-specific and more informative benchmark than the conventional observed flow mean. The relative parameter sampling sufficiency was also defined based on the comparative efficacy of two common model parameterisation routines of Latin Hypercube Sampling and Shuffled Complex Evolution for each catchment. Across 186 catchments with acceptable catchment models, we examined the association of uncertain runoff generation hypotheses (i.e. ensemble of modeled runoff fluxes) with 22 catchment attributes. We used the Flux Mapping method (https://doi.org/10.1029/2018WR023750) to characterise the uncertainty of runoff generation hypotheses, and a range of daily and annual summary statistics to characterise catchment attributes. Among the metrics used, Spearman rank correlation coefficient (R_s) was the most informative metric to capture the functional connectivity of catchment attributes with the internal dynamics of model runoff fluxes, compared to linear Pearson correlation and distance correlation coefficients. We found that streamflow characteristics generally have the most important influence on runoff generation hypotheses, followed by climate and then physiographic attributes. Particularly, daily flow coefficient of variability (Qcv) and skewness (Q Skewness), followed by the

same summary statistics of precipitation (Pcv and P Skewness), were most important. These four attributes are strongly correlated with one another, and represent the dynamics of the rainfall-runoff signal within a catchment system. A higher Pcv denotes a higher day-to-day variability in rainfall on the catchment, responded by a higher Qcv flow response. A higher variability in rainfall propagates through the catchment model and translates into a higher degree of equifinality in model runoff fluxes, which implies larger uncertainties of runoff generation hypotheses at catchment scale, and hence a greater challenge for reliable/realistic simulation and prediction of streamflow.