What is the optimal number of donor catchments for parameter regionalization in hydrology?

Hydrological models are used for water management decisions, and to predict the effects of climate or land use change on water resources. The parameters used to calculate the different water fluxes in a hydrological model usually need to be calibrated. This is typically done by maximizing the agreement between the observed and simulated discharge (i.e., optimizing model fit). However, most catchments are ungauged. This means that there is no discharge data available for them that could be used for calibration. Thus, it is challenging to find suitable model parameter sets that allow to predict discharge in ungauged catchments. Oftentimes, a regionalization approach is used to select parameter sets: The model is calibrated for gauged catchments that are located spatially close or that show a high degree of attribute similarity to the ungauged catchment of interest. The calibrated parameter sets from these so-called donor catchments are then used to simulate the discharge in the ungauged catchment.

While a lot of research about regionalization in hydrology has already been done (for some examples, see Drogue & Plasse (2014); He et al. (2011); Oudin et al. (2008); Pool et al. (2021); Swain & Patra (2017)), there are still open questions remaining, for example regarding the optimal number of donor catchments or the optimal number of parameter sets transferred from each donor catchment to the ungauged catchment.

It is the goal of this Master's thesis to investigate strategies of finding a suitable set of donor catchments for parameter regionalization. A special focus should be on the number of donor catchments as well as on the number of calibrated parameter sets used for the parameter regionalization to the ungauged recipient catchment. To be able to make general statements, we suggest using a large-sample data set, such as the CAMELS data set (Addor et al., 2017) containing discharge data and a variety of catchment information for over 600 unregulated but gauged catchments in the United States.

The thesis requires an interest in hydrologic modeling and (developing) programming skills (e.g., R or Python). The scope of the Master's thesis can be adjusted to the student's interest. For more information, contact Franziska Clerc-Schwarzenbach (Y25-L74): franziska.schwarzenbach@geo.uzh.ch.

Reading suggestions

Addor, N., Newman, A. J., Mizukami, N., & Clark, M. P. (2017). The CAMELS data set: Catchment attributes and meteorology for large-sample studies. *Hydrology and Earth System Sciences, 21*(10), 5293–5313. https://doi.org/10.5194/hess-21-5293-2017

Drogue, G. P., & Plasse, J. (2014). How can a few streamflow measurements help to predict daily hydrographs at almost ungauged sites? *Hydrological Sciences Journal*, *59*(12), 2126–2142. https://doi.org/10.1080/02626667.2013.865031

He, Y., Bárdossy, A., & Zehe, E. (2011). A review of regionalisation for continuous streamflow simulation. *Hydrology and Earth System Sciences*, *15*(11), 3539–3553. https://doi.org/10.5194/hess-15-3539-2011

Oudin, L., Andréassian, V., Perrin, C., Michel, C., & Le Moine, N. (2008). Spatial proximity, physical similarity, regression and ungaged catchments: A comparison of regionalization approaches based on 913 French catchments. *Water Resources Research*, *44*(3). https://doi.org/10.1029/2007WR006240

Pool, S., Vis, M., & Seibert, J. (2021). Regionalization for Ungauged Catchments — Lessons Learned From a Comparative Large-Sample Study. *Water Resources Research*, *57*(10). https://doi.org/10.1029/2021WR030437

Swain, J. B., & Patra, K. C. (2017). Streamflow estimation in ungauged catchments using regionalization techniques. *Journal of Hydrology*, *554,* 420–433. https://doi.org/10.1016/j.jhydrol.2017.08.054