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# A new method to determine effective hydraulic conductivity and mannings n parameters at multiple modeling resolutions in a mountain headwater catchment.

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Integrated models are based on theoretical equations of water fluxes measured and studied either in a lab or in small plots. These physical processes are then applied at successively larger and larger scales as the need to model full catchments, multiple catchments, or even entire continents has become a critical goal of the research community. Physically-based models at the catchment scale and larger are generally too computationally expensive to run traditional calibration processes so the few parameter observations that exist at this scale are used without calibration. One of the most critical parameters used in hydrologic models, whether simple or complex, is hydraulic conductivity.

Hydraulic conductivity (K) is easily measured in controlled laboratory experiments, but as scale increases the variability of K also dramatically increases. K varies over multiple orders of magnitude, not just across different geologies, but within individual formations. Numerous studies have examined the scaling of K [1]–[4], especially in the contaminant transport community, but rarely has this scaling behavior been contextualized in terms of catchment-scale modeling efforts. Kurylyk and Hayashi 2017 examined K scaling in an integrated model for a small talus field in a 2D hillslope, finding important relationships between flow and K that were critical to accurately model snowmelt at this scale. Despite frequent construction of catchment and larger-scale models, this type of analysis has never been conducted at a full catchment scale.

Here, we present a suite of sensitivity analysis for the two most sensitive parameters to modeling flow– hydraulic conductivity and mannings n– compared at two modeling resolutions– 1km and 100m. Further, we develop a procedure for downscaling or upscaling parameters to 'effective' values that incorporate differences in topography and cell size occurring at different resolutions. These results systematically document changes in physical modeling behavior as K and n are varied over 4 orders of magnitude in a real, complex, and heterogeneous mountain system. Given that most, if not all, regional integrated models lack the computational resources and time to do a traditional calibration, these results can help future model developers choose appropriate parameters for their domain, taking into account changes to physical process representation as resolution is coarsened to cover larger areas.

References

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