Geophysical Research Abstracts
Vol. 16, EGU2014-15359, 2014
EGU General Assembly 2014

Using landscape organization and functional similarity to reduce redundancy in distributed hydrological modeling

Erwin Zehe (1), Uwe Ehret (1), Ulrike Scherer (1), and Axel Kasparek (2)

(1) KIT Karlsruhe Institute of Technology, Institute for Water and River Basin Management, Chair of Hydrology, Karlsruhe, Germany (uwe.ehret@kit.edu), (2) Technische Universität München, Chair of Hydrology and River Basin Management

The landscapes we see are, to a large degree, not random combinations of their constituents. Rather we witness organization in the form of recurring, typical combinations of morphology, soils, vegetation, hydro-climate etc. A typical example in cool-moist hydro-climate at mid-altitudes would be a coniferous forested hill slope on shallow hydrophobic soils.

If we thus hypothesize that landscape is composed of non-unique, recurring entities, and if we further hypothesize that any two systems that share a similar structure, are in a similar initial state and are exposed to similar forcing will produce similar integral responses based on similar internal dynamics, then many of the computations in distributed hydrological models will be redundant. For instance, if we knew the internal dynamics and response of a hill slope to a rainstorm, we should be able to predict the response of a neighboring hill slope without explicitly computing its dynamics by transferring the results of its neighbor.

If this is true, then exploiting this redundancy has the potential to greatly reduce computational efforts in distributed modeling, while still considering structure and dynamics in high spatial and temporal resolution (unlike lumped approaches). The challenge then lies in the questions:
- What degree of similarity is sufficient to dynamically group landscape entities of similar structure, state and forcing?
- What are rules to decide on the temporal extend of such groups?
- How to select a representative group member to compute dynamics and how to assign the resulting state changes and responses back to each group member?

In this work, we introduce the concept of 'representative computation' and present results from a first application in the 3.5 km^2 Weiherbach catchment in Germany. The Weiherbach is situated in a hilly, intensively cultivated loess region composed of typical convex-concave shaped slopes and erosion catenas. The catchment was subdivided into 169 hill slopes and simulated with the distributed, process-based model CATFLOW. This was done i) in a fully distributed way (i.e. each slope individually) and ii) using typical hill slope representatives. The results show that the representative approach substantially reduces computing times, while simulation quality remained acceptable. This approach thus potentially allows extending the range of application of fully distributed hydrological models towards larger scales.

This work is part of the German-Luxembourg DFG-FNR research group CAOS (Catchments as organized systems).