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Spatial Averaging of Overland Flow Equations Using Perturbation Theory

JAEYOUNG YOON[1] and M. LEVENT KAVVAS[2]

[1]*Department of Environmental System Engineering, Korea University*
[2]*Department of Civil and Environmental Engineering, University of California*

Overland flow is a very important component in a watershed hydrology model as it provides lateral inflow for the channel flow component. From an environmental standpoint, it also plays a significant role in driving non-point source pollution mechanism. In this paper spatial averaging of overland flow equations at the hillslope scale is presented. Spatially averaged equations can be useful in reducing the computational burden involved with physically-based modeling of watershed processes by avoiding solving the two-dimensional point-scale equation for overland flow. Unlike the traditional configuration of simple plane geometry for a hillslope, interacting interril-rill configuration is considered in this study to model hillslope more realistically. Thus, spatially averaged equations for both interrill area and rill are developed respectively using perturbation theory. The developed equations consist of terms involving the statistics on multiple interrills and rills over a hillslope, which are the measure of heterogeneity in terms of terrestrial parameters such as slope and roughness coefficient. Hence, not only the equations are computationally more economical, but also are capable of accounting for the heterogeneous configuration of a hillslope. The performance of the model was tested using the data collected at experimental plots in Kentucky. The model was calibrated and validated against the observed data and showed good resemblance.

Keywords: Overland flow; Kinematic wave; Spatial averaging

References

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