Geophysical Research Abstracts
Vol. 19, EGU2017-11590, 2017
EGU General Assembly 2017

Nonlinear Multiscale Changes of Peak Flows on Tiled Landscapes

Ricardo Mantilla (1), Nandita Basu (2), Brandon Sloan (3), and Morgan Fonley (4)

(1) The University of Iowa, IIHR, Civil and Environmental Engineering, Iowa City, United States (ricardo-mantilla@uiowa.edu), (2) University of Waterloo, (3) St. Anthony Falls Laboratory, University of Minnesota, (4) Alma College, Michigan

We perform a multiscale analysis of the effect of tile drainage on peak flows. Our analysis suggests that a complex interaction of network topology and tile organization in space takes place even in the presence of a homogeneous runoff field. Subsurface drainage systems are common in agricultural landscapes all over the world, and yet there is a lack of understanding on how they modify the hydrologic flow regime, from the field to the watershed and the regional scale. In this study, we conduct a systematic assessment of the effect of agricultural subsurface drainage (tiling) on the hydrologic response as a function of the watershed scale. We used the field scale model DRAINMOD in conjunction with a linearized routing equation for our analysis, and use a watershed in south central Iowa as a case study. Tile drainage was observed to increase low flows, decrease intermediate flows, and have no effect on the largest floods. The reduction in peakflows was observed to be dependent on the event size and the spatial scale, such that the greatest flow reductions were apparent at the intermediate scale (100 to 1,000 km2), with lower reduction at the largest scale (> 10,000 km2). The scale dependence can be attributed to the fact that peakflows at larger scales are typically not caused by a single rainfall event, but by the accumulation of flows over a temporal window that is equal to the time of concentration of the catchments. Our linearized routing equation allows the use of hydrograph superposition to show how the impact of tiled fields on watershed peakflows is determined by the topological structure of the river network. We demonstrate that the percentage of tiled fields in a basin is not a definitive indicator of changes in peakflow regimes, but rather the spatial organization of these fields within the watershed is the determinant. We connect our results to the Width Function, a well-known geomorphological descriptor of river network topology, and demonstrate how tile placement in relation to the attributes of the width function controls watershed response. Although we focus primarily on peakflows, our results indicate that the impact of tile drains on the flow distribution is also scale dependent, and alterations to this distribution will, in turn, control sediment and nutrient transport in a basin.