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Effects of multi-scale rainfall variability on flood frequency: a comparative multi-site analysis of dominant process controls

M. Sivapalan (1), J. M. Samuel (2)

(1) Departments of Geography and Civil and Environmental Engineering, University of Illinois, Urbana, Illinois 61801 (sivapala@uiuc.edu), (2) School of Environmental Systems Engineering, University of Western Australia, Crawley WA 6009, Australia.

This paper explores the effects of multi-scale rainfall variability on the shape of the flood frequency curve. A comparative analysis is carried out in three catchments located in Perth, Newcastle and Darwin, Australia. The derived flood frequency approach is used by combining rainfall-runoff models that capture the intrinsic water balance variability in the study catchments with rainfall event sequences generated using a stochastic rainfall model that incorporates temporal variabilities over a multiplicity of time scales, ranging from within-event, seasonal, inter-annual to multi-decadal. The focus of this presentation is on the differences of the flood frequency responses, and on explaining these in terms of the underlying process controls. Results show that there are significant differences in the way that the multi-scale rainfall variability manifests itself in the flood frequency curve, these being attributed to the dominant runoff generation mechanisms. In Darwin the flood frequency curve exhibits a persistent break in slope, linked to a change in dominant runoff mechanisms from subsurface stormflow to saturation excess, caused by seasonal rainfall variability and enhanced by within-storm rainfall patterns. In Newcastle storminess dominates and floods are caused by a combination of saturation excess and fast subsurface flow at all times, and the flood frequency curve does not exhibit a break in slope under any circumstances, yet its magnitude and slope are affected by intra-annual, inter-annual and inter-decadal rainfall variabilities. In Perth, however, the shape of the flood frequency curve is highly variable, depending on the relative strength of seasonality and

inter-annual variability. In wet periods (i.e. La Nina years) the flood frequency curve exhibits a break in slope just as in Darwin, governed by a change of process which is further aided by seasonality. In dry periods (e.g., El Nino years), however, the flood frequency curve is governed by subsurface stormflow alone regardless of seasonality, and hence exhibits no break in slope