Geophysical Research Abstracts, Vol. 7, 09793, 2005
SRef-ID: 1607-7962/gra/EGU05-A-09793

Scaling of Floods Revisited: The Effect of Geomorphologic Controls

E. Foufoula-Georgiou (1) and B. Dodov (1)
St. Anthony Falls Laboratory and National Center for Earth-surface Dynamics (NCED)

Scaling of floods (maxima annual flows) has been the subject of considerable research in hydrology starting with the simple normalization methods of the 60’s, e.g., the index flood method, to the statistical multiscaling theories of floods in the 90’s. The question of interest is to describe how the probability density function of floods changes as the drainage area of the basin (scale) changes. The typical approach has been to perform a moments-based analysis of max annual floods and characterize scale invariance by the spectrum of scaling exponents function. Analysis of observations from several regions has supported the inference that floods exhibit a multiscaling structure with a scaling break at a characteristic scale Ac (not yet fully explained in physical terms). Below this characteristic scale, the variability of floods increases with increasing scale while above it decreases. Such an approach yields a concise statistical model which can be used for regional flood quantile estimation of design events. However, it ignores some important physical-geomorphological facts about floods. First, “floods” are composed of flows that come from two distinct geomorphological regimes: in-stream flows and over-bank (or floodplain) flows, which have different physical and statistical characteristics. Second, it has been demonstrated recently that the frequency of exceedance of bankfull flows, and thus the transition from one regime to the other, i.e., from in-stream to over-bank flows, is scale-dependent with a relationship exhibiting an abrupt change at a particular scale found to be associated with the scale at which the fluvial regime transitions from mostly erosional to mostly depositional. Based on these findings, we propose a revised scaling formalism for floods which acknowledges their multiphysics nature and uses geomorphologic information to appropriately combine each physics over the whole range of scales. Specifically, the new formalism is based on an extended “mixed lognormal multiscaling model” composed of two multiscaling models each describing the below and above bankfull flow regimes respectively,

mixed according to a scale-dependent relationship estimated independently from the frequency of exceedance of overbank flows. As such, it provides a more physically-pleasing statistical formalism which draws upon not only the hydrological but also the geomorphological information of the basin for estimation and inference and lends itself to easier interpretations, as for example, the origin of the scaling break and the characteristic scale at which it occurs. Application to Midwestern U.S. floods will be presented.