Developing consistency and transferability in topographic modeling index

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Abstract. A large part of the uncertainty in hydrological model prediction can be reduced if the causes of the uncertainty are understood. Geomorphological parameters such as upslope catchment area and slope are scale dependent. Flow variables such as discharge, depth and wave celerity are also scale dependent. The scale dependence of the geomorphological parameters can lead to inconsistency in the proper partitioning of the rainfall into surface runoff and subsurface flow. Development of a transferable rainfall-runoff model and identifying relations to transfer model parameter to account for differences in scale seeks connections among physical processes at disparate scales and possible linkage of hydrological similarities between catchments. This understanding, in turn, improves our understanding of scale transformation and scale invariance. In this research, methods are presented to downscale as well as upscale the upslope catchment area, land surface slope and contour length to correct for the effect of DEM resolution on the saturated area, surface runoff and base flow predicted by TOPMODEL. The derived geomorphometric parameter scaling relationships are used to scale the topographic index distribution in watersheds in different geographic regions of the world. Results show consistency in the rainfall-runoff transformation at a range of scales for catchments in Japan, Nepal, Panama, and the U.S. The scaling method is used to transfer the scale dependent hydrological information from one catchment to another. We start with model parameters identified in the Kamishiiba catchment in Japan, and apply these parameters through scale transformation to two Sun Koshi subcatchments in Nepal, the Upper Rio Chagres catchment in Panama and the Town Creek catchment in New York, and demonstrate how a-priori estimation of the effective model parameters sets can be used for poorly gauged / ungauged basins with some degree of confidence.