Geophysical Research Abstracts
Vol. 14, EGU2012-9178, 2012
EGU General Assembly 2012

Flipside coupling of bedrock-river sinuosity and slope-failure size

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Quantitative studies on fluvial erosion into bedrock have largely been focusing on vertical incision. Yet variations in lateral river erosion may significantly compromise channel-bank and hillslope stability, thus modulating incoming lateral sediment flux. Recent work suggested that the regional occurrence of bedrock meanders coincides with areas characterised by weak rock types and marked precipitation variability. If this notion is valid, channel sinuosity may be used to map the spatial variance of tuning parameters in fluvial erosion laws. Here we use various measures of sinuosity as a proxy of the lateral erosion potential in bedrock rivers in the Japanese archipelago. Bagged model trees show that bedrock-river sinuosity is the major distinguishing topographic characteristic on landslide occurrence at the island-arc scale, overriding metrics such as topographic relief, normalised channel steepness, or mean elevation, which commonly serve as proxies of erosion rates over various spatiotemporal scales. We find that the fraction of landslide-affected terrain scales inversely with river sinuosity. Increased bedrock meandering coincides with a systematic decrease in the heavy-tailed landslide sizes and commensurate volumes. We interpret this counterintuitive relationship as the result of a higher density of rock-mass discontinuities in weaker rocks that favour the formation of bedrock meanders, while setting an upper size limit to slope failure, thus potentially outweighing enhanced lateral fluvial scour and undercutting. We conclude that regional bedrock river sinuosity may contain a potentially important and independently derived morphometric signal for characterizing regional patterns of slope stability.