Geophysical Research Abstracts
Vol. 17, EGU2015-13403, 2015
EGU General Assembly 2015

Resilience of catchment sediment yield to climate perturbations

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It is commonly thought that catchment sediment yield is largely governed by allogenic controls acting on the catchment. Under this paradigm, variations in climatic, tectonic or anthropogenic forcing are directly transmitted to the catchment sediment yield. The sediment yield thus represents a temporal signature of the governing external forces. This paradigm, however, has been challenged by recent research, which has shown that autogenic controls from within the catchment can significantly affect and, in some cases, overwrite the allogenic signal in the sediment yield signal. In these cases the catchment sediment yield can be considered to be resilient to external perturbation. On the other hand, it also has been shown that, in some other cases, the allogenic signal can indeed be transmitted efficiently through the catchment, without too much distortion by the autogenic controls. In these latter cases, the sediment yield signal, and hence the downstream sediment deposits, can be a reliable archive of past environmental forcing.
This study uses computer simulation to investigate the autogenic resilience of catchment sediment yields. Specifically, it investigates allogenic signal preservation in catchment sediment yield in the context of climate signals. It is hypothesized that 1) the resilience of the catchment sediment yield signal is largely determined by the catchment's spatial heterogeneity (of topography, vegetation, soil properties, ...) and the external signal's temporal heterogeneity and amplitude; and 2) catchment resilience is inversely correlated with spatial heterogeneity and positively correlated with the temporal heterogeneity and amplitude of the allogenic signal. This hypothesis is tested using a set of similar catchments, but with different relief ranges, different levels of topographic smoothness, different sediment distributions, and different artificial vegetation covers. These catchments are subjected to a range of rainfall scenarios over a 300-year simulation period, using the CAESAR landscape evolution model. Results confirm that the sediment yields in the more homogeneous catchments are less resilient and better preserve the signal from all rainfall scenarios, whereas the more heterogeneous catchments are more resilient and only preserve those climate signals with higher amplitudes or larger wavelengths.