Geophysical Research Abstracts
Vol. 14, EGU2012-13477-1, 2012
EGU General Assembly 2012

Simulation of long-term debris flow sediment transport based on a slope stability and a debris flow routing model

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Debris flows play a crucial role in the coupling of hillslope-sediment sources and channels in mountain environments. In most landscape evolution models (LEMs), the sediment transport by debris flows is (if at all) often represented by simple empirical rules. This generally results from the mismatch of the coarse resolution of the LEMs and the small scale impacts of debris flow processes. To extend the accuracy and predictive power of LEMs, either a higher resolution of LEMs in combination with process-based debris flow models or a better parametrisation of subpixel scale debris flow processes is necessary. Furthermore, the simulation of sediment transport by debris flows is complicated by their episodic nature and unknown factors controlling the frequency and magnitude of events.

Here, we present first results using a slope stability model (SINMAP) and an event-based debris flow routing model (SCIDDICA-S4c) to simulate the effects of debris flows in LEMs. The model was implemented in the XULU modelling platform developed by the Department of Computer Science at the University of Bonn. The combination of the slope stability model and the event-based routing and mass balance model enables us to simulate the triggering and routing of debris flow material through the iteration of single events over several thousand years. Although a detailed calibration and validation remains to be done, the resulting debris flow-affected areas in a test elevation model correspond well with data gained from a geomorphological mapping of the corresponding area, justifying our approach.

The increased computation speed allows to run high resolution LEM in convenient short time at relatively low cost. This should encourage the development of more detailed LEMs, in which process-based models should be incorporated.