Geophysical Research Abstracts
Vol. 13, EGU2011-7157, 2011
EGU General Assembly 2011

A new numerical model to study the influence of climate on hillslope sediment supply: first results

Benoît Bovy (1,2), Alain Demoulin (1), and Jean Braun (2)
(1) FNRS; UGPQ, Université de Liège, Belgium (bbovy@ulg.ac.be), (2) LGCA, Université Joseph Fourier Grenoble, France

In most of the well-known surface processes models, complex processes which act on the hillslopes are typically modeled with a simple linear diffusion equation where the diffusion coefficient is assumed constant over long time scales. More attention has been paid to river erosion and transport that has mainly contributed to the evolution of many landscapes including the Rhenish Massif (NW Europe), our area of interest. However, field studies and the emergence of sediment-flux dependent river incision models have in some cases supported the assumption that variations in sediment delivery to river channels, partly due to climate oscillations, can play a key role on river incision rates.

Within the frame of numerical modeling, the purpose of our study is to better understand and quantify the impact of the Quaternary climate variations on sediment delivery from soil-mantled hillslopes to river channels, and especially the transient behavior of the system and its response time under different climate scenarios, soil transport mechanisms and hillslope geometries. To better deal with the complexity of both transport processes acting on hillslopes and their response to climatic variations, we developed a new numerical model of soil production and soil transport in which transport processes are represented separately by their own law. In addition to linear creep, depth dependent-creep and transport by overland flow that are thought to play an important role on soil-mantled hillslopes, periglacial processes such as solifluction and shallow active-layer landsliding are included to model sediment transport during the cold phases and the cold-warm transitions of the Quaternary. The parameterization of these transport laws requires the computation of specific variables (e.g. active-layer depth, overland flow discharge) that is made through simple thermal and hydrological models. Climatic variables such as air temperature and precipitation rate are used directly as inputs in the model so that we can investigate complex climate scenarios.

We present here the results of a first set of simulations made with this hillslope evolution model. We show among other observations that the time needed for the sediment delivery to reach an "equilibrium" under a constant climate is very sensitive to the temperatures (mean annual air temperature and its annual amplitude) and the transport mechanisms involved (e.g. the time could be very long without the action of depth dependent creep). We also show that in some cases the response of sediment supply to rapid climate change could be much longer than the periods of climatic oscillations that occurred during the Quaternary.
Used together with models of river erosion and transport, this model will help us to explore, through a fully coupled hillslopes/rivers system, the response of landscape to climate changes.