Geophysical Research Abstracts
Vol. 12, EGU2010-7797-1, 2010
EGU General Assembly 2010

Influence of surface slope and roughness on the shape of river basins: a comparison between nature and numerical experiments

Philippe Yamato (1,2), Sébastien Castelltort (2), and Sean Willett (2)

(1) Géosciences Rennes, UMR CNRS 6118, Université de Rennes 1, France (philippe.yamato@univ-rennes1.fr), (2) E.T.H. Zuerich, Department of Earth Sciences, Zuerich, Switzerland

The last two decades have been marked by a large amount of studies on the relative influences of climate and tectonics on landscape evolution. Coevally, considerable advances have been achieved in numerical modelling of landscape evolution. These have been particularly useful in testing hypotheses and scenarios of the potential controls and feedbacks between climate, tectonics and landscape evolution.
However, our current knowledge of the physical processes of erosion in nature remains incomplete. Indeed, although the predictions of landscape evolution models are often insightful, they are also sometimes overlooked due to their lack of physical basis. In parallel with current field and experimental investigations on erosion processes, one way to tackle this problem is to compare simulated and natural landscapes. Then, this allows us to know how can one assess whether a simulated landscape is realistic in a long-standing problem in geomorphology. The scaling between stream length and upstream drainage area, a relation known as Hack's law (Hack, 1957) provides a constrain on the geometry of natural landscapes. It is however notoriously difficult to use this law to assess the goodness of a landscape evolution model since it must be regarded over a logarithmic range of scales (stream orders), which is usually not possible in landscape evolution models because of their resolution.
The convergence angle, a measure of a basin's elongation (Castelltort et al., 2009) is a similar metrics of drainage basin shape. It is controlled by the slope and roughness of the undissected surface on which a new basin develops. This relation arises from analytical predictions of water flow over simple topography and is supported by data on median to large-scale natural networks.
In the present study we investigate the influence of slope and surface roughness on the shape of river basins using the CASCADE code (Braun and Sambridge, 1997). Results show that the rules used to route water in CASCADE (similar to those used in other landscape evolution models) are sufficient to produce a range of basin forms that correspond to the sample of natural basins used in this study. As expected, the convergence angle depends on the global slope and on the roughness. A new unexpected result is that it remains constant through time in the case of simple block uplift and is affected neither by the fluvial erosion coefficient nor by the diffusion coefficient used.

References:
Braun J. and Sambridge M. (1997), Modelling landscape evolution on geologic time scales: a new method based on irregular spatial discretization, Basin Research, v.9, 27-52.
Castelltort S., Simpson G. and Darrioulat A. (2009), Slope-control on the aspect ratio of river basins, Terra Nova, v. 21, 4, 265-270.
Hack J.T. (1957), Studies of longitudinal stream profiles in Virginia and Maryland. United States Geological Survey Professional Papers, 294-B.