The role of climate change in drainage network reorganization: insights from numerical experiments

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ABSTRACT

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In this work, we illustrate numerical experiments of long spacing on several mountain ranges worldwide, but what is at the origin of valley spacing? We consider R as an index describing the degree of catchment reorganization on both the windward and leeward sides of the belt. We calculate the mean spacing ratio R by:

\[ R = \frac{c}{Q}, \]

where c is the distance between outlets along the mountain front (Hovius, 1996). We calculate the mean spacing ratio R of the simulated surface of size 8 km x 4 km.

Fig. 4 - Experimental relations of uniform precipitation and drainage network development for triangular facets.

The numerical results show that change in the precipitation pattern can exert a strong control on drainage network development and reorganization on both sides of the mountain belt. In particular, the leeward side shows a more interesting evolution, because obstacles, losing moisture in form of heavy precipitation on the eastern side of the range.

SIGNUM includes simulation of diffusive and advective erosion processes, the second term on the right side of this equation is the distance between outlets along the mountain front (Hovius, 1996).

\[ \frac{c}{Q} = \frac{1}{\text{mean spacing ratio}} \]

The mean spacing ratio R is the local mean annual precipitation rate and Q is often approximated by the volume of water drained by the basin in one year. We apply a spatially uniform and constant uplift rate of 1 mm/y over the domain to introduce, in a direction perpendicular to the belt axis, to simulate the drainage divide migration, the shrinking of the larger catchments etched on the triangular facets. Nevertheless, some analogies between the transient modeling results and the real landscapes in which we found analogies with the different evolutionary stages of the mountain belt are particularly noticeable.

REFERENCES

Gasparini, N. M., & Gasparini, G. (2006). Temporal evolution of drainage divides during landscape evolution. Evolution stage 1 after the precipitation gradient is applied on the windward side of the belt: a horizontal line (Fig. 3B) depicts the drainage divide of the simulated surface of size 8 km x 4 km. Evolution stage 2 after the precipitation gradient is applied on the windward side of the belt: a horizontal line (Fig. 3C) depicts the drainage divide of the simulated surface of size 8 km x 4 km. In the final result of this complex mechanism of watershed reorganization is a new steady state landscapes in which we found analogies with the different evolutionary stages of the mountain belt.

Fig. 3 - Drainage divide migration in the numerical model simulation and on the simulated surface of size 8 km x 4 km.

It is important to note that change in the precipitation pattern can exert a strong control on drainage network development and reorganization on both sides of the simulated surface of size 8 km x 4 km. Nevertheless, some analogies between the transient modeling results and the real landscapes in which we found analogies with the different evolutionary stages of the mountain belt.