Geophysical Research Abstracts
Vol. 21, EGU2019-9091-1, 2019
EGU General Assembly 2019

Model-based assessment of the stochastic effect of landslides on cosmogenically-derived catchment-averaged denudation rates

François Clapuyt and Veerle Vanacker
Université Catholique de Louvain, ELI, ELIC/TECLIM, Louvain-la-Neuve, Belgium (francois.clapuyt@uclouvain.be)

In-situ cosmogenic radionuclides (CRN) have become a widely used tool in the geomorphic community to constrain geomorphic process rates. In many applications, catchment-wide denudation rates have been derived from in-situ produced 10Be concentrations in samples of river sand. These applications assume that sediment production and delivery rates within the catchment are reasonably steady and that river sediment is well mixed and all parts of the catchment are represented in proportion to their denudation rates. These assumptions are not necessarily met in active mountain ranges where deep-seated landslides or gully systems are contributing with deeply shielded soil or regolith to the river network. In this study, we analyse the variation in CRN-derived denudation rates as a function of the magnitude and frequency of geomorphic events. We first modified the CRN dynamics model of Yanites et al. (2009) to represent landslides as a proper spatial Poisson process and then adapted the code for the open-source programming language R. Then, we designed scenarios with different landscape and landslide configurations, taking into account the following four variables: the drainage area, the background erosion rate, the landslide return period and the landslide area distribution coefficient. The latter defines the shape of the magnitude-frequency landslide distribution curve, i.e. the probability of occurrence of landslides of a given magnitude. Finally, we run the scenarios for a time span of 200 kyr, and iterated 100 times each scenario to simulate the intrinsic variability of geomorphic events in landslide-prone landscapes.

All scenarios show that the CRN-derived denudation rates are equal or higher than the volumetrically-derived denudation rates. The overestimation of CRN-derived denudation rates is larger when large landslides are more likely to occur and the landslide return period is shorter. An increase in background erosion reduces the landslide effect on CRN surface and river sediment concentrations. In addition, the stochastic approach shows that the variability of CRN-derived denudation rates is strongly controlled by the landslide area distribution coefficient and landslide return period. As such, the magnitude-frequency distribution of landslides influences both the variability and the accuracy of CRN-derived denudation rates. Our results show that this parameter, along with the landslide return period, should be taken into account when assessing the validity of CRN-derived denudation rates.