Geophysical Research Abstracts
Vol. 12, EGU2010-1382, 2010
EGU General Assembly 2010


# Erosion rates, sediment transport and characteristic discharge in a transient landscape in the Entle catchment (northern border of the Central Alps, Switzerland)

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The 65 $km^2$-large Entle catchment is located at the northern border of the Central Alps of Switzerland and is underlain by various lithologies including Flysch, carbonate sequences, Molasse deposits and glacial till. It has been subjected to headward knickpoint migration since the termination of the LGM (16 $\pm$ 3 ka), due to a base level fall upon glacial retreat.

The incised portions of the catchment were delineated within a GIS environment in an effort to calculate volumetric differences between the glacial surface and the modern topography. The sediment budget estimates yield an average erosion rate of 1.93 $\pm$ 0.36 $mm.yr^{-1}$ in the incised reaches, and a maximum local erosion rate of 11.47 $\pm$ 2.15 $mm.yr^{-1}$. Assuming that there has been no erosion elsewhere, the basin-wide averaged erosion rate is estimated at 0.31 $\pm$ 0.06 $mm.yr^{-1}$. This is consistent with $^{10}$Be-based denudation rates measured in adjacent catchments.

Although constant erosion rates are generally assumed for studies involving $^{10}$Be analysis, field evidence indicate that headward knickzone migration through bedrock and unconsolidated glacial till has destabilized the surrounding hillslopes, resulting in supply of large volumes of sediment to the trunk channel by landsliding and/or debris flows downstream the knickzone. This additional influx of sediments may raise the local base level within the incised reach, thus perturbing the migration of the knickzone for a limited time interval. This time span critically depends on the relative importance between the probability density function (PDF) of the sediment particle size supplied by mass failure processes and debris flows, and the characteristic water discharge magnitude to remove that material.

Measurements of the PDFs of the sediment particles along the incised Entle reach together with the application a simple long profile stream-power model for the entrainment and transport of sediment allow the identification of characteristic bed-forming discharge magnitudes. In particular, the model illustrates that (i) the stream power increases in the knickzones (as expected), and that (ii) highest stream power values are calculated where tributary debris flow fans and landslides are being cut, illustrating the importance of hillslope-derived perturbations. Most important, the long-term averaged grain size threshold seems to correspond to that of the 5-year flood. Furthermore, the critical mobilized grain size for the 1-year flood exceeds the observed grain size at all sites along incised reach, suggesting that the majority of the sediments are readily carried away by even small floods. However, the large blocks derived by landslides (up to 11m in diameter, with origin in the glacial till) are very likely to remain in place, not being affected by any flood.