Geophysical Research Abstracts
Vol. 18, EGU2016-12767, 2016
EGU General Assembly 2016

Variations in vegetation cover and topography control gully density and sediment production on the Chinese Loess Plateau

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The factors controlling topsoil erosion rates are relatively well understood. This explains why topsoil erosion rates on the Chinese loess plateau (CLP) can be relatively accurately estimated using a combination of empirical data and relatively simple models (Zhao et al., in press). This is, however, not the case for non-topsoil erosion (sediment production by gullying and landslides): while it is well known that these processes produce significant amounts of sediment, the factors controlling their intensity on the CLP are far less understood.

In this study, the contribution of non-topsoil erosion to total sediment production on the CLP was investigated. We estimated non-topsoil erosion rates (E_{NT}) by making the difference between measured total sediment yield and the estimated topsoil erosion in 46 gauged catchments on the CLP for the period 1950-1970, when soil conservation measures were mostly absent in the area. We tested an extensive set of environmental variables related to topography, climate and the impact of land use for correlation

Our results showed that the average catchment erosion rate (E) and E_{NT} between 1950 and 1970 were 68.29 $tha^{-1}yr^{-1}$ and 58.02 $tha^{-1}yr^{-1}$ respectively. The sediment contribution of non-topsoil erosion to total sediment production ranged between 0 and 97% with a mean of 70%. Both E and E_{NT} were significantly related with river slope, land use, NDVI, and gully density. However, gully density was the only variable explaining a major part of the variance in both E (60%) and E_{NT} (57%). Gully density itself was significantly related to topography and vegetation cover but not to precipitation. Importantly, gully density was not only related to overall slope steepness, but also the river gradients and the hypsometric integral, suggesting that not only land cover disturbance but also tectonic uplift may control gully density and erosion rates. The absence of a clear climate signal, both with respect to the variation in gully density and in E, can be explained by the overwhelming effect that climate has on vegetation cover.

Our research showed that non-topsoil erosion is the dominated sediment sources on the CLP and is mainly controlled by the variation of gully density. As gully development is likely to be strongly controlled by natural factors and less by human disturbance, this result suggests that natural erosion strongly contributes to sediment production on the CLP.

Zhao, J., Van Oost, K., Chen, L., and Govers, G., (in press). Moderate topsoil erosion rates constrain the magnitude of the erosion-induced carbon sink and agricultural productivity losses on the Chinese Loess Plateau. *Biogeosciences*.