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Reassessment of soil erosion on the Chinese loess plateau: were rates overestimated?

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Several studies have estimated regional soil erosion rates (rill and interrill erosion) on the Chinese loess plateau using an erosion model such as the RUSLE (e.g. Fu et al., 2011; Sun et al., 2013). However, the question may be asked whether such estimates are realistic: studies have shown that the use of models for large areas may lead to significant overestimations (Quinton et al., 2010). In this study, soil erosion rates on the Chinese loess plateau were reevaluated by using field measured soil erosion data from erosion plots (216 plots and 1380 plot years) in combination with a careful extrapolation procedure.

Data analysis showed that the relationship between slope and erosion rate on arable land could be well described by erosion-slope relationships reported in the literature (Nearing, 1997). The increase of average erosion rate with slope length was clearly degressive, as could be expected from earlier research. However, for plots with permanent vegetation (grassland, shrub, forest) no relationship was found between erosion rates and slope gradient and/or slope length. This is important, as it implies that spatial variations of erosion on permanently vegetated areas cannot be modeled using topographical functions derived from observations on arable land. Application of relationships developed for arable land will lead to a significant overestimation of soil erosion rates.

Based on our analysis we estimate the total soil erosion rate in the Chinese Loess plateau averages ca. 6.78 t ha-1 yr-1 for the whole loess plateau, resulting in a total sediment mobilisation of ca. 0.38 Gt yr-1. Erosion rates on arable land average ca. 15.10 t ha-1 yr-1. These estimates are 2 to 3 times lower than previously published estimates. The main reason why previous estimates are likely to be too high is that the values of (R)USLE parameters such as K, P and LS factor were overestimated. Overestimations of the K factor are due to the reliance of nomograph calculations, resulting in significantly higher erodibility values than those obtained from field data. Overestimations of the P and LS factors are mainly due to the fact that erosion control measures such as terracing are not accounted for and that erroneous scaling functions are used on permanently vegetated areas.

Our findings have not only important implications with respect to the mobilization of sediments by agricultural erosion: we will also need to reassess the impact of erosion on biogeochemicaly cycling and crop productivity.

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