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Nonlinear response of soil erosion to mean annual precipitation: evidence from erosion plot data in China

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An extensive erosion plot database measuring soil loss and runoff under natural rainfall in China was compiled to gain new understanding of the overall response of the soil loss and runoff rate to land use, slope gradient, slope length and mean annual precipitation. Our results show that land use dominates the variation of soil loss and runoff: Soil loss and runoff rates on land covered by natural vegetation are one to three orders of magnitude lower in comparison to rates on agricultural land that is strongly disturbed by anthropogenic activities. Slope gradient and slope length affect soil loss and runoff rates on cropland but there is no statistically significant effect on either soil loss or runoff rate on permanent vegetation. This implies that different extrapolating relationships need to be used for cropland in comparison to land with permanent vegetation when erosion plot data are used to assess the erosion risk over large areas. Runoff rates consistently increase with mean annual precipitation. The relationship between soil loss and mean annual precipitation is different and is nonlinear for all land use types, with a clear increase of soil loss with precipitation up to a mean annual precipitation of ca. 700 mm yr⁻¹, a subsequent decline and a second rise when the mean annual precipitation exceeds ca. 1400 mm yr⁻¹. This non-linear response can be attributed to the interplay of an increasing rainfall erosivity and an increasing protection due to vegetation cover with increasing mean annual precipitation. It also implies that the effect of climate change on the erosion risk is not straightforward but depends on how both rainfall erosivity and vegetation cover change with changing climate.