Gully erosion assessment model with linear or areal development rate on the Loess Plateau

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Gully erosion represents an important sediment source, and changes in gully volume show the contribution of gully erosion to sediment yield. A valid method to assess gully erosion at a large scale is needed. Based a 3-D scanner and QuickBird images with 0.61 m spatial resolution from 2007 and 2013 in one study areas and from 2004 and 2013 in another study area in the central Loess Plateau, this paper aims to characterize bank gully morphology, identify the factors affecting gully volume, and establish a model for assessing gully volume. The results showed that gully volume ($V$) for 44 bank gullies calculated with a $0.15 \times 0.15$ m digital elevation model was closely related to gully length ($L$) and gully area ($A_g$). The power function between $V$ and $L$ was of the form $V = aL^b$. The high $R^2$ value (0.78) indicated that gully length was a good predictor of gully volume; however, compared with the $V$–$L$ relation, $V$ could be better predicted by $A_g$ by the form $V = 0.2762A_g^{1.3971}$ ($R^2 = 0.91$), which had a lower mean error and higher Nash–Sutcliffe efficiency. The other advantage of the $V$–$A_g$ model is that gully area can be easily measured from

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high-resolution satellite images. Gully erosion on the Loess Plateau of China, accessed with the $V-A_g$ relation and parameters measured from QuickBird imagery, ranged from 0.41 to 36.76 m$^3$ yr$^{-1}$ and averaged 10.32 m$^3$ yr$^{-1}$, which is equivalent to 15480 kg yr$^{-1}$. This study presented a feasible method for assessing gully volume over a large scale with QuickBird images.