Modelling soil erosion on unpaved road surface with process-based model and terrestrial laser scanning

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Unpaved roads are common man-made features that distributed in agricultural or forest watersheds. Road construction will change the underlying topography and alter the surface hydrology, in turn would enhance runoff generation and result in high soil loss risk. Therefore road erosion should be considered as one of the main sediment sources and should be properly evaluated. Process-based erosion models provide efficient tools to precisely evaluate soil loss along unpaved roads. This study was performed using the hillslope version of the Water Erosion Prediction Project (WEPP) to estimate soil loss from 20 typical road segments in the red soil region of South China. The terrestrial laser scanning (TLS)-measured soil losses were used to validate the model simulations. The results showed that the WEPP model could reasonably predict the total soil loss in relatively short (less than 100m) and gentle (slope gradient lower than 10%) road segments. On the contrary, the WEPP simulated soil loss would result in underestimation for long or steep road segments. Detailed WEPP plot outputs along roads revealed that most of the peak soil loss rates cannot be adequately calculated as comparing with the TLS-measured values. The linear critical shear stress theory in WEPP model for soil detachment simulation might responsible for the underestimation of non-linear peaked soil losses in long or steep road segments. Meanwhile, the lack of upslope flow and the curved road tortuosity were also found to be connected to the relatively low efficiency of the model outputs. Nevertheless, the WEPP simulation could accurately fit the detailed trend of soil loss variation along road segment despite the underestimation. Furthermore, the simulated results could provide a reliable prediction of the maximum soil loss positions. Therefore, the WEPP model could be adopted to evaluate erosion risk of unpaved roads in red soil region of China.