Vertical variation of soil erosion resistance in the water-level fluctuation zone of the Three Gorges Reservoir, China

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The operation of the Three Gorges Reservoir (TGR) altered the distribution of the soil properties, the plant community composition and biomass in the water-level fluctuation zone (WLFZ). However, the vertical variation of soil erosion resistance in the WLFZ of the TGR is still unclear and need to be further evaluated. The objectives of this study were to assess the vertical variation of soil resistance to rill erosion in the WLFZ of the TGR and to identify the factors influencing these variations. Soil samples from 150-155 m, 155-160 m, 160-165 m, 165-170 m and 170-175 m were taken along a slope profile at the same time from the WLFZ of the TGR area. All the samples subjected to scour under the combinations of five slope gradients (8.74%, 17.63%, 26.79%, 36.40% and 46.63%) and five flow rates (5, 10, 15, 20 and 25 L min⁻¹) by using a slope-adjustable steel hydraulic flume (4 m length, 0.4 m width, 0.2 m depth). The results showed that soil properties and biomass parameters were affected by the elevations of the WLFZ. The average soil detachment capacity fluctuated with the increase of elevation, maximum and minimum value of which were located at the 165-170 m and 155-160 m, respectively. The soil detachment capacity was significantly negatively correlated with MWD (P<0.05), but not positively correlated with other properties (P>0.05). The rill erodibility also fluctuated with the increase of elevation. Correlation analysis showed that rill erodibility corresponding to runoff shear stress and stream power respectively had significantly negative correlation with MWD (P<0.05), and rill erodibility corresponding to unit energy of water-carrying section had significant negative correlation with MWD (P<0.01). Therefore, the soil aggregate stability was the major factor responsible for the vertical variation in soil erosion resistance. In addition, critical shear stress, critical stream power and critical unit energy of water-carrying section ranged from 1.1950 to 1.6427 Pa, from 0.0132 to 0.3045 N·m⁻¹·s⁻¹ and from 0.0052 to 0.0062 m, respectively, all of them showed obvious fluctuations with the increase of elevation. These research results highlighted the effect of elevation on soil erosion resistance in the WLFZ and provide theoretical guidance for the establishment of soil and water loss prediction model as well as the development of soil and water conservation planning and controlling in the TGR area.

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