EGU24-20133, updated on 18 Jan 2025
https://doi.org/10.5194/egusphere-egu24-20133
EGU General Assembly 2024

Study on the Regulatory Role of Vegetative Measures in the Development of Gravity Erosion

Yunqi Wang[1], Bin Wang[2], and Yujie Wang[3]
[1]Beijing Forestry University, School of Soil and Water Conservation, China (wangyunqi@bjfu.edu.cn)
[2]Beijing Forestry University, School of Soil and Water Conservation, China (wangbin1836@bjfu.edu.cn)
[3]Beijing Forestry University, School of Soil and Water Conservation, China (wyujie@bjfu.edu.cn)

In natural environments, the occurrence of gravity erosion on slopes with vegetation is influenced by various external driving factors. Some are primarily controlled by the water field, such as rainfall infiltration, water level fluctuations, and freeze-thaw cycles, affecting the effective stress of the soil. Others are influenced by external loads transmitted to the soil through plants, affecting the original stress balance conditions, such as self-weight or wind force control. Additionally, extreme physical processes, such as wildfires and subsurface erosion, can degrade the soil strength and reduce the anti-sliding force. The investigations and experiments were conducted in the Chongqing section of the Three Gorges Reservoir Area in China. The triggering mechanisms and development patterns of gravity erosion on vegetated slopes under the influence of multiple factors were summarized from both field surveys and numerical models. Using remote sensing interpretation and numerical simulation, we estimated the potential volume of gravity erosion in the Chongqing section of the Three Gorges Reservoir Area in China. The research results indicate that the triggering factors for gravity erosion induced by rainfall and water level fluctuations are related to the soil entering the saturation process through the structural interface of the upper soil layer. This process leads to a reduction in matrix suction or the occurrence of positive pore water pressure. The essence of this phenomenon is the decrease in effective stress. The long-term instability of the surface soil layer in fire-affected areas is primarily due to the combined effects of root strength degradation and recovery, resulting in the deterioration of the overall shear strength of the soil. Wind disasters causing gravity erosion are attributed to local stress concentration and significant deformation induced by external loads, leading to traction and compression. Building upon the study of gravity erosion triggering mechanisms, the developmental process of gravity erosion was authentically reconstructed using aerial DEM and three-dimensional numerical models. The gravity erosion volume was estimated with a simulation accuracy of up to 92%. Additionally, the estimation of gravity erosion volume was extended to a regional scale, obtaining the potential gravity erosion volume in the Chongqing section of the Three Gorges Reservoir Area, with an estimated accuracy ranging from 35% to 60%. A protective solution utilizing vegetation measures is proposed to address gravity erosion induced by various external factors. For layered forested shallow slopes, consider permeable drainage through structural interfaces to address prolonged rainfall. For steep slopes with high wind exposure, consider the canopy-root plate type of afforestation species. In areas affected by fire disturbance, replanting and maintenance should

be considered before the prone period of landslides. For riverbank slopes experiencing fluctuations in water levels, consider planting regenerative live stakes in the upper-middle part between the alert water level and the normal water level. Activate landslide disaster warnings when water levels drop rapidly.