Karst bare slope soil erosion and soil quality: a simulation case study

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Abstract. The influence on soil erosion by different bedrock bareness ratios, different rainfall intensities, different underground pore fissure degrees and rainfall duration are researched through manual simulation of microrelief characteristics of karst bare slopes and underground karst crack construction in combination with artificial simulation of rainfall experiment. The results show that firstly, when the rainfall intensity is small (30 and 50 mm h⁻¹), no bottom load loss is produced on the surface, and surface runoff, underground runoff and sediment production are increased with the increasing of rainfall intensity. Secondly, surface runoff and sediment production reduced with increased underground pore fissure degree, while underground runoff and sediment production increased. Thirdly, raindrops hit the surface, forming a crust with rainfall duration. The formation of crusts increases surface runoff erosion and reduces soil infiltration rate. This formation also increases surface-runoff-erosion-damaged crust and increased soil seepage rate. Raindrops continued to hit the surface, leading the formation of crust. Soil permeability showed volatility which was from reduction to increases, reduction, and so on. Surface and subsurface runoff were volatile with rainfall duration. Fourthly, when rock bareness ratio is 50 % and rainfall intensities are 30 and 50 mm h⁻¹, runoff is not produced on the surface, and the slope runoff and sediment production present a fluctuating change with increased rock bareness ratio. Fifthly, the correlation degree between the slope runoff and sediment production and all factors are as follows: rainfall intensity-rainfall duration-underground pore fissure degree-bedrock bareness ratio.

1 Introduction

Karst regions have surface and underground double-layer karst structures. A large amount of bedrocks are bared and the soil cover is not continuous. The heterogeneity of karst structure is great due to developed fissures, ponors and underground rivers. A part of water and soil enter the underground rivers along with the fissures and the ponors, so that water and soil loss in karst regions is classified into surface loss and underground soil leak, which have obvious difference compared with that in non-karst regions such as agricultural land reported by Cerdà et al. (2009a, b, 2010) and García-Orenes et al. (2009). In non-karst regions, soil erosion is mainly related to surface cover, slope, and rainfall conditions (Cerdà, 2000; Giménez et al., 2010; Biro et al., 2013; Haregeweyn et al., 2013) and it could be prevented if people take reasonable measures (Haile and Fetene, 2012; Prokop and Poręba, 2012; Mandal and Sharda, 2013). However, due to special geologic structure in karst regions, soil erosion is rather more complicated than that in non-karst regions.

In China, the area of the karst regions can reach 3.463 million km² according to the distribution area of carbonate rocks (including buried karst), 2.06 million km² according to the bared area of strata containing carbonate rocks, and 0.907 million km² according to the bared area of carbonate rocks; the southwest karst region in China is the biggest karst continuous region in the world (Sweeting, 1993). The soil erosion harm of karst mountainous areas is as great as the harm of Loess Plateau areas, so that enhancing the work of water and soil conservation in karst regions and governing the soil erosion of drainage basins are urgent. Nowadays,