Geophysical Research Abstracts
Vol. 21, EGU2019-6516, 2019
EGU General Assembly 2019

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The spatial distribution of soil cover and rock exposure can significantly affect hydrological connectivity and runoff generation as it determines water storage and flow path. Thus quantifying the spatial distribution of soil cover or rock exposure and its relationship to the geomorphological characteristics of a landscape comprises an important challenge in understanding critical zone dynamics. The high mountains of Asia encompassing the Hindu Kush-Himalayas as well as the adjacent Tibetan plateau are characterized by step, rocky outcropping hillslopes. In this study, we adopt the Lhasa River Basin and an alpine hillslope within it as the study area. 341 catchments in the Lhasa River with an average area, proportion of bare rock and terrain slope of 14.4 km2, 17.59 % and 18.9° are randomly selected for derivation of rock exposure index (REI). We find that the strongest linear correlation between REI and the percentage of exposed rock mapped is for the critical slope = 29° (R2 = 0.70). The values of REI are close to 0 when the average slope of the catchments is less than 15°, i.e. slopes larger than 29° in these catchments is basically rare. Moreover, a 47.1 ha, approximately 5000 m asl hillslope is used for studying the transition of soil-rock and the distribution of soil thickness. Soil thickness is measured at 310 sites through digging soil pits (profiles) or drilling borehole by auger. A 1 m resolution LiDAR-derived DEM is adopted to determine the topographic attributes. We find 10.3% of the hillslope is covered by rock, and it outcrops at sites with relatively higher gradient and the percent of which is over 94.0% with slope > 29° for all the rock pixels. We also find that soil cover become thinner as elevation rising or slope steepening. On soil mantled areas, a strong linear relationship (R2>0.50) between soil thickness and topographic index can be observed for most conditions. The datasets and spatial distribution of soil thickness on the steep hillslopes can enable improved mapping of soil cover and rock outcrop in the 3rd pole.