Understanding Hydrological Connectivity using Spatiotemporal Patterns of Soil Moisture in Lesser Himalayan Hillslopes

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Hydrologic connectivity has been stated as the qualitative assessment of spatial variability of soil water content on hillslopes. Micro-topographic conditions i.e. slope and vegetation has a significant influence on the hillslope connectivity, however, longer a hillslope, the re-infiltration process disturbs the hydrologic connectivity. Thus a fine resolution (0.5 m) digital elevation model (DEM) for accurate interpretation of terrain conditions has been developed for two lesser Himalayan hillslopes. Moreover, ten soil moisture sensors and an HS flume with water level recorder were installed on both the hillslopes to record the dynamics of soil moisture and hillslope runoff. To understand the influence of rainfall dynamics (i.e, intensity and duration) on soil moisture response, hillslope hydrological connectivity and surface runoff, detailed analysis of eight rainfall-runoff events having rainfall intensity 12 mm/hr to 106 mm/hr will be presented. In-situ soil hydraulic conductivity experiments data at 4x4 m grid in conjunction with soil moisture dataset is used to identify the hydrologically active areas under different rainfall conditions. Soil hydraulic conductivity varies between 6 mm/hr to 24 mm/hr. Event analysis showed that the major portion of runoff gets infiltrated into the soil surface even during the extreme rainfall events resulting to a very low runoff coefficient (<10%). However, during a low rainfall intensity event, the re-infiltration process was observed which interrupt the link of hydrological connectivity, especially in grass-covered hillslope. The process of re-infiltration is more active in dense vegetation and low gradient conditions. Hillslope areas with low hydraulic conductivity generated quick runoff in comparison to high conductivity areas. During an extreme rainfall event (10/07/2017), the major runoff contributing area after an hour of rainfall is up to 78% where the volumetric soil moisture was in between 0.215 to 0.338 m^3/m^3. The maximum rainfall intensity during that time frame was 79 mm/hr which was higher than the hillslope hydraulic conductivity values resulting 3% runoff at the outlet of the hillslope. Further, it was noticed that only lower and middle portion of hillslope were generated runoff at the beginning phase of the storm. This study explained the combined effect of slope, vegetation and hydraulic conductivity on hillslope hydrological connectivity.

Keywords: Lesser Himalaya, soil moisture dynamics, hydrological connectivity

