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Multiscale soil moisture measurement for mapping surface runoff generation on torrential headwater catchments (Draix-Bléone field observatory, South Alps, France)

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Runoff generation in the headwater catchments in various land use conditions still remain a core issue in catchment hydrology (Uhlenbrook S. et al., 2003). Vegetation has a strong impact on flows distribution (interception, infiltration, evapotranspiration, runoff) but the relative influence of these mechanisms according to geomorphological determinants is still not totally understood. The "ORE Draix" located in the Alpes-de-Haute-Provence (France) allows to study these parameters using experimental watersheds equipped with a long term monitoring instrumentation (rainfall, streamflow, water, soil and air temperature, soil erosion, soil moisture...). These marl torrential watersheds have a peculiar hydrological behavior during flood events with large outflow differences between the wooded and the bare areas. We try to identify the runoff production factors by studying water storage/drainage processes within the first 30 cm depth of soil (Wilson et al., 2003, Western et al., 2004). Soil moisture can explain runoff during floods, that's why we try to upscale this variable at the watershed level. Unlike studies on soil moisture monitoring in agricultural context (flat areas), conventional remote sensing methods are difficult to apply to the badlands (elevation between 1500 masl and 1800 masl, approximately 1km^2 areas, steep slopes, various land uses) (Bagdhadi, 2005). This difficulty can be overcome by measuring soil moisture at different spatial (point, plot, slope, catchment) and time scales (event, season, year) using innovative approaches. In this context, we propose a monitoring of soil moisture based on geostatistical treatments crossed with measurements at different scales. These measures are provided from ground and airborne sensors deployment. Point measurements are ensured at a very high time frequency using capacitance probes. At an intermediate level, a slope is equipped with a DTS sensor (distributed temperature sensing) to obtain a 2D estimate of soilwater flow of from the surface to - 30 cm. Another distributed approach will be carried out from a measurement of cosmic neutrons mitigation (Cosmic ray sensor) to estimate a soil moisture averaged value over 40 ha (Zreda et al., 2012). Finally, the smallest scale (slope and catchment) will be approached using remote sensing with a drone and/or satellite imagery (IR, passive and active microwave). This concatenation of scales with different combinations of time steps should enable us to better understand the hydrological dynamics in torrential environments. It aims at mapping the stormflow generation on a catchment at the flood scale and defining the main determinants of surface runoff. These results may contribute to the improvement of runoff simulation and flood prediction.

References :

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