



Flowlength, a new spatial metric for measuring the connectivity of runoff-source areas in drylands considering vegetation pattern and topography

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The connectivity of runoff-source areas is considered one of the main factors controlling surface runoff and sediment yield in patchy vegetated landscapes. In this work, we derived and tested a simple spatial metric, Flowlength, for quantifying the connectivity of runoff-source areas in sparsely vegetated hillslopes using vegetation pattern and topography. We designed Flowlength to be sensitive to plant cover and spatial pattern, surface rugosity, and slope angle, which are key determinants of surface water and sediment fluxes, particularly in drylands. Flowlength is derived from raster-based maps obtained either from field-survey maps or from aerial photography, and thus can be applied to assess connectivity at various spatial extents. From binary maps with pixels classified as runoff-source and runoff-sink areas, Flowlength is calculated as the average of the maximum potential length of the runoff path from each cell. The direction of the flowpaths is determined from digital elevation models overlying the binary maps. A higher value of Flowlength indicates a higher average length of the runoff pathway and therefore a higher hydrological connectivity. Thus, Flowlength provides quantitative information about the actual spatial connectivity of runoff-source areas, without comparing with baseline or reference conditions. We tested the sensitivity of Flowlength to different spatial patterns of runoff-sources and runoff-sinks and its relationships with runoff and sediment yields measured on 6 plots and 3 catchments in a semiarid grassland-shrubland landscape in semiarid Southeast Spain. Flowlength distinguished between varying degrees of connectivity from vegetation patterns with

similar vegetation cover. The connectivity increased with the grain size of the spatial pattern of the runoff-source areas (bare soils) in the study plots and was positively related to plot runoff and sediment yields. Flowlength also correctly ranked the three catchments accordingly to total runoff yielded during the study period. The contribution of the microtopography to the quantification of the connectivity of runoff sources improved the relationships between Flowlength and the measured fluxes, highlighting the importance of topographic features in the connectivity of surface flows. In general, the microtopography had a net decreasing effect on the connectivity, which was mainly attributed to an increase in the amount of runoff-sink areas caused by the sediment terracettes developed upslope the plants. Our results demonstrated the applicability of Flowlength for quantifying the connectivity of runoff sources and its potential for assessing runoff and sediment losses in semiarid landscapes.