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A network theory approach for a better understanding of overland flow connectivity

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Hydrological connectivity describes the physical coupling, or linkages of different elements within a landscape regarding (sub)surface flows. A firm understanding of hydrological connectivity is important for catchment management applications, for e.g. habitat and species protection, and for flood resistance and resilience improvement. Thinking about (geomorphological) systems as networks can lead to new insights, which has been recognised within the scientific community as well, seeing the recent increase in the use of network (graph) theory within the geosciences. Network theory supports the analysis and understanding of complex systems by providing data structures for modelling objects and their linkages, and a versatile toolbox to quantitatively appraise network structure and properties. The objective of this study was to characterise overland flow connectivity dynamics on hillslopes in a humid sub-Mediterranean environment by using a combination of high-resolution digital-terrain models, overland flow sensors and a network approach. Results showed that there are significant differences between overland flow on agricultural areas and semi-natural shrubs areas. Positive correlations between connectivity and precipitation characteristics were found, while negative correlations between connectivity and soil moisture were found, probably due to soil water repellency. The combination of a structural network to determine potential connectivity with dynamic networks to determine the actual connectivity proved a powerful tool in analysing overland flow connectivity.