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Hydrological connectivity of upland-riparian zones in agricultural catchments: implications for runoff generation and nitrate transport

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In this paper we address the issue of *hydrological connectivity* between discrete units of the landscape, notably, upland and riparian zones, and its implication for runoff generation and chemical transport. We present results based on a field experiment carried in Susannah Brook catchment in Western Australia, during which measurements of relevant physical and chemical parameters were carried out using a sampling strategy that enabled us to capture the complete cycle of hydrological connection and disconnection over the entire hillslope, and over a whole year. The results show that the upland and riparian zones respond to rainfall events almost independently and differently, and remain disconnected from each other for much of the year. During a 2-3 month period in mid-winter, however, a shallow groundwater system becomes established all the way across the hillslope, providing a direct hydrological connection between the two zones, enabling not only down-slope transport of fresh water but also nitrates that had previously accumulated in the upland zone through fertiliser application. Associated with the establishment of connectivity is a sharp increase in the hydraulic gradient that drives shallow subsurface flow to the stream. These results have important implications for the modeling of runoff generation and nutrient export. The lack of connectivity for much of the year precludes the use of traditional models that assume that the shallow subsurface flow system is connected all the way up the slope, and that hydraulic gradient is equal to local topographic gradient. Our findings relating to hydrological connectivity also have important ramifications for the modelling of Cl^- and NO_3^- transport and export. The complex internal dynamics of flow,

transport and reaction, and their dependence on hydraulic connectivity, must be explicitly captured if we are to develop predictive models that remain accurate as well as internally consistent.