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Tracers and GIS as integrating tools to conceptualise hydrological functioning in ungauged basins

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Process conceptualization in sparsely gauged and ungauged mesoscale basins requires tools that aid understanding of hydrological functioning at scales larger than those suited to traditional intensive hillslope investigations. Well-planned and carefully executed tracer studies - when used in conjunction with GIS-based analysis of hydrologically significant landscape features (eg soils, topography, geology, land use etc) - can provide a rapid and effective means of gaining insight into the hydrological response and internal functioning of catchments. This paper will present the findings of one such study in the sparsely gauged 31km2 Girnock catchment in the Cairngorm mountains of Scotland. Tracers (Gran alkalinity and ä18O values) were used to identify dominant runoff sources and assess mean residence times at the catchment outfall and in 8 nested sub-catchments. The GIS was used to identify the dominant landscape controls on this hydrological function. In particular, digital soil maps, derived from the UK HOST (Hydrology Of Soil Type) database - in combination with a topographic index - were found to provide an effective conceptual understanding of cachment hydrological functioning that was consistent with the tracer data. Tracer-based assessment showed that low (<30%) groundwater contribution to annual runoff and short (<0.4 yr-1) mean residence times were observed at all scales within the Girnock catchment. This was consistent with the dominant coverage of responsive, acidic peaty soils (peaty gleys and peats) that generate large volumes of acidic, saturation-excess overland flow that dominates storm period response at all scales. Storm runoff appears to be generated from extensive saturated areas that expand during hydrological events and pro-

vide a high degree of hydrological connectivity between catchment hillslopes and the stream channel network. In contrast, low flows within the catchment exhibit a highly variable chemistry which is determined by sub-catchment geology and a wide range of complex flow paths with longer residence times. The paper will argue that combining tracers and GIS analysis of catchment characteristics can provide a much more rapid and efficient insight into the hydrological functioning at larger spatial scales than traditional hydrometric monitoring and has largely untapped potential to help underpin modelling studies and management decisions in sparsely gauged basins.