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Temporary streams in a peatland catchment: the pattern and timing of stream network expansion and contraction and controls on these

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Intermittent and ephemeral streams have been observed in a variety of environments as the perennial stream network expands into headwater reaches. One environment where these variations in network extent have been observed are peatlands. Here, baseflows are often so poorly maintained due to the limited amount of seepage available that many small streams dry up completely, particularly during the dry season. This network expansion and contraction results in large changes in drainage density and as such, has implications for the connectivity of the catchment and the associated flux of water, sediments and solutes.

It is hitherto been difficult to quantify ephemeral streamflow due to the logistical difficulties of monitoring this phenomenon. Recently, Electrical Resistance (ER) technology has been harnessed to create inexpensive sensors capable of detecting the presence and absence of flow in ephemeral portions of the channel. Networks of these sensors are used here to provide high resolution data on the patterns of network variation in a peatland catchment.

The study took places in the Upper North Grain research catchment, a small peatland headwater catchment in the south Pennines, UK. Networks of around 40 sensors were deployed in autumn 2007 and summer 2008, giving a total of almost 4 months of high-resolution monitoring data. This allows us to characterise the timing and pattern of network expansion and contraction, and examine the key controls on these.

It was found that one of the key factors determining the presence or absence of streams was water table measured at the catchment weather station. It is thought that water table at each site varies in line with this, suggesting that the occurrence of flow at each site is strongly controlled by local water table. This allows us to model how network extent varies with water table. It was found that when water tables fall below 180 mm, flow in ephemeral channels is completely absent, being restricted to the perennial channel network. This represents a drainage density of 1.41 km/km2 and occurs around 13% of the time. Complete connectivity of the fully expanded network is not achieved until water tables are within 3 mm of the surface, which occurs 39% of the time. This represents a drainage density is 29.98 km/km2. When compared to the drainage density of the perennial channel network, this represents an increase of over 2,000%, illustrating the dramatic differences in connectivity which can occur within the catchment. For the remaining 48% of the time the extent of the network varies between these two extremes, highlighting the dynamic nature of network extent within the catchment.