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Evaluating water table variability and behaviour across a blanket peat landscape

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Blanket peats represent a dominant landscape type in the uplands of Britain. The hydrological status of blanket peat influences a wide range of peatland functions, with peatland water tables controlling factors such as runoff generation, water quality, vegetation distribution and rates of carbon sequestration. Water table status is therefore a crucial attribute of blanket peat systems and a key parameter in models of, for example, peatland carbon balance or the response of runoff regimes to climate change. Spatial variability in water table conditions can be substantial at both the local (site) and landscape scale. However, most studies which measure peatland water table conditions use a restricted number of data points and are often based on continuous (temporal) monitoring of water tables at one or more individual dipwells which are then assumed to represent wider landscape conditions. This paper reports on an extensive survey in 2008/09 of water table conditions across the blanket peat landscape of the Peak District National Park, UK (53.27.58N, 1.51.09W) which is affected by extensive gully erosion. The survey involved regular measurement of water table depth in over 530 dipwells at sites across a 47 km2 landscape and had two key aims: (i) to evaluate spatial variability on water table conditions at both the site and landscape scales and (ii) to evaluate temporal water table behaviour at peatland sites with different topographic conditions and erosion status.

A pilot study was used to analyse within-site variability in water table, where site is defined as a 30 x 30 m area of blanket peatland. Forty one dipwells were randomly located within a 30 x 30 m area and manually measured for water table depth. Stochastic simulations were used to estimate uncertainty in the calculation of mean and standard deviation in site water table depth and to determine the number of dipwells required to reliably quantify water table conditions at the site scale. Variability at the site scale was high, and the simulations indicated that at least 15 dipwells are required at each site. In the main study, twelve sites were selected along a topographic gradient, represented by the widely used topographic (wetness) index. The survey included (i) a campaign of regular, simultaneous, manual water table measurements from clusters of 15 randomly located dipwells at each site and (ii) continuous (hourly) logging of water tables in a single dipwell at each site. There is substantial between-site variation in average water table conditions across the landscape, with median water table varying from 26 to 451 mm. This variation is strongly associated with site topography and the proximity of erosion gullies. Distinct patterns of temporal water table behaviour are also apparent between sites with different topographic conditions and erosion status. These spatio-temporal patterns in water table depth demonstrate the very different hydrological behaviours of eroded and intact peats, with clear implications for the hydrological functioning of the peatland. The study emphasizes the need for landscape-scale assessment of peatland water table conditions, including appropriate sampling frameworks which take into account local site-scale variability and allow the integration of spatial and temporal data.