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Geomorphological control of water tables in a blanket peat landscape: implications for carbon cycling

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Water tables are an important control on carbon cycling and rates of carbon sequestration in peatland systems, and water table depth is therefore a key parameter in carbon models for blanket peat systems. Although there is a wide literature on blanket peat hydrology, including studies which specifically evaluate water table conditions, detailed data on water table behaviour and variability at the landscape scale are sparse. In particular, many British blanket peats are affected by gully erosion and this has been generally assumed to influence water table conditions. However, there has been limited evaluation of this geomomorphological control on peatland water tables. This paper presents results from a project which evaluated water table conditions in the blanket peatlands of the Peak District National Park, UK. A key aim was to quantify the impact of gully erosion on peatland water tables. A detailed programme of water table monitoring was undertaken during 2008/09, involving regular measurements of water table depth in over 530 dipwells at 19 sites across the 47 km2 peatland landscape of the Kinder Scout / Bleaklow area. This included a campaign of regular, simultaneous water table measurements from clusters of dipwells at the main sites, supplemented by continuous (hourly) water table monitoring in selected dipwells. It also included studies to evaluate within-site variation in water table conditions and local water table drawdown effects associated with gully erosion.

Results indicate that gully erosion causes water table drawdown through two distinct processes. The first is local water table drawdown immediately adjacent to erosion gullies. This effect is restricted to a zone within 2 m of gully edges, and water tables within the gully edge drawdown zone are approximately 200 mm lower than in the adjacent peatland. The second effect is a more general water table lowering at eroded sites, with median water table depths at heavily eroded sites up to 300 mm lower than intact sites. This site-scale effect is hypothesised to result from reduced hydrological contributing areas (drainage areas) at eroded sites, with hillslope drainage diverted into gully channels. Distinct patterns of temporal water table behaviour are apparent between intact and heavily eroded locations. At intact locations water tables are predominantly close to the ground surface, except during periods of dry weather when a pattern of gradual water table drawdown occurs. Water tables rise rapidly following rainfall. This behaviour is characteristic of intact blanket peats in other regions. Water table behaviour at heavily eroded locations is very different, characterised by predominantly low water table conditions with 'wet-up' responses to rainfall, i.e. very rapid rises in water table followed immediately by rapid drain-down after the cessation of rainfall. These spatio-temporal patterns in water tables conditions demonstrate the very different hydrological behaviours of eroded and intact peats. In this eroded peatland landscape there is strong geomorphological control on water table conditions. Implications for both the hydrological functioning of the peatland and the carbon cycle are discussed.