Trajectories of water table recovery following re-vegetation of bare peat

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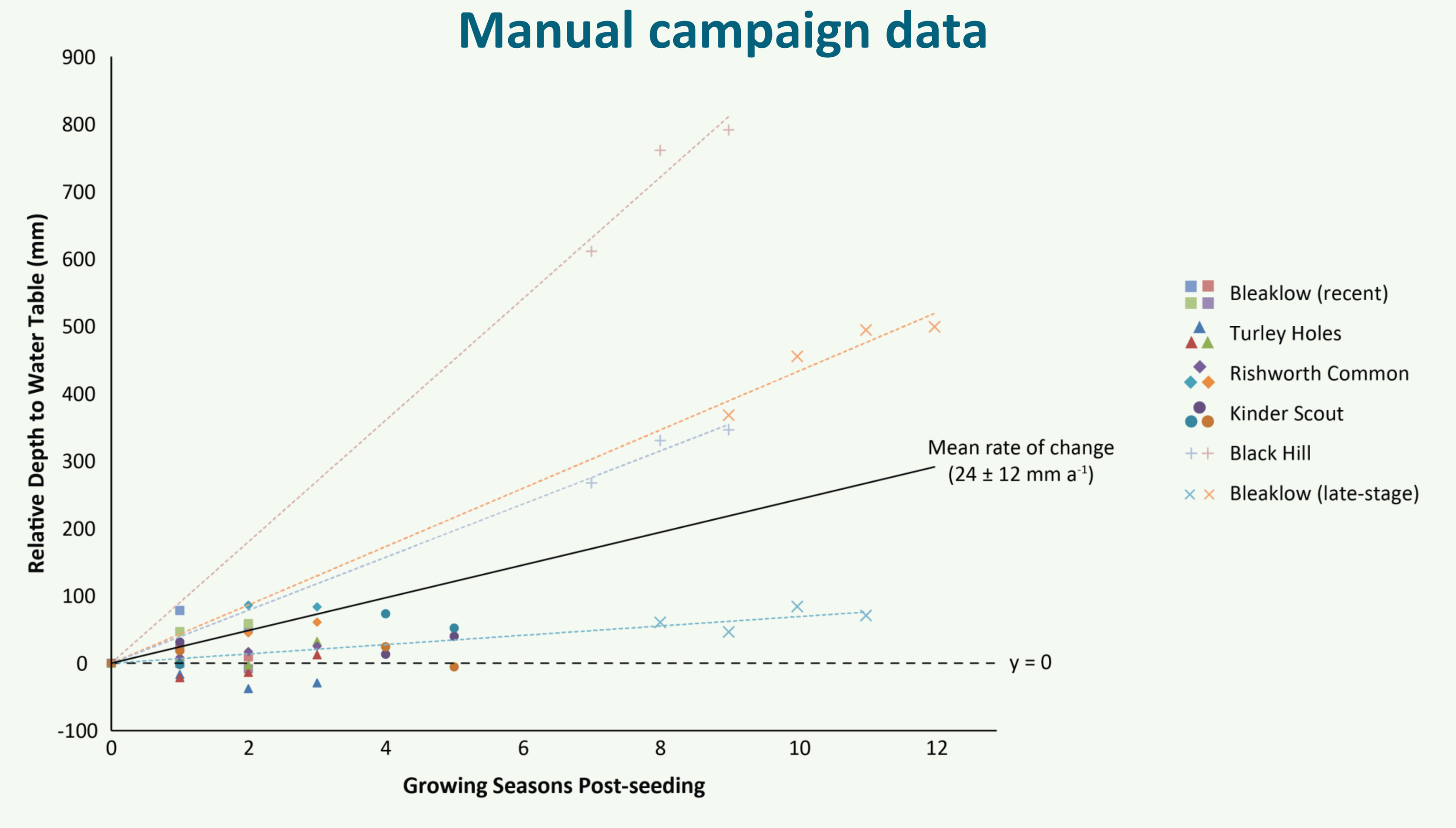
Over the last 13 years, major landscape scale restoration has been undertaken in the eroded peatlands of the Southern Pennines. The ‘Peak District Prescription’, consisting of aerial seeding of utility grass, together with brashing, liming and fertiliser application, has been applied over extensive areas of bare peat. Although the **re-vegetation does not explicitly target water table modification**, the dramatic change in surface cover has the potential to alter surface water exchange and transfer processes, and these changes to the water balance of a site **may impact water table behaviour**.

This analysis is based on water table datasets collected by the Moors for the Future Partnership between 2010 and 2015 from six peatland restoration sites of varying ages across the South Pennines. Two types of data were available: (1) **Manual campaigns** of weekly or fortnightly measurements at clusters of 15 dipwells throughout Autumn (September-December); (2) **Automated data** from single dipwells based on trutrack capacitance probe readings.

Data has been normalised so that the water table changes are relative to the pre-restoration condition, i.e. at the time of restoration the deviation is zero. The dotted lines on the plots linking the late stage data to the origin indicate this assumption.

Water Table Recovery Trajectories

Manual campaign data

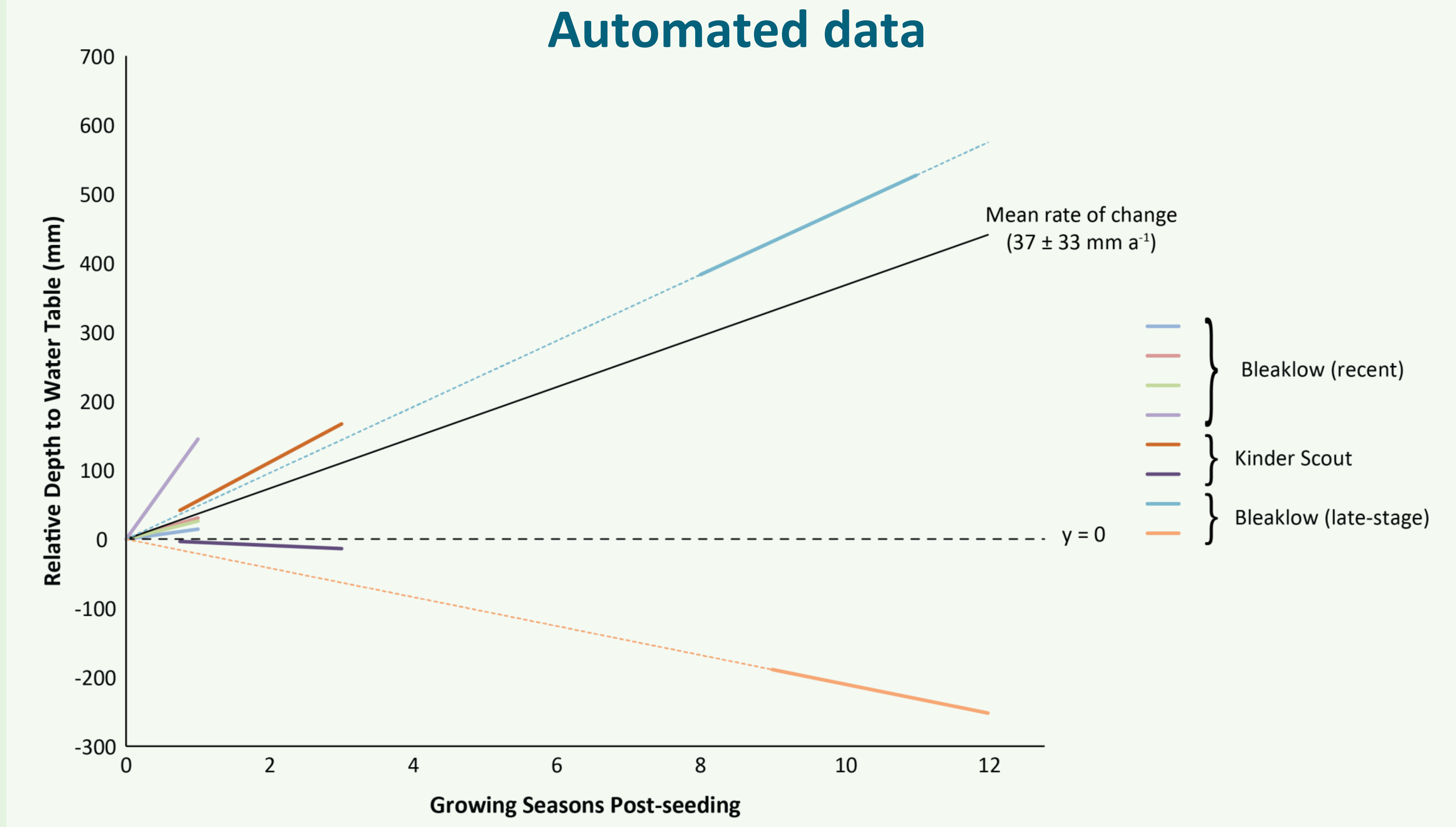


14 of the 17 sites show an increase in relative depth to water table.

Rates of change range from -14 to 83 mm a^{-1}, with a mean of 24 mm a^{-1}.

Average rate of change for late stage restoration (38mm a^{-1}) exceeds that for early stage (20 mm a^{-1}) but the sample sizes are small and these findings should be treated with caution.

Automated data



6 of the 8 sites show an increase in relative depth to water table.

Rates of change range from -21 to 145 mm a^{-1}, with a mean of 37 mm a^{-1}.

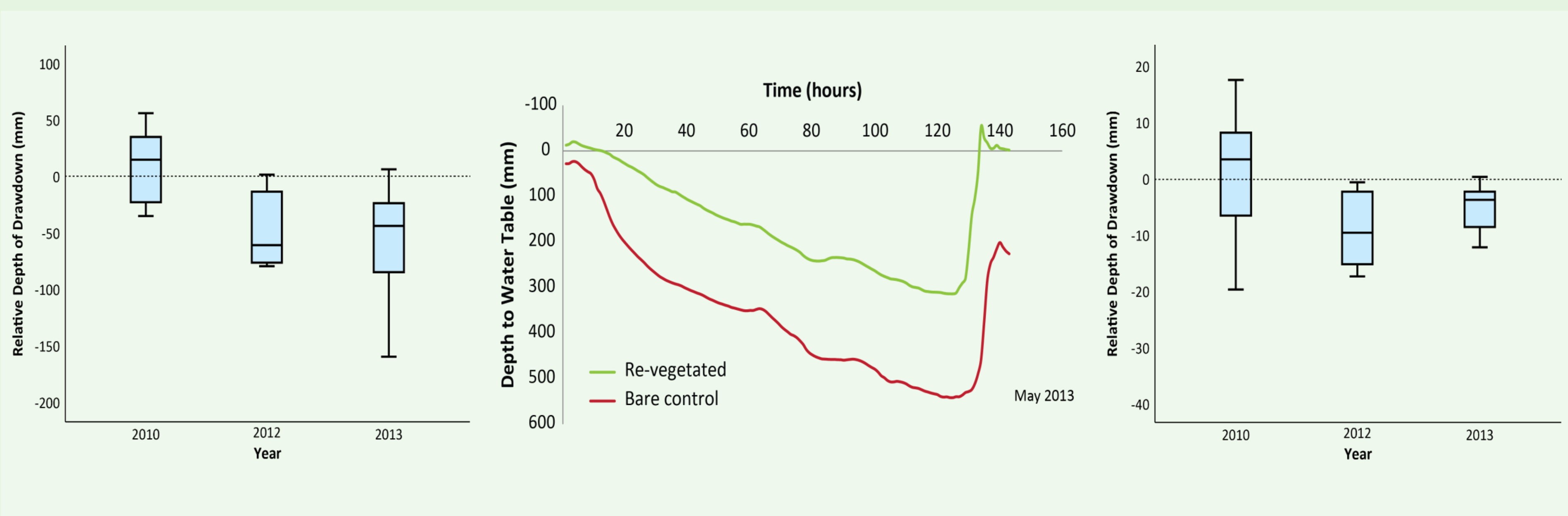
This is considerably (~50%) higher than the mean rate of the manual campaign, but the 95% CIs for the different methods overlap, and 75% of the automated data falls within the range of the manual data.

Water Table Drawdown Behaviour

Drawdown occurs during dry periods. It is controlled by evapotranspiration and lateral drainage, which is in turn controlled by the hydraulic conductivity and macropore structure of the peat. If restoration is producing long term recovery in peat structure this should be apparent in drawdown behaviour.

Kinder Scout sites were used to investigate drawdown as they had the cleanest continuous datasets.

Individual drawdown events were identified in the records and two parameters extracted: (i) depth of drawdown, and (ii) rate of drawdown.



Prior to restoration (2010) there was little difference between the drawdown behaviours at the two sites.

After restoration there was an apparent shift in behaviour, with the restored site showing *consistently* less deep and less rapid drawdown in response to periods of dry weather.

Comparison of the 2010 data with the 2013 data shows a significant difference in drawdown depth (P = 0.026) but not in rate (P = 0.083). However, evidence of consistently slower drawdown following re-vegetation is clear.

Key Findings

Methodological

The manual dipwell data appears to provide a robust and reliable approach to monitoring water table recovery.

Calibration is a critical issue for continuous data.

High resolution data has the potential to demonstrate changes in water table dynamics indicative of hydrological recovery in the restored peatlands.

Water Table Recovery

Water tables are raised relative to bare peat control sites post re-vegetation.

Recovery is ongoing (evident up to 12 years post re-vegetation), but rates are small (~24 mm a^{-1}) and highly variable.

However, over longer time scales (10+ years) the cumulative changes in water table are relevant in terms of peatland function.

Rate and depth of drawdown are reduced post re-vegetation indicating recovery of peat structure and improved hydrological integrity.

Peatlands are likely to be under significant moisture stress in the future (Clark *et al.,* 2010), so this shift in drawdown behaviour is an important component of understanding the resilience of restored systems to climate change.

Long term monitoring of restored peatland water tables is crucial to provide increased confidence in these results – particularly continued monitoring of recently re-vegetated sites to confirm to ongoing recovery inferred from older restoration sites.