The importance of topographic controls on groundwater recharge for plantation forestry in southeast Australia

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ABSTRACT
The trade off between water use and carbon sequestration by plantation forestry is the subject of ongoing debate in Australia. Many tree plantations are planted without consideration for their impact on groundwater recharge. The spatial variation of recharge across a landscape can provide useful information on where to best situate a plantation while minimising its impact on groundwater recharge.

Recharge is generally assumed to take place at topographic high points across a landscape, especially when rocky outcrops occur. This study analysed recharge rates at several points across a small paired catchment site to determine the most prevalent areas of recharge. Water-table fluctuations, Cl^- mass balances, tritium and ^{14}C ages were used to estimate recharge at 23 points across a 0.8 km^2 catchment covered predominantly in a blue gum tree plantation, and an adjacent 0.5 km^2 pasture catchment, in southwest Victoria, Australia. The Cl^- mass balance method and water-table fluctuation methods were modified to better reflect the recharge processes taking place at the study site, including longer term hydrograph fluctuations and input from streams.

Hydrographs from data loggers (since 2009) in bores situated close to the drainage line show considerably more recharge taking place compared to bores situated further upslope. Cl^- mass balances show a similar trend, as do the hydrographs for the past 20-30 years, indicating that the majority of recharge is occurring along the drainage lines and towards the bottom of the slopes. Hydrograph fluctuations from these areas of the study site also often show significant response to runoff, measured at weirs on both catchments. Fracture heterogeneity contributes to some of the recharge variations, but the general trend is for recharge to occur more consistently in the topographically lower areas.

In order to minimise the interception of groundwater recharge by tree plantations in regions similar to the study area, the bulk of the plantation should be situated on the upper slopes, away from drainage lines and the immediately adjacent slopes. This would have less of an effect on the groundwater levels, as the plantation is not intercepting recharge in the zones where the majority of infiltration is occurring.