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A two-staged modelling approach to predict the effects of reforestation on stream flow and salinity

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Forest clearing in many parts of Australia has lead to increased groundwater recharge and ensuing discharge of saline groundwater to the surface. Returning forests has the potential to reduce salt discharge. It also has other potential environmental benefits as well as disbenefits. In particular, forests reduce recharge by virtue of their higher water use, and therefore any reduction in catchment salt yield will be associated with a reduction in water yield. If afforestation is to produce a net reduction in stream salt concentrations, the former has to outweigh the latter.

Ways of maximising the environmental and commercial benefits of forestry in medium rainfall areas (500-800 mm y^{-1}) are presently under investigation, with an initial focus on the 3,742 km^2 Southwest Goulburn catchment in Victoria, Australia. We used a two-staged model analysis, consisting of (1) 'screening' to identify broad areas (of 10 km^2 or more in size) where net reductions in stream salinity may be achievable; followed by (2) hillslope scale modelling within selected broad areas to compare the relative benefits of afforestation at alternative locations and in different spatial arrangements. In the screening stage we used a partially conceptual model (BC2C model, Dawes et al., 2004), based on dimensional arguments and the topographic and geohydrologic attributes of small subcatchments ($\sim$10 km^2). At the finer level of individual hillslopes, we used a semi-distributed framework (FLUSH, Gallant et al., 2004) to interface a one-dimensional forest growth and hydrology model with a conceptual geohydrological model. In both modelling approaches, we used regression analyses between climate, satellite-based land use data, salinity in $\sim$2000 bores, 8 broad geohydrological units, topography, and stream flow and salinity data for 37 subcatchments to derive model parameterisations.

The main factors determining the trade-off between salt and water were rainfall, geol-

ogy, and topography. Overall, the results emphasised the importance of careful targeting if environmental benefits are to be achieved. There appeared to be substantial areas with stream benefits as well as commercial growth rates, and modelling was valuable in identifying these.

Uncertainty in the magnitude and spatial variation of the predicted impacts decreases as afforestation becomes more substantial and widespread. Predictions for scenarios in which only small, localised areas are planted have high uncertainty attached, primarily because of the typically high but unquantified local heterogeneity in soil hydrologic and groundwater behaviour, and groundwater salinity. This can only partially be remedied by using (semi-) distributed models (being equally limited by the availability of spatial data), but the two-staged modelling approach followed does make cost-effective spatial data collection for selected areas more feasible.