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Water Use Dynamics in Disturbed Australian Montane Forests

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High country forests in Australia yield most of the water and support much of the agricultural wealth and water supply to major cities, towns, and industry. The project focuses on the Cotter Catchment to the west of Canberra where many of the forest stands were severely burnt in 2003. This resulted in large-scale regeneration of forests of between 700 to 1400 m elevations.
Forest disturbance by fire results in changes to rainfall interception and transpiration rates. Numerous studies have confirmed the significant differences in the transpiration/stand age relationships that results in enhanced regrowth water use relative to mature stands, evidencing long-term changes in the water yield when compared with pre-disturbance levels. With rising temperatures and more frequent bushfires, accurate bio-hydrological models are required and without such models water supply agencies and catchment managers are exposed to economic, social and environmental risks. Understanding fundamental processes and controls of vegetation water use is crucial for meaningful quantification of water yield while such dynamics are often overlooked in hydrological simulations. In Australia, forests display a variety of survival adaptations to fire; mainly categorized as those regenerating from the seeds or regrowing from the base of the trunk. In this study we investigated water uptake and physiological controls of water use dynamics for species from both categories, and affected by fire. Accordingly, we observed transpiration and soil moisture regimes in burnt and unburnt plots and compared how different species regulate forest water yield differently in similar environmental conditions.
Here we report measurements of tree water use, soil moisture, climatic factors (e.g. temperature, relative humidity, photosynthetically active radiation) over more than 400 days. Changes in leaf conductance with age have been suggested as an additional control on stream flow as leaf development and senescence influence tree water use. However, little is known about stomatal anatomy and physiology for the vast majority of eucalypts that cover Australia's catchments. Thus we measured leaf conductance and physiology of three dominant tree species, under burnt and unburnt conditions.
Our results can be applied to establish new stand age-structure-evapotranspiration relationships in Australian mixed-species forests. Future focus will be on determining the particular role of different forest stands to the catchment response after disturbance. This facilitates better quantification of predominant hydrological and eco-physiological drivers regulating inflows to water reservoirs of the Australian Capital Territory.