Can we use state and transition models to add dynamism to fire risk and behaviour models?

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Abstract: Fire risk and fire behaviour models have long assumed static fuel profiles: fuels reaccumulate post-disturbance to an equilibrium value following the Olson curve (Olson, 1963). However, fuel load is not the only vegetation-related predictor of fire behaviour and does not always follow Olsen accumulation patterns, and, perhaps more importantly such static models are unable to represent the dynamic changes to ecosystems that are likely under climate change. One approach for modelling and mapping ecosystems dynamically is using State and Transition Simulation Models (STSMs; Daniel et al., 2016), a spatially-explicit parameterisation of state and transition conceptual models (S&TMs; Westoby et al., 1989), that has been widely applied in the United States . S&TMs, or similar models with the same underpinning theory, have been utilised by Australian ecologists and practitioners for over 50 years. Many such models exist but few have been parameterised to make spatially explicit predictions of the extent and change of different vegetation types in Australia.

We outline an approach for using STSMs to model fuels and fire risk at both landscape and continental scales. This involves (a) identifying important expressions of ecosystem dynamics (e.g. frequently burnt savanna or structurally mature forest) and pathways between them (e.g. succession), (b) identifying anthropogenic drivers of change (e.g. reference or altered fuel structure) and drivers of transitions between states (e.g. fire exclusion) for an ecosystem type, (c) locating existing states and expressions in the landscape using remote sensing variables, and (d) using existing abiotic and biophysical models (e.g., fire behaviour, climate change, and plant growth) to understand how rates of change along these pathways might be altered by climate change interacting with land management. We then discuss two case studies of the landscape-scale approach: one in Tasmanian wet eucalypt forest, and one in tropical savanna in central Arnhem Land, providing preliminary results and indicating how this approach fits into a national state and transition modelling framework. We examine how this approach could create ecologically meaningful, dynamic maps of fuels that will be compatible with modern fire risk and behaviour modelling efforts, contributing to a nationally consistent map of fuels and fire risk through inclusion in the Australian Fire Danger Rating System (AFDRS) and inform natural asset protection.

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