

Scenario simulation modelling for future states of Australian socioecological landscapes

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Abstract: Decision-making for sustainable and resilient landscapes requires tools that can engage with complexity, accommodate uncertainty, and support structured exploration of plausible futures. We share insights from the development and application of a regional-scale state-and-transition simulation model (STSM) designed for a case study in regional NSW, Australia. The model integrates diverse land use types – agriculture, eucalypt woodlands, rivers, and wetlands – in the NSW southwestern slopes bioregion. It was co-produced by expert elicitation, with local NRM organisations, scientists, agronomists, and local landowners/managers, to assess how alternative management strategies and external pressures could affect long-term landscape condition and function. We particularly asked participants to identify drivers of change that were system-level, i.e., underlying drivers, such as a desire for cleared agricultural land and the motivations behind that, rather than an ecological description like “land clearing”. Assumptions from scenario narratives developed with stakeholders were used to modify baseline model parameters to explore long-term landscape futures. STSMs, when grounded in participatory and systems-based approaches, offer a framework for decision support. They allow for transparent representation of uncertainty, support transdisciplinary integration, and facilitate dialogue through scenario exploration. The model encodes qualitative knowledge, such as expert elicitation of transition drivers, and enables adaptive iteration as knowledge, goals, or policy contexts shift. This work identifies lessons for decision support: the importance of co-design and place-based knowledges, and the value of simulation for exploration and as a boundary object for discussion, rather than solely a prediction engine.

Keywords: *State-and-transition models, scenario modelling, spatial modelling, decision support.*