

Embedding public health in environmental stewardship: lessons from participatory landscape modelling in central New South Wales, Australia

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Abstract: Landscape management decisions are often made without a clear view of how human health and well-being is affected by transitions in land cover, land use, and management. Ecological and environmental interactions influence a variety of health risks in landscape ecosystems. Because these pathways intersect with structural determinants (remoteness, service access, income, housing, governance, culture), the same change can impose unequal burdens across communities. Therefore, integrating health and equity into landscape decisions is essential. The aim of this study was to develop a decision-support approach that couples State and Transition Models (STMs) with participatory scenario design to identify health outcomes and practical levers in a mixed-use region of south-eastern Australia.

Two workshops were held in 2023–2024 to bring together ecologists, agronomists and local landholders to co-design these STMs through expert elicitation for four interconnected landscape ecosystems: agriculture, eucalypt woodlands, wetlands, and rivers. The goal was to collaboratively develop models and positive future scenarios. The drivers elicited in these workshops were synthesised into ecological, climatic, social and governance domains. Health-related observations, such as blackwater events, degraded drinking water, and livestock mortality, were treated as sentinel indicators rather than causes. Using this data, we conducted a secondary health-centred analysis using a deductive-inductive coding approach and systems analysis to trace how drivers linked to health outcomes and identify leverage points for action.

Health-related drivers included drought, floods (including blackwater events), fire-regime change and salinisation. Social and demographic drivers included water-allocation conflict, price volatility and shifting landholder values across generations. These drivers created exposure pathways to water and food security, psychological trauma associated with repeated shocks, and environmental degradation. Governance frictions, especially perceptions that environmental water is “wasted” during drought, were linked to community stress and mistrust, underscoring how political and institutional dynamics shape the feasibility and legitimacy of stewardship options. Social and demographic change was repeatedly identified as pivotal for system resilience, balancing innovation potential against loss of ecological and cultural knowledge and reduced local capacity.

Using a systems lens, we developed causal loop diagrams that make these relationships explicit. The analysis showed that bundles of drivers, not single hazards, generate clustered health outcomes. Several negative reinforcing cycles were revealed in which health burdens erode capacity, degrading stewardship and governance performance, illustrating classic path-dependence and lock-in. Institutional fit and trust are found to be just as important as biophysical solutions. Environmental restoration, transparency and communication of environmental watering policies, and mentoring support emerged as a set of feasible no-regrets levers that could break multiple loops at once. Sentinel indicators include livestock deaths and drinking water incidences. Three leverage areas for decision-support were thus identified: i) immediate actions with cross-loop impact such as riparian/groundcover programs; ii) enabling measures such as on-farm water storage, and iii) structural, slower-payoff strategies, including salinity management and equitable market instruments.

Our findings demonstrate that participatory scenario-based planning can integrate human health and wellbeing considerations, which is often overlooked in landscape stewardship discussions, highlighting trade-offs and co-benefits to influence planning, budgeting and community engagement. Making health and wellbeing an explicit objective in landscape governance, alongside other interventions, can harmonise production, ecosystem health, and community resilience, strengthening the robustness and legitimacy of decisions under climatic and economic uncertainty.

Keywords: *participatory modelling; state-and-transition models; scenario planning; decision support; landscape governance*