25th International Congress on Modelling and Simulation, Darwin, NT, Australia, 9 to 14 July 2023
mssanz.org.au/modsim2023

A modelling framework informs how changes in Mount Bold Reservoir's flood attenuation capacity will affect plant biodiversity

J. P. Newman [a], **J. Nicol** [b], **S. Kennedy** [a], **S. Gehrig** [c], **C. Noack** [d], **E. von Wielligh** [a], **C. Harvy** [a], **T. Kildea** [a] **and L. van der Linden** [a]

[a] *SA Water, 250 Victoria Square, Adelaide, South Australia, 5000, Australia*
[b] *South Australian Research and Development Institute, West Beach, South Australia, 5022, Australia*
[c] *Flora, Flow & Floodplains, Mildura, Victoria, 3500, Australia*
[d] *Mott MacDonald, Adelaide, South Australia, 5000, Australia*
Email: jeffrey.newman@sawater.com.au

Abstract: Remnant vegetation on the periphery of reservoirs is predominantly terrestrial, and despite its close proximity to water, would not be expected to survive prolonged submergence or waterlogging because they typically lack the appropriate adaptations for flood tolerance. Consequently, dam construction or alteration projects which change backwater hydrology may significantly impact these plant communities and therefore assessments of expected dieback and approvals from various regulatory frameworks will usually be required.

Anticipating the dieback of vegetation is not trivial as there is a lack of established guidance by which to estimate losses, or published case studies to draw upon. Unlike losses brought about through the direct impact of construction activities, multiple flood events will occur into the future, and ecosystem losses will depend on the nature of each flood event, which are inherently unpredictable in terms of inundation levels and duration, their timing with respect to seasonal growth cycles, and the amount of time between flood events that plant communities have for recovery. Furthermore, the nature of inundation a plant is exposed to will depend on its position on the elevation gradient, with those plants lower and closer to the reservoir experiencing prolonged and deeper inundation than those at higher elevations. Finally, there is a lack of data to predict how terrestrial species will respond to sporadic flooding, which while often short lived (on the order of days to a few weeks), can fully inundate canopy species situated near the full supply level.

This paper presents a modelling framework developed for evaluating dieback resulting from dam construction or alteration projects. The framework was based on a simple conceptual model, that: (1) represented the make-up of different plant communities that exist at a reservoir location, (2) used ex-situ pond experiments to develop response curves to inundation stress (3) developed a modelling chain that used hydraulic modelling of several design floods to predict how plant communities would respond to flooding across the elevation gradient in a temporally dynamic fashion, and (4) translated how these predicted responses would affect the value of plant communities based on assessment methods that are endorsed by regulatory bodies.

The framework was applied to Mount Bold Reservoir, where upgrades to the dam wall are being considered based on the Australian National Committee of Large Dams (ANCOLD) guidelines, and a desire to improve the reservoir's retention and discharge hydrology to mitigate downstream flood losses. The representation of the plant community within the model was based on the Bushland Assessment Method, and from this, losses in the significant environmental benefit (SEB) points were quantified as the basis of mitigation proposals put forward to the Native Vegetation Council. To implement the framework, 1200 BCA spreadsheets were linked with a 10,000 year Monte-Carlo simulation to characterise flooding impact at 30 sites occupied by five different communities, across the 0-8 m elevation gradient and five different flood scenarios.

Results from the ex-situ pond experiments subjecting representative plant species to inundation revealed much variability in flood tolerance. Together with the literature review, these suggested that complete dieback would not occur, although cohorts of some plant species might be temporarily removed from lower elevation bands. Once integrated into the model, this data suggested a 40% maximum reduction in SEB points for plants existing at the full supply level, with *Eucalyplus obliqua* (stringybark) communities being the most sensitive. Integrating experimental data and knowledge from the literature, the modelling was a rigorous approach to environmental impact assessment and supported discussions with the regulator.

Keywords: *Biodiversity, native vegetation, climate change, reservoir alteration, inundation stress*