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An ecohydrological approach for modelling and optimisation of vegetation health in dryland wetlands

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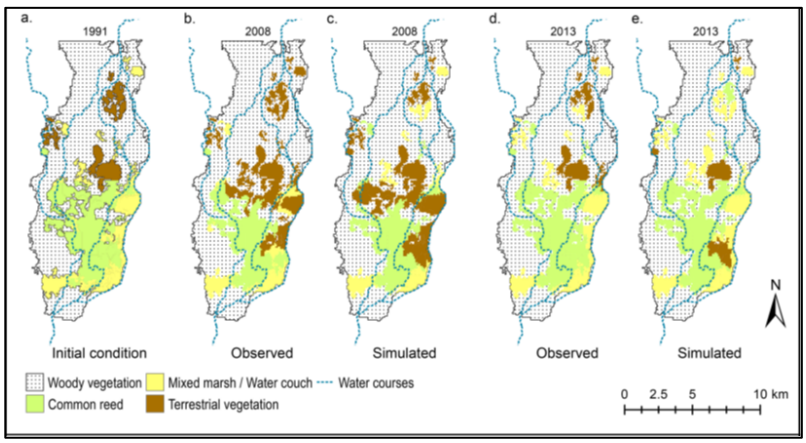
Abstract: Ecohydrological modelling is a powerful tool to assess wetland evolution under changes in management or climatic conditions resulting from global warming. The physically-based models show promise in predicting evolution under situations that have not been experienced in the past, as they don't exclusively rely on observations. Modelling and optimisation of management measures in wetland systems require a focus on the scales of ecohydrological relevance (patch scale) dictated by the dynamics of vegetation. Vegetation dynamics at the patch scale can be incorporated into traditional hydrological and hydraulic models using vegetation response models. The development of vegetation response models can be achieved by a combination of remote sensing observations and hydrological/hydraulic models that provide the watering conditions. Vegetation dynamics is sometimes characterised by deterioration and other times by transition to a different vegetation type. We present applications of our approach to a dryland wetlands using numerical models and remote sensing data. Our focus is on the long-term evolution of these systems under climate change and climate variability conditions, so our models have to be able to capture short-term (intra annual variability) and long-term (climate change) processes. They also have to be able to assess uncertainty in our predictions.

Our application site is the Macquarie Marshes, a dryland wetland in the Murray Darling Basin, Australia. Environmental water is indispensable for promoting and maintaining environmental assets in the Macquarie Valley, with releases from Burrendong Dam supplying water to the Ramsar listed Macquarie Marshes. Management decisions tools are necessary to analyze impacts of environmental water at a catchment scale and are critical to preserve ecosystems services under future uncertainties of climate variability and change. Models of wetland inundation and vegetation response are developed and tested using observations from a 30-year period that included drought and flood conditions and then applied to assess the evolution of the wetland under different scenarios of management and climate variability and change.

The figure shows the comparison of our results with observations during this period that included periods affected by floods in 1991, by drought in 2008, and by floods again in 2013. Our model successfully predicts invasion of terrestrial vegetation over Common Reed and Mixed Marsh/Water Couch and River Red Gum deterioration during the drought and also the recovery of all vegetation species during floods.



Analysis of vegetation indices obtained via remote sensing products with high temporal resolution showed that our model also predicts the transitions between vegetation states correctly.

Keywords: *Wetlands, modelling, ecohydrology, management*