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

Hydrodynamic and hydrological modelling to assess benefits, risks, and trade-offs from engineered flooding with a limited water resource

M. Montazeri [a], **D. McCullough** [b] **and M. Gibbs** [a]

[a] *Environment, CSIRO, Urrbrae, South Australia*
[b] *Water Science and Monitoring, Department for Environment and Water, Adelaide, Australia*
Email: mahdi.montazeri@csiro.au

Abstract: Regulation and water extraction has reduced streamflow in many rivers worldwide. This has led to a reduction in the frequency and duration of inundation, and in turn degradation of water-dependent vegetation. One response to address this degradation has been the construction and modification of infrastructure to 'engineer' floodplain inundation at discharges that historically would not have caused overbank flooding. Such actions have the potential to benefit floodplain vegetation; however, the resulting reduction of in-channel velocities, increases the risk of adverse water quality.

Detailed hydrodynamic modelling was undertaken for the Pike Floodplain, located near Renmark, South Australia, as a case study to investigate the influence of engineered flooding, and associated changes to in-channel hydraulics at this floodplain, on key velocity thresholds. Numerous scenarios were modelled using MIKE FLOOD to represent a wide range of conditions in order to gain a detailed understanding of the impacts of different modes of operation on floodplain dynamics.

The results from these hydrodynamic scenarios were used to parameterise and calibrate an existing hydrological model of the system. The ability of the hydrological model, built in eWater Source, to represent the velocity thresholds, was developed using pre-computed results from the detailed hydrodynamic models (Figure 1), to relate upstream flow and downstream water level to the proportion of each reach in the river model meeting each velocity threshold. The hydrological model also represents changes in discharge, inundated area and a water quality parameter, dissolved oxygen, to evaluate the responses to a potential infrastructure operation.

The 2021 Pike Floodplain operation event was simulated using the hydrological model and the outputs were validated against dynamic modelled outputs derived from the hydrodynamic model, as well as water quality data that was monitored during that event.

The validated hydrological model was then used to consider different infrastructure operation scenarios, all with the same discharge time series upstream in the main river channel. The results indicate a direct trade-off between overbank inundation created by infrastructure and in-channel velocity, with an increase in inundation area resulting in a decrease in velocity, as well as increasing water quality risk as inundation area, and rate of inundation, increased.

This work has demonstrated an approach to a more extensive evaluation of infrastructure operation, extending analysis beyond discharge and inundated area to risks and benefits occurring across ecosystems. This refined and integrated approach to the management of regulated river systems will become critical in the future as water resources are projected to decline, and sophisticated management intervention is undertaken to maintain as much of the remnant ecosystem as possible.

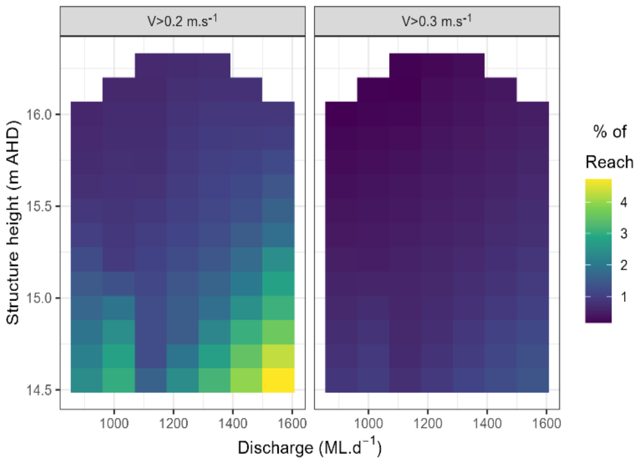

Figure 1. The proportion of the reach upstream of the Pike floodplain regulating structure exceeding different velocity classes as a function of the inflow to the Pike Floodplain (discharge) and height of the regulating structure

Keywords: *Hydrodynamic modelling, hydrological modelling, inundation, dissolved oxygen, infrastructure*