Modelling Lake Bonney: The salty problem child of the Lock 3 weir pool at River Murray South Australia

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Abstract: Short-term changes to river hydrology can cause mobilisation of salt mass which poses an ongoing threat to the environment, e.g., leading to a decline in biodiversity and potentially threatening ecological systems. The extent to which such salt mobilisation contributes to adverse outcomes depends upon the sequence of hydrological events. If these salts continue to enter the river as the flood recedes into a low flow period, the risks associated with salinity are further elevated (MDBA, 2014). An example of such an event was the elevated River Murray salinity in January 2017 resulting from backflow from Lake Bonney in the aftermath of the 2016 high flow event.

Lake Bonney is located above Lock 3 on the River Murray in South Australia, next to the township of Barmera and adjacent the Loch Luna wetland complex. Lake Bonney is the largest permanent lake in South Australia, covering an area of about 1,700 hectares (ha) at normal pool level, with a volume of approximately 59,000 megalitres (ML). The lake is connected by an inlet at the north-western side of the lake to Chambers Creek, which ultimately joins the River Murray near Cobdogla (Government of South Australia, 2021).

Lake Bonney is subject to evaporative salinity accumulation effects that contribute to River Murray salinity during water level recessions. Comparison of this modelled hydrological representation of the system against observed conditions indicated an underestimation of the rate of salt accumulation in Lake Bonney and in turn the salinity impact on the main river channel during flooding events, both natural and managed. Additionally, while the Department's Lock 3-6 MIKE FLOOD hydrodynamic model accounts for the additional salt mass from groundwater contributions associated with backflow from Lake Bonney to the River Murray Lock 3 reach, the Source hydrological model does not. The further development of the Source model was required to enhance model functionality related to salinity to support future decision making during both weir pool manipulation (WPM) and high flow events.

To improve estimation of salt accession to the River Murray Lock 3 reach by the Source model during both WPM and high flow events, scenarios of various plausible WPM events at Lock 3 and high flow conditions were first simulated with the Lock 3-6 MIKE FLOOD hydrodynamic model. An estimation of modelled total salt mass at Chambers Creek under each scenario was then collated for use in the Source model calibration. Salt mass relationships considering multiple variables such as (i) target water levels at Lock 3; (ii) rate of water level change during raising/lowering operations and (iii) upstream flow were developed with a regression model, which was added to the storage node that represents Lake Bonney in the Source model.

To understand salinity impacts associated with changing water regimes, WPM events in 2020 and 2021 and natural high flow events in 2016 and 2022 were simulated in the refined Source model for validation purposes. Modelled salinity in the Lock 3 reach was compared to observed salinity data at River Murray Lock 3 Upstream, A4260516 (AMTD 431.4km). Comparisons of salinities have demonstrated that this refined Source model can effectively replicate the in-river salinity at Lock 3 reach during both managed and natural events. This provides river operators and environmental water managers with a valuable tool to assess the potential salinity impact of events and an opportunity to consider mitigation strategies in response to predicted salinity spikes.

REFERENCES

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