26th International Congress on Modelling and Simulation, Adelaide, SA, Australia, 30 Nov–4 Dec 2025
mssanz.org.au/modsim2025

Improving the understanding and prediction of low extreme dissolved oxygen (DO) events in Victorian rivers

Peiran Yan[a], Harrison Pietsch[b], Dawei Chen[a] and Danlu Guo [b,c]

[a] School of Computing, ANU College of Systems and Society, Australian National University, Australian Capital Territory, Australia
[b] School of Engineering, ANU College of Systems and Society, Australian National University, Australian Capital Territory, Australia
[c] Institute for Water Futures, Australian National University, Australian Capital Territory, Australia
[c] School of Civil Engineering, The University of Sydney, Sydney, NSW, Australia
Email: danlu.guo@anu.edu.au

Abstract: Dissolved oxygen (DO) in rivers is a critical indicator of the health of waterways and aquatic ecosystems. Extreme low river DO is often closely linked to detrimental social, environmental and ecological impacts such as blackwater events and fish deaths. This presentation compiles key experiences and findings from our recent effort towards improving the understanding and prediction of low extreme DO events. In line with recent global advances in machine learning models for DO prediction, we developed two parsimonious machine-learning models, a short-term memory (LSTM) model and a transformer model, which both predicted daily DO from only two explanatory variables, the same-day daily streamflow and daily water temperature, across 46 river monitoring stations across Victoria with record spanning 5 to 10 years. The model achieved a Nash-Sutcliff Efficiency (NSE) of 0.54 which was comparable with the similar type of model relying on a more comprehensive set of predictors including meteorological variables and catchment conditions, highlighting potentially wide practical applicability for tracking DO levels across Victoria even for unmonitored locations. To better predict the low extreme DO events (defined as DO < 2 mg/L), we further adjusted the objective function of both models to increase the weights for data points within low extreme DO events. However, the performance of both models remained limited in either classifying the low extreme DO event and predicting the actual DO values during these events, which is likely attributed to the limited number of data points with low DO compared to the remaining data.

In the following work, we further focused on understanding the processes and critical conditions that drive low extreme DO events. Following a comprehensive review, we identified multiple short- and mid-term preceding conditions of hydrology and meteorology that could lead to extreme low DO events, such as recent droughts, floods, and warm weather. Multiple hydro-meteorological conditions leading to the occurrence of extreme low DO events were assessed across 73 Victorian water monitoring sites where sufficient data on DO and preceding hydro-meteorological conditions were available. From this, we identified a set of key hydro-meteorological drivers of extreme low DO events to be included in predictive models. Our ongoing work includes testing and comparing multiple potential models, including logistic regression, decision trees and their gradient-boosted variants, random forests, support vector machines, and the k-nearest neighbours algorithm. Initial models have shown promising results in binary classification, successfully separating extreme low DO events (DO < 2 mg/L) from normal DO conditions (DO > 4 mg/L). However, model performance generally degraded slightly when extended to tri-class classification, distinguishing between extreme low (DO < 2 mg/L), low (2 ≤ DO ≤ 4 mg/L), and normal (DO > 4 mg/L) conditions. Further modelling will involve refining the initial models, as well as unpacking regression coefficients and feature importances from the machine learning models to interpret the effects and relative contributions of individual hydro-meteorological drivers on DO events. Our results are expected to provide valuable insights for waterway and catchment management to better prepare for and mitigate these detrimental water quality events.

Keywords: *Dissolved Oxygen, Catchment Water Quality Modelling, Extreme Events, Hypoxia, Machine Learning*