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Logistic regression model for early detection and prediction of algal blooms in estuarine environments

Mayya Podsosonnaya[a], Maria Schreider[b], Sergei Schreider[c]

[a] Monash University, Vic, 3800, Australia, Email: mayya.podsosonnaya@monash.edu; [b] Phillip Island Nature Parks, Cowes, Vic, 3922, Australia; Email: mschreider@penguins.org.au; [c] Business School, Rutgers University, Newark, NJ 07102 USA, Email: sergei.schreider@business.rutgers.edu

Abstract: Algal blooms have a negative impact on ecosystems, and in the case of cyanobacterial blooms (unicellular blue-green algae), they can pose a direct threat to human health, either through direct exposure or contamination of seafood. The latter is particularly relevant in coastal regions with developed aquaculture and fisheries. This study focuses on the timely detection of bloom onset and the prediction of such events.

Multispectral satellite images were used to monitor estuaries in Australia: Curdies River (Vic) and Tuggerah Lakes (NSW) where two different types of algal blooms— cyanobacteria and macroalgae respectively—occur periodically. A common feature of both organisms is their ability to increase biomass significantly within a short period of time (blooming). They photosynthesize, meaning they contain chlorophyll, which could be detected through spectral satellite images. To detect blooms using satellite data, the Floating Algae Index (FAI) was applied in both cases, as it effectively highlights the spectral signature of chlorophyll. This method proved effective in identifying both floating macroalgae (e.g., *Ulva spp*.) and cyanobacteria suspended in the water column.

To analyse the spatiotemporal dynamics of algal blooms, a multivariable logistic regression model was developed. The model was validated against direct field observations and demonstrated higher accuracy compared to a simple classification approach. Environmental variables such as water temperature, flow rate, is estuary mouth open or closed and salinity were incorporated into the model.

The developed model can be used to assess estuarine conditions and predict the likelihood of future bloom events based on environmental factors.

Keywords: *Algal blooms, remote sensing, multispectral images, machine learning algorithm*