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

Using remotely sensed data to understand global lake colour variability

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Abstract: Water colour can reflect waterbody health and environmental conditions of inland waterbodies. As a result, changes in water colour may be associated with environmental dynamics resulting from either climate or catchment changes or both. It is important to effectively monitor water quality in waterbodies with sparse sampling records. In the absence of long term, spatially comprehensive global databases of lake water quality, satellite-derived water colour can be used to understand water quality variability. Here we analyse the spatial-temporal variability of water colour for more than 300,000 inland waterbodies around the world using Landsat 5, 7, and 8 images for 35 years. We investigated the spatial variability in the baseline water colour and temporal patterns of water colour across 41 climate reference regions. We found that the mean dominant wavelengths of small waterbodies were constantly higher (less blue) than larger waterbodies. We also found that most waterbodies became increasingly bluer, with an average change of -14.5 nm ± 0.15nm over the 35-year study period. The exception were waterbodies in north-eastern Russia which tended to shift towards red wavelengths. The waterbodies were grouped based on their inter-annual water colour change and intra-annual variation (standard deviation) in water colour. Intra-annual variability increased for two thirds of the waterbodies over the study period. Around 20% of the waterbodies have tended to shift to redder wavelengths accompanied by increased intra-annual variation, which may indicate they are more vulnerable to environmental stresses. Both climate drivers and urbanization can explain the interannual water colour changes. The findings from this work provide a strong baseline understanding of historical global lake water quality variability with which future projected climate change impacts can be compared.

Keywords: *Water colour, remote sensing*