Combining new technologies for more effective spatial and temporal monitoring of water quality

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Good monitoring data is vital for tracking changes in water quality due to changing climate, point-source and diffuse pollution, as well as for evaluating efficacy of restoration measures in lakes and catchments. We have developed and deployed a network of solar-powered water quality monitoring stations at central locations in lakes of the North Island of New Zealand. The buoys measure temperature, chlorophyll and phycocyanin fluorescence, dissolved oxygen and turbidity, as well as meteorological variables. They telemeter measurements to a database and web-based interface every 15 minutes. On several lakes, water quality surveys are regularly undertaken (approximately monthly) using a towed probe with a similar suite of water quality sensors to the buoys, providing complementary spatial coverage. These cross-validated data streams can be used for calibrating and validating relationships between water quality indices and spectral/thermal images from satellites. We have used this method to derive surface water temperature, chlorophyll concentrations and turbidity from remote sensing images for a range of New Zealand lakes. Atmospheric correction and ground-truth data can increase the accuracy of satellite measurements. For example, Landsat 7 ETM+ thermal data were used to derive water temperature for 14 images between 2007 and 2009 on Lake Rotorua. These temperature predictions were validated with Lake Rotorua monitoring buoy data for validation, and atmospheric correction using the radiative transfer model MODTRAN v.3.7, yielding a root-mean-square-error of 0.36 °C. Satellite imaging has important potential as a monitoring tool to resolve heterogeneity within lakes at single instances, and through time. Integration with real-time monitoring stations and spatial data collection programmes enables instantaneous assessments of lake water quality across catchment, regional, national and international scales.