Remote Sensing of Water Quality – Fact Sheet

Linking lake restoration with end users for positive environmental outcomes

LERNZ
Lake Ecosystem Restoration New Zealand

Remote Sensing

Evaluating water quality is a key tool in lake management. Typically water quality samples are restricted to a limited number of point samples collected *in situ* in the field, which can be time consuming and costly. Also, the few *in situ* points sampled fail to capture the spatial variability, e.g., for the large Lake Waikare (3,400 ha; Figure. 1).

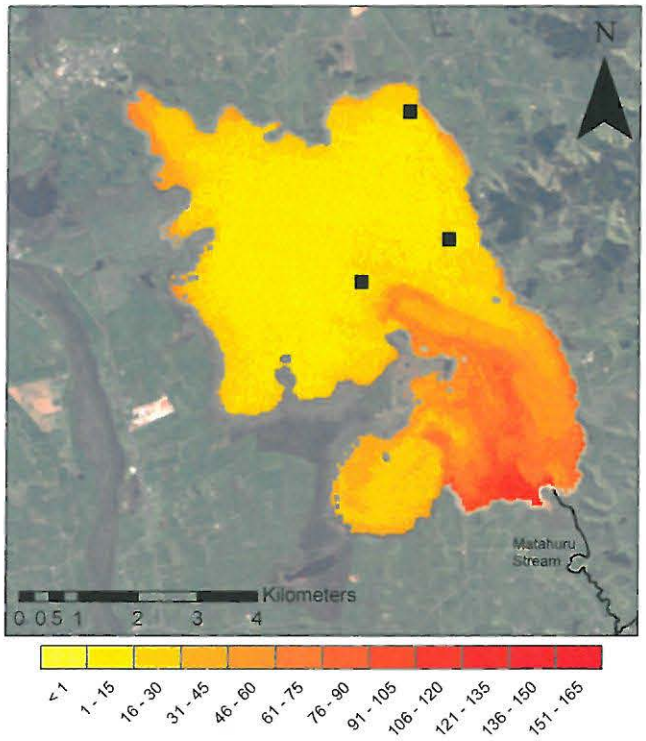

Figure 1. Estimated total suspended solids (mg/L) in Lake Waikare, 9 September 2001, using Landsat data. Black squares indicate position of point samples (source: Hicks et al. 2013).

Figure 2. Landsat 8 satellite in low-Earth, Sun-synchronous orbit (source: https://commons.wikimedia.org).

Validation

In situ sampling of Secchi depth, suspended solids, and chlorophyll *a* (Figure. 3) are used initially to create algorithms to calculate these values from the coloured bands in the satellite image.

Figure 3. Measuring Secchi depth in Lake Koromatua.

Suspended Solids

Landsat data is freely available from on-line data archives, and we have developed geographic information system (GIS) tools to automate the steps required to estimate suspended solid concentration (Figure. 1). This data set has provided us with the means to hind cast suspended solids concentration in lakes and extend or fill in gaps in monitoring data over the past decade (Figure. 4).

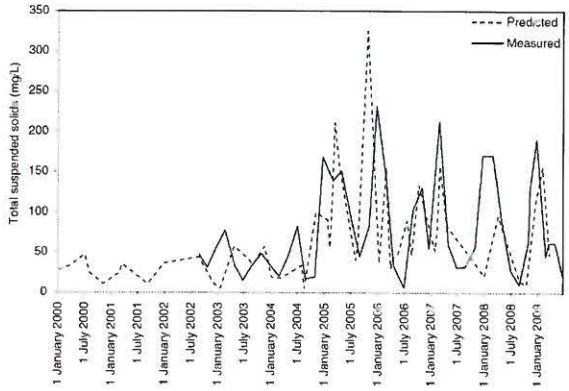

Figure 4. Measured total suspended solids in Lake Whangape between 2000 and 2009 compared to estimates from Landsat 7 data for the entire lake (source: Hicks et al. 2013).

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Chlorophyll *a*

Spatial distributions of chlorophyll *a* can be estimated from Landsat satellite imagery with our novel algorithms (Figure. 5). Automated analyses are easy to apply to a time series of images.

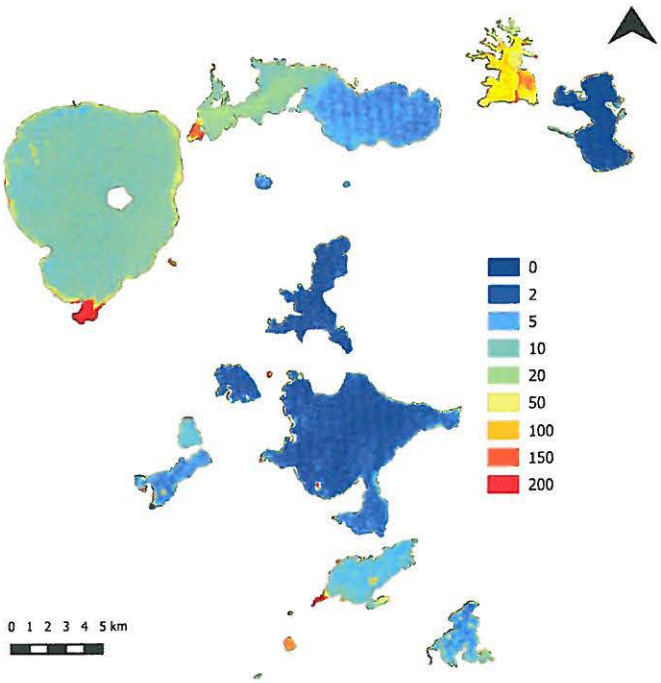

Figure 5. Chlorophyll *a* concentration in µg/L in the Rotorua lakes on 24 January 2002 estimated from Landsat 7 satellite data (source: Allan et al. 2011).

Conclusion

Remote sensing of water quality and surface water temperatures highlights the ability of satellite imagery to extend existing datasets or capture data in lakes that were not previously monitored. The methods that we have developed can easily be applied to other lakes using the GIS tools. As part of the University of Waikato's Environmental Research Institute we have now set up a dedicated GIS laboratory to apply these techniques and expand our capabilities.

Water Surface Temperature

Lake surface water temperature can be estimated from Landsat thermal infrared data with the method that we have developed (Figure 6). The accuracy of temperatures estimated by this method (i.e., ± 0.36° C) is comparable to traditional *in situ* monitoring.

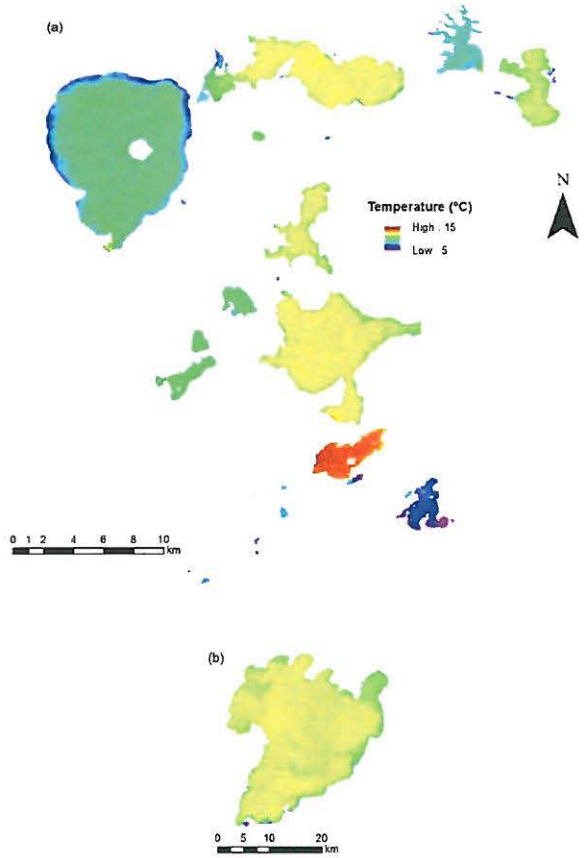

Figure 6. Surface water temperature in °C on 20 June 2009 in (a) the Rotorua lakes and (b) Lake Taupo estimated from Landsat images (source: Allan 2013).

References

Allan, M.G. 2013. Remote sensing, numerical modelling and ground truthing for analysis of lake water quality and temperature. PhD thesis, University of Waikato.

Allan, M., Hamilton, D.P., Hicks, B.J. and Brabyn, L. 2011. Landsat remote sensing of chlorophyll *a* concentrations in central North Island lakes of New Zealand. International Journal of Remote Sensing 32: 2037–2055.

Hicks, B. J., Stichbury, G. A., Brabyn, L. K., Allan, M. G. and Ashraf, S. 2013. Hindcasting water clarity from Landsat satellite images of unmonitored shallow lakes in the Waikato region, New Zealand. Environmental Monitoring and Assessment 185: 7245-7261.