Towards restoration of water quality in the Rotorua lakes, New Zealand, science and engineering

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EXTENDED ABSTRACT

The restoration of water quality in the Rotorua lakes, North Island, New Zealand, has a high priority for the local community and for central government. This is reflected in ongoing research into water quality in the lakes and in the lake catchments, and ongoing development of engineered solutions to water quality problems. This paper will outline current research into water quality in lake catchments and within the lakes, and will summarise present developments to restore lake water quality.

Thirteen lakes occur in the Rotorua area in the central North Island: Rotorua, Rotoiti, Tarawera, Rotoiti, Rotoehu, Rotoma, Okataina, Okareka, Tikitapu, Rotokakahi, Okaro, Rerewhakaaitu and Rotomahana. Water quality in these lakes ranges from poor to good, largely reflecting land use in the lake catchment. Land uses such as urban and agriculture have contributed to the degradation of lake water quality. Water quality problems such as deoxygenation, algal blooms and reduced clarity have occurred in the lakes with poor water quality including Rotorua, Rotoiti, Rotoehu and Okaro. The Rotorua lakes are important for recreation, and groundwater in the lake catchments is commonly used for domestic water supply. Therefore the local community has been concerned for many years about the effects of land use on water quality in lakes and catchments.

The Rotorua Lakes Restoration Project aims to restore water quality in degraded lakes and this project is managed by a governance group which includes local government, regional government, central government and local Maori. The project has attracted significant funding from central, regional and local government, allowing assessment and implementation of engineering solutions to water quality problems.

Groundwater is very important to the hydrology of the lake catchments (White et al. 2007) as approximately fifty percent of rainfall enters the groundwater system. Most streams are spring-fed and large areas of the lake catchments have no permanent surface water flow. Current research aims to identify groundwater catchment boundaries leading towards future assessments of land use and identification of land use options, that aim to reduce nutrient generation in lake catchments. For example the outer groundwater catchment boundary of Lake Rotorua has been assessed, and major groundwater catchments associated with spring flows up to approximately 3 m^3/s, within the Lake Rotorua catchment have been proposed. Groundwater flows at the local scale have been assessed for the many springs, including spring flows as low as 1 L/s, in one catchment within the Lake Rotorua groundwater catchment.

Management of nitrogen discharge from the catchment is largely an issue of management of land use in winter. Observations of rainfall and rainfall recharge to groundwater at a site of pastoral land use indicate that approximately 99.7% of the annual total nitrogen discharge occurs in the March to August period, including the winter months. Therefore management of stock and soil, including best-practice land use in the March to August period is a critical issue to management of nitrogen leaching to groundwater.

Nitrogen discharge from the catchment is predicted to increase significantly in the future, as catchment water quality equilibrates with current land use, and climate change may cause increasing temperatures and changing rainfall patterns. The impacts of land use and climate change on water quality within Lake Rotorua is assessed using a lake water quality model (CAEDYM) coupled with a 3-D hydrodynamic model (ELCOM), both linked to a groundwater flow model of the catchment.

Development of engineered solutions to water quality problems includes dosing lakes with materials that aim to lock up phosphorus on the lake bed. For example whole-lake dosing of Lake Okaro in 2007 appears associated with a reduction in phosphorus concentrations, and a reduction in the period of lake deoxygenation. Continuous dosing of materials that aim to lock up phosphorus in the Utuhina Stream, Lake Rotorua catchment, appears associated with a reduction in phosphorus concentrations in the stream, and therefore a reduction phosphorus discharge to Lake Rotorua.

Poor quality water has flowed from Lake Rotorua into Lake Rotoiti for many years. A multi-million dollar diversion wall has been built recently in Lake Rotoiti to divert the approximately 15 m^3/s flow from Lake Rotorua. This wall appears to have resulted in a significant reduction in nitrogen and phosphorus discharge to Lake Rotoiti. Future improvements in Lake Rotoiti water quality are predicted with lake water quality models.

Rotorua District has invested in improvements in wastewater treatment, including carbon dosing, that aim to reduce nitrate concentrations in treated wastewater by 50%. Central and local government have funded new sewerage mains for rural communities, and trials are underway to denitrify approximately 30 tonnes N/year of ammonia-rich water discharging from a geothermal field.

REFERENCE

White, P.A., Hong, T. Y-S., Zemansky, G., McIntosh, J., Gordon, D., Dell, P. (2007). "Groundwater and surface water hydrology in the Lake Rotorua catchment, New Zealand, and community involvement with lake water quality restoration." South Korean Water Resources Association annual conference.