Geophysical Research Abstracts
Vol. 21, EGU2019-12034, 2019
EGU General Assembly 2019

A case for multi-use lake management with constrained optimization: Lake Taupo, New Zealand

Varvara Vetrova (1) and Earl Bardsley (2)

(1) University of Canterbury, School of Mathematics and Statistics, Christchurch, New Zealand (vetrova.varvara.v@gmail.com), (2) University of Waikato, Faculty of Science and Engineering, Hamilton, New Zealand

Lake Taupo in New Zealand's North Island is the nation's largest lake by surface area (616 km2). Its 3,487 km2 catchment provides inflow water from numerous rivers and streams. The lake discharges to the Waikato River and provides hydro storage for a cascade of down-river power stations. Lake outflow rates are controlled and discharge is normally no less than 50 m3s-1, and may go to a maximum of approximately 300 m3s-1. Lake hydro storage use operates within a permitted water level range of between 355.85 and 357.25 metres asl.

The lake is a popular tourist destination and in recent years there has been considerable increase in lake shoreline housing. A resulting environmental controversy has arisen over public concerns about shoreline wave erosion when high water levels coincide with periods of strong winds.

New Zealand operates an electricity market with fluctuating electricity wholesale prices and various separate state-owned power companies operate to maximise their respective incomes. This has potential to lead to conflicts of use if, for example, water is held back in a lake to create high levels and flooding risk rather than releasing the water to generate power when prices are low. Such operation appears to be a contributing factor to high water levels at Lake Taupo because the record of lake level variation has strong similarities to output from an optimisation model which seeks to maximise power sales income with no constraints other than the upper and lower permitted lake level bounds. By adding further constraints to a linear programming optimisation model, it is shown that the frequency of both high and low lake levels might be considerably reduced by an alternative lake operating mode. In this case the model operates in a multi-objective framework, seeking to maintain the lake levels within a more desirable range in addition to aiming toward maximisation of income from hydro power generation.