Seasonal inflow and rainfall prediction in the Waitaki hydro electricity catchment, New Zealand

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Approximately 70% of New Zealand's electricity is produced from hydro generation. This, coupled with the fact that demand for electricity has increased at 5% per annum in New Zealand in the past two years, results in the increasing vulnerability of New Zealand electricity supply to seasonal climate fluctuations. Improved seasonal rainfall and inflow forecasts will result in the better management of the water used in hydro generation on a seasonal basis.

Seasonal rainfall forecasting has been the focus of much international research in recent years, but seasonal inflow forecasting is in its relative infancy. Researchers have stated that key directions for both fields are to decrease the spatial scale of forecast products, and to tailor forecast products to end user needs, so as to provide more relevant and targeted forecasts, which will hopefully decrease the enormous socio-economic costs of climate fluctuations.

This study has calibrated several season ahead lake inflow and rainfall forecast models for the Waitaki river catchment, in the South Island of New Zealand, which produces approximately 40% of the country's power. These models use statistical techniques to quantify relationships between land-ocean-atmosphere state variables and seasonally lagged inflows and rainfall. Techniques include principal components analysis and multiple linear regression, with cross-validation techniques applied to estimate model error, and randomisation testing to examine the significance of results. Predictor variables include sea level pressure, sea surface temperature and 700hPa geopotential height, in combination with datasets such as sunspot number and local rainfall, temperature, and pressure indices. The Quasi-biennial oscillation of stratospheric winds over Singapore was found to be a significant predictor.

Many of both the continuous and discrete format models calibrated in this study predict anomalously wet and dry seasons significantly better than random chance, and better than using the long term mean as a predictor. 95% confidence limits around most model predictions in this study offer significant skill when compared with the range of all probable inflows (based on the 80 year recording history in the catchment). These seasonal forecasts are now being applied operationally by the hydro electricity generation company managing the Waitaki catchment, and better management of the hydro resource on a seasonal scale is expected.