Modelling Impacts of Land Cover on Critical Water Resources in the Motueka River Watershed, New Zealand

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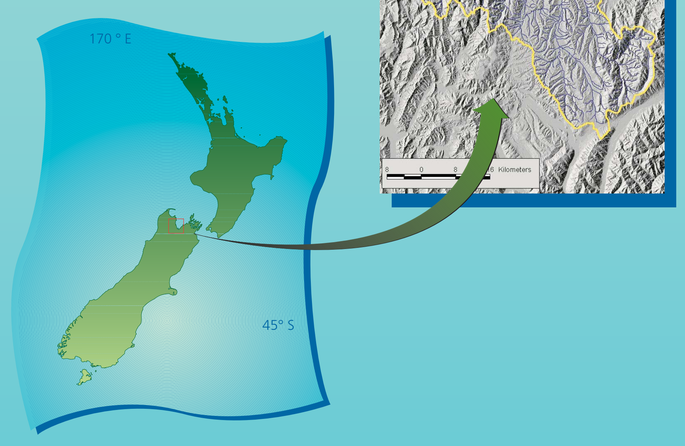
Background

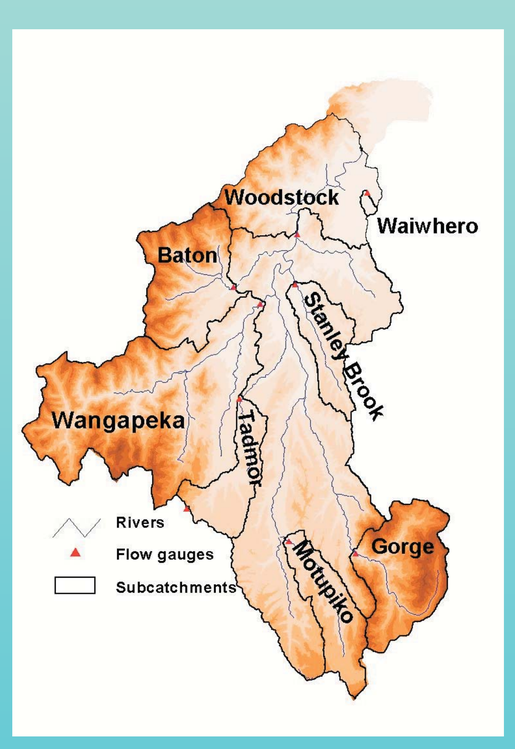
- Water is a critical resource in the seasonally-dry Motueka River basin. Over much of the watershed demand for water is generated by abstractions from both surface and ground water and indirectly by changes in land cover.
- The watershed is a case study area for a large research project on Integrated Catchment Management (**ICM**) (http://icm.landcareresearch.co.nz).
- ICM is an approach to managing land, rivers and coast in an interconnected, holistic fashion. The Motueka ICM research programme encompasses the principles of integration among science disciplines, integration between communities, scientists and environmental managers, and management of natural resources within catchment or watershed boundaries.

Methods

- Study area



- The Soil and Water Assessment Tool (SWAT) has been calibrated and validated to historic flow records for the current land use conditions in Motueka Watershed. Two land-cover scenarios (estimated prehistoric land cover and maximum potential conifer plantation cover) were used to evaluate the impacts of land use change. There is concern among horticulturalists and recreational fishers that land use change to more extensive plantation forestry could decrease seasonal low flows, threatening irrigation supplies and adversely affecting trout habitat.
- The model was calibrated and validated for an eleven-year record of daily flows, including six subcatchments.

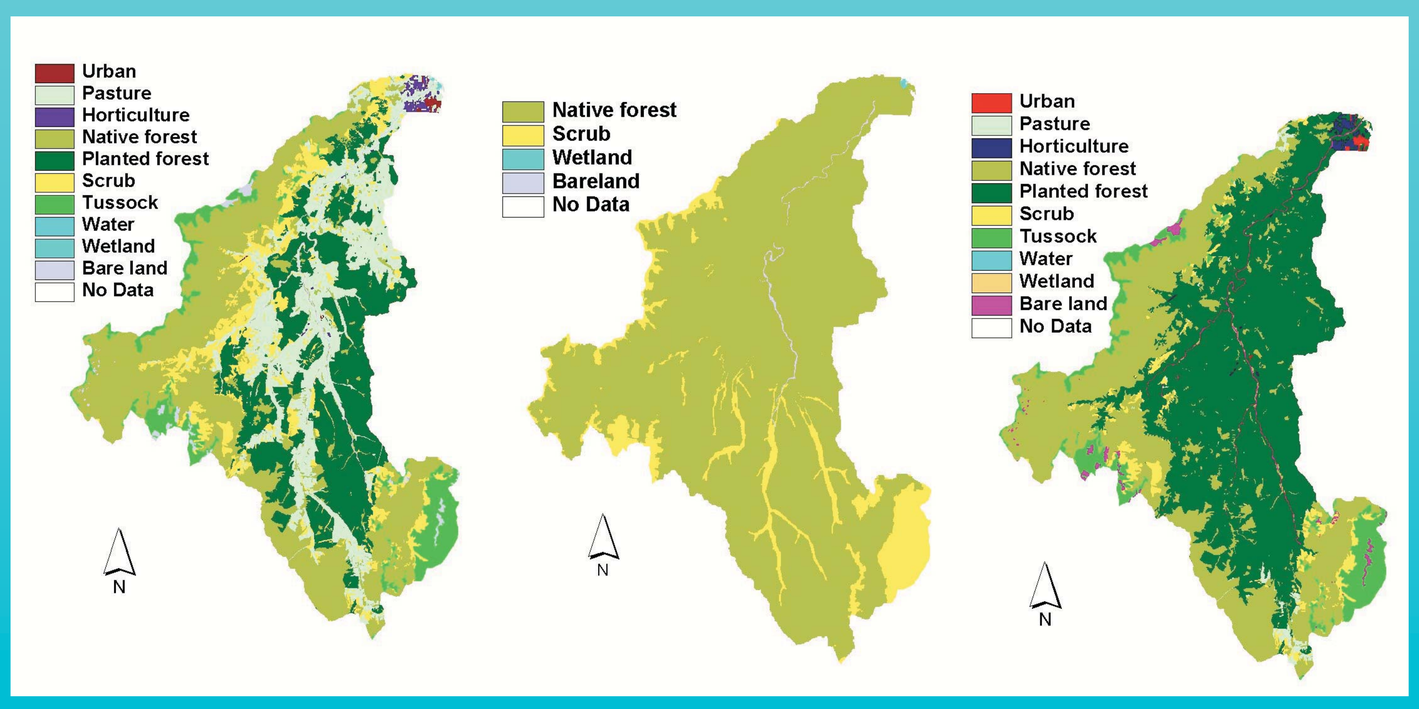


Subcatchments used for model validation in the Motueka Watershed (Shading represents topography)

Current land cover

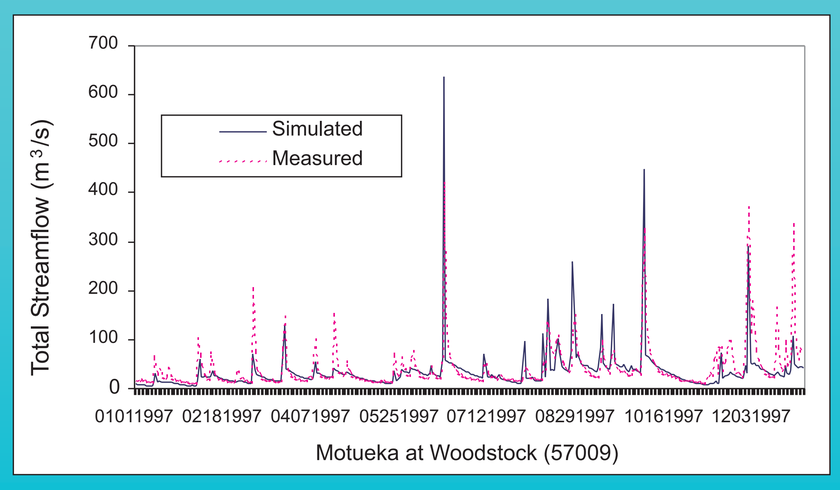
Prehistoric land cover scenario

Potential conifer (pine) plantation scenario



The current land cover and two land-cover scenarios

Results & discussion

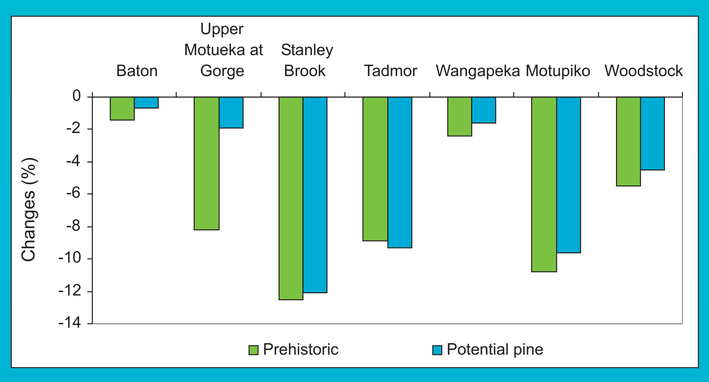


SWAT model performance for 1997 after calibration and validation

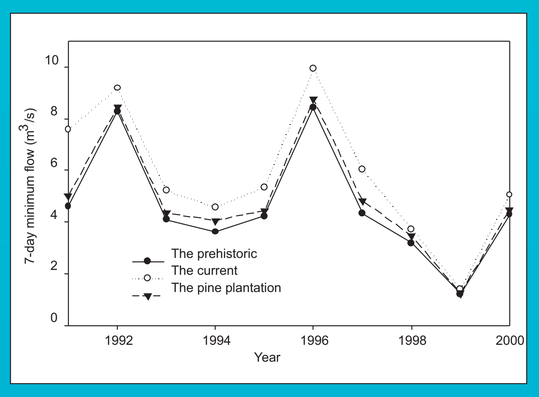
Mean water balance changes in the Motueka watershed compared with the current land use

- Total water yield under both prehistoric and the potential pine scenarios decreased by around 5% (relative to the current conditions) for the whole watershed with considerable variation among subcatchments.
- The main change in the water balance was increased evapotranspiration, which resulted in decreased quick flow and groundwater flow. The amount of change in either quick flow and/or groundwater flow varied among subcatchments.

Mean annual total water yield changes for subcatchments



Mean annual 7-day minimum flow changes at Woodstock



Conclusions

- Total annual water yield was reduced by 5.5% at Woodstock under the prehistoric land cover and 4.5% for the pine potential scenario. However, the decrease in total annual water yield in some subcatchments was large and important. These results are to be expected given the changes in water balance associated with an increase in tall woody vegetation.
- Streamflow decreases exceeded 10% for low flows within the Q_{70}-Q_{99} range (70-99% of time that flow is equalled or exceeded at Woodstock). In some subcatchments low flows are reduced by more than 40% within the Q_{50}-Q_{99} range.
- The maximum potential commercial forestry (pine) scenario still results in higher water yields than the estimated prehistoric flows, although considerably lower flows than the current land use.
- The predicted minimum 7-day low flows reduced by an average of about 20% and 15%, under prehistoric and maximum potential pine scenarios, respectively. These decreases in streamflow would accumulate on top of the maximum river extraction for irrigation (12% reduction in streamflow at Woodstock) given in the **Motueka Water Conservation Order**, which does not take into account the flow impacts of land use change.