Developing an integrated socioeconomic-hydrological model to support catchment-scale water allocation decisions

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Abstract: The water demand for farming, domestic and industrial uses is increasing in Aotearoa-New Zealand. Intensifying competition for water has led to sharp increase in stress on aquatic and wetland ecosystems. In a growing number of catchments and aquifers, the volume of water allocated has reached or exceeded sustainable limits. Total allocation limits have been breached in several catchments. These issues are predicted to worsen in the future with climate change, which is projected to alter the intensity and patterns of precipitation both seasonally and annually. Irrigation accounts for nearly two-thirds of consumptive consented water use and the benefits of irrigation for agricultural production are well established. New Zealand's current water management approaches are not optimised to increase water resilience. The process that water governing authorities use for granting consents is based on a 'first-in, first-served' principle. The outcome of this process, at current levels of demand, is not conducive to prioritise environmental and human health ahead of commercial practices, especially when water is already fully allocated. Allocation is static, which means that consents to take water are locked in for extended periods and are generally prioritised to the same level of surety of supply. Relatively little water storage exists to buffer against times of low supply or high demand. To address these current water management issues, the Ministry for the Environment (MfE) initiated a pilot study to assess catchment level water management systems to inform the implementation of the National Policy Statement for Freshwater Management 2020 (NPSFM). To inform this policy initiative as well as the freshwater science community more broadly, we developed a catchment-scale water allocation model that demonstrates how integrated socioeconomic and hydrological models can be used to support water allocation decisions. We primarily focused on the largest water user, the agricultural sector. We used a real-world catchment, Mid-Mataura catchment in Southland, where consumptive use under the current allocation rules is limited by water scarcity, for this study. We considered the abstractive practices of two large agricultural users of water: pastoral farming and crop production, in our methodology. Our water allocation model consists of two components: (1) a hydrology model, and (2) an economic model – these two models are loosely coupled. We adapted an integrated surface-groundwater hydrology model originally developed by Op den Kelder (2021) using MODFLOW. The economic model, which was originally developed by Sağlam (2013), was carried out in three broad steps. The first step explores how different agricultural practices value water in their production by estimating the marginal value of water using the New Zealand Longitudinal Business Database (LBD). Utilising the estimated value of water, the second step investigates how water can be efficiently allocated across different agricultural practices and farms using a static setup. The last step considers temporal allocation (dynamic allocation) of water. This presentation will demonstrate how the developed model may be used to sustainably allocate water across competing water users to: (1) maximise socioeconomic output from the use of water during the allocation round within the allocation policy parameters, (2) dynamically allocate water (saving carry over stock in storage) to maximise economic benefits such as agricultural profit, and (3) inform the process of how data and policy is compiled, recorded, analysed, and used in the model.

REFERENCES

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