Modelling the ground(water) beneath our feet: Supporting a resilient water supply for Wellington

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ABSTRACT

The Waiwhetū aquifer beneath the Lower Hutt Valley is a critically important source of water for Wellington, providing up to 70% of the capital's drinking water during the summer from abstraction wells located at the Waterloo and Gear Island wellfields. Abstraction of groundwater from the Waiwhetū aquifer is constrained by depletion effects on Te Awa Kairangi/Hutt River and mitigation of saline intrusion risks from Te Whanganui-a-Tara/Wellington Harbour.

The detection of E.coli in raw water from the Waterloo Wellfield in late 2016 indicated that further refinement of the hydrogeological conceptual model was necessary. This, combined with the need for additional work to support wellfield planning, resilience, and operations, resulted in significant field investigations in 2020-2021. These investigations yielded information that directly supported the revision of the Hutt Aquifer Model, including detailed aquifer testing and ongoing groundwater level monitoring across the Lower Hutt Valley.

The fifth revision of the Hutt Aquifer Model (HAM5) is an update of previous groundwater models of the region, including HAM3 (Gyopari, 2014) and HAM4 (Gyopari, 2018). HAM5 is intended to provide water suppliers (Wellington Water) and water resource managers (Greater Wellington Regional Council) with a tools for understanding groundwater flow and solute transport in the Waiwhetū aquifer and enable robust modelling approaches to support decision-making.

To meet the objectives of Wellington Water and GWRC, HAM5 is being developed within a framework comprising the following three components: A Database model; predictive scenario analyses; and operational tools.

The Database model is a deterministic, 'calibrated' (or 'history-matched') numerical groundwater flow model that will act as a starting point for subsequent predictive simulations. It incorporates information from previous revisions of the Hutt Aquifer Model, as well as additional information collected since. The basis of the Database model is a three-dimensional hydrostratigraphic model of the Lower Hutt aquifer developed by Begg (2023).

The numerical groundwater flow model has been developed MODFLOW 6 (Langevin et al., 2017) using a scripting tools (Bakker et al., 2016) to support subsequent predictive scenario analysis. Model parameters have been estimated by matching model results to observations using PEST (Doherty, 2010) and PEST++ (White et al., 2020) tools that are model-agnostic and support further uncertainty analysis.

Predictive scenario analysis will be used to support decisions about important issues required from resource operators and managers, such as optimisation of production well placement with respect to aquifer yield, saline intrusion, drawdown and contamination constraints. The simulated scenarios are intended to "expose the uncertainties of decision-critical predictions" (GMDSI, 2021) and reduce those uncertainties where possible. The predictive scenarios comprise model ensembles that are based on the

Database model but with refinements including climate change effects (sea level rise, river flows and rainfall recharge), and changes in river morphology.

Operational tools provide model results in a context useful for both resource operators and resource managers. Wellington Water Ltd currently uses tools developed from previous iterations of the Hutt Aquifer Model as part of their daily operations. The evolution of these operational tools will incorporate predictive simulation outputs developed as part of HAM5 to assist with real-time management of this precious resource.

References

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Keywords

Groundwater, Uncertainty, Water supply, Resilience, Numerical modelling, MODFLOW, Parameter estimation

Declaration

Topic	Modelling for an uncertain future
☒	Can attend in person
☒	Have permission / authority to speak on the topic
☒	Have a backup speaker if they fall ill or cannot present