

The hydrological regime of the Wairau River Aquifer, New Zealand: Detecting change using uncertain data

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The Wairau Aquifer covers a small proportion of the Wairau catchment in the Marlborough District of New Zealand just prior to the river discharging into the sea. The aquifer is almost exclusively recharged by surface water from the Wairau River and serves as the major resource for drinking water and irrigation in the region. A constantly declining trend in aquifer levels and spring flows have been observed over the past decades, which triggered a range of investigations on the Wairau Plains, but also for the entire Wairau catchment (3430 km²). Experimental evidence and numerical modelling of the interacting river-groundwater exchange flows on the Plains suggest that the river is hydrologically perched in the upstream regions and that aquifer recharge is particularly sensitive to an increase of days with extreme low river flows.

Since the Wairau River flow and therefore also the storage of the Wairau Plains aquifer are strongly linked to the hydrological processes in the entire catchment, investigations were carried out to analyse the hydrological regime and potential trends or changes thereof on the catchment-scale. The analysis of a 50-year period of precipitation from NIWA's Virtual Climate station network revealed that annual mean catchment precipitation for the years 2000 - 2015 was significantly lower than the long-term average. Similar trends were also found for the Wairau River flow record, but both precipitation and runoff exhibit a large inter-annual variability. In addition, particularly the historic measurements are relatively uncertain. Despite these uncertainties, the different trends follow a consistent pattern which, together with water budget calculations, suggest a change in the hydrological regime in the past 15 years. These changes seem to be well correlated with the current negative phase of the Interdecadal Pacific Oscillation (IPO) index, and are not necessarily an indication of climate change.

The evidence from different data sources, analyses, and numerical modelling supports a change in the hydrological regime of the Wairau catchment. Since the year 2000, precipitation and Wairau River flows have been below the long term average while PET was on average higher. This resulted in an increased number of days with extreme low flow, which in turn explains in part the declining Wairau Plains aquifer recharge. Further questions to be addressed in that respect are the impact of concurrent land-use changes in some parts of the catchment, and uncertainties related to groundwater usage. In particular, only little historic information is available on actual groundwater abstraction from the aquifer and its spatio-temporal variation.