Geophysical Research Abstracts
Vol. 16, EGU2014-4421, 2014
EGU General Assembly 2014

Assessing river-groundwater exchange fluxes of the Wairau River, New Zealand

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Allocation limits in river-recharged aquifers have traditionally been based on static observations of river gains and losses undertaken when river flow is low. This approach to setting allocation limits does not consider the dynamic relationship between river flows and groundwater levels. Predicting groundwater availability based on a better understanding of coupled river - aquifer systems opens the possibility for dynamic groundwater allocation approaches.

Numerical groundwater models are most commonly used for regional scale allocation assessments. Using these models for predicting future system states is challenging, particularly under changing management and climate scenarios. The large degree of uncertainty associated with these predictions is caused by insufficient knowledge about the heterogeneity of subsurface flow characteristics, ineffective monitoring designs, and the inability to confidently predict the spatially and temporally varying river - groundwater exchange fluxes. These uncertainties are characteristic to many coupled surface water - groundwater systems worldwide. Braided river systems, however, create additional challenges due to their highly dynamic morphological character and mobile beds which also make river flow measurements extremely difficult.

This study focuses on the characterization of river - groundwater exchange fluxes along a section of the Wairau River in the Northwest of the South Island of New Zealand. The braided river recharges the Wairau Aquifer which is an important source for irrigation and municipal water requirements of the city of Blenheim. The Wairau Aquifer is hosted by the highly permeable Rapaura Formation gravels that extend to a depth of about 20 to 30 m. However, the overall thickness of the alluvial sequence forming the Wairau Plain may be up to 500 m. The landuse in the area is mainly grapes but landsurface recharge to the aquifer is considered to be considerably smaller than the recharge from the Wairau river.

This study aims at the assessment of river-groundwater exchange fluxes and presents first results from data mining and analysis of river flow records, stage gaugings, groundwater head data, pumping test, and the sampling of spring flows. In addition, a methodology is presented that will allow the prediction of transient river exchange fluxes by using a Modflow model, global optimisation techniques, and techniques for quantifying predictive uncertainty which have been recently developed (Wöhling et al 2013). A long-term goal of the study is the reduction of predictive uncertainty of model predictions by optimal design of sensor networks as well as the assessment of this utility by different observation types.

Preliminary results indicate that about 7 cumec from the Wairau River is recharged to the aquifer under low flow conditions. A similar volume of groundwater re-emerges as springs where groundwater is forced upwards by the confining Dillons Point Formation.

References

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