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Rainfall recharge estimation on a nation-wide scale using satellite information in New Zealand

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Models of rainfall recharge to groundwater are challenged by the need to combine uncertain estimates of rainfall, evapotranspiration, terrain slope, and unsaturated zone parameters (e.g., soil drainage and hydraulic conductivity of the subsurface). Therefore, rainfall recharge is easiest to estimate on a local scale in well-drained plains, where it is known that rainfall directly recharges groundwater. In New Zealand, this simplified approach works in the policy framework of regional councils, who manage water allocation at the aquifer and sub-catchment scales. However, a consistent overview of rainfall recharge is difficult to obtain at catchment and national scale: in addition to data uncertainties, data formats are inconsistent between catchments; the density of ground observations, where these exist, differs across regions; each region typically uses different local models for estimating recharge components; and different methods and ground observations are used for calibration and validation of these models.

The research described in this paper therefore presents a nation-wide approach to estimate rainfall recharge in New Zealand. The method used is a soil water balance approach, with input data from national rainfall and soil and geology databases. Satellite data (i.e. evapotranspiration, soil moisture, and terrain) aid in the improved calculation of rainfall recharge, especially in data-sparse areas. A first version of the model has been implemented on a 1 km x 1 km and monthly scale between 2000 and 2013. A further version will include a quantification of recharge estimate uncertainty: with both "top down" input error propagation methods and catchment-wide "bottom up" assessments of integrated uncertainty being adopted. Using one nation-wide methodology opens up new possibilities: it can, for example, help in more consistent estimation of water budgets, groundwater fluxes, or other hydrological parameters. Since recharge is estimated for the entire land surface, and not only the known aquifers, the model also identifies other zones that could potentially recharge aquifers, including large areas (e.g., mountains) that are currently regarded as impervious. The resulting rainfall recharge data have also been downscaled in a 200 m x 200 m calculation of a national monthly water table. This will lead to better estimation of hydraulic conductivity, which holds considerable potential for further research in unconfined aquifers in New Zealand.