Geophysical Research Abstracts
Vol. 20, EGU2018-12333-2, 2018
EGU General Assembly 2018

Uncertainty analysis of the Chloride Mass Balance approach to regional-scale groundwater recharge estimation

Gemma Bloomfield (1), Neil McIntyre (1), and Harald Hofmann (2)

(1) The University of Queensland, Sustainable Minerals Institute, Australia (g.bloomfield@uq.edu.au), (2) The University of Queensland, School of Earth and Environmental Sciences, Australia

The Chloride Mass Balance (CMB) method is a common approach for estimating long-term average groundwater recharge. In its simplest form, the CMB method requires three inputs for producing point estimates of recharge; namely chloride concentration in groundwater (CIGW), chloride concentration in rainfall (CIRF), and precipitation. Point estimates of recharge can then be upscaled to regional estimates using an interpolation method such as kriging. Out of the various uncertainties involved, we highlighted three for further investigation: 1) the number of available CIGW samples; 2) estimation of runoff at sample locations; and 3) estimation of removal of chloride through cropping and grazing at sample locations. Current work focuses on the first of these using the outcrop area (approximately 9,000 km^2) of the Main Range Volcanics (MRV) in southeast Queensland, Australia as a case study. Rainfall in the region ranges from approximately 630 mm/yr in the west to approximately 1,200 mm/yr in the east. A total of 1,203 CIGW samples from the MRV were available. Sub-samples of sizes 10, 25, 50, 100, 250, 500, and 1,000 were randomly drawn, without replacement, from the full dataset. This was repeated 1,000 times to give 1,000 draws of each sub-sample size. For each sub-sample, ordinary kriging was then used to generate gridded estimates of CIGW at a resolution of 5 km by 5 km across the MRV outcrop area. The uncertainty in the spatial pattern and spatial average of recharge over the 1,000 draws for each sub-sample size was evaluated. The MRV outcrop-average recharge using all 1,203 samples was 4.6 mm/yr, while it ranged from 1.6 to 230 mm/yr for sub-sample size 10, and 4.3 to 5.2 mm/yr for sub-sample size 1,000. As sub-sample size increased, the distribution of MRV outcrop-average recharge values tended towards a normal distribution (from a positively skewed distribution), which is consistent with the central limit theorem. At least 250 CIGW samples were required to achieve a satisfactory level of uncertainty, which is defined as 95% of the MRV outcrop-average recharge values falling within 1.0 mm/yr of the mean value. Spatially, recharge values converge to a predictable pattern as sub-sample size increases, including the consistent placement of the highest recharge rates in the southeast of the outcrop area. This is due to the better spatial coverage of CIGW samples with increasing sample size. This work demonstrates that many previous applications of the CMB method may suffer from large and unquantified uncertainties due to the number and distribution of samples used.