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Hydrology and Earth System Sciences
Discussions

# *Interactive comment on* "Theory of the generalized chloride mass balance method for recharge estimation in groundwater basins characterised by point and diffuse recharge" *by* N. Somaratne and K. R. J. Smettem

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My concern with this analysis is the lack of recognition of the boundary conditions associated with the CMB (chloride mass balance) method (see Wood 1999 for their definition). That is, the authors claim that the CMB method is inappropriate in aquifers exhibiting variable spatial recharge rates. The authors are certainly correct in their assessment of the large hydraulic heterogeneity of karst systems; however, they appear to have confused the physics of the mass balance approach with the sampling prob-



lems associated with heterogeneity. For example, if one had a steady-state chemically homogeneous and isotropic aquifer with no sources of chloride other than precipitation and had a constant spatial and temporal value of chloride in the precipitation, a single groundwater sample would suffice to estimate regional recharge of the entire aquifer. If the aquifer were heterogeneous containing areas of both focused and diffuse recharge, then a single sample is unlikely to represent the average value. Thus, groundwater-sampling density in a heterogeneous system is critical in acquiring an unbiased estimate of the average chloride concentration, thus, average recharge flux. Mass balance is, however, independent of focused or diffuse flow; mass balance is mass balance! In this system it might be argued that there is insufficient groundwater sampling points, that the distribution of chloride in the rainfall is not adequately known, or that chloride in rainfall is not at steady state; thus, the CMB is inappropriate. It is not, however, the failure of the CMB approach, only the lack of application of the necessary boundary conditions.

Unfortunately one does not generally know a priori what percentages of recharge are diffuse or focused flow; thus, how many samples to collect. Owing to the unknown, and realistically unknowable, spatial distributions of diffuse and focused recharge areas in most aquifers I fail to see the practicability of the authors deterministic equations, which require basically the same assumptions as the CMB plus additional and difficult to acquire parameters with unknown errors. One, however, might be able to develop a stochastic expression based on the standard deviation of chloride concentration with space in an aquifer system that addresses the heterogeneity of recharge and assist in constraining the location and number of samples required to provide a representative regional chloride value.

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Wood, W. W., 1999, Use and misuse of the chloride-mass balance method in estimating ground water recharge; Ground Water, v. 37, no. 1, p. 2-3.