Estimating groundwater recharge: uncertainty in the Chloride Mass Balance method and its spatial disaggregation

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Background

Previous research on groundwater recharge estimation shows that the assumptions of the estimation method used have a significant impact on the generated estimates. In particular, the Chloride Mass Balance (CMB) method is a widely-used technique, yet there is little literature addressing the uncertainty of the method.

Research Questions

- Which are the important uncertainties in the CMB calculation and what influence do these have on recharge estimates at different spatial scales?
- What are the minimum data requirements to support application of the CMB method?

Case Study Area

The Main Range Volcanics (MRV):
- 1,203 chloride in groundwater (Cl_{GW}) samples available

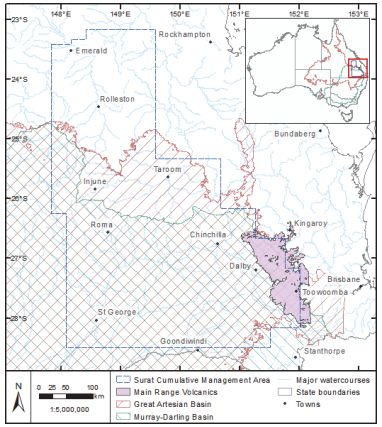

Fig 1 Location of the Main Range Volcanics.

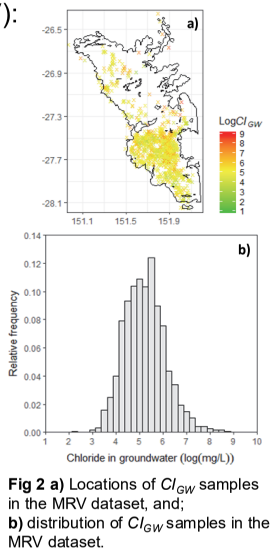

Fig 2 a) Locations of Cl_{GW} samples in the MRV dataset, and; **b)** distribution of Cl_{GW} samples in the MRV dataset.

CMB Method – Influence of Sample Size

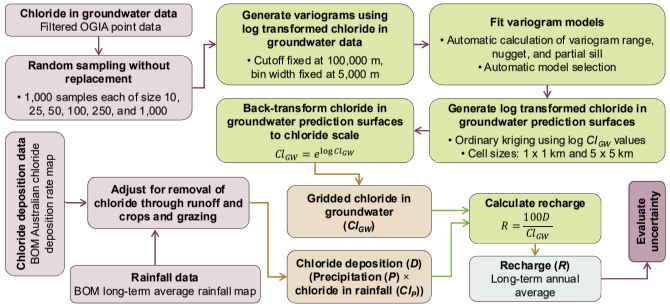

Fig 3 Process used to assess the influence of sample size on recharge estimates produced using the CMB method and kriging.

Fitted Variogram Models

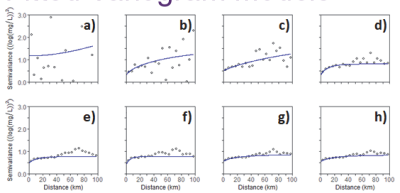

Fig 4 Variogram models for Subsample No. 560, subsample sizes: **a)** 10; **b)** 25; **c)** 50; **d)** 100; **e)** 250; **f)** 500; **g)** 1,000; and **h)** all samples.

Fitted model type for full dataset: Matérn.

Gridded Estimates of Cl_{GW}

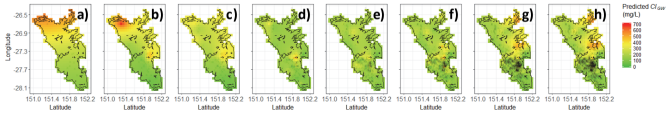

Fig 5 Subsample No. 560, subsample sizes: **a)** 10; **b)** 25; **c)** 50; **d)** 100; **e)** 250; **f)** 500; **g)** 1,000; and **h)** all samples. 'X': sample locations (CRS: GDA94).

Gridded Recharge Estimate Components

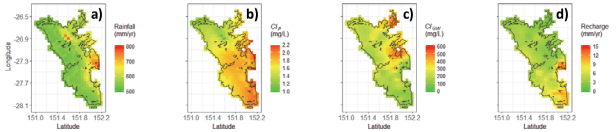

Fig 6 a) Scaled rainfall (i.e. rainfall minus potential runoff); **b)** scaled Cl_P (i.e. reduced by 25% to account for cropping and grazing); **c)** predicted Cl_{GW} for full dataset; and **d)** estimated annual average recharge for full dataset (CRS: GDA94).

Recharge Estimates

Subsample Size	Mean (mm/yr)	St Dev (mm/yr)
10	6.27	9.71
25	5.33	1.35
50	5.28	1.36
100	5.18	0.75
250	5.11	0.56
500	4.99	0.46
1,000	4.81	0.16
1,203	4.73	-

Table 1 Average whole-outcrop recharge estimates calculated from the 1,000 layers for each subsample size.

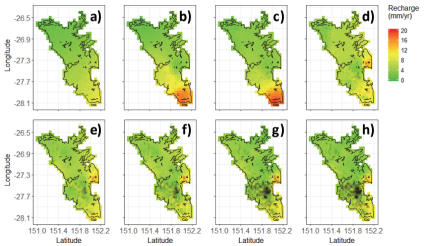

Fig 7 Gridded recharge estimates for Subsample No. 560, subsample sizes: **a)** 10; **b)** 25; **c)** 50; **d)** 100; **e)** 250; **f)** 500; **g)** 1,000; and **h)** all samples. 'X': sample locations (CRS: GDA94).

Variability in Recharge Estimates

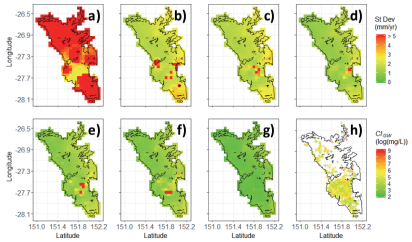

Fig 8 Standard deviation based on the 1,000 recharge estimate layers for subsample sizes: **a)** 10; **b)** 25; **c)** 50; **d)** 100; **e)** 250; **f)** 500; and **g)** 1,000 with **h)** distribution of the full dataset of Cl_{GW} values for reference (CRS: GDA94).

Conclusions

- Results sensitive to kriging process
- Output recharge maps not appropriate for applications sensitive to spatial distributions of recharge

Next Steps

- Investigate influence of spatial distribution of Cl_{GW} samples
- Investigate alternative methods for back-transforming log Cl_{GW} predictions

Acknowledgements

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