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Discussions

Interactive comment on "Estimating fast and slow reacting component in surface and groundwater using 2R model" *by* P. Jamwal et al.

Anonymous Referee #2

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General Comments

The title does not accurately reflect the content of the paper. A more appropriate one would be "Comparison of fast and slow reacting components in surface and groundwater using the two-reactant model" The abstract provides good coverage.

The paper does not present any new concepts or tools, but does contain new data sets for chlorine decay in one surface and one ground water. It also presents new ideas on the fitted initial reactant concentrations, but these are questionable for reasons given in the Specific Comments below. Consequently, the conclusions reached are not sustainable. The methods and assumptions are generally valid, well described and sufficient to allow reproduction of similar results by peers.

The authors have clearly distinguished their new contributions. However, they have not given appropriate credit to already published work on chlorine decay in groundwaters and have incorrectly cited other work (see below).

The overall presentation is mostly well structured, but the language would benefit from further editing, particularly the lack of definite and indefinite articles. Mathematical formulae and associated symbols, abbreviations and units are generally well defined and used. There is some overlap between Results, Discussion and Conclusions, which should be eliminated. Perhaps a combined Results and Discussion would be beneficial for this purpose. References were mostly appropriate.

Specific Comments

P201, L9. Neither Mutoti et al. (2007) nor Rossman (2006) considered the 2R model to describe chlorine decay in bulk water. Their papers assume a traditional first-order bulk decay model and are more concerned with the additional decay due to interaction of chlorine with the pipe wall.

Fisher et al. (2011) primarily showed that the 2R model accurately described the effect of varying initial chlorine concentration (ICC) with a single set of (constant) coefficients. It was Fisher et al. (2012) that conclusively showed the same was true for any combination of ICC and temperature imposed on a given water, provided a single additional coefficient was used to characterise the effect of temperature. This augmented (2RA) model additionally accurately describes decay under multiple rechlorinations (Fisher et al., under review).

More recently, by characterising bulk chlorine decay in individual waters with the 2RA model, Fisher et al. (2015) found that decay in blends of two (or more) waters at any blend ratio was accurately predicted by a suitable combination of these models, without any change to coefficients after the initial model calibrations.

P206, L6ff. The authors claim that it is the high ratio of initial concentrations of slow to fast reactants that is responsible for the poorer prediction of the groundwater validation data by the 2R model. It should first be noted that even R2 values of 0.94 and 0.89 indicate a very good match to the data (also evident visually from Figure 3).

The high reactant ratio in groundwater arises from a very low (calibrated) value of fast reactant (0.003mg/L) compared with 8mg/L of slow reactant. The low value indicates that the fast reaction is negligible in groundwater; i.e. a single slow reaction would represent the groundwater decay data almost as well as the fitted 2R model. However, a more likely reason for the lower R2 values of 0.94/0.89 for the validated data is that R2 is a measure of fit involving the error relative to the variance in the data. The groundwater data has far lower variance than the surface water data and the lower-ICC groundwater data has lower variance than the higher-ICC data. Even with the same level of error in all data, this would account for the variation in R2. This is another reason for using RMSE, rather than R2, as a measure of model accuracy.

The evidence presented (and the previous work from the literature) does not support the authors' contention that "Employing [e.g. 2R] models that accurately predict chlorine decay in surface water may not always be suitable for groundwater" (P205, L15).

P205, L10. The authors claim that the 2R model has not previously been fitted to decay data from groundwaters. On the contrary, Fisher et al. (2011) fitted the 2R model to data from an artesian bore water at Wanneroo Groundwater Treatment Plant (Warton et al. 2006), achieving R2>0.94 for ICCs up to 10mg/L with a single set of coefficients, even when only the highest and lowest ICCs were used as calibration data. Fisher et al. (2015) fitted the 2R model to a different artesian water and two shallow groundwaters from the Mirrabooka Groundwater Treatment Plant. They achieved RMSEs 0f 0.02-0.07mg/L, which is of similar order to measurement accuracy ($\pm$0.05mg/L). R2 values were not presented as they were greater than 0.9.

The authors' presentation of parameter values in Table 5 are not those from Fisher et al. (2011), but instead are some of those of Fisher et al. (2012).

No technical corrections are included here, due to the following recommendation.

Recommendation

The authors' main claim to novelty was that there has been no previous work published on representing chlorine decay with the 2R model. As discussed above, this is incorrect. The novelty is therefore reduced to generation of two new datasets, from which unsustainable conclusions were drawn, regarding the adequacy of the 2R model to represent decay in groundwaters. I therefore do not recommend that the paper be published in its current form.

If the novelty of fitting extra data sets with the 2R model is sufficient for DWES, then a heavily revised version of the paper that reached more sustainable conclusions might warrant review for future publication.

Additional References

Fisher, I; Kastl, G; Sathasivan, A., (2012). A suitable model of combined effects of temperature and initial condition on chlorine bulk decay in water distribution systems. Water Research, 46(10), 3293-3303. Fisher, I., Kastl, G., Sathasivan, A., Cook, D., and Seneverathne, L. (2015). A general model of chlorine decay in blends of surface waters, desalinated water and groundwaters. ASCE Journal of Environmental Engineering DOI:10.1061/(ASCE)EE.1943-7870.0000980. Fisher, I., Kastl, G., Sathasivan, A. (under review). A comprehensive bulk chlorine decay model for simulating residuals in distribution systems. Warton, B., Heitz, A., Joll, C., Kagi, R., (2006). A new method for calculation of the chlorine demand of natural and treated waters. Water Research, 40:2877.

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