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Drinking Water Engineering and Science Discussions

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Interactive Comment

Interactive comment on "A bottom-up approach of stochastic demand allocation in water quality modelling" *by* E. J. M. Blokker et al.

Anonymous Referee #2

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The present manuscript includes descriptions of significant field experiments and presents extensive data sets pertaining to an intermediate-scale water system. The seven-week tracer study alone should prove very valuable to the water distribution research community. Instead of using the traditional top-down method, the authors employed a bottom-up approach to analyzing stochastic demand allocation for water quality modeling. In particular, they used "water age" (or "water retention time") in the pipe network as the key parameter. Consequently, the bottom-up model accounts for water demand variability and thus exhibited a better performance when predicting water age at four locations over the distribution network. The study highlights the importance of using a representative hydraulic model in order to better predict water quality. The authors noted the advantages of their approach, contending that it gave insight into the variability of travel times as an added feature, beyond the conventional way of modeling.

My specific comments, suggestions, and concerns are as follows;

1. Overall, both models (BU vs. TD) produced acceptable results. Although it is clear that ModelBU does not require measurements and calibration processes, it involves coupling the hydraulic model with SIMDEUM and multiple runs to account for variability. I suggest that the authors strengthen the manuscript by specifying the benefits of the bottom-up approach, particularly those related to the input data requirement.

2. Because water age is the key variable when evaluating and comparing the performance of both models, it is important to specify the presence or absence of water tanks.

3. I can see the reasoning behind the statement made on Page 2, in Lines 14-16, specifically the reasoning of saying “without the need for any flow measurements or calibration measurements.” However, this is partially true if we consider that ModelBU did require a DMPbooster and a DMPhotel as indicated by Table 2. It is true that SIMDEUM does not require any flow measurements or calibration measurements?

4. It would be helpful to include the input pulse in Figure 7, although it may be redundant as shown in Figure 3. This would also account for the discrepancy on p. 5, L1: 3 h + 20 h = 23 h (which most likely should be 3 h + 21 h = 24 h).

5. There are only 14 houses at the location 4. Thus, an intermittent, low-Reynolds number flow along the pipe is quite possible. The electrical conductivity in mS/m for Loc. 4 has a 24-hour delay, which is quite reasonable for the given circumstance. If so, I would expect the flow rate to fall below the critical Reynolds number (Re = 2100) for a prolonged period and then the corresponding concentration (or EC) would become significantly influenced by axial dispersion. I see a significant tailing, but I am puzzled by the EC readings. I would expect the EC curve to be completely flattened with a long tail. The maximum EC reading at 68 mS/m at loc. 4 is indeed higher than those

measured at loc. 1 and loc. 2. I suggest the authors revisit their data analysis.

6. As the authors noted, the EPANET water quality model does not presently include dispersion or mixing. Mixing may not be so important for the present study; however, dispersion can be significant. A few dispersion models are available as a result of a series of concerted efforts (made by Tzatchkov, Buchberger, etc.). Those models have not yet been properly validated for the present study. Nonetheless, it would be helpful if the authors were to summarize in a paragraph the recent development of water quality models and how those efforts could help to estimate water retention time for the present study. Additionally, the ranges in Reynolds number could be helpful in understanding the degree of dispersion in the network; i.e., the maximum and minimum Re in addition to the percentages given on p. 10, L. 15-19. This does not mean that the authors should address the dispersion issue in detail in the present paper. The issue is critically relevant but beyond the scope of the present study.

7. In Figure 8, the measured water age points are consistently aggregated along ModelBU and ModelTD when the time approaches 18 h and beyond. Those are especially pronounced in (a)-(c). Explain the reason.

8. p. 4, L27-28: The baseline EC = 57 mS/m seems reasonable. "EC = 68 mS/m with dosage" seems quite low and the difference is merely 10 mS/m from the baseline EC. It might be challenging to detect accurately at the downstream, but all the readings look excellent and consistent. To assure readers, include the accuracy of the conductivity measurement devices used for the field experiments. Was there any concern about the buoyancy effect (i.e., heavy salt water settling to the bottom of the tube)?

Other minor comments are:

Page 2, Line 1: Spell out DMA.

Page 3, Line 20: Typo. "Methods" instead of "Methodes."

Table 2 – Should DPMhotel be DMPhotel?

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Page 6, Line 23: Explain the criteria used in determining the different time steps (i.e., how and why were those steps selected?).

Page 10, Lines 4-8: The following two sentences refer to the results obtained using ModelTD when accounting for variability. However, I do not see these results in Figures 8.

“With the top-down approach it is also possible to introduce variability; based on two weeks of flow measurements14 different DMP and 14 corresponding day factors (with values between 0.9 and 1.3) were imposed (Blokker and Beverloo, 2009). This resulted in a narrow 95% confidence interval around the mean, as shown in Fig. 8.”

Page 9, Line 7 & Page 10, Line 10: The second of the following statements seems to contradict the first. The authors should either explain the apparent contradiction or revise one of the statements so as to alleviate the problem. “For all locations the ModelBU predicts the water age better than ModelTD.” “Both models resulted in similar flow patterns at the booster station and similar water ages at the demand nodes.”

Page 10, Line 16: Correct the typo in “12% if the pipes.” It should be “12% of the pipes.”

Figure 1: Location labels should not be above the depicted the pipe lines. Use leaders or arrows to pinpoint the locations.

Figure 3: Though it seems obvious that the dashed line corresponds to location 1 and the continuous gray line corresponds to location 2, labels make this clear. Delete the background concentration running at around 58 mS/m (dark gray line, apparently denoting a location further downstream)

Figure 4: Although the purpose here is to plot the diurnal multiplier patterns, indicate the average demands (mˆ3/h) for both the booster station and the hotel patterns.

Figures 5 and 6: Indicate the demand allocation model used to obtain simulated flow rates (ModelTB)

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