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Interactive comment on "GLOBAL-FATE: A GIS-based model for assessing contaminants fate in the global river network" *by* Carme Font et al.

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This manuscript presents a generalization of the FATE model for global applications. The model inherits all the simplifying assumptions and limitations of FATE and focuses on providing a GIS platform suitable for global applications.

General comments

The modeling part is simplistic, as in FATE, and boils down to the application of the following first order decay equation, providing the contribution of a cell to the annual load observed at the reference cell: $L = L_0 exp[-k\tau]$, where L is the contaminant annual load $[g/year]$ at the reference cell, L_0 is proportional to the population of the contributing cell and τ is the residence time from the contributing cell to the reference

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Discussion paper

one. The loads of all the cells contributing to the reference one are added such as to obtain the total load, which is then divided by the annual water discharge at the same cell. This approach does not capture important mechanisms, such as seasonality in the releases, temperature and hydrology, which may cause significant fluctuations of the contaminant concentration. This is somewhat acknowledged by the authors in the discussion.

Recently, we published a more comprehensive model (Diamantini et al., 2019), which under suitable assumptions can be reduced to the approach presented in the manuscript, but that is more general and allows to take into account the above processes. This previous published work includes also the effect of lakes that the authors claim they introduced for the first time. I think that the work we did is relevant to this contribution since it represents a generalization of the proposed approach.

I appreciated the disclaimer the authors introduced in the conclusions, where they warned users against the application of the model at what they call the "very local" scale. However this scale is not adequately defined, though by mentioning the watershed scale as an example of scale at which the model cannot be applied and the following suggestion of not using the model "below the country level" provides some, but still ambiguous, guidelines. This notwithstanding, the disclaimer poses strong limitations to the analyses that can be done and a more comprehensive discussion about the limits of applications is needed, in my view, to avoid misuses of the proposed model. Considering that the model cannot provide valuable information at important scales, such as the watershed scale and downstream large urban areas (see sentence beginning at line 9 of page 15), where the impacts are evaluated, I am wondering what type of indications the model can actually provide, besides suggesting the reduction of drug consumption, a recommendation that can be done by considering the total consumption based on census information. In other words, my concern is that hydrological processes may not be so relevant for the type of questions that the model can actually answer, considering the level of simplification introduced, thereby making this model

not clearly preferable to alternative approaches, such as simple regressions or machine learning, for example. A discussion supporting the utility of the model is needed here.

The authors remark that GLOBAL-FATE is not associated to a spatial resolution, or extent, and consider this as the "main strength" of the proposed approach. I disagree with this conclusion. The size of the cell has an impact on the way the river systems are represented and a coarse gridding may produce inaccurate estimates of the residence time. For instance, the raster of 1/16 degree used in the example of application is already too coarse and does not guarantee a good reproduction of the river system in densely populated areas, such as in Europe for example. On the other hand, this gridding may be ok in large rivers with low population density, but as a consequence with low impact. An upper limit should be indicated here and a warning to avoid improper applications with large cells should be issued.

Detailed comment

I am wondering how the value that the NS assumes after log-transforming the data compares with that obtained without the transformation. In Figure 5 the points are rather disperse and this may be due to the attenuating effect of errors when the log-transform is applied.

Alberto Bellin

References

Diamantini, E., Mallucci, S., Bellin, A. 2019 A parsimonious transport model of emerging contaminants at the river network scale. Hydrol. Earth Syst. Sci., 23(1): 573-593, doi:10.5194/hess-23-573-2019.

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