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Discussions

Interactive comment on "Possibilistic response surfaces combining fuzzy targets and hydro-climatic uncertainty in flood vulnerability assessment" *by* Thibaut Lachaut and Amaury Tilmant

Anonymous Referee #2

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Lachaut and Tilmant introduce the concept of "possibilistic surfaces" to describe conditions under which success or failure of a water resources system is possible, where regions of "possibility" are defined in three different ways: 1) using logistic regression and defining success regions as conditions under which the logistic regression predicts success in meeting a threshold of satisfaction with at least some probability p, 2) using fuzzy performance thresholds in which a hard success/failure threshold does not need to be defined for a logistic regression model, rather a fuzzy membership function is used to assign continuous performance values to fuzzy sets, and 3) using convex

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Discussion paper

hulls to define regions of success based on the outer bound of scenarios in which performance was found to be acceptable. The authors also discuss benefits of employing non-gridded sampling of conditions under which to evaluate water system performance to generate these surfaces.

Of the 3 possibilistic surfaces introduced by the authors, I believe only the second is new to the literature. As noted by the authors, Kim et al. (2019) use logistic regression to define success and failure regions. However, the authors do not discuss Quinn et al. (2018), who used logistic regression as described in this paper to define success/failure regions that account for stakeholders' different levels of risk aversion by choosing different probabilities of success from the logistic regression to define the boundary. The authors also state that logistic regression cannot capture nonlinear relationships in the mapping of climate conditions to success/failure, but this is not true. One can easily incorporate interaction or nonlinear predictors in a logistic regression just as in a linear regression. See Hadjimichael et al. (2020) for an example. Other studies which use logistic regression for scenario discovery that were not cited by the authors include Lamontagne et al. (2019) and Marcos-Garcia et al. (2020).

With respect to the convex hull representation of possibilistic surfaces, this sounds like info-gap decision theory (Ben-Haim, 2006), which the authors do not discuss in the paper. It is not clear what their method contributes beyond this approach. It is also worth noting potential problems with this approach. One, which is briefly described by the authors, is that if the failure boundary is not convex, it could be too conservative. For example, a failure region like the red region in the attached figure could be estimated by logistic or linear regression with an interaction term between the two factors on each axis to capture the non-convexity. The convex hull, however, would include everything to the right of the black line, which includes a substantial region of successes in blue. But a convex hull might not always be more conservative like the authors imply. This is because it is defined by the realized values from their model simulations. As discussed by the authors with respect to their logistic regression model, none of the GCMs met their failure definition, but the probability of success in those worlds did not always meet their threshold of acceptability. They might not fall within the convex hull of failures, though, making the convex hull a less conservative definition in that case.

Where I think the authors have introduced a new approach to the literature is in combining logistic or linear regression with fuzzy set membership. The question is, what value does this method add to the alternative approaches? I think this should be the focus of the paper, and it is not currently clear what that value is. Personally, I find the first and third approaches more intuitive. It is easy to understand what a probability of success represents, so defining success regions based on probability contours from a logistic regression makes sense to me. Similarly, it is easy to understand a failure region defined by lines connecting the farthest scenarios in which failures have occurred. I find fuzzy sets much harder to interpret, and more subjective to define. But I think it could provide value in that no hard success/failure threshold has to be assumed if using it with linear regression, whereas this is not true for the other two approaches. It would be helpful to expound more on this benefit, and the differences that come out of using this approach as opposed to Method 1. It is likely no method dominates all others, but why is this new method on the Pareto front of options? This needs to be better emphasized by comparing and contrasting the regions that come out of the alternative approaches.

Finally, the authors discuss shortcomings of using gridded scenarios to build models of success/failure regions, but they never compare their non-gridded sampling to a gridded sample to illustrate its claimed superiority. I suggest the authors remove this argument entirely as it is a secondary argument anyway, and is never actually illustrated. Please see the annotated manuscript for additional, more minor comments.

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Please also note the supplement to this comment:
https://hess.copernicus.org/preprints/hess-2020-214/hess-2020-214-RC2-supplement.pdf

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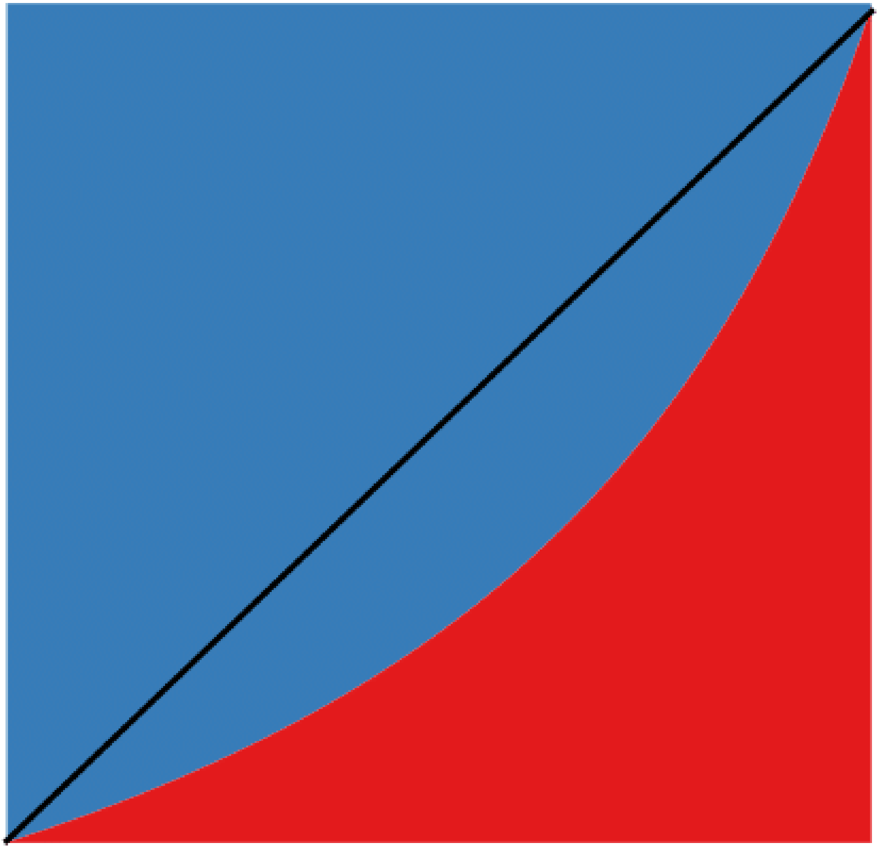

Fig. 1.