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Notes on revised draft of Hu, HZ, Q Ke, W Wu, M Zhang, YJ Wu, CM Jin, JH Wen, “Robust Adaptive Pathways for Long-Term Flood Control in Delta Cities: Addressing Pluvial Flood Risks under Deep Uncertainty.”

Upon reading the authors’ response to reviewers and the revised manuscript, I continue to believe that the authors present an interesting and important study that will be important not only to the local authorities in Shanghai but also provide an illustration that may be applied more broadly. Especially with the incorporation of guidance from Reviewer #2, the bulk of the paper is in a form that should now be considered for publication.

However, I continue to also believe that the authors buy themselves more conceptual trouble than they need in the first quarter of the paper. I refer back to my comments on the relationship of robustness to adaptivity. Because of the potential implications for methodology and problem framing, I think the matter more than just a trivial problem of nomenclature.

In a way, the authors have been made the innocent victims of the teething problems of the nascent field of DMDU, a field whose practitioners have either failed, not yet gotten around to, or deliberately chosen not to define terms with precision nor the relation of these terms to their several methods. It is not incumbent upon the present authors to resolve this muddle. But they should be afforded the opportunity to not be made targets for criticism stemming from this condition.

The term robustness, as indicated in my initial review comments, is much abused in the sense that different fields use it differently. There is, of course, the concept of a robust statistics. In engineering, a structure is made robust by designing it for some multiple of the strain that might be incurred during its lifetime. The meaning of robustness as applied to the problem of decision making under deep uncertainty has from the onset been similar to that used by the authors: “the ability of a strategy [sic] to maintain acceptable performance across a wide range of plausible futures” (l. 135-6). The use of the word “strategy” is itself somewhat problematic. A more apt phrase would be “course of action”. That is because it is in the essence of robust decision approaches in the DMDU setting to use adaptation as the principal mechanism for determining what will unfold as a course of action. What is established as a result of a robust decision analysis is not so much a strategy in the traditionally understood meaning of the term but rather a set of rules that may be agreed to ex ante the better to guide the adaptations that the principles of robustness under deep uncertainty presume will be necessary.

Robust Decision Making (RDM), to which the authors specifically refer, is built upon principles derived from traditional decision science, exploratory modeling (Bankes, 1993), Assumption-Based Planning (Dewar, 2002), and an operationalized version of scenario planning. What the

authors cite as “metrics...to quantify robustness under uncertainty” (l. 251-2) represent only the first of these components. They can be used as metrics, as the authors later do, but they were not proposed by their creators as definitions of robustness as the authors also do. They are a set of theoretically derived alternative decision rules. It is precisely because all recognize that they are susceptible to perverse corner solutions, particularly under evolving circumstances, that they cannot in themselves be guaranteed to provide robustness nor easily to account for all the multi-attribute problems of wicked problems under deep uncertainty. They work best in a world in which there are only a limited number of criteria for success. It was precisely for this reason that a more over-arching concept of robustness was required and methodologies developed to explore robustness. And those methods are inherently adaptive in pursuit of robustness. (As an historical aside, what is termed RDM was originally called Robust Adaptive Planning (RAP). RDM was presented as a larger categorical term to which RAP belonged. The further vicissitudes of this nomenclature are not relevant to this review.)¹

Again, this matters because despite offering a workable definition of robustness, their actual use of the concept still sets up what is in the opinion of the review a false dichotomy with adaptiveness: e.g., “...comparing the costs and benefits of a flexible investment strategy with those of **a less flexible, that is, a more robust** strategy” [emphasis added, l. 330]. This usage tends much more toward the engineering use of the term than that which has evolved in the DMDU community.

Let’s take this last point as a step towards resolution. If there is fundamentally a concept of system integrity lying behind the use of these theoretical decision rules as metrics, let’s use a term better suited to the characterization of an evolving system than to that of a strategy or course of action. Since they are being used in the sense of achieving criteria for measuring system integrity with regards to pluvial flood risk, perhaps two terms that would avoid the problems that currently arise in the draft would be to characterize these as measures of “sufficiency” or “resilience”. Both would be more apt in characterizing long-term fault resistance by a system built over time than is the word “robust” which is used to characterize a course of action determined by analytically derived decision rules.

MINOR POINTS

¹ Perhaps one of the best illustrations of this may be the RDM analysis found within [Molina Perez, E., D. Groves, et al. \(2019\)](#), *pace* the cited claim attributed to Kwakkel (2019) (l. 78). This is not at all to gainsay the considerable value conveyed by the DAPP approach which in its applications and publications has placed priority on spelling out the operational mechanics of adaptation and so made the concept into a method that has been widely applied to great benefit. I think that the authors can use this in their narrative. An analysis of system resilience by use of the chosen metric, Laplace insufficiency, is not adequate because of being led into possible corner solutions, insufficient consideration of all criteria, etc. The use of adaptation analysis will help to avoid these pitfalls.

The sentence in l. 23-24 is problematic as it stands. Suggest: “Decision-makers face significant challenges in determining whether and how to invest in flood defence.”

l. 24-25. This sentence lays the fundamental problem focused on by this reviewer squarely up front. Despite that, both instances of the word “to” should be deleted.

l. 125. Delete “an” before “options”.

l. 310-11. The phrase “vulnerable scenarios” does not quite ring correctly. It is not the scenarios which are vulnerable. Rather, these are scenarios under which particular chosen courses of action may prove to be vulnerable. It might be better instead to refer to “stressful” scenarios. That is, a set of conditions that might stress the ability of a chosen set of rules governing a course of action to meet long-term objectives.