

Response to Reviewer 1

We thank anonymous reviewer 1 for their considered and constructive comments on our manuscript “A framework for modelling the complexities of food and water security under globalisation”.

Following is our response. The reviewer’s comments are written in *Italics*.

This is an interesting and timely paper, proposing a new method/framework to capture cross-scale and cross-sector, globalized food-water interactions as apparent, for example, in virtual water trade. It is great to see such a forward-looking paper that promotes novel ways of modelling (building on combinations of existing approaches). However, the text is rather long and it is difficult to comprehend what the core and the novel aspects of the new framework are about. Thus, I recommend rewriting some sections, i.e. coming up with a better and more concise paper structure that much earlier introduces the main aspects of the framework, also introducing cities and their hinterlands as a focus/example. Below are some comments on where and how such a better focus could be arranged.

We agree in reflection that the paper can benefit from a more concise structure which presents the core elements of the framework earlier. We have rewritten section 1 to immediately outline the knowledge gaps in understanding food and water security under globalisation that we set out to fill with our framework. Namely, it remains a knowledge gap to capture regional and sectoral interdependencies and cross-scale feedbacks associated with food and water security within a single model framework. Following this, we introduce the main aspects of the framework: cities and hinterlands and the networks that connect them. We explain why these are important elements to capture in order to understand food and water security under globalisation.

Abstract: “The approach unifies and extends the existing fields of hydrology, Integrated Assessment Modelling and agent-based modelling.” This may be an overstatement: maybe not unifying but combining, integrating certain aspects of, or something like this. I think the present concept is not yet as mature.

In the revised manuscript, this is rewritten as “The framework integrates aspects of existing models and approaches in the fields of hydrology, Integrated Assessment Modelling and agent-based modelling”

Why have this first paragraph of the Introduction (which is more on water stress than the questions addressed here).

We agree and have removed the first 2 paragraphs of the introduction from the revised manuscript and replaced with an introductory paragraph that outlines the knowledge gaps within food and water security under globalisation that our framework sets out to address.

p 3 | 15: really unifies existing model approaches? see comment above

We have removed this from the revised manuscript

p 5 | 17: twice “it challenging”

Corrected

p 8 | 34: “envisage a collection of basin-scale sociohydrology’s”, what do you mean?

We have made the section on sociohydrology more concise, as a result the phrase quoted here has been omitted in the revised manuscript.

Section 2 reads like a review of literature (2.1, cities in global context; 2.2, feedbacks of projections in general; 2.3 food and trade; 2.4 water use pathways – all three subsections only loosely connected by the way). It would be good if the overall idea of your (new) concept was summarized earlier and more systematically, so that readers know the particular context of this section. Also, in section 2.1, cities appear rather suddenly as a topic, please introduce this focus earlier.

In the revised manuscript, we have integrated section 2 and 3 into a new section 2 which is more concise. In the new section 2, we have focused on three core topics which we feel are key to understanding water resource use within the globalised food system. These are regional interdependence, sectoral interdependence and cross-scale feedbacks. We outline how these are addressed to differing extents in existing models and approaches and the knowledge gaps in those approaches that we set out to close with our framework. Namely, integrating regional and sectoral interdependencies and cross-scale feedbacks within a single model framework. In the new section 3 in which we present our framework in detail, we systematically outline how our framework can fill the knowledge gaps outlined in section 2.

Similarly section 3: lot of literature review (also including process descriptions that would better fit section 2) while one rather assumes that this section better guides the reader how and for what purpose earlier modelling/accounting approaches (i.e. footprint/virtual water trade studies and sociohydrological studies, ABM-based studies) could be unified. I recommend that these two sections be shortened, more focused, as they are quite verbose.

See previous remark

Section 4 also lacks some introductory remark on how all the aspects (or which of them) mentioned before find their way in a unified model framework. The claimed purpose that it will “capture the structure and constraints of the food system and the dynamics that operate within these constraints and bring about emergent water use patterns” is rather general and probably too ambitious (really capturing all the structure and constraints of the food system? this would include many more aspects than those mentioned, including e.g. access). The basic structure of the framework needs to be clarified much earlier, otherwise it is difficult to follow what it actually covers, and how it does so. Section 4.2 starts with introducing yet other model types (water & food models), so this should rather go to section 3. Then follow again some process descriptions (cities linked to hinterlands) which should rather go to section 2?

In the revised manuscript, all information about other models and processes has been moved to section 2 which covers knowledge gaps in current approaches. We have expanded on the description of land use models (reviewer 3) and placed this in the section 2 of the revised manuscript.

In the revised manuscript, the framework is introduced for the first time in the 2nd paragraph of the introduction section 1. Section 3 of the revised manuscript presents a detailed description the framework. We have removed general terms such as “capture the structure and constraints of the food system and the dynamics that operate within these constraints and bring about emergent water use patterns”. Instead, we provide detailed and specific descriptions of the aspects of the global food system the framework sets out to capture.

And: is any of this new model and analysis framework already in operation, or is it ‘just’ a concept not yet tested?

Elements are in operation already. In the revised manuscript, we are explicit about the level of development of each component of the framework. This will is shown in a revised version of figure 8.

p 7 | 26-27: is that really substantiated, “much of the mid-latitudes will become much less agriculturally productive”?

In the revised manuscript, we have moderated the tone of the statement as follows: “studies indicate that unsustainable groundwater abstraction in mid-latitude regions threatens future food security”. This is substantiated by studies that show that an increasing proportion of irrigated agriculture in mid-latitude countries is sustained by unsustainable groundwater abstraction (see Dalin et al., 2017; Wada et al., 2012).

p 10 | 35: Basel, hinterland crossing three nations: I am not surprised by this and would expect that it actually extends across many more countries (because as you say earlier, industrialized countries import most of their products – from many countries around the world)?

We have removed the specific example of Basel from the revised manuscript. As we mention in the discussion manuscript (P10, L34), if policy between two hinterlands stimulates free trade, then the effective hinterlands of those cities may expand.

p 11 | 12: “Thomas Brinkhoff”: there are more such cases where citation is not correct (only surname to be used).

Examples such as this have been corrected in the revised manuscript

References

- Dalin, C., Wada, Y., Kastner, T., Puma, M.J., 2017. Groundwater depletion embedded in international food trade. *Nature* 543, 700–704. doi:10.1038/nature21403
- Wada, Y., van Beek, L.P.H., Bierkens, M.F.P., 2012. Nonsustainable groundwater sustaining irrigation: A global assessment. *Water Resour. Res.* 48, W00L06. doi:10.1029/2011WR010562