

Interactive comment on “An agent-based model for flood risk warning” by Thomas O’Shea et al.

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RC1 – Response

The authors would like to extend their sincere thanks to the referee for their time and considered thoughts on the submission. All comments and corrections have been thoroughly considered, with our respective action and/or response to these outlined below.

General comments:

This paper recognises the complexity of hazard situations and responses, but also that adaptive actions overall may be simulated from individual or ‘agent’ behaviours through using agent-based models (ABMs). On the physical side, hydrodynamic behaviour can have an equivalent concern for the local through detailed topographic modelling and

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floodwater routing. The paper demonstrates how combining the two, through an innovatively developed approach coupling hydrodynamic and agent-based models (named here HABMs), allows site-specific procedures for warning provision and evacuation to be usefully designed. This is accomplished through simulating populations and exploring their alternative behaviours to see which might be of most benefit for responses to flooding events given the local geography – as in the case of Lancaster, UK, flooding described here. An interesting feature of the approach is that the human behavioural aspects are here justified by appeal to social theory, just as the (now better-established) hydrodynamic modelling is justified and rests on physical theory.

Author response: The authors appreciate the referee’s acknowledgement of their attempt to innovate an approach towards the development of useful designs for warning provision and evacuation that harness the detailed elements of physical and social theory together. The authors agree that physical theory is, currently, the better-established format for justifying action with respect to warning provision and evacuation but also believe that there are influential degrees and actualities of the warning and evacuation processes which are not yet, or cannot be, accounted for within physical theory. It is here where the authors hope their attempts to illustrate the potential influence of these unaccounted factors, through the lens of urban flooding and the HABM framework, find the greatest value.

Specific Comments:

The promotion of new quantitative approaches that combine physical understanding of hazards with possible actualities of human responses to them is surely to be welcome. Until recently there has commonly been an academic gap between the two: (1) improved modelling of physical phenomena and their dynamics on the one hand, but (2) ‘top-down’ imposition of (mostly hard engineering) solutions at affected sites without exploring what their populations might be doing, or could best be doing, in response. Localized decision-making is likely to improve greatly if those involved have good understanding of what best to do in the situation they confront – rather than

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putting schemes to the vote at some higher political level, the advantages or disadvantages of which are little understood on the ground. 'Participatory methods' have to be better than this. Coping with hazards is at heart a human cognitive activity, and so how people at different participatory levels can behave, or get informed as to how better to behave, should be beneficial.

Author response: The authors roundly agree with this assessment and hope the essence of this agreement can be felt from reading the submitted paper. De Groot and Schuitema (2012) suggest, quite robustly, that there is a distinct link between the acceptability of environmental policies, social norms and the characteristics of those policies, further to which, Kinzig (et al., 2013) suggests that the insufficient insight on the coevolution of these norms and policy instruments is what compromises the ability of decisionmakers to craft effective solutions to society's most intractable environmental problems. The authors recognise the growing annual losses attributable to the environmental problem of flooding as an extension of this lack of insight and as having a solution in the analysis, evaluation and development of participatory methods which are equally informed by both physical and social theory. This paper and example therein serve as a vehicle for this sentiment and the authors hope the approach outlined in the paper serve as a catalyst for the development of further hybrid narratives that are necessary for the advancement of effective participatory methods and policy.

Technical Corrections:

Author response: The referee's direction for technical corrections throughout the submission are very much appreciated by the authors and these have been implemented within an updated version of the manuscript to be uploaded following the period of interactive discussion.

18. '... constructed using the Bass Diffusion Model'. 118. Omit last comma in cited references. 127. Put 'Dawson' in the bracketed reference. [also line 570] 171. Dawson et al., 2011; Müller, . . . 183. Semi-colons needed between EA Reports: 2006; 2012;

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2016. And after Neal et al., 2009; [Also in line 752 after 2003.] No need for 'ands' within the reference brackets; see also lines 207-8; 214; 234; 267. 304. 'imitators' 305. a priori. 323. Chen & Zhan, 2008; 334. One quote mark only needed. 394. Dawson et al., 2011; also, no full stop after 1994 within the brackets. 487. Comma after information [to be consistent with elsewhere]. 587. Add full stop to sentence after bracket. 627. How does the map show 'areas through which people are most likely to move' as the caption suggests? That's made more visible in figure 10. 651. Why a semi-colon here? Perhaps: '...traditional terms that may be thought of as an acceptance' 654. Give cited reference, not just its number. [Also line 665] 659. Semi-colon needed after 2015. 719. Last sentence of caption incomplete. 751. Omit 'of'. 758. Full stop after bracket, not before it. 846/7. (Figure 8a), (Figure 8b) [add the word 'figure', and not in bold]. Also line 859. 875. 'being based on shifted Gompertz...' 902. 'value' rather than 'truth' perhaps. 907. Not bold. Need to check house style (especially whether 'figure' should have a capital letter). This long sentence at the start of the paragraph needs recasting, too. 923. their understanding. 940. Readers might appreciate a page number for this quotation. Lettering sizes on Figures 2, 3 and especially the side panels of Figures 5-7 are on the small size.

References:

De Groot, J.I.M. & Schuitema, G., How to make the unpopular popular? Policy characteristics, social norms and the acceptability of environmental policies. *Environmental Science & Policy*, 19-20, 100-107, DOI: <https://doi.org/10.1016/j.envsci.2012.03.004>, 2012. Kinzig, A.P., Ehrlich, P.R., Alston, L.J., Arrow, K., Barrett, S., Buchman, T.G., Daily, G.C., Levin, S., Oppenheimer, M., Ostrom, E. & Saari, D., Social Norms and Global Environmental Challenges: The Complex Interaction of Behaviours, Values, and Policy. *BioSciences*, 63-3, 164-175, DOI: <https://doi.org/10.1525/bio.2013.63.3.5>, 2013.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2019-370>, 2019.

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