Nat. Hazards Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/nhess-2019-132-AC2, 2019

Natural Hazards and Earth System Sciences
Open Access
Discussions

Interactive comment on "A methodology based on numerical models for enhancing the resilience to flooding induced by levee breaches in lowland areas" *by* Alessia Ferrari et al.

Alessia Ferrari et al.

alessia.ferrari@unipr.it

Received and published: 23 September 2019

The authors gratefully acknowledge the positive and constructive review of the anonymous Referee. In this document the comments provided by the Referee are reported in italic, whereas the authors' response and indications about the original paper modifications are marked in bold fonts.

I enjoy reading the paper by Ferrari and co-authors. It presents a method aimed at improving the resilience of lowland areas that are subject to flooding caused by possible levee failures. The method is simple, as it consists of composing a database

of flooding dynamics caused by a (large) number of simulated levee breaches a priori, which allows knowing with good accuracy the flooding dynamics in case of a real levee failure by choosing the simulated event that is most similar in terms of breach locations (and possibly flood magnitude).
I can confirm from my experience that such an information could be extremely useful for civil protection purposes. I am thinking of the case of a town that ten years ago was completely flooded about a day and a half after the occurrence of a levee failure, without undertaking significant countermeasures due to the lack of knowledge about flooding propagation in that area.

The authors wish to thank the anonymous Referee for his positive overview about the manuscript.

The text is clear and generally well written. The English could be slightly improved in term of readability with a careful proofreading.

We thank the Reviewer for his suggestion. The entire manuscript will be carefully revised.

It could be worth adding some discussion on the role of the drainage network that typically dissects rural anthropogenic lowlands. Drainage networks, which comprise ditches and channels of gradually increasing size, as well as small obstructions, were proven to affect the flow dynamics at a local scale, encompassing flood formation, the speed of the submerging wave and the flow direction (Hailemariam et al., 2014; Viero et al., 2014; Viero and Valipour, 2017). On the other hand, it must be recognized that the present study deals with the simulation of major flood events, as those caused by levee breaches generally are, and it is reasonable to assume that relatively small *landscape features produce negligible effects in such cases.*

We thank the Referee for this comment and we agree that drainage networks and microtopography (i.e. tillage feature, ditches) influence the flood dynamics at a local scale, for example by defining preferential pathways. However, as already pointed out by the Referee, in the scenarios here considered, the flood volume (in the order of 10^7 m^3) largely exceeds the discharge capacity of the drainage systems. It is also relevant to notice that most of the minor channels are equipped with gates that are kept closed at the passage of huge flood waves in the river, and hence they do not contribute to the drainage of the flooded volume until the end of the event. Even the possible presence of pumping stations is not relevant during the event, considering the extension of the inundations modelled here.
As a result, these networks are not expected to significantly contribute to the flood dynamics, and hence they were neglected in the terrain description to avoid the excessive increase in the number of computational cells. In fact, the riverbed, the levees, the main artificial embankments and channels were described with the maximum resolution (5 m), whereas the description of the remaining lowlands with small channels would have led to an 80% increase in the number of cells. In addition to this, most of these micro-features would have required an even finer resolution (e.g. 1 m), which would have further increased the computational time.

Finally, I suggest stressing that such a database should be updated when significant modifications affect the landscape and, particularly, the topography of the floodable area, particularly for embankment construction and/or removal, as they can change the flood dynamics dramatically and, often, in unexpected fashions (e.g., Viero et al., 2019).

We thank the Referee for this comment. In the discussion section, we will stress that in order to keep an updated simulations database, the high-resolution bathymetric information has to be periodically modified to include changes to the landscape (i.e. construction/removal of relevant embankments) that are expected to affect the flood dynamics.

ADDITIONAL REFERENCES
Hailemariam, F.M., Brandimarte, L., Dottori, F., 2014. Investigating the influence of minor hydraulic structures on modeling flood events in lowland areas. Hydrol. Process. 28, 1742–1755. doi:10.1002/hyp.9717
Viero, D.P., Peruzzo, P., Carniello, L., Defina, A., 2014. Integrated mathematical modeling of hydrological and hydrodynamic response to rainfall events in rural lowland catchments. Water Resour. Res. 50, 5941–5957. doi:10.1002/2013WR014293
Viero, D.P., Valipour, M., 2017. Modeling anisotropy in free-surface overland and shallow inundation flows. Adv. Water Resour. 104, 1–14. doi:10.1016/j.advwatres.2017.03.007
Viero, D.P., Roder, G., Matticchio, B., Defina, A., Tarolli, P., 2019. Floods, landscape modifications and population dynamics in anthropogenic coastal lowlands: The Polesine (northern Italy) case study. Sci. Total Environ. 651, 1435–1450. doi:10.1016/j.scitotenv.2018.09.121

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