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Interactive Comment

Interactive comment on "Coastal flooding of urban areas by overtopping: dynamic modelling application to the Johanna storm (2008) in Gâvres (France)" *by* S. Le Roy et al.

S. Le Roy et al.

s.leroy@brgm.fr

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Firstly, the authors want to thank M. MacCabe for his review and his comments that allow us to improving our paper.

General comments
Even if closer to the works presented in the poster of Pedreros et al. (2011, see attached file), the work presented in the paper is effectively quite similar to the one presented by Stansby et al. (2013). Consequently, Stansby et al. (2013) will be added

and referenced in the introduction of the paper.

Specific comments

1. As mentioned above, the work of Stansby et al (2013) must be referenced, as it uses a very similar modelling approach.

Author's response: OK, this reference will be added in the next version of the paper (see General comments)

2. P4959 L20-30. Did you use any specific criteria for deciding where to force the SURF-WB model (e.g. water depth/wavelength, or wave height/wavelength)? Can you be sure all the waves are within the surf zone?

Author's response: As SURF-WB is a NLSW model, it should effectively be used from the surf zone to the inundation area. Nevertheless, we have used SURF-WB before the breaking area (at least during the storm peak), but to limit the consequences of the absence of frequency dispersion, we have chosen to force SURF-WB as close as possible to the dike. In details, here is how wave breaking occurs during the simulation (γ is defined as γ=H/d where H designs the wave height and d the water depth): When the sea water level is low (beginning and end of the simulation), waves imposed to SURF-WB are effectively in the breaking zone (γ about 0.7) At intermediate water levels (γ about 0.6 in the forcing area), wave breaking can't be well controlled because it occurs on the beach, and SURF-WB simulates it during the propagation; nevertheless, overtopping remains very limited for these water levels and the consequences for the flood simulation remain very limited; For high sea water level (γ about 0.5 in the forcing area), spectral simulations show that wave breaking mainly occurs on the steep slope of the dike, because of the quite important water depth (more than 3 m on the main part of the beach); the fact that the distance the waves have to cross before reaching the dike is very short (less than 100m, about 2 times the wavelengthes) limits the undesirable effects of using NLSW equations:

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no important shrinkage of the waves appears on the beach, whereas the most part of energy dissipation appears during the shock of the waves on the dike. Even if applicable in Gâvres, this approach can't be systematically used, according to the wave characteristics and the coast configuration. We tried some other models that allow the identification of the breaking area (typically Boussinesq-NLSW models), but we met other problems because of the boundary conditions management (essentially because we needed unstationary conditions in terms of sea water levels and wave characteristics). Our further works should consist in using in unstationary conditions Boussinesq/NLSW models to correctly manage the problem of wave breaking, and to generalize this approach (in particular by taking the boundary away from the coast, with respect to the limitations in terms of $k \times d$ values). In order to improve the clarity of the paper, we propose to replace the paragraph in page 4959 (L20-28) by the following one:
"If a NLSW model like SURF-WB can efficiently simulate wave breaking, it remains unable to simulate correctly the coastal propagation and the shoaling processes and to detect the wave breaking, like for example Boussinesq/NLSWE hybrid models (Stansby et al., 2013; Tissier et al., 2012; Shi et al., 2012). The consequences generally translate into a significant premature wave decrease caused by a premature breaking. To limit this problem, the forcing of the waves in SURF-WB has been placed as close as possible of the dike (about 100 m): thus, the short propagation distances doesn't allow important consequences of the absence of dispersion terms, and at the peak of the storm (when the sea water level is high and when overtopping appears), most of the energy dissipation is controlled by the steep slope of the dike, in accordance with the results obtained with the SWAN model. Moreover, a forcing very close to the coast offers the advantage of using quite homogeneous waves perpendicular to the coast (after refraction)."
Finally, we propose to evoke in the conclusions the interest of hybrid models to manage this particular problem in short-term future, and to extend this type of applications.

3. P4961 L11-13. The wall at the crest of the dike will have a big effect on overtopping rates - can you be sure it collapsed near the start of the storm? Perhaps you could test the sensitivity of the timing of the wall failure on the resulting flood levels.

Author's response: Indeed, there is no available information on the collapse time of the wall, so a collapse at the start of the storm has been supposed as a hypothesis. Nevertheless, following this remark of the reviewer, a complementary simulation has been realized with the other extreme hypothesis (no collapse of the wall during the storm). Obtained results show that the conservation of the wall leads to a slightly smaller inundated area, with maximal water heights about 16cm below (there are still sporadic overtopping over the wall). These new results will be introduced in the next version of the paper to illustrate the sensitivity of the results with the failure timing.

4. P4966 L4-6. It may be worth showing some results (of flood depths) calculated using mean overtopping discharges, to highlight the importance of using a full time-series.

Author's response: As the goal of our study was to reproduce as realistically as possible the flood in Gâvres to understand damage mechanisms to the buildings, we didn't try to use mean discharge from our simulation. Moreover, as SURF-WB allows us to simulate simultaneously both overtopping and flooding, the gain of this type of approach remains limited in our study. Nevertheless, this type of results has been presented by Le Cornec and Schoorens (2007) on Gâvres for events very close to the Johanna storm, using empirical formulas to estimate overtopping discharge. This reference will be added and commented in the paper: their results show that maximal flow velocities barely exceed 1.5 m/s, whereas our simulation show that these velocities can reach 3 to more than 5 m/s on several tens meters behind the dike.

5. P4967 L9-11. You state that using DTM with roughness to represent urban areas is insufficient, and that DEM is much better. However, would a DTM, with greatly *increased roughness only in the location of buildings (i.e. not the whole urban area), have a similar effect?*

Author's response: Effectively, according to the bibliography, an increased roughness only in the location of buildings should improve the results by canalizing the flows in the streets (and would allow water storage in the buildings). Nevertheless, according to the simulations realized by Syme (2008), flow velocities may remain locally different (in particular for the upstream slowdown and along the building walls). Moreover, the channeling of the flows by street walls (besides building walls) can be very important in Gâvres, and could not be taken into account by increasing roughness only in the location of the buildings. These elements will be precised in the paper, and complementary simulations on Gâvres should be realized in the future.

Technical corrections

1. P4951 L26-27. It would probably be better to reference Eurotop (2007), rather than TAW (2002). The TAW equations (with updated research and testing) are included within Eurotop (2007).

Author's response: Effectively, we took the reference cited by Peeters et al. (2009), but Eurotop (2007) is more commonly known; the reference will be remplaced in the paper.

2. P4956. Could you state the crest level of the dike, so that the reader can work out the relative crest freeboard.

Author's response: The crest level of the dike is about 4.1m above the mean sea water level; moreover, the dike is topped by a 0.8m wall that has been partially destroyed in the eastern part during the storm. These elements will be added in the paper (paragraph 3.1, that describes the site).

3. P4958 L12. I think Fig. 3 should be Fig. 5 instead.

Author's response: Effectively, this mistake will be corrected in the next version.

4. P4960 L18. I think you should write "offshore boundary" rather than "left boundary".
Author's response: OK, it will be more explicit.

5. P4962 L3, and many other locations, including figures. Can you please not refer to "water height" - I think it is ambiguous. Could you use either "water depth" or "water level" instead - the definitions of these are clearer.
Author's response: OK, "water height" will be remplaced by "water depth" in the whole paper to avoid any confusion.

6. P4962 L10. Change "that" to ",which".
Author's response: OK

7. P4962 L14. Does "Fig. 8" refer to Fig. 8 of Cariolet (2010)?
Author's response: There is a mistake in the figure numeration: it should be "Fig. 9, top part".

8. P4975 Fig 2. This figure is quite small and hard to read - maybe it would be better dispayed as 2 figures (in a higher resolution).
Author's response: OK, the figure will be split in two distinct figures to improve quality.

9. P4978 Fig 5, right hand figure. Should the y axis label read "m above mean sea level", not "m / mean sea level"?
Author's response: This will be corrected in the next version to avoid confusions.

10. P4981 Fig 8. Y axis label - I think "Mean incoming discharge" would be better than "Mean incoming throughput".
Author's response: OK

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11. P4982 Fig 9. This figure is difficult to read, especially the high water levels in the top map.

Author's response: Effectively; this top map has been extracted from Cariolet (2010); we will try to improve readability by enlarging the numbers on the map.

Complementary references

Le Cornec, E. and Schoorens, G.: Etude de l'alea submersion marine sur le site de la Grande Plage de Gâvres, Rapport d'étude GEOS-DHI, 2007 (in French).

Pullen, T., Allsop, N.W.H., Bruce, T., Kortenhaus, A., Schüttrumpf, H. van der Meer, J.W.: EurOtop. Wave overtopping of sea defences and related structures: Assessment manual, http://www.overtopping-manual.com, 2007.

Stansby, P., Chini, N., Apsley, D., Borthwick, A., Bricheno, L., Horillo-Caraballo, J., McCabe, M., Reeve, D., Rogers, B., Saulter, A., Scott, A., Wilson, C., Wolf, J., Yan, K.: An integrated model system for coastal flood prediction with a case history for Walcott, UK, on 9th November 2007, Journal of Flood Risk Management, 6, 229-252, doi:10.1111/jfr3.12001, 2013.

Syme, W. J., Flooding in Urban Areas – 2D Modelling Approaches for Buildings Fences, 9th National Conference on Hydraulics in Water Engineering, Engineers Australia, Darwin, 2008.

Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/2/C3690/2015/nhessd-2-C3690-2015-supplement.pdf

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 2, 4947, 2014.

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