Title : "Extreme events flooding analysis of Somo-Loredo's beaches system"

Author : Alexandre Antoine Paris

Directors : Ana Cristina Rueda Zamora, Sonia Castanedo Bárcena

Convocation : Thursday October 20, 2016

Keywords : flooding, extreme events, total sea water level, waves, propagation, run-up.

Abstract :

This document presents the extreme events flooding analysis of Somo-Loredo (Cantabria, Spain) beaches system.

The main objective is to create flooding maps from the propagation of sea states based on annual total sea water level maximums. This level is defined as the sum of astronomical tide, storm surge and run-up, obtained thanks to the Stockdon et al. (2006) formula. The study continues with the identification of annual maximums of the total sea water level, with the software Ameva, from IHCantabria. We get 61 maximums that we transform into 61 sea states, used in the propagation model SWAN, so as to get sea conditions next to the studied beach. Every single sea state has a certain number of variables, like significant wave height, average period, astronomical tide, wind speed, wind direction and wave direction. The SWAN model requires a general mesh, including all the topobathymetryn and a mesh detail that focuses on the beach. In output, we have 23 points along the beach to get new sea conditions. In these conditions, we have new values such as significant wave height and average period. From there, we can calculate el run-up but we can't use the Stockdon formula considering we are not in deep water anymore. Therefore we will try three other formulas, of Hunt (1959), Nielsen and Hanslow (1991) and Bowen et al. (1968). With the run-up results analysis, we will be able to see the variability of the formulas. After the run-up, we calculate the new total sea water level, used to generate flooding maps that we get with a "bathtub" methodology.

To conclude, we observe more important levels with the Nielsen and Hanslow and Bowen et al. run-up formulas. This can mean that the Hunt formula underestimates the run-up values or that the two others overestimate those values. Furthermore, we see that the levels in the order of 4 or 5 meters can generate strong flooding in Somo and Loredo regions.

Finally, we could do three steps to improve this study. First of all, it would be interesting to include a study of the extreme events return periods and generate flooding maps with different return periods. Then, a study of the run-up in field or laboratory would remove the doubts about the appropriate run-up formula in this case. At last, we should study the flooding with the waves heights variations that exists along the beach, between the output points of the model.

This study gives a first approach of the flooding problem of the Somo-Loredo's beaches system and constitutes the first step in a study of flood risk in the region.

Bibliography :

Barredo, J.I., 2009. Normalised flood losses in Europe : 1970 – 2006. , pp.97–104.

Bowen, A.J., Inaman, D.L. & Simmons, V.P., 1968. Wave "set-down" and "set-up" 2569– 2577. *Journal of Geophysical Research*, Oceans(73 (8)), pp.2569–2577.

Douglass, S.L., 1990. Estimating runup on beaches: a review of the state of the art.

Goda, Y., 1985. *Random seas and design of maritime structures*, World Scientific Publishing Co. Pte. Ltd.

Gouldby, B. et al., 2012. A flood system risk analysis model with dynamic sub-element 2D inundation model, dynamic breach growth and life-loss. *Proceedings of the 2nd European Conference on Flood Risk Management*, pp.1–13.

Gouldby, B. et al., 2014. A methodology for deriving extreme nearshore sea conditions for structural design and flood risk analysis. *Coastal Engineering*, 88, pp.15–26. Available at: http://dx.doi.org/10.1016/j.coastaleng.2014.01.012.

Hedges, T.S., 2001. Wave breaking and reflection. *Lecture Notes: Dept of Civil Engineering, University of Liverpool*.

Hunt, I.A., 1959. Design of seawalls and breakwaters. *Journal of Waterways and Harbours Division*, ASCE 85, pp.123–152.

Losada Rodriguez, M.A., 2009. *ROM 1.0-09*, Puertos del Estado.

Malej, M., Smith, J.M. & Salgado-dominguez, G., 2015. Introduction to Phase-Resolving Wave Modeling with FUNWAVE. , (July).

Nielsen, P. & Hanslow, D.J., 1991. Wave Run-up Distributions on Natural Beaches. *Journal of Coastal Research*, (7(4)), pp.1139–1152.

Robert, S. et al., 2012. A highly efficient 2D flood model with sub-element topography. *Proceedings of the ICE - Water Management*, 165(10), pp.581–595.

Stockdon, H.F. et al., 2006. Empirical parameterization of setup, swash, and runup. *Coastal Engineering*, 53(7), pp.573–588.