The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

# Quantization applied to the visualization of low-probability flooding events

**C. Sire[1], R. Le Riche[2], D. Rullière[3], J. Rohmer[4], Y. Richet[5], L. Pheulpin[6]**

[1] IRSN, BRGM, CNRS, LIMOS (Mines St-Etienne and UCA), charlie.sire@irsn.fr
[2] CNRS, LIMOS (Mines St-Etienne and UCA), leriche@emse.fr
[3] CNRS, LIMOS (Mines St-Etienne and UCA), Postal Address, drulliere@emse.fr
[4] BRGM, j.rohmer@brgm.fr
[5] IRSN, yann.richet@irsn.fr
[6] IRSN, lucie.pheulpin@irsn.fr

**Keywords**: *Quantization, Rare event, Visualization, Metamodeling*

Visualization is essential in the risk assessment of coastal or river flooding. In this work, we deal with expensive-to-evaluate hydraulic simulators, taking as random scalar inputs offshore meteo-oceanic conditions and dyke breach parameters, whereas the output is a flooding map. The challenge is to display a few prototype maps representing at best the probability law of the flooding event, which is a typical quantization problem. The K-Means algorithm classically serves to minimize the expected squared distance between samples of the random event and their representatives [1]. This clustering technique is adapted to handle three key specificities of our context. First, the quantization is done in the specific space of flooding maps, which requires to define an appropriate distance measure, such as a weighted $L2$ distance in a matrix space. Second, because of the time-consuming simulators, the clustering is done in a space defined by Gaussian process proxies of the maps [2]. Third, flooding being a low-probability event, traditional Monte Carlo approaches are inefficient and an Importance Sampling scheme is introduced to generate the maps. The prototype maps obtained represent the distribution of the floodings and each is associated to a probability mass. To discriminate between the scenarii leading to similar flooding events, a second quantization procedure is carried out in the input space within each cluster. The method is evaluated on an analytical example before being extended to the coastal case of Les Boucholeurs on the French Atlantic coast [3].

## REFERENCES

[1] H-H Bock, Origins and extensions of the k-means algorithm in cluster analysis, *Electronic Journal for History of Probability and Statistics*, Vol. **4**, 2008.

[2] T.V.E. Perrin, O. Roustant, J. Rohmer, O. Alata, J.P. Naulin, D. Idier, R. Pedreros, D. Moncoulon, P. Tinard, *Reliability Engineering and System Safety, Vol.* ***211****, 2021*

[3] J. Rohmer, D. Idier, L. Paris, R. Pedreros and J.Louisor, Casting light on forcing and breaching scenarios that lead to marine inundation: Combining numerical simulations with a random-forest classification approach, *Environmental modeling and software* Vol. **104**, pp. 64–80, 2018.