Deepening analysis of uncertain categorical inputs using Gaussian processes -application to marine flooding

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Marine flooding assessment relies on the use of high-resolution hydrodynamic numerical models to understand the relationships between inputs (e.g. offshore sea conditions) and the output variables (e.g. flood spatial extent), and to characterize the uncertainty. The input-output mapping is, however, hindered by two aspects: 1. the high computation time cost of the numerical model limits the number of model runs (usually a few 100s); 2. some of the input variables are often categorical in nature, because different modelling assumptions are equally appropriate. In this communication, we propose to explore how recent advances in Gaussian Processes with mixed continuous/categorical inputs can bring valuable insights into the influence of such categorical inputs. Depending on how they are modelled (nominal, ordinal) and integrated in the kernel (level-related heteroscedasticity, compound symmetry, group structure and interactions, etc), different viewpoints can be brought. Three application cases with gradual complexity are investigated: i. nominal input to analyse the scenarios of rupture geometry for tsunamis; ii. ordinal variable to reveal the latent influence of the angle of approach for cyclone tracks; iii. group kernels to reveal the interactions between artificial and natural coastal defences' failure scenarios for storm tides. Finally, the problem of selecting the most appropriate kernel structure using exploratory analysis and cross-validation procedures is discussed.