Polynomial Chaos based hurricane loss estimation model

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Abstract

Hurricane hazard is one of the major causes for the loss of life and property and has recently led to an enormous economic loss and social disruption specifically in the coastal regions. Monetary loss of damage to the built infrastructure represents a significant portion of overall hurricane-induced damage. A detailed simulation of hurricane damage at regional scale requires large amount of specific information, which can be poorly understood or is not available with sufficient level of certainty for a large spatial extent. The existing wind damage models often assume a prescribed mathematical structure to describe the dependency between aggregated loss and the hazard intensity in an average sense. The effect of uncertainty is then introduced by treating model parameters as random variables. In the present study, a new approach to tackle this problem is introduced, which relies on a more rigorous and reliable quantification of the involved uncertainties. In particular, the damage induced by wind is modeled as a non-stationary stochastic process for which a probabilistic representation is constructed using polynomial expansion. As a case study, the economic damage data collected by an insurance company is used to calibrate and test the predictive capability of the proposed stochastic loss model. This representation has the advantage of being based on minimal prior assumptions and constraints, in addition to being computationally less demanding since it generates the vulnerability at a coarser regional level. The loss model is used to evaluate the storm risk curve or loss-exceedance model for the region.

Keywords: Polynomial-Chaos, Hurricane loss, Karhunen-Loeve, Loss model, storm-risk model

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