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Predicting extreme wind speeds on a tropical island for multi-peril catastrophe modelling

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Catastrophe models are important tools used by the reinsurance industry for assessing and managing risk. Here, we present the methods used to develop high-resolution wind hazard maps for the Indian Ocean island of La Réunion. As the recent Cyclone Dumile (January 2013) reminded us, the island is at considerable risk from the extreme weather associated with tropical cyclones. It also contains a significant proportion of the total value insured in French overseas territories. The wind maps, alongside flood and storm surge maps, were ultimately combined with exposure information in a multi-peril catastrophe model to provide probabilistic estimates of insured loss.

Our wind mapping methodology used established extreme value theory statistics to estimate the annual probability of extreme wind speeds, including those exceeding the observed maxima of our 19 year record, at meteorological stations. This gave approximate wind speeds for a range of return periods at these specific locations. Since the spatial density of the stations was insufficient to resolve the numerous potential effects of the complex island topography, geographically weighted regression (GWR) models were then developed to interpolate these cyclonic wind speeds across the entire island. Factors known to affect local wind speed such as elevation, surface roughness and coastal proximity were explicitly accounted for.

Using this advanced interpolation method, wind hazard maps were produced for six return periods between 1 in 10 and 1 in 1000 years. Our maps compared favourably with those of historical events, and also showed patterns of wind speed in agreement with the findings of other studies investigating the effects of topography. Leave-one-out cross-validation (LOOCV) further confirmed the satisfactory performance of the models in providing a robust and comprehensive description of wind patterns during cyclone passage. Uncertainty increased with return period as more extrapolation of the limited observational data was required. We conclude by providing a brief explanation of how the maps were incorporated into our multi-peril probabilistic model, thus demonstrating their applied value for estimating industry losses.