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Vulnerability functions based on insurance data for wind, precipitation, hail and flood damages for residential and commercial buildings in the Netherlands

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Global warming is changing the climate and causing more frequent extreme weather events, such as floods and precipitation extremes. Future financial losses are expected to rise further due to a continued increase in economic exposure to intensifying extremes. As a result, climate change is recognized as an important source of risk for financial institutions. Insurance companies use natural catastrophe models to estimate the expected climate-related risk (in terms of losses) of their non-life insurance portfolios. Within these models, the vulnerability function describes the susceptibility of objects to damages from natural hazards, which is of fundamental importance to the sound estimation of natural catastrophe losses. This paper constructs empirically based vulnerability functions for natural catastrophe models that estimate wind, precipitation, hail and flood damages for distinct object classes (i.e., residential and multiple commercial building types). For this, we leverage a unique insurance dataset from Achmea with high quality damage claims for different perils. This dataset contains the claim amount, building reconstruction value, location and multiple building characteristics (e.g., building use and material) at the object level for more than half a million claims over the past 40 years in the Netherlands. The vulnerability functions describe multivariate relationships between the damage ratio of objects and one or multiple natural hazard intensity measures (e.g. wind speeds and direction), primary and secondary modifiers (i.e., building characteristics). In addition, both confidence and prediction intervals are constructed. This study innovates upon the literature by using large samples of high quality damage claims data to estimate vulnerability functions for multiple natural catastrophes and object classes in the Netherlands. Our analysis pays special attention to model assumptions, the goodness-of-fit and uncertainty intervals. The results can serve as inputs for public, academic and open-source natural catastrophe models to facilitate the estimation of accurate natural catastrophe damages now and in the future.