A Modeling Framework for Inland Flood Risk Assessment in Japan

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Flooding has been the most frequent natural disaster that claims lives and imposes significant economic losses to human societies worldwide. Japan, with an annual rainfall of up to 4000 mm is extremely vulnerable to inland flooding with over ¥300bn average annual loss, 60% of which is from Tropical Cyclone(TC) flooding and 40% from non-TC flooding. The focus of this research is to develop: (i) a detailed flood hazard model for japan, (ii) a vulnerability module that captures damageability of Japan’s built environment to flooding, and (iii) an industry exposure data set that has Japan’s entire building stock modeled at a very granular resolution.

The flood hazard component consists of three building blocks: (a) a stochastic precipitation model that simulates TC and non-TC precipitation separately and blends the two model outputs in a 10K samples of continuous annual precipitation over Japan, (b) a hydrologic model that takes the precipitation as an input and produces a 10K catalog of extreme peak flows and runoffs and (c) a hydraulic model that transforms the river peak flows to flood depths for each event in the catalog. The hazard component is heavily validated with most of the available meteorological, hydrological and flood map data for Japan.

The vulnerability module consists of functional relationships, also referred to as damage functions that relate hazard intensity to damage in terms of the so called damage ratio - the ratio between loss and replacement value. Damage functions are built separately for building, content and business interruption related losses and for each building construction type, height, occupancy, etc. Once the entire family of damage functions is available, the magnitude of the hazard extracted from the stochastic catalog at each instant in time and at each specific location is linked to a loss estimated as the damage ratio times each building components’ replacement value. Finally, all losses in a portfolio are aggregated at different spatial and temporal scales to provide a complete view of risk to the portfolio. To better validate the risk at a country level, an industry exposure database is developed that ultimately represent all potentially affected properties and provides means for assessing the risk for the entire flood insurance industry. The view of risk at prefecture and country level is intensively validated with loss data from major insurance companies and all available government sources.

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