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Deriving fluvial and pluvial flood risk curves using large ensemble climate simulation data with a fast 2-D flood model: A case study in Nagoya City, Japan

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Against flood disasters to be intensified in a future climate, we are required to implement adaptation strategies on a limited budget. In urban areas, heavy rainfall-based floods are classified into two types: pluvial and fluvial floods. It is well known that fluvial floods cause deeper inundation and stronger fluid force while pluvial ones occur more frequently. Such hydrodynamic characteristics have been intensively discussed in a literature; however, their impact and the resulting damage have not yet been examined in a comprehensive manner due to small samples of storm events in one region that leads to high uncertainty in frequency analysis. In the context of climate change impact assessment on extreme events, considerable ensembles of climate data have become available, contributing to smaller uncertainty in frequency analysis of flood damages. This study presents a case study of frequency estimation of fluvial and pluvial floods in an urban area set in Nagoya City, Japan. We applied a large ensemble climate simulation database, d4PDF, to a combined pluvial and fluvial flood model, from which we derived flood risk curves for each type of flooding. The results indicated that pluvial flooding presents comparable economic risk to fluvial flooding (16% and 17% lesser damage at 50- and 100-year return periods, respectively) despite its significantly shallower flood depths (area with flood depth over 45 cm was only 10.5% and 5.4%, respectively). This is because pluvial floods widely occur over the city, including areas further away from the river. Furthermore, probably similar with other mega cities with long history, fluvial flood risk has been managed by settling the central economic district (originally the Nagoya Castle founded several centuries ago) on higher altitudes. The results suggest that pluvial flooding could have comparable economic risks to fluvial flooding in urban areas where major economic assets are widely sprawled over the city as well as historical countermeasures are implemented against fluvial flooding. Pluvial floods, countermeasures against which tend to be smaller than fluvial floods, should be managed at a comparable level in urban areas.