

A building-level input–output framework for urban carbon footprints and climate-risk exposure

Topic: Input-Output Theory and Methodology (3)

Author: Kehan He

Climate policies and extreme weather are reshaping environmental burdens across time and space through complex industrial and spatial networks. Conventional environmental input–output (IO) models, usually aggregated at national or, at best, city scales, cannot resolve heterogeneity among buildings and firms within cities or trace how economic shocks and emission responsibilities propagate dynamically. Taking Hong Kong as a core case, we integrate government building-physics databases, construction and business registries, the Hong Kong IO table, sector-specific carbon emission intensities, and records of historical extreme weather combined with a digital elevation model to downscale macro IO logic to individual buildings and neighbourhoods. Treating each building as a "micro-economy", we construct a building-level, multi-scale environment–economy network and a high–spatiotemporal-resolution carbon-footprint accounting framework. First, we disaggregate the city IO table using building floor-area and industry attributes to compile a building-level IO network and consumption-based carbon footprints. Second, we translate historical extreme-weather events into economic losses and functional disruptions for buildings and industries, thereby quantifying climate-risk exposure and economic vulnerability at the building scale. Third, we develop building-level emission inventories and emission heat maps for critical infrastructures, such as data centres and energy facilities, that jointly capture emission responsibilities and climate-risk exposure. Finally, through multi-source data visualisation, we reveal pronounced intra-urban inequalities in both emission responsibilities and climate-risk bearing across Hong Kong. These outputs provide a concrete data foundation and methodological tools for monitoring regional decoupling and emission-reduction progress, identifying high-risk neighbourhoods and critical infrastructures, and supporting responsibility chains for health losses and micro-level evaluations in emerging carbon markets.