Introduction

Despite decades of improvement in activities aimed at reducing impacts from extreme events, the rapid increase in disaster losses and people affected suggests that swelling populations, development trends, and vulnerabilities are outpacing mitigation, leading to more events and amplified impacts. Due to data, computational, and methodological restrictions, research quantifying changes in human exposure to hazards has been relatively limited. We attempt to rectify this deficiency, advancing a framework for future work exploring how exposure and vulnerability contribute to disasters.

Methods

Our investigation employs historical demographic exposure data on a uniform grid to appraise how transformations in Chicago’s land use have led to greater potential for tornado disasters. Chicago is an ideal example of the enormous growth that metropolitan regions have witnessed during the last century. The area is characterized by a dense urban core and has experienced extensive, spatially fragmented suburban growth, or sprawl ... leading to an expanding bull’s-eye effect (Fig. 1).

Spatiotemporal Changes in Tornado Hazard Exposure: The Case of the Expanding Bull’s Eye Effect in Chicago, IL

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We superimpose 5 full-length tornado paths based on our Synthetic 2 (represented in Fig. 2A, bottom panel) across the study area, with the paths spaced north-to-south, 15-20 km apart (Table 3, Fig. 3). Further analyses in extended abstract overlaid hypothetical tornado events atop varying development morphologies.

Results show that the number of people and their housing continues to geographically expand, confirming that more people and their possessions are potential targets for tornadoes.

Differing development types (see extended abstract) lead to varying exposure rates that contribute to the unevenness of potential weather-related disasters across the region. For instance, a sprawl type of suburban development has led to the greatest change in hazard exposure setting. Conversely, while population loss along the periphery of the urban core has decreased the number of people potentially affected, those that remain may be highly vulnerable due to greater sensitivity/susceptibility and lower adaptive capacity caused by poverty.

Expanding bull’s-eye effect?

“Targets”—i.e., humans and their possessions—of geophysical hazards are enlarging as populations grow and spread. It is not solely the population magnitude that is important in creating disaster potential, it is how the population and built environment are distributed across the landscape that defines how the fundamental components of risk and vulnerability are realized in a disaster.