Resilient Livelihoods: The Vulnerability of Commutes to Street Network Disruption

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Project Objective

This project explores what happens when streets fail unexpectedly and looks at the street design characteristics that keep commutes running smoothly. By using real commuting data from 387 U.S. metro areas, it offers practical takeaways for planners and policy experts who want to protect critical infrastructure and support local economies.

Problem Statement

Millions of people rely on dependable street networks to reach their jobs and other essential services every day. But when a flood closes off low-lying streets, or a major highway is blocked by a vehicular collision, entire neighborhoods can be cut off from the places they need to go. This loss of access hinders workforces, slows economic growth, and especially harms those essential workers with the fewest transportation choices.

Research Methodology

This study used open data on streets and commute trips from across the United States, covering 387 metro areas. It simulated 266 million daily commutes under three different types of disruptions. First, it “destroyed” the most important intersections and bridges (chokepoints) to see how a targeted attack might affect commutes. Second, it destroyed the lowest-lying street segments to mimic severe coastal or river flooding. Third, it randomly shut down parts of the network to reflect collisions or sudden infrastructure failures. After each of these “disasters” we measured which commutes became fully disconnected and which took longer detours (as shown in Table 1). By studying how connected or circuitous each trip became, and how many important intersections it depended on, our analysis pinpoints the design features that make people’s connections to their livelihoods more resilient.

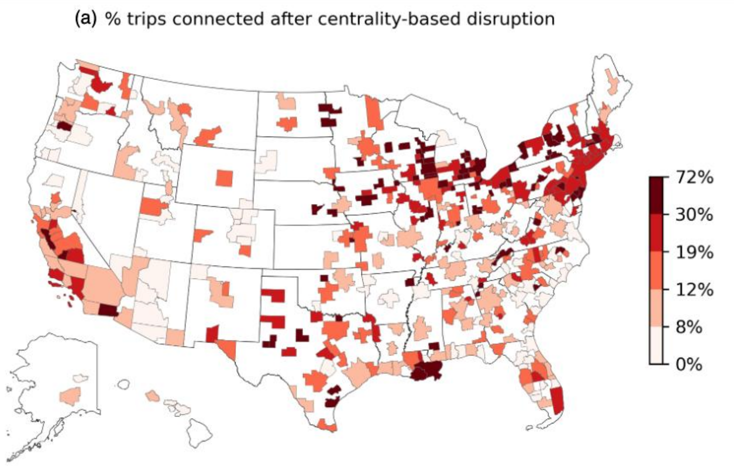
Results

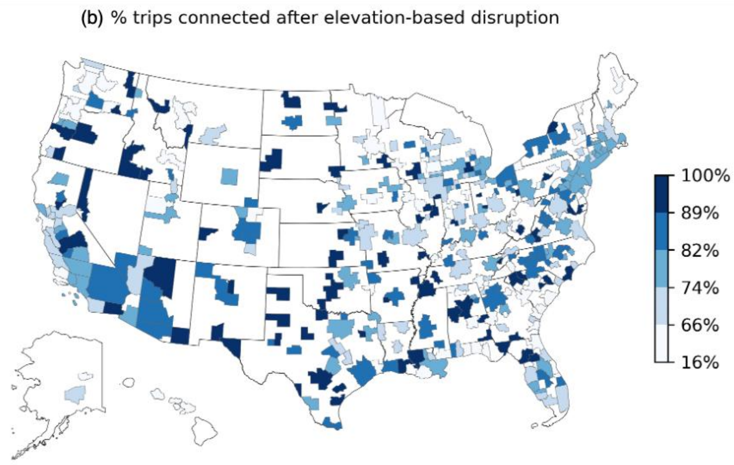
When just 10% of the most important intersections were taken offline, up to two-thirds of all commutes were cut off in some cities (Figure 1-a.) These findings reveal how city’s street system can depend on a small number of major highways or bridges. In places with multiple route options, most trips continued—though some took detours—allowing workers to reach their jobs. Flooding had a smaller overall effect but still caused major problems where bridges or causeways were limited (Figure 1-b.) Many rerouted trips in these flood-prone areas grew much longer, adding extra strain on commuters and their dependents. Random disruptions—e.g., scattered collisions or unexpected street closures—touched almost every commute but rarely caused total shutdowns (Figure 1-c.) Overall, well-connected street layouts and shorter commutes held up better across all disruption scenarios.

To reduce large-scale breakdowns, city planners should strengthen crucial streets and offer multiple ways to travel. Balanced housing and job locations help keep commutes short and flexible, and building in safer areas can protect against flooding. Finally, climate-adaptive infrastructure and land-use policies can further reduce the risk of losing major transportation links.

Table 1. The disruption types' commute trip outcomes

	Centrality		Elevation		Random	
	Count	Pct	Count	Pct	Count	Pct
Nullified	10,516,712	15.8%	12,811,118	19.2%	12,804,382	19.2%
Disconnected	44,696,279	67.1%	3,087,541	4.6%	18,018,364	27.1%
Connected	11,368,531	17.1%	50,682,863	76.1%	35,758,776	53.7%
Unaffected	2,656,243	4.0%	40,001,852	60.1%	1,005,317	1.5%
Rerouted	8,712,288	13.1%	10,681,011	16.0%	34,753,459	52.2%





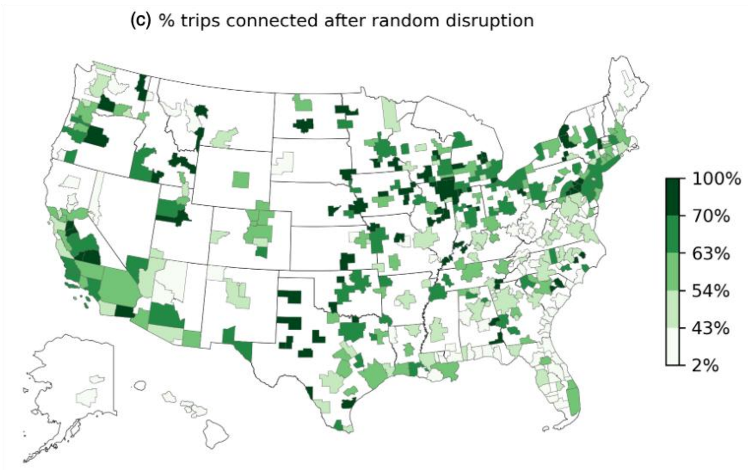


Figure 1. Percent of commutes remaining connected per MSA after each disruption type