Urban Land Subsidence and Differential Settlement Hazards to Infrastructure across Major U.S. Cities

Leonard Ohenhen

Department of Earth System Science

University of California Irvine

Collaborators:

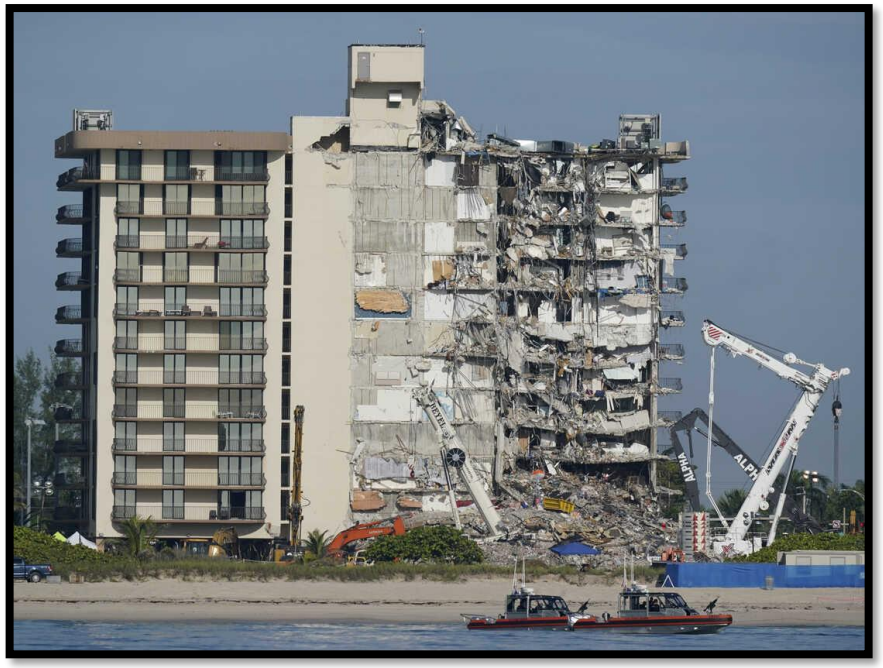
...

read the full paper published in ***Nature Cities, 2025***.

Background

- **Land Subsidence is recognized in the U.S., but often treated as a broad, uniform hazard.**
- **Global megacities around the world experience locally intense and spatially heterogeneous land subsidence.**
- **Such spatially heterogeneous subsidence can slowly comprise the integrity of infrastructures.**

- **Differential subsidence is a major hazard to infrastructure – incremental settlement can compound other stressors.**



Credit © AP

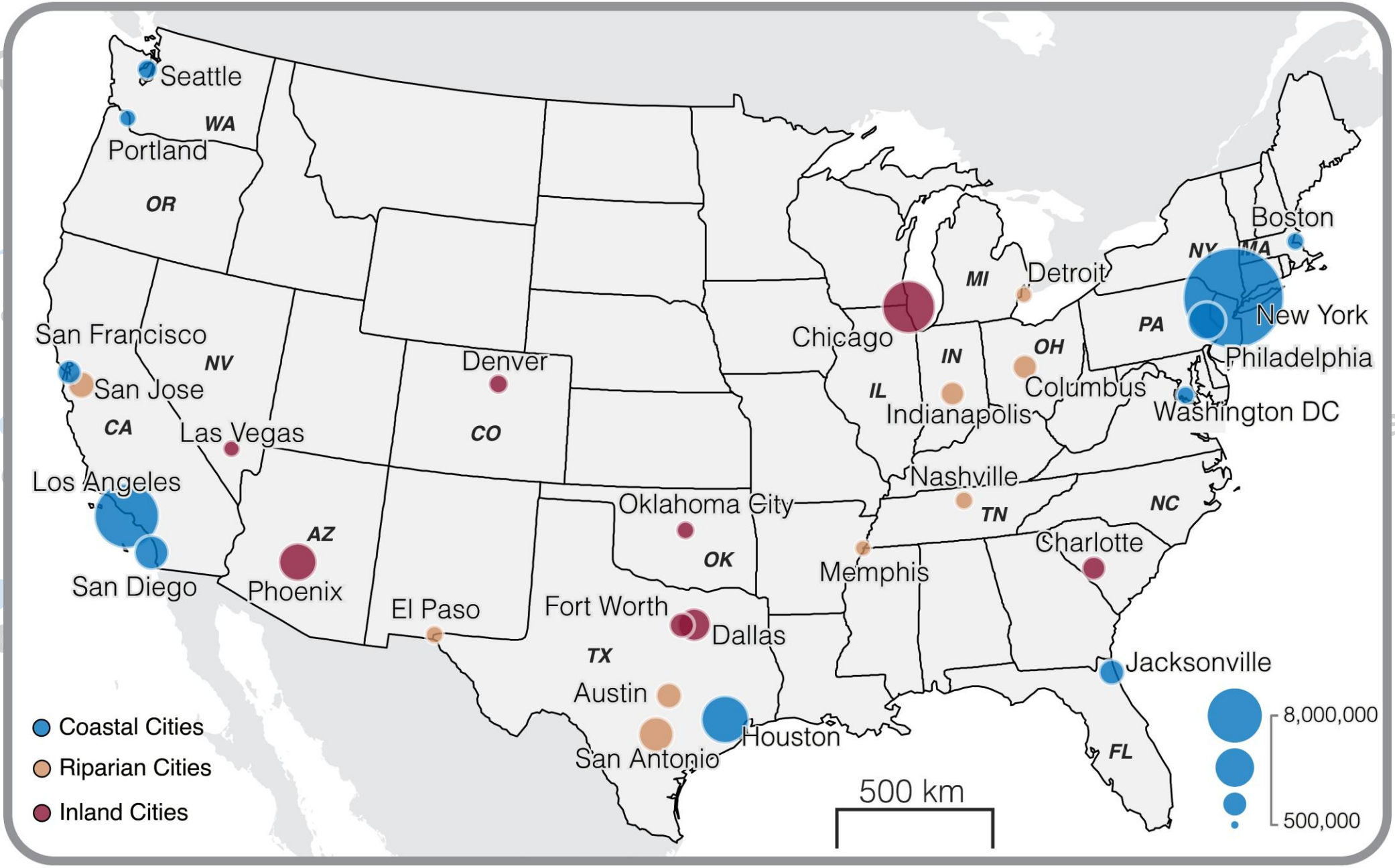
ENVIRONMENT

Surfside Condo Was Sinking for Years, and So Are Other Miami Structures, Says FIU Prof

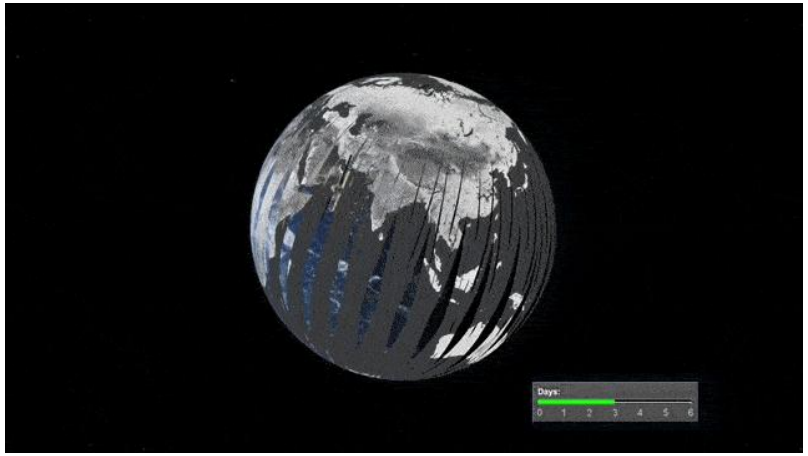
The Champlain Towers condo building had been sinking at a steady rate for years, according to research from Florida International University.

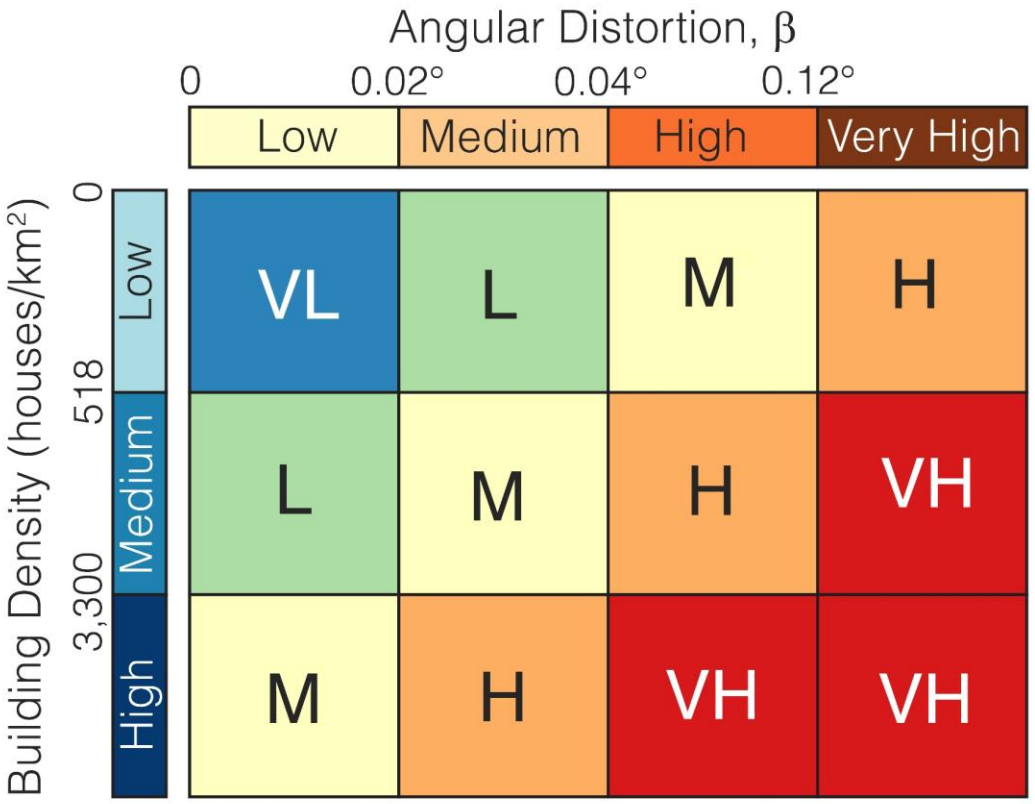
By Joshua Ceballos | June 24, 2021

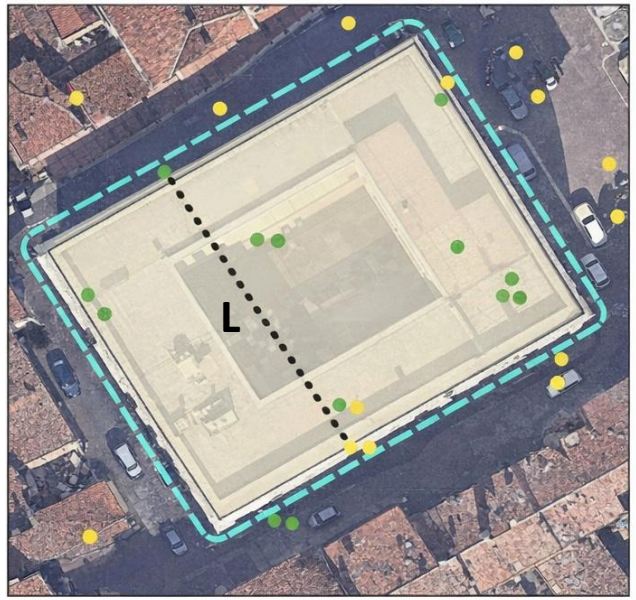
Objectives & Study Area

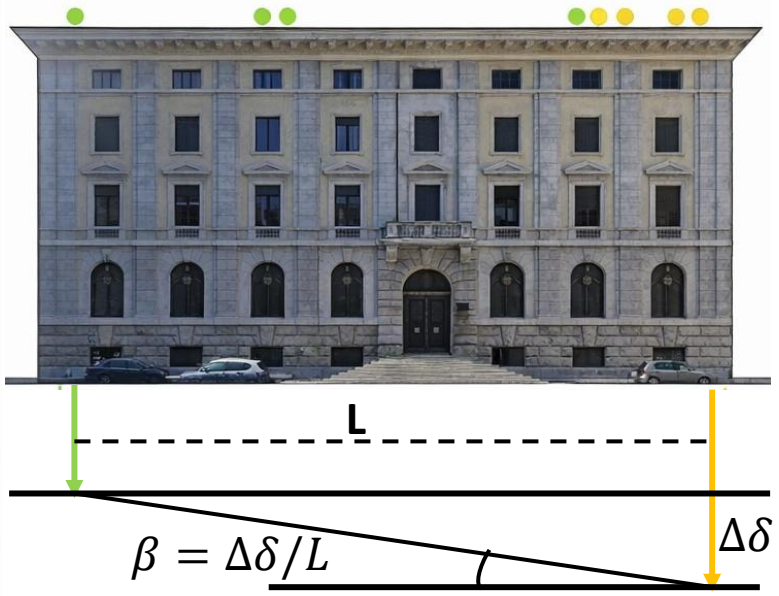


- **We utilize interferometric Synthetic Aperture Radar (InSAR) to measure heterogeneous VLM at 28 m spatial resolution.**
- **We use a risk matrix that combines angular distortion (β) and the building density in a city.**



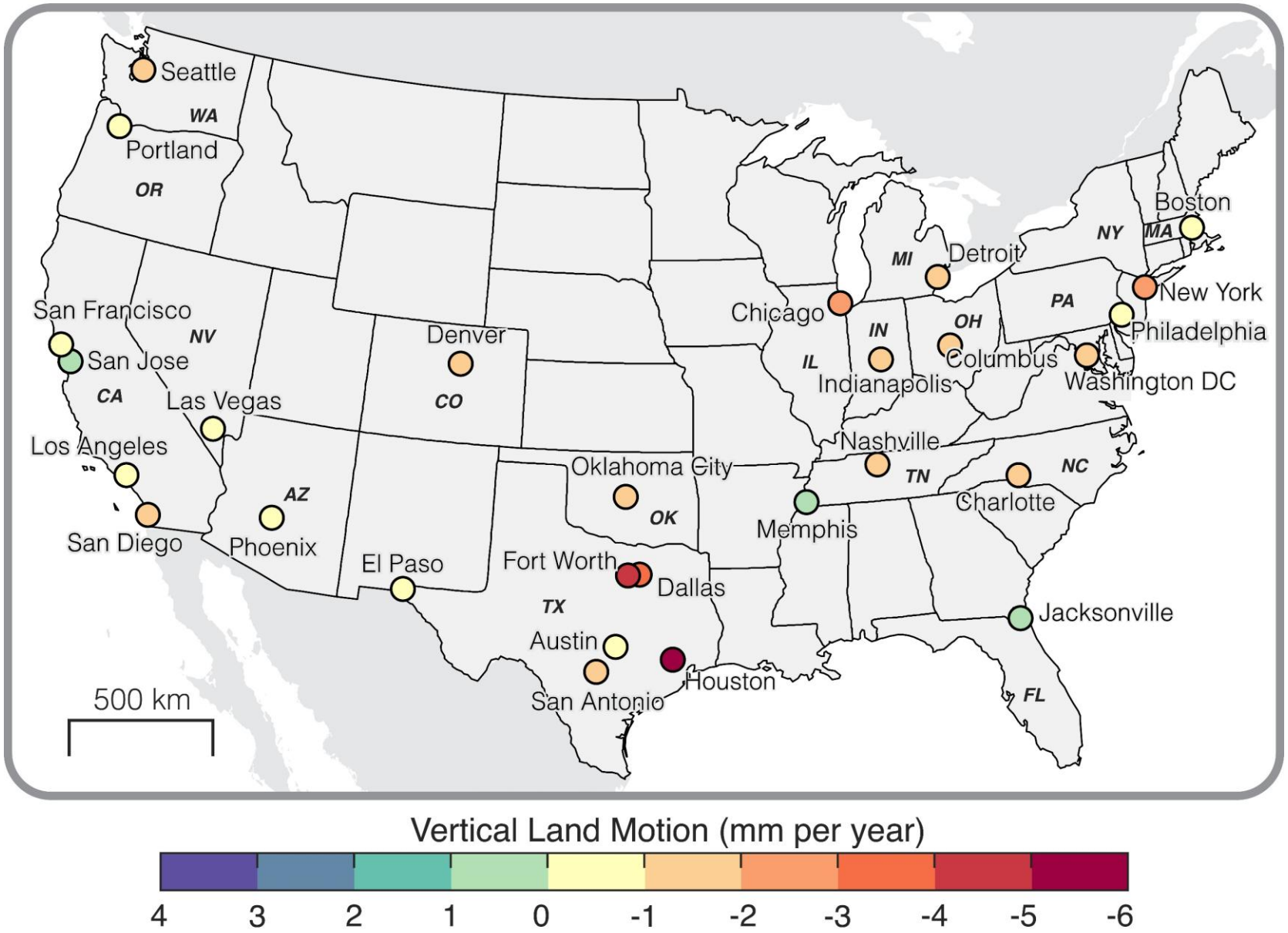




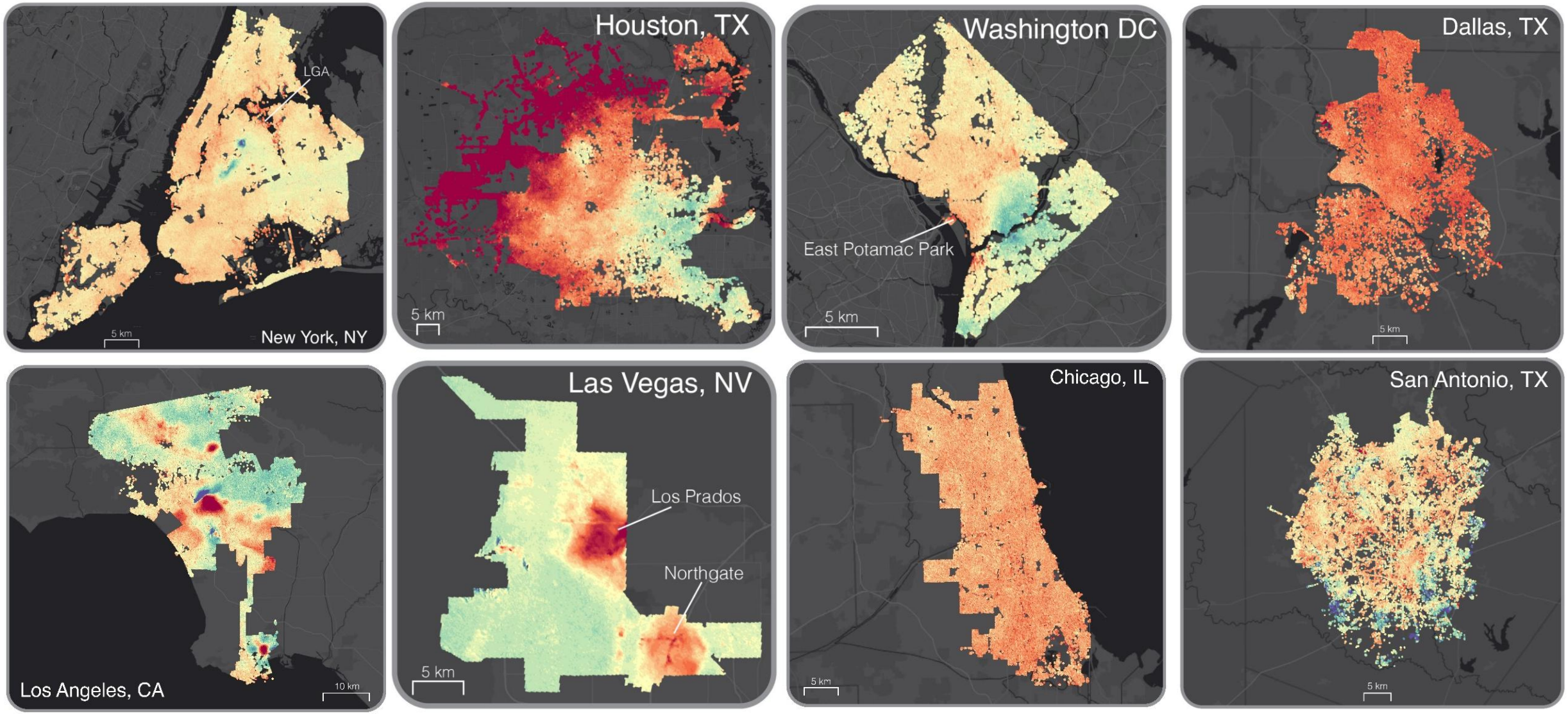


Source: Nappo et al. (2021)

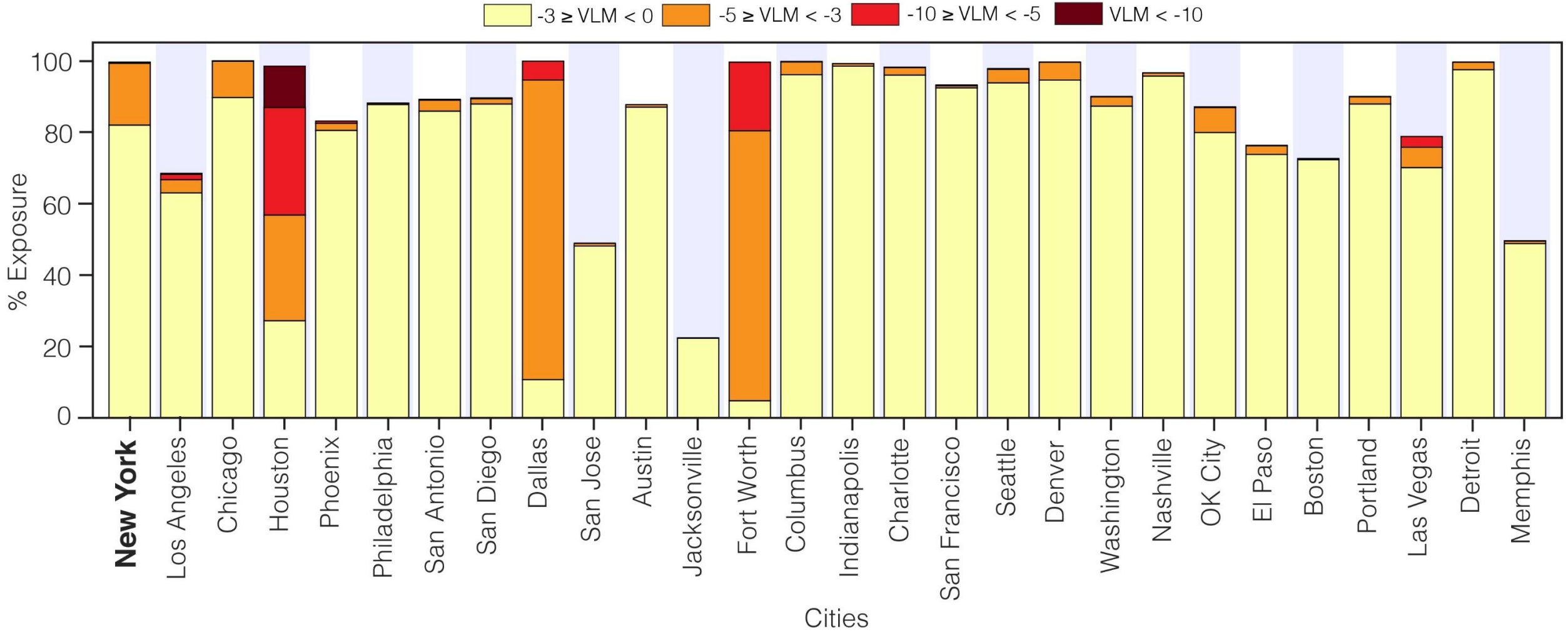
- **25 out of 28 cities are sinking.**
- **9 out of 25 sinking cities are sinking at rates greater than 2 mm per year.**
- **Houston, Dallas, and Forth Worth exhibit average rate exceeding 4 mm per year.**



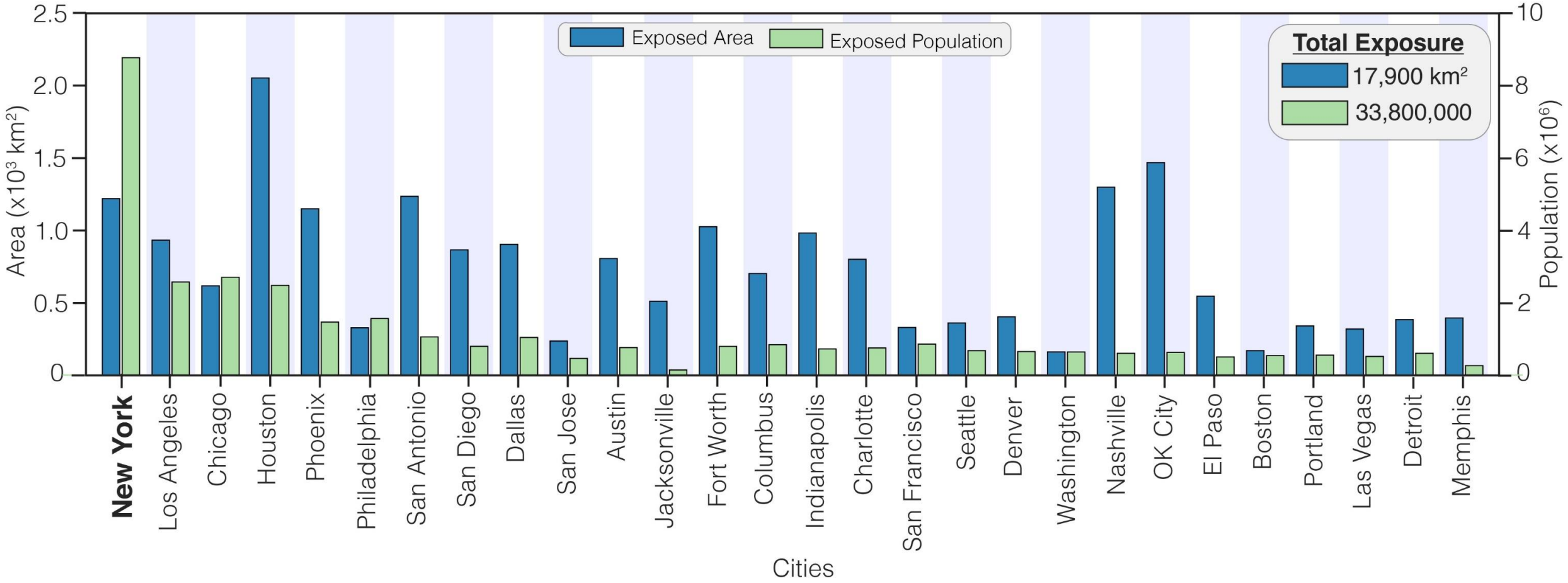
Results


LGA
5 km
New York, NY
Houston, TX
5 km
Washington DC
East Potamac Park
5 km
Dallas, TX
5 km
Los Angeles, CA
10 km
Las Vegas, NV
Los Prados
Northgate
5 km
Chicago, IL
5 km
San Antonio, TX
5 km
Vertical Land Motion (mm per year)
4
3
2
1
0
-1
-2
-3
-4
-5
-6

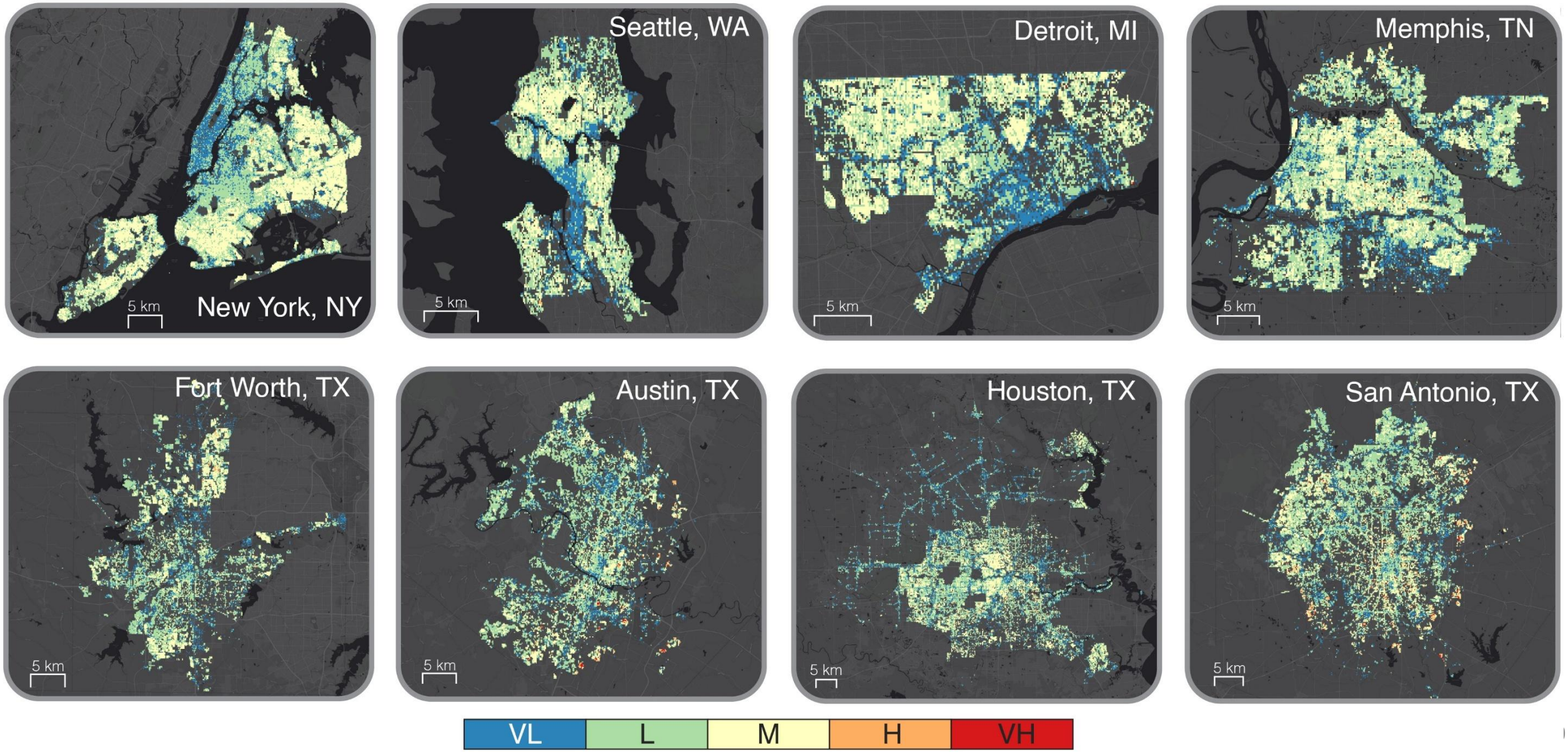
- **In every city, at least 20% of the area is sinking and in 25 out of the 28 cities, at least 65% is sinking.**



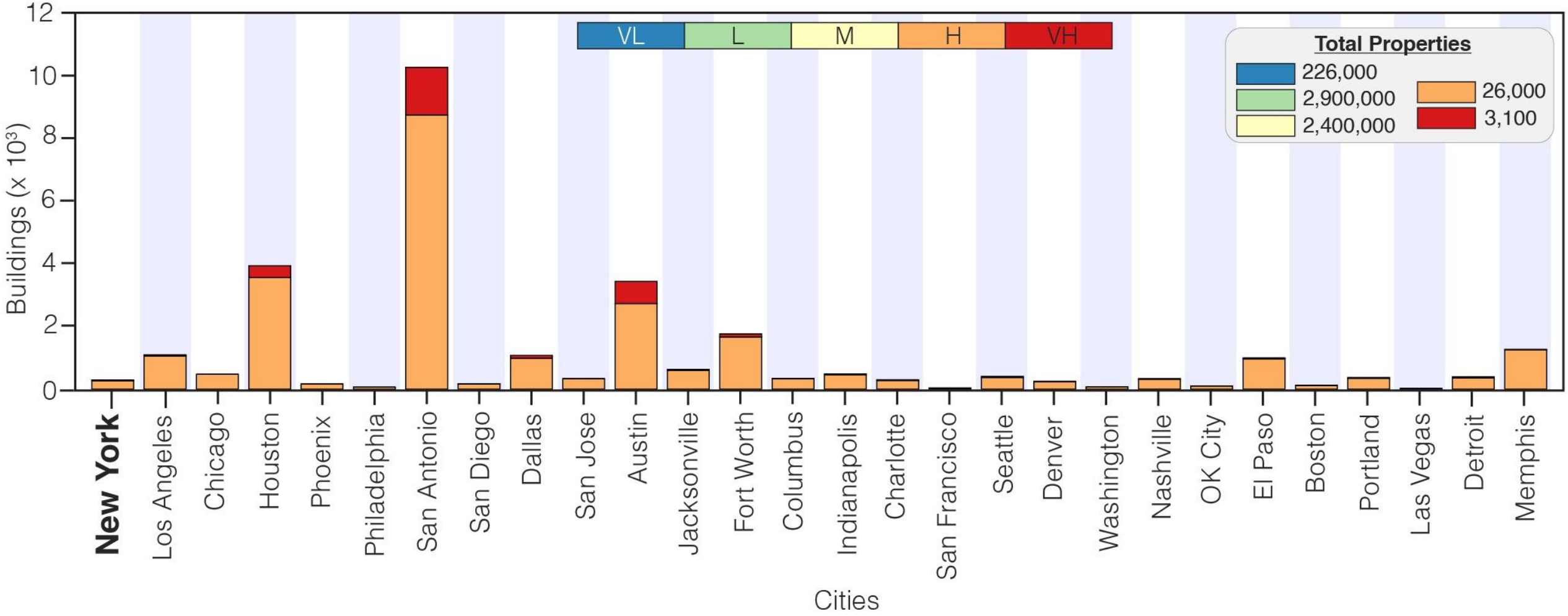
- **We estimate that a total land area of 17,900 km² is sinking.**
- **34 million people (1 in 10 US population) live on sinking land in 28 US cities.**



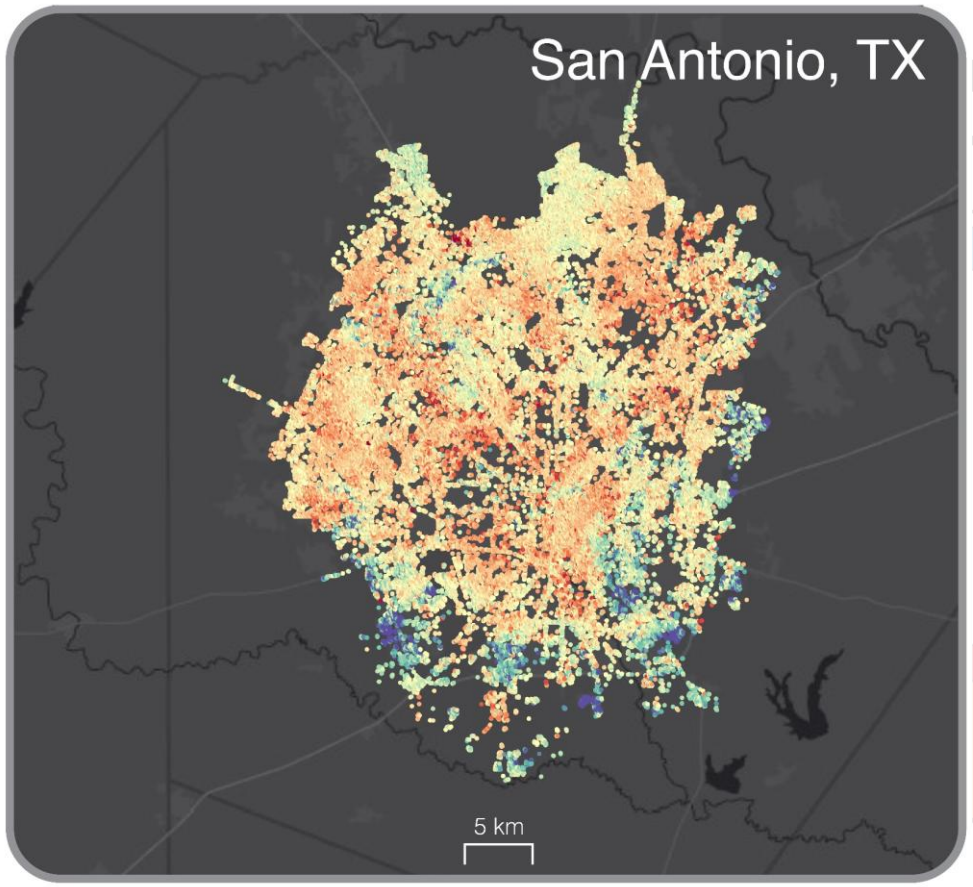
- **95% of the buildings in all cities are at low-medium risks.**

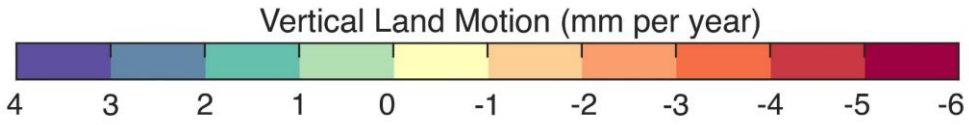


- **29,000 buildings are at high risk of infrastructure damage in the US.**
- **San Antonio has the highest number of at-risk buildings with more than 10,000 buildings at high risk and 1,500 at very high risk.**



Results



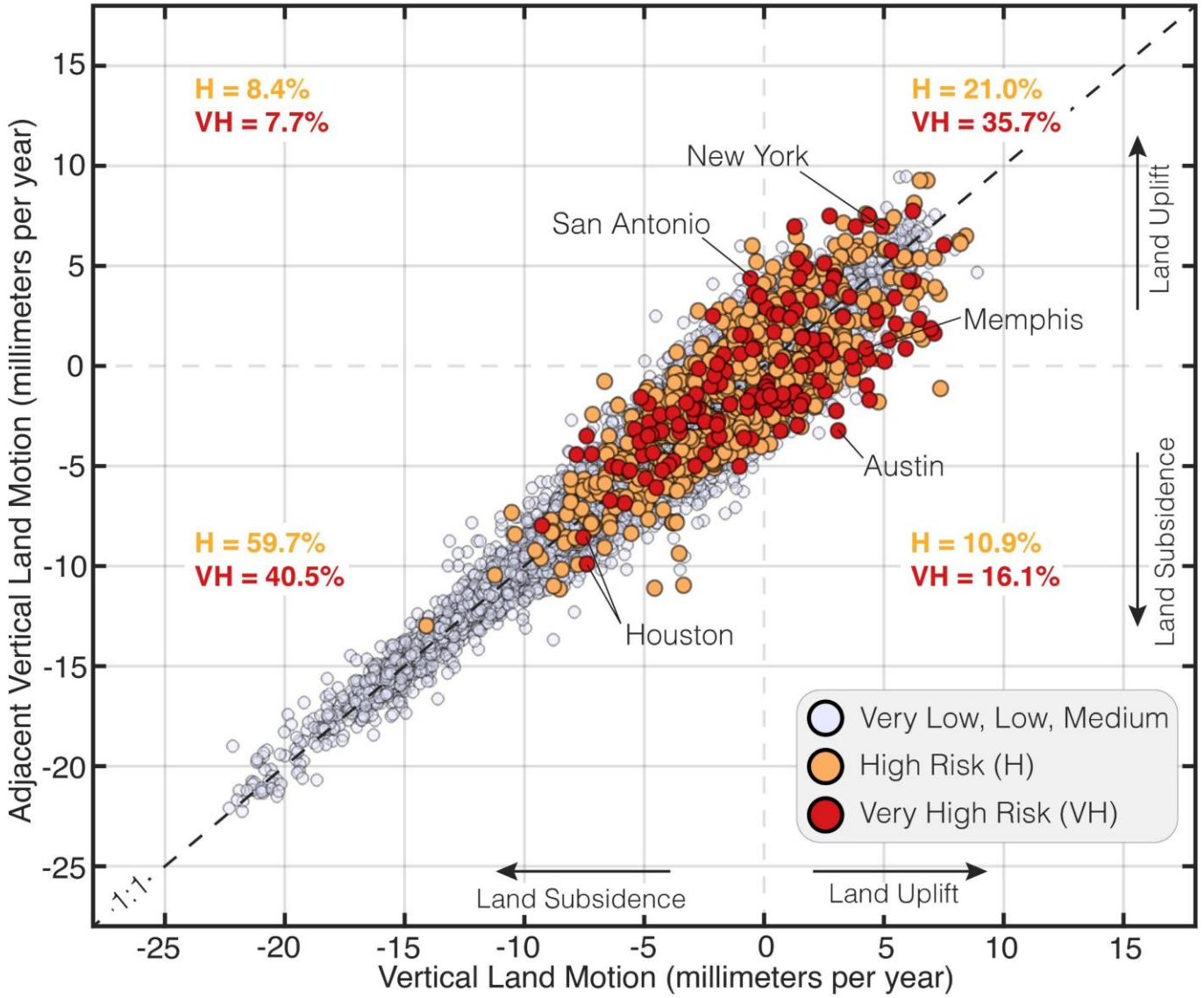


Experts weigh in on home foundation issues in Central Texas

FOX 7

By Angela Shen | Published December 30, 2025 10:44pm CST | 7 On Your Side | FOX 7 Austin |

Results



- **Both uplift and subsidence produce infrastructure risk.**
- **Uniform deformation → low structural stress: minimal differential settlement and low angular distortion.**
- **High (H) and Very High (VH) risks areas cluster in steep gradients.**

From millimeter-scale deformation to infrastructure resilience strategy

- **Land subsidence is a critical but overlooked driver of infrastructure risk in U.S. metropolises.**
- **Spatial heterogeneity governs infrastructure risk–differential settlement and not average subsidence controls infrastructure risks.**
- **Integrate deformation monitoring into building codes and asset management.**