The New York Times https://www.nytimes.com/interactive/2025/05/08/climate/sinking-cities-us-causes-groundwater.html

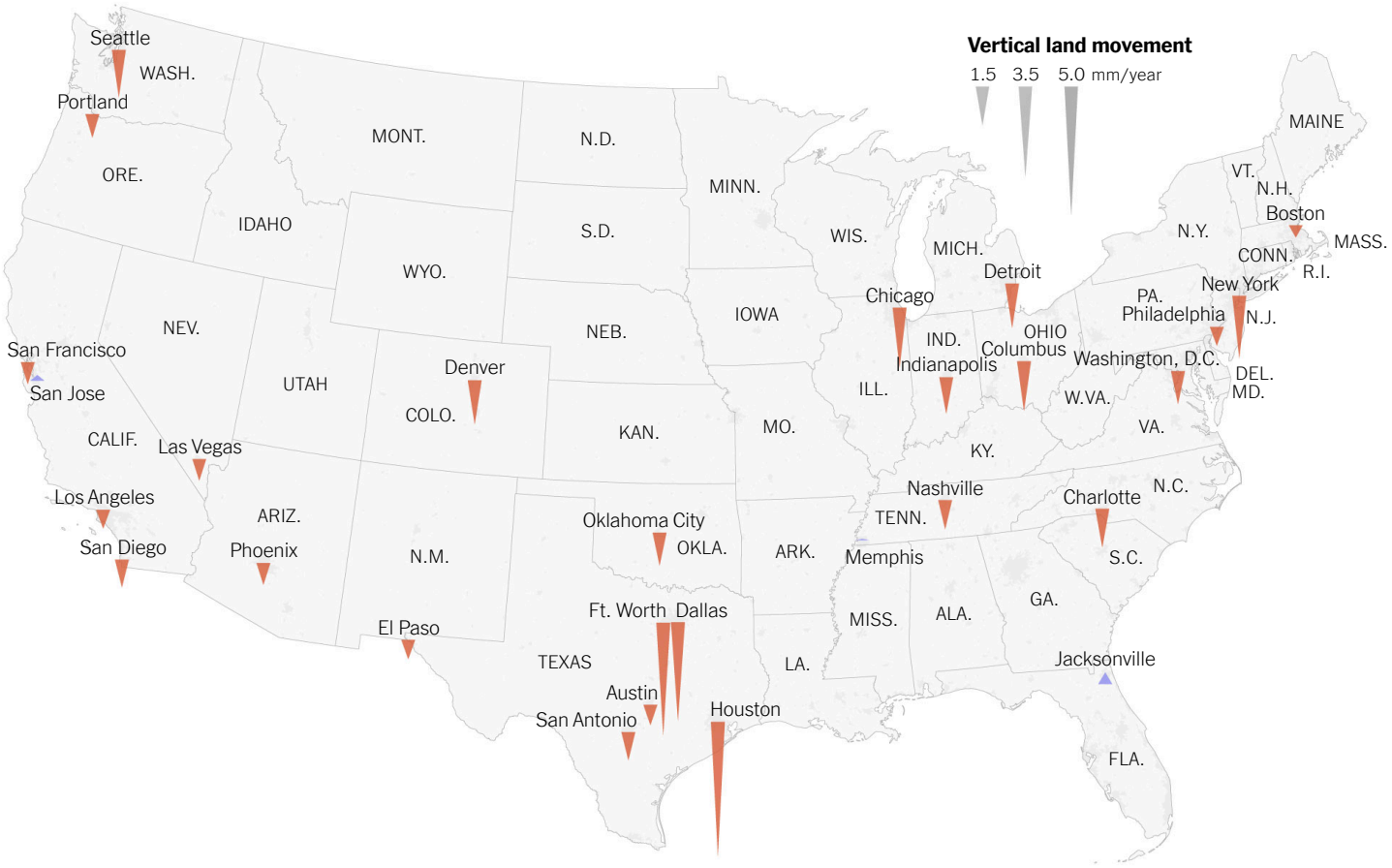
Across America, Big Cities Are Sinking. Here's Why.

A major reason is too much groundwater is being pumped out, new research shows, threatening buildings and infrastructure nationwide.

By Mira Rojanasakul May 8, 2025

A new analysis of America's 28 largest population centers found that all but three are sinking overall, and in many cases significantly.

Several of the most affected areas are in Texas, particularly around Fort Worth and Houston. But the problem is nationwide, affecting cities as scattered as Seattle, Detroit and Charlotte, N.C.



Source: Ohenhen, Shirzaei, et. al., Nature Cities (2025) • Note: Values reflect the average vertical land movement within city boundaries from 2015 to 2021.

The sinking of land, also called subsidence, can worsen the effects of sea-level rise, intensify flooding and strain the very foundations of urban infrastructure.

The new research, published in the scientific journal Nature Cities, built on previous work using satellite measurements to paint a detailed picture of rising and falling land. It also closely examined the connection between changes in land elevation and changes in groundwater, using data from individual monitoring wells.

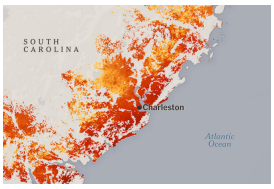
Water pumped from wells isn't something that people think about often. "You just turn on your tap, do what you need to do, and you go on your way," said

Leonard Ohenhen, a researcher at Columbia University's Lamont-Doherty Earth Observatory and lead author of the study.

But extracting more water than can be replenished "can have a direct relationship with what happens on the surface," he said. "You can cause the ground to sink significantly."

A 2023 New York Times investigation found that unsustainable pumping of water from underground aquifers can be a major cause of sinking land.

Other factors also influence land elevation. For example, a vast expanse of bedrock beneath parts of the country, pressed downward by enormous glaciers during the last ice age, is slowly rebounding back into place. But over time it creates a sort of see-saw effect that today is adding 1 to 2 millimeters per year to subsidence rates in much of the northern United States.

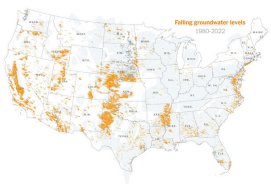


The East Coast Is Sinking

Land is slumping into the ocean, compounding the dangers from sea level rise. A major culprit: overpumping of groundwater.

By Mira Rojanasakul and Marco Hernandez

Feb. 13, 2024



America Is Using Up Its Groundwater Like There's No Tomorrow

Unchecked overuse is draining and damaging aquifers nationwide, a data investigation by the New York Times revealed, threatening millions of people and America's status as a food superpower.

By Mira Rojanasakul, Christopher Flavelle, Blacki Migliozzi and Eli Murray

Aug. 28, 2023

Texas draws immense amounts of groundwater for agriculture, industry and the public water supply. The extraction of oil and gas, including the growing use of "monster fracks," can also cause the land surface to slump.

Climate change can worsen the issue. Hotter temperatures and more extreme droughts, particularly in the West, dry out soil, streams and reservoirs, leading people to pump larger quantities of freshwater from underground.

Americans have also been moving in droves to some of the hottest and driest parts of the country. In the past few decades, metro areas in Texas have ballooned in population and sprawl.

Groundwater depletion was the main cause of subsidence in Houston between the 1950s and 70s, when nearly all water usage came from the ground, said Bob Wang, a professor of geophysics at the University of Houston. Cracked roads and buildings were a common sight.

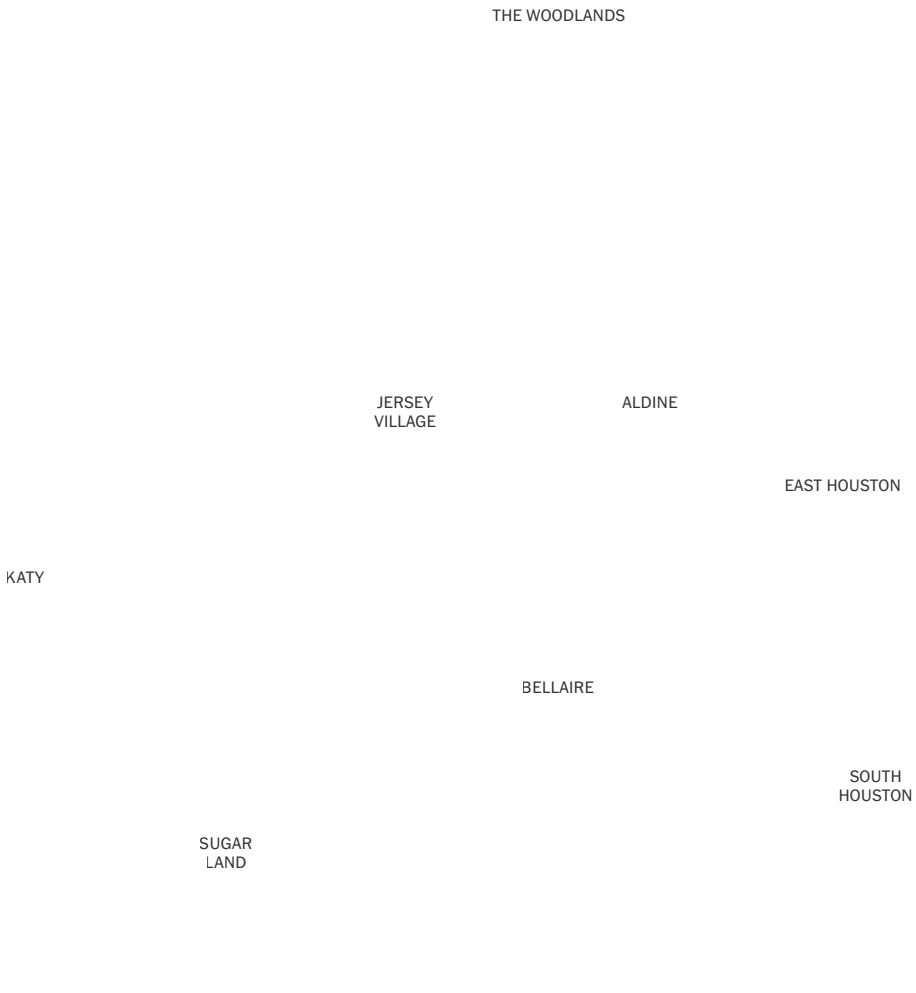
Several subsidence-management districts were established in the area to address the issue. Among other things, groundwater use was reduced and instead more water was taken from surface-water sources such as rivers. Subsidence has since slowed in the city center.

However, when new neighborhoods developed to support growing populations, the most affordable source of water was often what people could pump from below.

Houston 2.3 million residents

Vertical land movement

−6 −4 −2 0 +2 mm/year



Source: Ohenhen, Shirzaei, et. al., Nature Cities (2025)

Subsidence is in itself a hazard. But when adjacent land sinks at different rates, or when sinking occurs next to land that's rising, it can cause roads and buildings to crack. Though this process happens slowly, in millimeters per year, over time it can create added stress to infrastructure in areas where flooding, earthquakes or sea level rise are already a problem.

Extreme weather adds to the risk. When surface soils expand during extreme rainfall, then compact during prolonged droughts, it can lead to structural damage. "In the Houston area, foundation repair is a very good business," said Dr. Wang.

Cities along the coast, which are often built on soft soil or marshland like Houston, can be particularly vulnerable. But the research paper also looked at inland cities facing similar sinking challenges.

Phoenix, a desert city, has a long history of groundwater depletion but has managed to turn things around. After the state of Arizona implemented its 1980 Groundwater Management Act, management districts were established and many conservation rules were put in place.

Phoenix 1.6 million residents

Vertical land movement

−6 −4 −2 0 +2 mm/year

Old landfills can show up as hotspots.

DEER VALLEY

PARADISE VALLEY VILLAGE

NORTH MOUNTAIN VILLAGE

WESTGATE

DESERT WEST PARK

The state is still monitoring subsidence in the southwest corner of the city.

SOUTH MOUNTAIN VILLAGE

Source: Ohenhen, Shirzaei, et. al., Nature Cities (2025)

Still, the legacy of overpumping still affects the area. One reason is that, once groundwater is pumped out, it can be difficult if not impossible for some aquifers to recharge and refill to their earlier levels. In other words, it's very hard to reverse land that has already settled.

Subsidence can still occur "even as groundwater levels recover, because the pore spaces in the sub-surface that were once being held open by groundwater are now just filled with air," said Brian Conway, a principal hydrogeologist at the Arizona Department of Water Resources. Those spaces sometimes can be refilled with water, but sometimes they compress and can't be recharged.

In Phoenix, managed recharge has helped to fill those pore spaces, replenishing underground reservoirs. While subsidence still occurs, it's a far cry from the rates that caused a record 18 feet of elevation drop in Phoenix between the 1950s and 1990s.

Outside the city, however, land is still sinking as fast as ever.

Methodology

Vertical land movement data with higher uncertainty, including areas around dense vegetation and water bodies, were not included in the maps.

Researchers analyzed the most populated areas in the United States, and included all cities with more than 600,000 residents. They used 2020 U.S. Census data for the population estimates.