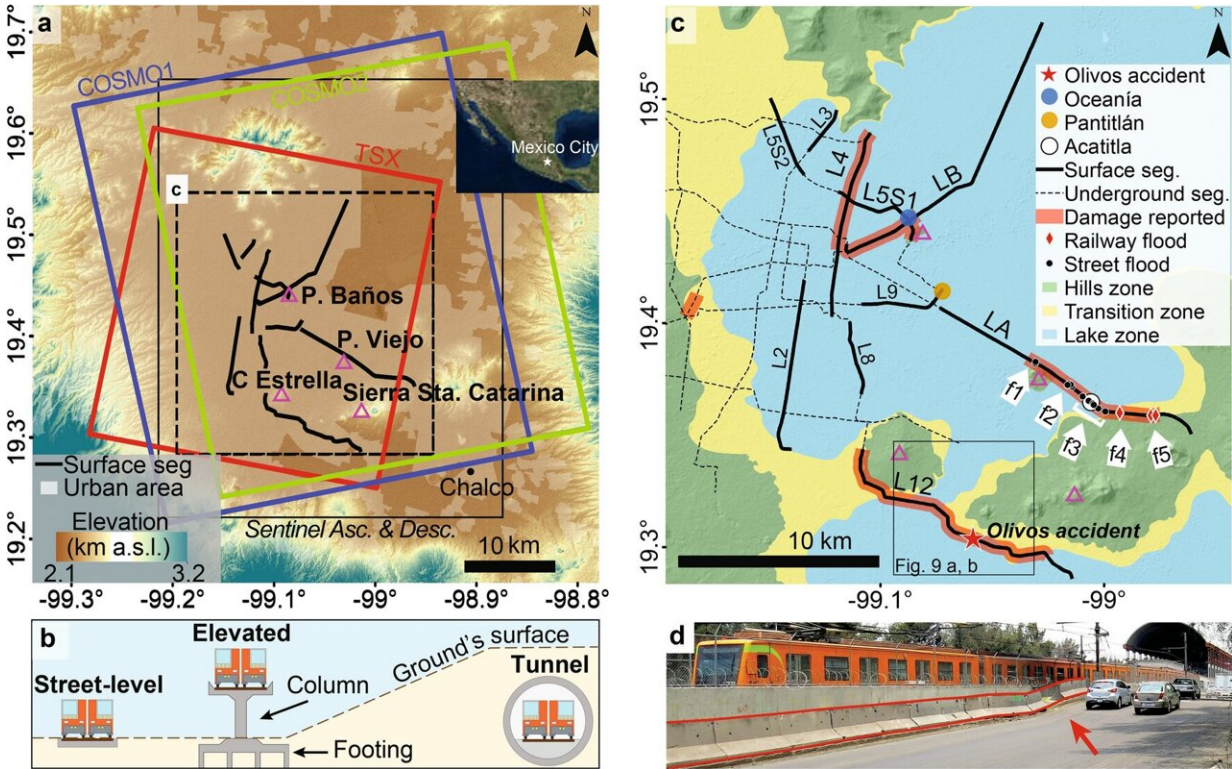


Study identifies areas in Mexico City Metro affected by land subsidence

March 21 2024, by Ayleen Barbel Fattal



SAR datasets used in this study, railway engineering designs used by the Metro and locations of subsidence-related damage reports. (a) SRTM elevation map overlaid by the footprints of the five SAR datasets. (b) Illustration of street-level, elevated, and underground Metro line designs used in Mexico City. (c) Damaged segments and stations of the Metro system overlaying the city's official geotechnical zoning. (d) Differential subsidence at Acatitla Station as indicated by the tilted road traffic barriers (marked by two red lines). Credit: *Scientific Reports* (2024). DOI: 10.1038/s41598-024-53525-y

A new assessment study identifies areas in Mexico City's metro system affected by land subsidence, providing a roadmap for mitigating damage, prioritizing repairs, and informing future designs for the metro's infrastructure.

Using [satellite radar data](#) and structural engineering analyses, the research team identified zones where the rate of subsidence changes rapidly.

Subsidence is a naturally occurring phenomenon, but often amplified by [human activity](#) such as groundwater extraction. Mexico City is built within a mountain basin over a variable thickness layer of soft lake sediments. Excessive groundwater extraction in the city has led to rapid subsidence with rates reaching nearly 20 inches per year.

Sharp changes in subsidence rates from low to fast subsiding areas cause progressive damage to the city's core infrastructure, including the Mexico City Metro, which is the second largest [metro](#) system in North America after the New York City Subway.

"By comparing two or more radar observations from roughly the same location in space, we can detect small changes of the Earth's surface with centimeter-level accuracy," said Shimon Wdowinski, FIU geophysics professor and co-author of the [study](#) published in *Scientific Reports*. "Over time, changes can be observed with millimeter-per-year accuracy."

In 2021, an overpass located near the Olivos station collapsed onto the road as a train was traveling over it, resulting in more than 20 deaths. This occurred along a metro line that had been in operation less than 10 years. It was following this tragic accident that system authorities became aware subsidence-related structural damage existed.

This discovery led to major repairs to two of the twelve metro lines. Still, the need for quantifying the magnitude and extent of the subsidence's effects on the metro system's widespread infrastructure remained. This study was designed to help determine those effects and provide data that could help prevent similar events.

Using a remote sensing approach, the study's researchers were able to evaluate land subsidence throughout the metro's different engineering designs and determine most of the damage was observed along street-level and elevated segments. The observed damage includes cracks, faults, railway deformation and topographic slope changes which can lead to recurrent flooding, reduced train speed, service interruptions and accidents like the collapse of 2021.

"Our analysis provides key information that can be incorporated in the root cause analysis of the Olivos accident as well as in the evaluation of other vulnerable line segments. It can provide insights into the future development of the Metro lines," said lead author Darío Solano-Rojas, former FIU postdoctoral researcher and current geophysics professor at La Universidad Nacional Autónoma de México.

The research team recommends similar geohazard evaluations be conducted for other infrastructure in Mexico City and other highly subsiding areas throughout the world. The data could inform proactive measures to assess and mitigate the risks posed by widespread [land subsidence](#).

More information: Darío Solano-Rojas et al, Geohazard assessment of Mexico City's Metro system derived from SAR interferometry observations, *Scientific Reports* (2024). [DOI: 10.1038/s41598-024-53525-y](https://doi.org/10.1038/s41598-024-53525-y)

Provided by Florida International University

Citation: Study identifies areas in Mexico City Metro affected by land subsidence (2024, March 21) retrieved 27 April 2024 from <https://techxplore.com/news/2024-03-areas-mexico-city-metro-affected.html>

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