

# Liquefaction: When terra firma turns to mush

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Having a paved surface does not protect you from the liquefaction

Survivors of the enormous 7.5-magnitude earthquake and tsunami in Sulawesi, Indonesia that killed 1,234 people have given harrowing testimony of how the ground beneath their feet seemed to churn and

suddenly rise up—swallowing everything in its path.

In some cases, the ground swelled up several metres, sweeping away entire houses and communities and flipping hefty vehicles onto their roofs.

This is due to a phenomenon called "liquefaction", where an earthquake shakes the soil with such force that its particles loosen, and—saturated with water—the ground itself starts behaving like a liquid, turning into a kind of quicksand.

Indonesia's minister of public works and housing, Basuki Hadimuljono, said liquefaction was the cause of many deaths and had hit one housing complex containing 1,333 homes.

Here are some key questions and answers about liquefaction.

## **How does it happen?**

It happens when the earth shakes so violently from an earthquake that the bonding between the sand and silt grains that make up the soil become looser.

Into the gaps rush groundwater which becomes more highly pressurised by strong shaking. This causes the ground to behave temporarily like a liquid and automatically flow down to lower areas, rivers or drainage systems.

It may also cause sand to erupt to the surface and lift up buried infrastructure such as sewers.

## **Where can it happen?**

Liquefaction occurs mainly in low, flat areas near the ocean, where groundwater levels are already high, said Yoshimichi Tsukamoto, a professor at the Tokyo University of Science.



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"In Japan, reclaimed areas have seen damage due to this phenomenon," he told AFP.

Scientists have warned that Tokyo Bay could be prone to liquefaction in the event of a big earthquake nearby. Historically, San Francisco has also been vulnerable to quake-driven liquefaction.



## Why is it dangerous?

Aside from the immediate dangers of huge shaking and potential tsunamis, liquefaction is one of the biggest causes of death and destruction during a seismic event.

The ground is turned to paste in an instant, tilting buildings onto their sides and rendering houses immediately uninhabitable.

Having a paved surface is no help, as higher groundwater pressures and loosened sand may crack road surfaces or cause the ground to cave—as has been seen in the images from the latest quake in Indonesia.

"It can cause significant impact on people's lives by destroying lifelines, such as distribution of electricity, gas and water—infrastructures that are buried underground," said Tsukamoto.

## What are recent examples?

Liquefaction caused major destruction in Christchurch, New Zealand, in 2011, turning parts of the city to mush. It also resulted in a massive "bulge" along the playing surface of the city's rugby stadium that was supposed to be used for that year's World Cup.

During the devastating 2011 earthquake in Japan, areas around Disneyland Tokyo, which is built on reclaimed land in Tokyo Bay, suffered liquefaction and the theme park was shut down for five weeks.

The most notable case in Japan happened in 1964 when a 7.5-magnitude [earthquake](#) struck under the sea off Niigata, northern Japan.

The quake unleashed a huge tsunami but also triggered massive

[liquefaction](#) of soil in low-lying areas, destroying the foundations of four-storey apartment blocks and causing them to tilt.

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