

Climate change sea level rises could increase risk for more devastating tsunamis worldwide

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As sea levels rise due to climate change, so do the global hazards and potential devastating damages from tsunamis, according to a new study

by a partnership that included Virginia Tech.

Even minor [sea-level](#) rise, by as much as a foot, poses greater risks of tsunamis for coastal communities worldwide.

The threat of rising sea levels to coastal cities and communities throughout the world is well known, but new findings show the likely increase of flooding farther inland from tsunamis following earthquakes. Think of the tsunami that devastated a portion of northern Japan after the 2011 Tohoku-Oki [earthquake](#), causing a nuclear plant to melt down and spread radioactive contamination.

These findings are at the center of a new *Science Advances* study, headed by a multi-university team of scientists from the Earth Observatory of Singapore, the Asian School of the Environment at Nanyang Technological University, and National Taiwan University, with critical support from Virginia Tech's Robert Weiss, an associate professor in the Department of Geosciences, part of the College of Science.

"Our research shows that sea-level rise can significantly increase the tsunami hazard, which means that smaller tsunamis in the future can have the same adverse impacts as big tsunamis would today," Weiss said, adding that smaller tsunamis generated by earthquakes with smaller magnitudes occur frequently and regularly around the world. For the study, Weiss was critical in helping create computational models and data analytics frameworks.

At Virginia Tech, Weiss serves as director of the National Science Foundation-funded Disaster Resilience and Risk Management graduate education program and is co-lead of Coastal@VT, comprised of 45 Virginia Tech faculty from 13 departments focusing on contemporary and emerging coastal zone issues, such as disaster resilience, migration, sensitive ecosystems, hazard assessment, and natural infrastructure.

For the study, Weiss and his partners, including Lin Lin Li, a senior research fellow, and Adam Switzer, an associate professor, at the Earth Observatory of Singapore, created computer-simulated tsunamis at current sea level and with sea-level increases of 1.5 feet and 3 feet in the Chinese territory of Macau. Macau is a densely populated coastal region located in South China that is generally safe from current tsunami risks.

At current sea level, an earthquake would need to tip past a magnitude of 8.8 to cause widespread tsunami inundation in Macau. But with the simulated sea-level rises, the results surprised the team.

The sea-level rise dramatically increased the frequency of tsunami-induced flooding by 1.2 to 2.4 times for the 1.5-foot increase and from 1.5 to 4.7 times for the 3-foot increase. "We found that the increased inundation frequency was contributed by earthquakes of smaller magnitudes, which posed no threat at current sea level, but could cause significant inundation at higher sea-level conditions," Li said.

In the simulated study of Macau—population 613,000—Switzer said, "We produced a series of tsunami inundation maps for Macau using more than 5,000 [tsunami](#) simulations generated from synthetic earthquakes prepared for the Manila Trench." It is estimated that sea levels in the Macau region will increase by 1.5 feet by 2060 and 3 feet by 2100, according to the team of U.S.-Chinese scientists.

The hazard of large tsunamis in the South China Sea region primarily comes from the Manila Trench, a megathrust system that stretches from offshore Luzon in the Philippines to southern Taiwan. The Manila Trench megathrust has not experienced an earthquake larger than a magnitude 7.8 since the 1560s. Yet, study co-author Wang Yu, from the National Taiwan University, cautioned that the region shares many of the characteristics of the source areas that resulted in the 2004 Sumatra-Andaman earthquake, as well as the 2011 earthquake in northern Japan,

both causing massive loss of life.

These increased dangers from tsunamis build on already known difficulties facing coastal communities worldwide: The gradual loss of land directly near coasts and increased chances of flooding even during high tides, as sea levels increase as the Earth warms.

"The South China Sea is an excellent starting point for such a study because it is an ocean with rapid [sea-level rise](#) and also the location of many mega cities with significant worldwide consequences if impacted. The study is the first of its kind on the level of detail, and many will follow our example," Weiss said.

Policymakers, town planners, emergency services, and insurance firms must work together to create or insure safer coastlines, Weiss added.

"Sea-level rise needs to be taken into account for planning purposes, for example for reclamation efforts but also for designing protective measures, such as seawalls or green infrastructure."

He added, "What we assumed to be the absolute worst case a few years ago now appears to be modest for what is predicted in some locations. We need to study local sea-level change more comprehensively in order to create better predictive models that help to make investments in infrastructure that are or near sustainable."

More information: L. Li et al., "A modest 0.5-m rise in sea level will double the tsunami hazard in Macau," *Science Advances* (2018). [DOI: 10.1126/sciadv.aat1180](https://doi.org/10.1126/sciadv.aat1180) , advances.sciencemag.org/content/4/8/eaat1180

Provided by Virginia Tech

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