

Many low-lying atoll islands could be uninhabitable by mid-21st century

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Wave-driven flooding and overwash on Roi-Namur Atoll, Republic of the Marshall Islands. Credit: Peter Swarzenski, US Geological Survey

Sea-level rise and wave-driven flooding will negatively impact freshwater resources on many low-lying atoll islands in such a way that many could be uninhabitable in just a few decades. According to a new study published in *Science Advances*, scientists found that such flooding not only will impact terrestrial infrastructure and habitats, but, more importantly, it will also make the limited freshwater resources non-potable and, therefore, directly threaten the sustainability of human populations.

Most of the world's atolls are in the Pacific and Indian oceans. The scientists focused on Roi-Namur Island on Kwajalein Atoll in the Republic of the Marshall Islands for their site study from November 2013 to May 2015. The Republic of the Marshall Islands has more than 1,100 low-lying [islands](#) on 29 atolls, is home for numerous island nations and hundreds of thousands of people.

Scientists from the U.S. Geological Survey, Deltares, National Oceanic and Atmospheric Administration, and the University of Hawai'i at Mānoa used a variety of climate-change scenarios to project the impact of sea-level rise and wave-driven flooding on atoll infrastructure and freshwater availability. The approach and findings in this study can serve as a proxy for atolls around the world, most of which have a similar morphology and structure, including, on average, even lower land elevations.

"The tipping point when potable groundwater on the majority of atoll islands will be unavailable is projected to be reached no later than the middle of the 21st century," said Curt Storlazzi, USGS geologist and lead author of the new report.



Wave-driven flooding and overwash on Roi-Namur Atoll, Republic of the Marshall Islands. Credit: Peter Swarzenski, US Geological Survey

Sea levels are rising, with the highest rates in the tropics, where thousands of low-lying coral atoll islands are located. Previous studies on the resilience of these islands to sea-level rise projected they will experience minimal inundation impacts until at least the end of the 21st century. However, those previous studies did not take into account the additional hazard of wave-driven overwash (storm waters and waves that wash up and over the low-lying island) nor its impact on freshwater availability.

"Such information is key to assess multiple hazards and prioritize efforts

to reduce risk and increase the resiliency of atoll islands' communities around the globe," said Storlazzi.

These findings have relevance not only to populated atoll islands in the Marshall Islands, but also to those in the Caroline Islands, Cook Islands, Gilbert Islands, Line Islands, Society Islands, Spratly Islands, Maldives, Seychelles, and Northwestern Hawaiian Islands.



Aerial photograph of Kwajalein Atoll showing its low-lying islands and coral reefs. Credit: Thomas Reiss, US Geological Survey

Thus, the study scientists project that, based on current global [greenhouse gas emission](#) rates, the interactions between [sea-level rise](#)

and wave dynamics over coral reefs will lead to an annual wave-driven overwash of most atoll islands by the mid-21st century. Such annual flooding would result in the islands becoming uninhabitable due to frequent damage to infrastructure and the inability of their [freshwater resources](#) to recover between overwash events.

The primary source of freshwater for populated atoll islands is rain that soaks into the ground and remains there as a layer of fresh groundwater that floats on top of denser saltwater. As atoll islands come to be overwashed annually, on average, in the next few decades (assuming current greenhouse gas emission rates), flooding impacts to infrastructure and the loss of freshwater resources would make human habitation difficult in most locations beginning between the 2030s to 2060s, requiring the relocation of island inhabitants or significant financial investments in new infrastructure.

"The overwash events generally result in salty ocean water seeping into the ground and contaminating the freshwater aquifer. Rainfall later in the year is not enough to flush out the saltwater and refresh the island's water supply before the next year's storms arrive repeating the overwash events," explained Stephen Gingerich, USGS hydrologist and co-author of the new report.

More information: C.D. Storlazzi et al., "Most atolls will be uninhabitable by the mid-21st century because of sea-level rise exacerbating wave-driven flooding," *Science Advances* (2018). [DOI: 10.1126/sciadv.aap9741](https://doi.org/10.1126/sciadv.aap9741) , advances.sciencemag.org/content/4/4/eaap9741

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