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Honolulu under triple threat of flooding as sea level rises

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This photo was taken during king tides in the Mapunapuna area in 2017. The flooding is a result of a combination of groundwater inundation and drainage backflow, with no direct overwash flooding from the ocean.

A new study by researchers at the University of Hawaii at Manoa has found that Honolulu will be under increasing siege by a triple threat of flood waters associated with escalating sea level rise in the decades ahead.

Surprisingly, direct flooding from ocean waves represents the smallest threat — only 3% — while flooding that emerges from the ground, known as groundwater inundation, appears to be the greatest single threat, according to the study published in the journal Scientific Reports.

What that means is that anyone thinking of building a seawall for protection against a rising ocean might want to think twice.

“That’s because it’s not going to stop 97% of the flooding,” said Shellie Habel, lead author and coastal geologist and extension agent with the UH Sea Grant College Program and UH Coastal Geology Group.

Habel said it was surprising that direct flooding from ocean waves alone accounted for so little of the coastal flooding Honolulu can expect see.

“It’s time to readjust our thinking regarding the flooding that accompanies sea level rise,” she said. “We want to be sure to implement flood management strategies that will be effective in dealing with the problem.”

The study focused on the three types of flooding linked to the high-tide events expected to challenge urban Honolulu in the decades ahead: flooding from water washing directly over the shoreline, groundwater inundation as the water table is pushed to the surface, and reverse flow through the municipal drainage system.

The study found that more than a quarter of flooding is attributed to groundwater inundation alone, while a combination of the three types will eventually account for more than half of the projected flooding generated by climate change.

“Anyone who is planning to be here in the decades to come needs to start thinking about this now,” Habel said.

The top threat, groundwater inundation, occurs as a rising ocean lifts Oahu’s caprock aquifer, an underground lens of brackish and polluted water that floats on a base of higher-density saltwater connected to the ocean.

During high-tide events, the groundwater breaks the surface to create temporary urban wetlands that grow even larger when high tides and rainfall coincide.

Over time, in perhaps as soon as three decades from now, those wetlands will become permanent. And, increasingly, the standing water will require special engineering, costly public works and other measures to help the city continue to function and thrive.

“You can’t stop the flooding with seawalls,” said co-author Charles “Chip” Fletcher, UH professor of geology and associate dean of the School of Ocean and Earth Science and Technology. “You have to adapt to it. Over time it will force all of us to figure out new urban designs to live with the water.”

A previous study from Fletcher’s research group found that groundwater flooding in urban Honolulu and Waikiki will eventually threaten some $5 billion in taxable real estate, nearly 30 miles of roadway and a host of other facilities and assets.

In the latest study, Habel and co-authors developed a method that identifies the various flood types and their reach within the city.

The impacts, the researchers found, will be widespread and are already being felt as far inland as Beretania Street.

Vulnerable areas were revealed when maps were produced identifying likely flood locations and depths generated by each of the three flooding types and overlapping simulations.

The UH Sea Level Center then developed a statistical model with predicted tide and projected magnitudes of local sea level rise to establish the frequency with which flooding is likely to occur in various locations.

To demonstrate the utility of the flood simulations, the research group identified critical infrastructure likely to fail and lead to problems. Their results revealed dangerous and impassable roadways, storm drainage inlets likely to fail or act as funnels for further flooding, and inoperable or flooded cesspools likely to pollute coastal groundwater and the ocean.

According to the study, the 2030s could very well see stretches of roadway that become impassable to even four-wheel-drive vehicles, including emergency response vehicles. Drainage failure will become increasingly widespread.

The problems only multiply through the decades, according to the models, as the amount of area inundated by “multimechanism flooding” increases fivefold.

Habel, a former Pacific Beach Hotel aquarium diver who has studied under Fletcher since 2011, said groundwater inundation and storm-drain back-flow are often overlooked in studies that inform planning.

“Because each type of flooding infiltrates through unique pathways, they will require unique engineering strategies to manage,” she said.

Habel said she plans to partner with the Honolulu Board of Water Supply and other agencies to develop a real-time coastal groundwater monitoring network that will help improve future modeling of flooding events, including the effects of rainfall.