

Sewage contamination locations threatening west Hawai'i coral reefs

ASU research identifies most polluted areas of coastline and targets for remediation

By Sandy Keaton Leander, ASU News
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A new Arizona State University study reveals the extent to which sewage pollution threatens the fragile coral reef ecosystems of west Hawai'i Island.

The study identifies exactly where sewage-contaminated water is entering the ocean, further damaging coral reefs already impacted by climate change and endangering human health.

Researchers with the [ASU Center for Global Discovery and Conservation Science](#) used advanced airborne mapping techniques aboard the ASU Global Airborne Observatory, along with comprehensive field sampling and sophisticated statistical models, to pinpoint locations where high levels of fecal bacteria associated with populated coastal areas are driving worsening contamination.

Why this research matters

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The study, published today in [Frontiers in Marine Science](#), provides the data needed by government officials and local communities to mitigate this threat and protect the health and biodiversity of coastal ecosystems.

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“It’s concerning how many sites we tested were contaminated, but not surprising when we consider statewide, 55 million gallons of wastewater effluent enters the ground each day — much of that within a few hundred yards of the coast,” said [Kelly Hondula](#), the study’s first author and an associate research scientist with the Center for Global Discovery and Conservation Science in the [Julie Ann Wrigley Global Futures Laboratory](#).

“The results are clear. The high number of cesspools and faulty wastewater systems, and amount of land development along the coast, are highly predictive of whether the water is contaminated,” she said.

Much of the contaminated water entering the ocean comes from submarine groundwater discharge — basically, groundwater that flows directly into the ocean from the land instead of through rivers or streams. The water seeps through sediment and porous rocks along coastlines, bringing with it contaminants from tens of thousands of cesspools, leaking septic systems, and overbuilt coastal urban areas.

According to the state of Hawaiʻi’s [Department of Health](#), there are more than 88,000 cesspools in the state, with approximately 55,000 on the Big Island alone. Tens of thousands of cesspools and other leaking wastewater systems pose a risk to local water resources and coral ecosystems. More than 1,000 discharge sites along the west Hawaiʻi coastline [were mapped](#) in 2024.

Fixing the problem requires converting outdated wastewater systems to more advanced wastewater treatment units. However, pinpointing specific locations to prioritize for mitigation has been a challenge for officials, especially in the context of submarine groundwater discharge that moves contaminants into the coral reef system.

Understanding more precisely where this discharge occurs, and how contaminated it is, is difficult to study. The research team collected water samples from 47 sites along 120 miles of the west Hawaiʻi coastline from finely mapped locations of submarine groundwater discharge. Then they used landscape-scale statistical models to identify areas susceptible to contamination through the coastal groundwater-connected system.

Key findings

In 42% of the 47 sampled sites, the team found elevated levels of *Enterococcus*, a key fecal indicator bacteria that identifies sewage contamination. Of these sites, 23% exceeded health risk thresholds, which means the water poses a direct threat to human health as well as to the environment.

The researchers also found two clearly linked factors causing the contamination: the presence of inland on-site sewage systems (mostly cesspools and septic systems) and the prevalence of high-density land cover near the coastline — particularly coastal urban development.

Additionally, the study confirms that submarine groundwater discharge acts as a major conduit that delivers sewage-contaminated groundwater directly onto some of west Hawai'i's most vulnerable coral reefs.

Highlights from the study show that contaminated submarine groundwater discharge varies but is influenced by even small increases in infrastructure near the coastlines.

In the southern portion of the study area, a region called South Kona is especially vulnerable to water contamination because of increased coastal development and because it has a porous, volcanic land base that allows sewage to travel quickly through the underground natural water system.

The South Kona area is a critical environmental area for both coral and fish populations.

The good news

"This study provides crucial insight into the impacts of development on our coastal ecosystems that will help us prioritize upgrades to our wastewater infrastructure," said Kimo Alameda, mayor of the county of Hawai'i. "We are grateful to the ASU research team for their commitment to this important work. Their findings will play an important role in helping us protect our coral reefs for future generations."

The team's landscape-scale statistical model can predict the likelihood of sewage and bacterial contamination for each submarine groundwater discharge site mapped along the west Hawai'i coastline. The model, which considers upstream land cover and known sewage sites, can help inform state policy- and decision-makers and guide restoration.

"The findings not only provide tactical information for government- and community-based interventions on land, they indicate where interventions are most needed as part of our reef restoration program here in Hawai'i," said [Greg Asner](#), senior author of the study, professor in the [ASU School of Ocean Futures](#) and director of the [Maui Oceanographic Society's](#) Reef Restoration Program. "Restoration is not just about planting corals, it involves a spectrum of land management, reef interventions and education effort."

The research team encourages a multifaceted approach to mitigating sewage pollution, including continuing to replace cesspools and septic tanks with newer, more effective wastewater treatment systems, targeting restoration in the areas most likely to protect coral reefs and human health, and implementing new, advanced green infrastructure to reduce the impact of coastal development on groundwater quality.

The Dorrance Family Foundation funded this research. The [Maui Oceanographic Society's](#) cultural advisory board assisted in the design and execution of field sampling.

This story originally appeared on [ASU News](#).

Main image



Research scientist Kelly Hondula gathers water samples from submarine groundwater discharge sites along west Hawai'i Island. In 42% of sampled sites, the team found elevated levels of a key fecal indicator bacteria, which identifies sewage contamination. Of these sites, 23% exceeded health risk thresholds, which means the water poses a direct threat to human health and the environment. Courtesy photo

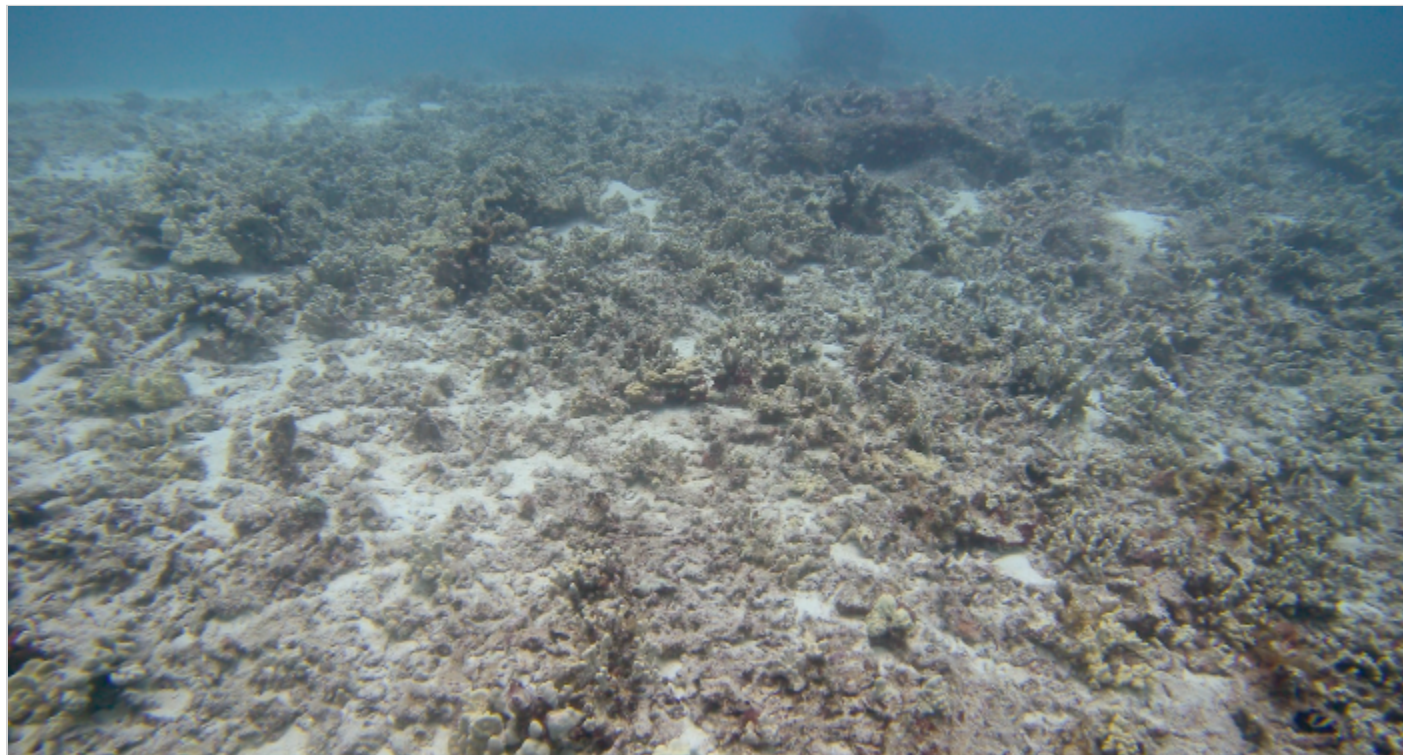
Gallery



ASU researchers use advanced mapping techniques, along with field sampling and sophisticated statistical models, to pinpoint locations where high levels of fecal bacteria are driving ocean contamination.



Contaminated sewage water enters the ocean from submarine groundwater discharge. More than 1,000 discharge sites have been mapped along the west Hawai'i coastline alone.



ASU researchers found two clearly linked factors causing ocean contamination: the presence of inland on-site sewage systems and the prevalence of high-density land cover near the coastline — particularly coastal urban development. Submarine groundwater discharge acts as a major conduit that delivers sewage-contaminated groundwater directly onto some of west Hawai'i's most vulnerable coral reefs. Here, coral reef at Puako are seen in declining health.



Highlights from the study show that contaminated submarine groundwater discharge varies but is influenced by even small increases in infrastructure near the coastlines. Here, the reef can be seen

alongside a Puako neighborhood.