Social media and aerial mapping of sea floor reveal that tourists love Hawaiian coral reefs just a little too much

January 11 2023

Waikīkī Beach, Honolulu, United States. Credit: Unsplash/CC0 Public Domain

Coral reefs are vibrant ecosystems for marine life and provide vital environmental benefits for humanity, such as storm wave mitigation, bountiful fish stocks, and ocean-based livelihoods. They are also a global attraction for tourists, drawing millions of visitors every year and billions of dollars in tourism revenue. However, reef ecosystems are also as fragile as they are beautiful. Coral reefs are swiftly and steadily

declining due to the combined effects of global warming and local human stressors. A new study led by Princeton University in collaboration with Arizona State University provides insights into the local impacts of tourist visitation on live coral cover, as well as the draw reefs can have for coastal visitation.

The study published in the journal *Nature Sustainability* provides novel evidence that live coral reef cover is both an attraction for and victim of tourists at a large scale, raising complex tradeoffs between environment and the economy. Even though tourism revenue is a boon to the economy and can benefit reef preservation efforts, that increased tourism also negatively impacts the health of coral reefs directly, both through tourism-related development and pollution, as well as through on-reef activities such as scuba diving and snorkeling.

"Coastal tourism is a multi-billion-dollar industry and will increasingly feature in the future use of marine resources," said Bing Lin, a doctoral student at Princeton University's School of Public and International Affairs and lead author of the study. "It is only through an adequate understanding of tourism's large-scale impacts on reef ecosystems that we can appropriately pinpoint pathways to make it more sustainable," Lin said.

Lin and co-authors created unique, high-resolution datasets collected at the archipelago scale across the state of Hawaii, a prime coastal tourism hotspot. To determine coastal visitation rates, Lin web-scraped hundreds of thousands of Instagram posts to quantify both on-reef and overall coastal visitation. To quantify live coral cover, the authors used a high-resolution airborne mapping and machine learning procedure to map the seafloor, a method previously developed by Asner and colleagues. Lin then obtained additional information from the Ocean Tipping Points project and the Hawaii Statewide GIS Program on various metrics of site accessibility, human activity, and water conditions to determine the

relationship between tourist visitation and live coral cover across hundreds of coastal sites in Hawaii.

"We took the world's first live coral maps, combined them with the power of social media and data analytics, to derive wholly new information on the interaction between people and reefs," said Greg Asner, co-author on the study and director of the ASU Center for Global Discovery and Conservation Science in the Julie Ann Wrigley Global Futures Laboratory.

"The results were astonishing to see at such a large geographic scale and yet also corroborative at the local scales in which some communities have voiced significant concern about coral reef tourism," Asner said.

They found that high-quality coral reefs are popular tourist sites for both overall and on-reef specific visitation. At the most highly visited sites, coral reefs were also doubly at risk from tourism: they are indirectly impacted by overall visitation and the elevated pollution and infrastructure development it brings, and directly impacted by on-reef visitation and the physical damages accrued through recreating tourists.

These findings provide new insights into the role of local human activities in impacting coral reef health, a finding only possible through the high-resolution, meter-scale mapping methods used in this study.

"Local stressors to the world's reefs are often overshadowed by the large, looming threat of global climate change and subsequent coral bleaching. However, our research underscores the importance of localized stressors in also contributing to coral decline," Lin said.

This study also highlights the importance of both strong reef-protecting policies and coral restoration measures, especially at popular tourist sites in Hawaii and beyond. Higher rates of on-reef visitation occur when

there is better reef quality, site accessibility, and water quality. This suggests that potential synergies also exist in promoting stronger coastal management practices that can simultaneously improve both reef quality and revenues generated from tourism.

"Healthy coral reefs and a vibrant tourism economy go hand in hand," said David Wilcove, a professor of ecology, evolutionary biology, and public affairs at Princeton and a co-author of the study. "But achieving the right balance requires careful planning and management," Wilcove said.

The paper, "Coral reefs and coastal tourism in Hawaii," was published on January 9, 2023 in *Nature Sustainability*. The authors include Bing Lin, Yiwen Zeng, and David Wilcove of Princeton University and Greg Asner of Arizona State University.

More information: Bing Lin et al, Coral reefs and coastal tourism in Hawaii, *Nature Sustainability* (2023). DOI: 10.1038/s41893-022-01021-4

Provided by Princeton School of Public and International Affairs