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Sea-level rise drives shoreline retreat in Hawaii

Honolulu, HI – Sea-level rise (SLR) has been isolated as a principal cause of coastal erosion in Hawaii. Differing rates of relative sea-level rise on the islands of Oahu and Maui, Hawaii remain as the best explanation for the difference in island-wide shoreline trends (that is, beach erosion or accretion) after examining other influences on shoreline change including waves, sediment supply and littoral processes, and anthropogenic changes. Researchers from the University of Hawaii – Manoa (UHM), School of Ocean and Earth Science and Technology (SOEST) and the State of Hawaii, Department of Land and Natural Resources published a paper recently showing that SLR is a primary factor driving historical shoreline changes in Hawaii and that historical rates of shoreline change are about two orders of magnitude greater than SLR.

Example of chronic coastal erosion threatening a building on the island of Maui. Higher average rates of erosion on Maui are due in part to higher rates of localized sea level rise compared to nearby Oahu Island.
Credit: Zoe Norcross-Nuu

The authors of the work point out that knowing that SLR is a primary cause of shoreline change on a regional scale allows managers and other coastal zone decision-makers to target SLR impacts in their research programs and long-term planning. This study is confirmation that future SLR is a major concern for decision-makers charged with managing beaches.

"It is common knowledge among coastal scientists that sea level rise leads to shoreline recession,"

stated Dr. Brad Romine, coastal geologist with the University of Hawaii Sea Grant College Program. “Shorelines find an equilibrium position that is a balance between sediment availability and rising ocean levels. On an individual beach with adequate sediment availability, beach processes may not reflect the impact of SLR. With this research we confirm the importance of SLR as a primary driver of shoreline change on a regional to island-wide basis.”

Globally-averaged sea-level rose at about 2 mm per year over the past century. Previous studies indicate that the rate of rise is now approximately 3 mm per year and may accelerate over coming decades. The results of the recent publication show that SLR is an important factor in historical shoreline change in Hawaii and will be increasingly important with projected SLR acceleration in this century. “Improved understanding of the influence of SLR on historical shoreline trends will aid in forecasting beach changes with increasing SLR,” said Dr. Charles Fletcher, Associate Dean and Professor of Geology and Geophysics at the UHM SOEST.

“The research being conducted by SOEST provides us with an opportunity to anticipate SLR effects on coastal areas, including Hawaii’s world famous beaches, coastal communities, and infrastructure. We hope this information will inform long range planning decisions and allow for the development of SLR adaptation plans,” said Sam Lemmo, Administrator, Department of Land and natural Resources, Office of Conservation and Coastal Lands.

Results of island-wide historical trends indicate that Maui beaches are significantly more erosional than beaches on Oahu. On Maui, 78% of beaches eroded over the past century with an overall (island-wide) average shoreline change rate of 13 cm of erosion per year, while 52% of Oahu beaches eroded with an overall average shoreline change rate of 3 cm of erosion per year.

The variation in long-term relative SLR rates along the Hawaii archipelago is due, in large part, to variations in island subsidence with distance from actively growing Hawaii Island and/or variations in upper ocean water masses. The islands of Oahu and Maui, Hawaii, with significantly different rates of localized sea-level rise (SLR has been approximately 65% higher rate on Maui) over the past century, provided a natural laboratory to investigate possible relations between historical shoreline changes and SLR.

Island-wide and regional historical shoreline trends were calculated for the islands using shoreline positions measured from aerial photographs and survey charts. Shoreline positions were manually digitized using photogrammetric and geographic information system (GIS) software from aerial photo mosaics and topographic and hydrographic survey charts provided by the National Ocean Service (NOS). Shoreline movement through time was measured using GIS software. Historical shoreline data were optimized to reduce anthropogenic influences (e.g., constructing seawalls or sand mining) on shoreline change measurements. The researchers controlled for influences other than SLR to determine if SLR remains as the best explanation for observed changes. They also utilized a series of consistency checks to determine if results are significant and to eliminate other possible explanations.

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