

## ***Rising Sea Level in a Changing Climate: Evidence from the Pacific Islands***

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The West Pacific Islands [such as the Territory of Guam, Republic of Palau, Commonwealth of the Northern Mariana Islands, Republic of the Marshall Islands, Federated States of Micronesia, and American Samoa (Fig. 1), and other neighboring islands are among the world's most vulnerable communities to climate variability and change, especially sea level rise, as many parts of these islands are regularly affected by erosion and inundation. The small size, lower elevations and extensive coastal areas of the islands, their remoteness and limited financial resources, and in some cases, poor economic and social decisions contribute to great ecosystem and human vulnerability to disasters.

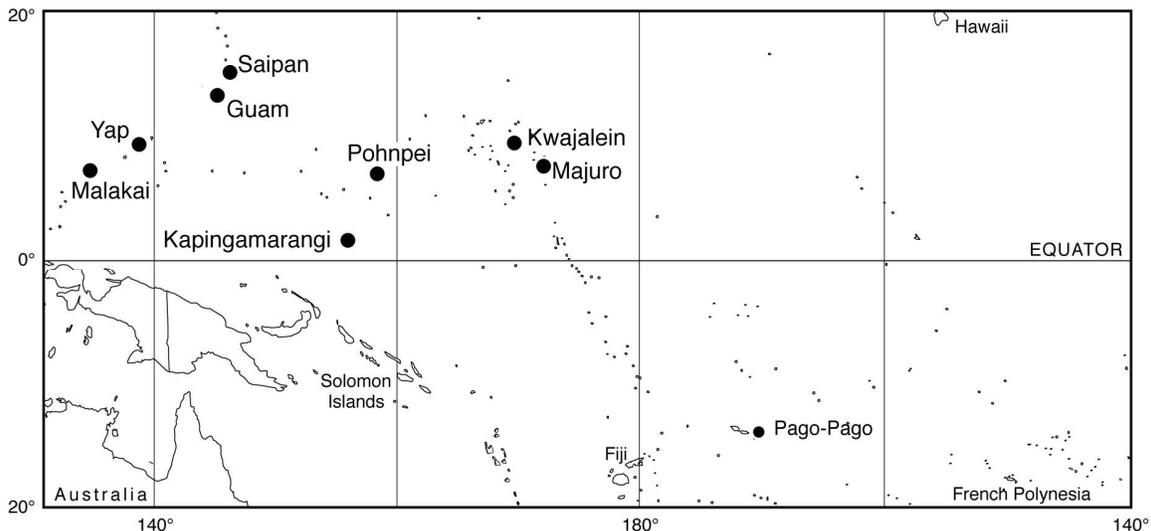


Figure 1: Locations of tropical Pacific tide-gauges. Those islands discussed here are labeled with large black circles.

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The climate literature provides abundant evidence that the tropical climate variability is heavily influenced by the phase of El Niño-Southern Oscillation (ENSO) climate cycle. Based on the pervasive tropical Pacific zonal wind anomalies accompanying ENSO fluctuations, recent studies at the Pacific ENSO Applications Climate Center (PEAC) have described the degree of sensitivity of sea-level anomalies in the tropical Pacific island communities to the phase of the ENSO cycle, with below normal sea level during El Niño events and above normal sea level during La Niña events.

During the 2006-08 El Niño and La Niña events, many Pacific Islands continuously experienced high sea-level for a period of 18 months. From July to December 2006, weak-to-moderate El Niño conditions influenced the ocean and atmosphere; then, after a brief transition through ENSO-neutral conditions, weak-to-moderate La Niña conditions developed and persisted from February 2007 through May 2008. In order to determine the relative intensity of each of the El Niño and La Niña events, the authors employ the Southern Oscillation Index (SOI) and the Oceanic Niño Index (ONI). According to these two indices, the 2006-07 El Niño is considered to have been a weak to moderate event and the 2007-08 La Niña event is considered to have been moderately strong. Likewise, the 1997-98 and 1986-87 El Niño events are classified as strong and moderate, and 1998-99 and 1988-89 La Niña events are classified as moderately strong. When the rise in sea level during the two other moderately strong La Niña events (1998-99 and 1988-89) is compared to the rise of sea-level in the 2007-08 event, the latter was found to be considerably higher. As a result, most of the tide stations in these islands recorded elevated sea levels from July 2006 to June 2008, which from a historical perspective is quite significant, since no other El Niño event on record has resulted in an observed sea level rise in these islands.

One immediate answer to this question appears to be in the tide gauge records, showing a rising trend in sea-levels at all stations, to varying degrees, over the past 15 to 20 years. This evidence supports the many anecdotal assertions that global extreme high-water levels have increased within recent decades. According to the Intergovernmental Panel for Climate Change (IPCC), global average sea-level rose at an average rate of 1.8 [1.3 to 2.3] mm per year over the period from 1961 to 2003. The rate was even faster from 1993 to 2003, with an average of about 3.1 [2.4 to 3.8] mm per year. Other scientific publications projected sea level rise in this century. This 3.1 mm per year rising trend is in approximate agreement with the rise observed in some of these locations, particularly within the Federated States of Micronesia. In fact, the rate of rise at Federated States of Micronesia is higher than that projected by IPCC over the globe in general. The tide gauge measurements elsewhere around the globe do indeed show qualitatively similar trends over the last 2 to 3 decades.

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The sea-level rise in these small islands for 1997 to 2007 maintains a close correspondence with the faster rate of predicted average global sea-level rise. However, it is unclear whether the rise is a reflection of recent decadal variability or an actual increase in the rate of the longer-term trend. While more research is necessary to test hypothesis of the latter cause, our immediate observations do confirm that the sea-levels have recorded a rise at most of these North Pacific stations over the last approximately 20 years. Despite some uncertainties in sea-level behavior, findings from these islands are significant in that they demonstrate that the rate of sea level rise in parts of the tropical Pacific basin is higher than the general global projections made by IPCC. It is an important regional example demonstrating the importance and societal ramifications of sea-level rise. Moreover, it supports the observations of sea-level rise worldwide, generating greater confidence that the rate of observed sea-level rise has increased from the 19<sup>th</sup> to the start of the 21<sup>st</sup> century.