EL NIÑO AND SEA LEVEL IMPACTS IN THE PACIFIC

During El Niño events, sea levels across the Pacific region undergo a significant shift, generally characterised by a drop in sea level in the western Pacific and a rise in the central and eastern Pacific.

WHY EL NIÑO AFFECTS SEA LEVELS

The primary reason for this change is the weakening of the equatorial trade winds.

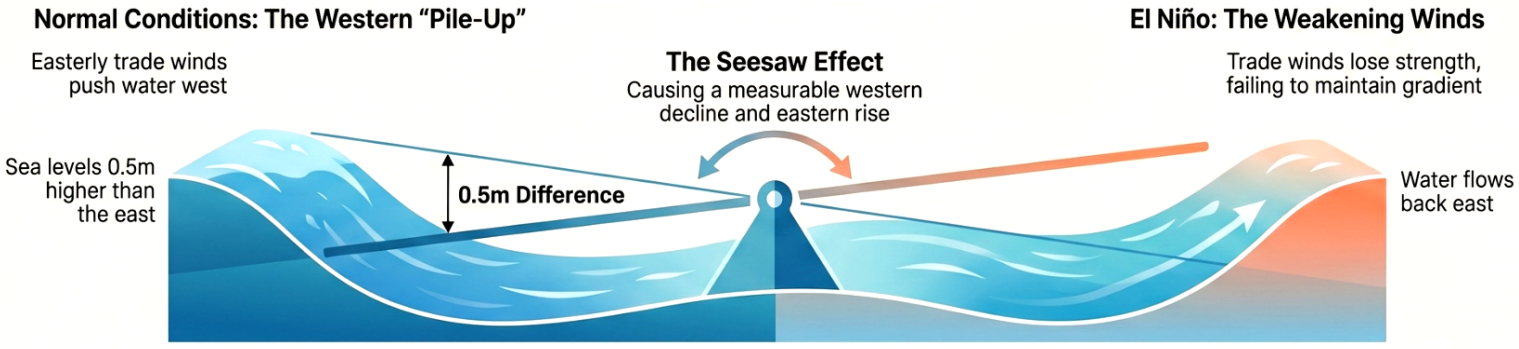
Normal Conditions

Easterly trade winds push warm surface water toward the west, causing water to “pile up.” This creates a strong zonal slope where the sea level in the western Pacific is about half a metre higher than in the eastern equatorial Pacific.

During El Niño

These trade winds weaken and are unable to maintain the normal sea-level gradient across the ocean. As a result, water flows back toward the east, leading to a measurable decline in sea level i n the west and a corresponding rise in the east.

THE SCIENCE OF THE SHIFT



Weakened Trade Winds

During El Niño, winds cannot maintain the normal sea-level gradient across the tropical Pacific.

The Equatorial “Hot Zone”

Islands within 10° of the equator experience the most intense sea-level variations.

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SPREP Secretariat of the Pacific Regional Environment Programme

WMO

PACIFIC REGIONAL CLIMATE CENTRE NETWORK

EL NIÑO IMPACTS BY COUNTRY

RISE (Higher)

Kiribati

Nauru

PRIMARY REASON:
Weakened winds allow water to pile up in the east/central Pacific

DROP (Lower)

Federated States of Micronesia, Fiji, Palau, Papua New Guinea, Samoa, Solomon Is., Tonga, Tuvalu, Vanuatu

PRIMARY REASON:
The normal "pile" of water in the western Pacific recedes eastward.

MIXED/EXTREME RISKS

Cook Islands

PRIMARY REASON:
Lower seasonal levels but higher risk of extreme surges from cyclones.

FIGURE 1: Sea level impact of El Niño by country

The following table summarizes the impact of El Niño on sea levels for various countries in the region:

Country	Sea Level Impact	Details / Why
Kiribati	Rise (Higher	Islands like Kiritimati, Kanton, and Tarawa see higher sea levels. In Kiritimati, all 10 of the highest recorded water level events occurred during El Niño.
Nauru	Rise (Higher)	Located near the equator, Nauru experiences higher short-term water levels during El Niño years.
Cook Is.	Mixed / Extreme Risks	While seasonal background sea levels can be lower, the risk of extreme high sea levels actually increases because El Niño is associated with a higher frequency of tropical cyclones in this area.
FSM	Drop (Lower)	Seasonal sea levels are significantly lower during El Niño conditions. None of the top 10 highest water levels recorded at Pohnpei or Chuuk occurred during an El Niño.
Fiji	Drop (Lower)	There is a tendency for lower seasonal sea levels during El Niño months, specifically from March through October.
Marshall Is.	Drop (Lower)	Sea levels are usually lower during El Niño events. This drop can significantly hamper the extraction of fresh ground water.
Palau	Drop (Lower)	Sea levels in Palau are strongly influenced by ENSO, showing lower levels during El Niño compared to the higher levels seen in La Niña.
PNG	Drop (Lower)	Seasonal water levels at locations like Lombrum and Rabaul are significantly lower during El Niño years.
Samoa	Drop (Lower)	Sea levels tend to be lower from February to September during El Niño years.
Solomon Is.	Drop (Lower)	Sea levels are lower by approximately 0.1 m during El Niño seasons.
Tonga	Drop (Lower)	The seasonal sea-level signal becomes negative (lower than average) from March–May and August–November during El Niño.
Tuvalu	Drop (Lower)	The seasonal contribution to sea level is lower during El Niño events.
Vanuatu	Drop (Lower)	Seasonal water levels tend to be slightly lower during El Niño years.

Pacific islands located within about 10° of the equator are generally the most strongly affected by these ENSO-related sea-level variations.

SOURCES:

PCCSP_CCIP_Volume-1_Ch2-Climate-of-the-Western-Tropical-Pacific-and-East-Timor.pdf:
This source details the climate features of the Western Tropical Pacific and East Timor, including atmospheric and ocean data, seasonal cycles, and the Walker and Hadley Circulations.

PCCSP_CCIP_Volume-1_Ch3-Observed-Climate-Variability-and-Trends.pdf:
This source summarizes studies on climate variability and change in the region, focusing on patterns like the El Niño-Southern Oscillation (ENSO), the South Pacific Convergence Zone (SPCZ), and sea-level trends.

PCCSP_CCIP_Volume-2-country-reports-complete.pdf:
This comprehensive document contains detailed climate reports for 15 individual Partner Countries, covering their seasonal cycles, climate variability, observed trends, and future projections for rainfall, temperature, and sea levels.