# PERSPECTIVES ON SEA LEVELS

## HOT TAKES

1 Sea levels are rising and falling at different rates in different places due to various causes. IPCC estimates of rise in 'global sea level' should be viewed with caution.

2 The IPCC predicts that by 2100 the annual rate of increase in sea levels will be five to ten times greater than if humans were not causing global warming, but empirical measurements and problems with the computer models cast doubt on these predictions.

3 Long term natural trends suggest local impacts of any sea level rise will, in any event, differ greatly.

**Computer models, summarised by the Intergovernmental Panel on Climate Change (IPCC), predict global warming will cause a sea-level increase of 52 to 98 centimetres by 2100. It also suggests that by the end of the century the rate of sea levels rise will have increased by a factor of five to ten times, to somewhere between eight and 16 millimetres per year.[1] However these predictions are entirely dependent on worst-case scenarios, and are only as good as the modelling.**

## How is Sea Level Measured?

In 1841, an Antarctic explorer organised for a sea-level mark to be cut into the Isle of the Dead in Tasmania (see Figure 1), the first scientific attempt to record a fixed reference point relative to sea level in the Southern Ocean.[2]

This enabled one of the world's longest records of sea-level rise, and one of the very few long-term records in the Southern Hemisphere. It shows that since 1841 sea level in Tasmania has risen 16 centimetres, a rate of just one millimetre per year after local upward movement of the land surface is taken into account.[3] This is considerably slower than the IPCC global estimate of 1.7 millimetres per year between 1901 and 2010.

## The Elusive Concept of a Global 'Sea level'

There are difficulties with the IPCC's global estimate. For instance, none of its estimates correspond to any direct measurements at any point on the open sea, or along any coastline. The figures are calculated constructs arising from complex computer models, yet we are being asked to simply trust them. Predictions of future sea level rise are broadcast widely with such a sense of confidence that a false impression is created.

The sea level models need to be calibrated against historic observations, a far from straightforward process. Of most concern are vertical land movements which in some cases extend over millions of square kilometres, causing changes in local sea level relative to the land. Then there are weather-related simultaneous pauses, declines, or accelerations in regional sea level recorded in tide gauges thousands of kilometres apart that can persist for decades. These effects hinder estimates of natural global sea-level change over time.

**Figure 1:** Isle of the Dead sea-level benchmark[4]

View of the Isle of the Dead from the north-east (top) and photograph of the sea-level benchmark taken at mean tide on August 29, 1999 (bottom ).

## Measuring Sea Level Using Tide Gauges

Tide gauges record changes in sea level over time. They are the only long term records of sea level based on direct measurements. Records go back to the early nineteenth century, whereas satellite-based measurements only go back to 1993. Tide gauges can be affected by local subsidence at major cities or ports. They are also subject to vertical land movement, or they might have been replaced or relocated (requiring corrections). These challenges are rarely discussed openly.

## Real-life Twentieth-century Sea Levels

Figure 2 shows falling relative sea levels. The land has been rebounding faster than the sea since the melting of giant continental ice sheets approximately 10,000 years ago. This is underway over large parts of Europe, North America, and east Asia.

Sydney's Fort Denison (Figure 3) is the oldest operating tide gauge in the Southern Hemisphere. There was a dip in sea levels from the 1910s through to just after 1950. Then almost no sea-level rise for nearly 50 years up to just before the year 2000. The record for Newcastle is similar.

**Figure 2:** Annual mean sea level at Stockholm (Sweden) and Juneau (Alaska), 1889 to 2018[5]

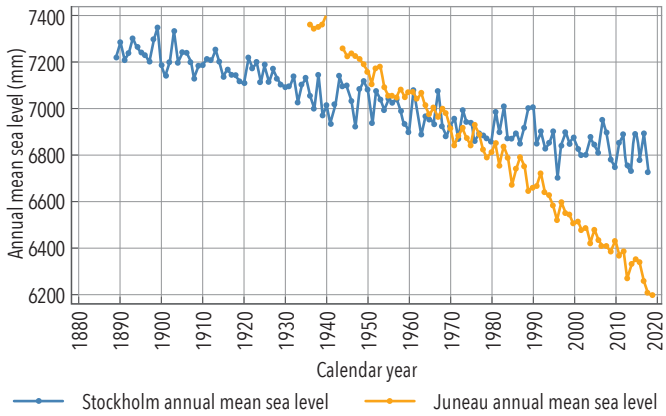
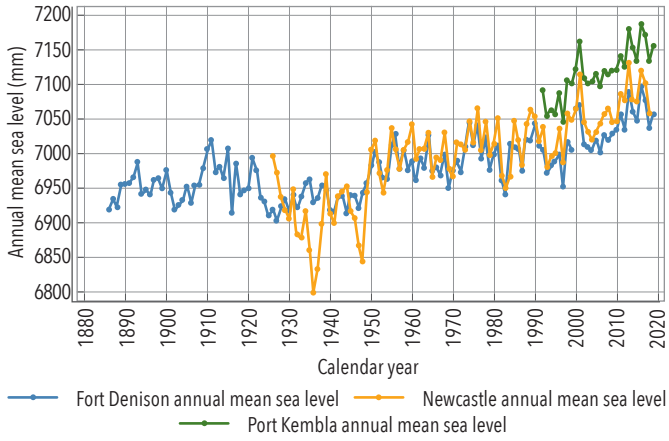



**Figure 3:** Annual mean sea level at Sydney Fort Denison, Newcastle, and Port Kembla (Australia), 1886 to 2019[5]




Meanwhile, two 'at risk' coral atolls in the South Pacific (Figure 4), demonstrate no long-term trend for either rising or falling sea levels, although there are rapid short-lived falls corresponding to El Niños affecting millions of square kilometres of open ocean.



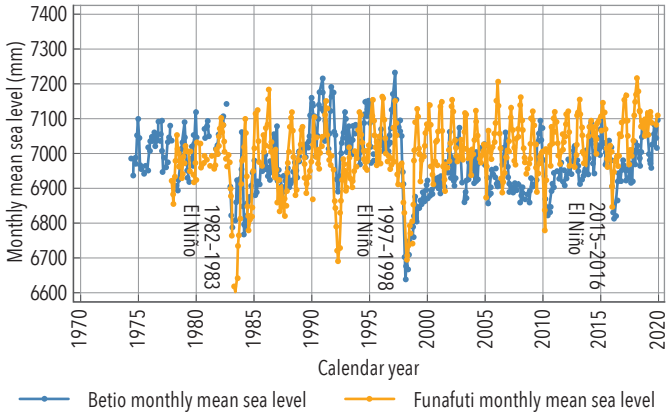
With such variability, is a 'global' rate of sea-level rise due to any cause meaningful, or even relevant?

## Future Sea Levels

Computer models predicting impending catastrophic sea-level rise depend on models of the impact of global warming which in turn are dependent on which future $CO_2$ emissions scenario you choose. The model calculations are complex and interdependent, and are only as credible as the required assumptions. If just one assumption is wrong, for example if the assumed hypothetical $CO_2$ emissions scenario results in an incorrect future global temperature, then the predictions of sea-level rise will also be wrong. Future $CO_2$ emissions are themselves based on modelling that depends on even more assumptions. Each calculation step comes with inbuilt uncertainties and these uncertainties add together.

In any case, even if correct, the predictions will have widely differing local impacts. This is evident from historic tide gauges. For example, where sea levels are presently falling relative to the land, as is the case along many thousands of kilometres of coastline, there may be little or no impact at all. The IPCC neglect to disclose this 'inconvenient truth' in their high-impact headline summaries.

**Figure 4:** Monthly mean sea level at Betio (Kiribati) and Funafuti (Tuvalu), western Pacific Ocean, 1974 to 2020[5]




### SEE ALSO

**FACT SHEET #6:** Monitoring Temperatures and Sea Ice with Satellites

**FACT SHEET #18:** Climate Science and Policy-based Evidence

Information in this fact sheet has been drawn from *Climate Change: The Facts 2020* (IPA 2020), Chapter 17, by Dr Arthur Day and Dr Jennifer Marohasy. Fact Sheet series general editor: Dr Arthur Day

1. See, for example, Alexander et al. 2013, *Summary for Policymakers*: https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_SPM_FINAL.pdf
2. Ross, Captain Sir JC 1847, *A Voyage of Discovery and Research in the Southern and Antarctic Regions, During the Years 1839–43*, John Murray, London, vol. 2.
3. Hunter, J, Coleman, R & Pugh, D 2003, 'The Sea Level at Port Arthur, Tasmania, from 1841 to the Present', *Geophysical Research Letters*, vol. 30, pp. 54-1.
4. Sources: Photograph of the Isle (top), https://upload.wikimedia.org/wikipedia/commons/c/cf/2018-02-15_111355_Port_Arthur_Isle_of_the_Dead_anagoria.JPG, and photograph of the benchmark (bottom) taken by John L. Daly. Chapter 17 was inspired by the sea level work of the late John L. Daly (1943–2004).
5. Sources: Permanent Service for Mean Sea Level: https://www.psmsl.org/data/obtaining/

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