

# Extreme coastal water levels much higher due to combination of storm surge and waves

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*The US West Coast (photo: [Bonnie Moreland, www.flickr.com](http://www.flickr.com))*

Water levels at the coast during extreme events are the combined effect of tides, storm surges and waves (wave setup and run-up). In flood risk assessments, the impact of waves is often left out. The contributions of storm surge and waves to extreme water levels should be combined, however.

When doing so, it makes a huge difference if these contributions are considered to be independent or not. The same storms causing storm surges also generate wind waves. Because of this, the contributions of storm surges and waves are not independent statistically. The probability of their joint occurrence is higher than that expected considering the extremes of each variable separately, with a consequent increase of the likelihood of coastal flooding.

The first global assessment of the dependence between storm surges and wind waves and its effect on extreme coastal water levels was published recently. The assessment focused on the period 1979-2014.

The study shows that in more than half of the world's coastal regions, storm surges tend to be accompanied by large wind waves, thus increasing the potential coastal flooding. The probability of facing a 1 in 100-year event is more than doubled in 30% of the global coastlines when accounting for the dependence between storm surges and waves. In other words, in these locations, an event expected at most once in 100 years without considering dependence between storm surges and waves, is in fact a 1 in 50-year event because of this dependence. Likewise, a fivefold (tenfold) difference in the 50-year return period is found in nearly 20% (8%) of the global coastlines for calculations in which this dependence is taking into account or left out.

The importance of considering this joint occurrence of storm surge and waves is illustrated for the North Sea. An extreme water level of 3.2 m resulting from the combined action of surges and waves is expected once every 50 years. Without dependence of storm surge and waves, this water level would be a 1 in 532-year event.

Considering these dependences has a strong impact on return period estimates of extreme events and is therefore relevant for the design of coastal flood defences.

Source: Marcos et al., 2019. *Geophysical Research Letters* 46: 4356-4364.