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Global Estimates of Tide Surge Interaction and its Benefits for Coastal Protection

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Large parts of the world's coastlines are exposed to extreme high water levels, which have the potential to cause widespread flooding and costly damages. Knowledge on potential water level extremes is thus essential for coastal protection strategies and is usually building upon observations, e.g. from tide gauges. These instruments measure the local water level in response to astronomical (i.e. tide) and meteorological forcing (i.e. surge) superimposed onto the base water level (i.e. mean sea level). For more than 60 years, nonlinear tide-surge interactions have been reported for many places but a distinct global quantification is still missing.

We introduce a new approach to statistically assess the interaction of tide and surge useful to value its contribution to total water levels (and coastal protection) globally. Our findings highlight that tide-surge interaction significantly reduces high water levels by up to 30% or 70 cm at some places, a value which is similar to recent sea level rise projections by 2100 (based on a temperature increase of +1.5°). Conversely, extreme value analysis – as routinely utilized by current coastal impact studies – may overestimate return water levels by an amount equal to or larger than future sea level rise projections, if tide-surge interaction is not accounted for. We further find evidence for changes in tide-surge interaction at some places, which have the potential to counteract the increasing flood risk associated with sea level rise, tidal and/or meteorological changes alone. Not accounting for tide-surge interaction also leads to an overestimation of present day coastal exposure. Using the DIVA modelling framework, we find reduced estimates of global sea flood costs by nearly 16% and population exposed by almost 8% when tide-surge interaction is considered