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The Timing of Decreasing Coastal Flood Protection Due to Sea-Level Rise

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Sea-level rise (SLR) amplifies the frequency of extreme sea levels as it raises their baseline height. Projections of the frequency amplification of extremes are often computed for arbitrary future years and relative to the historical centennial event, which is not necessarily meaningful locally. Consequently, such projections may not provide salient information to adaptation planners, as they do not indicate when certain flood risk thresholds will be crossed given the current degree of local coastal flood protection.

To better support adaptation planning, we introduce a framework that extends the emerging timing perspective on sea-level rise to the frequency amplification of extreme sea levels. Moreover, by relating amplification factors to local flood protection standards estimated with the FLOPROS modelling approach, we project the timing of decreases in the local degree of protection. The sea-level rise required for such decreases is derived from extreme sea-level distributions inferred from GESLA3 observations and combined with the relative sea-level projections of the Sixth Assessment Report of the IPCC until 2150 to compute the timing of these decreases at tide gauges globally.

Our central estimates indicate that the estimated degrees of protection will be exceeded 10 times

as frequently within the next 30 years (the lead time that large adaptation measures may take) at 26 & 32% of the tide gauges considered, and annually at 4 & 8%, for respectively a low & high emissions scenario (SSP1-2.6 & SSP3-7.0). Even though our results are based on estimated degrees of protection, they highlight that at several locations substantial decreases in the degree of protection may occur before large adaptation measures can be completed. Furthermore, we find that under SSP3-7.0, the same decreases in the degree of coastal protection will occur substantially faster in the future as sea-level rise accelerates. Our projection framework adds a new perspective on the frequency amplifications of extremes that may help adaptation planners to assess the available lead time and useful lifetime of protective infrastructure, given unacceptable decreases in the degree of coastal protection.