Coastal risks

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Defence against the rising seas

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The rate of sea-level rise varies around the world, as do local infrastructure and standards for defending against the risks of flooding. Now research indicates that coastal communities can also have very different times left to act before defences fall short of those standards.

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Extreme storm surges and tides already pose a major risk to coastal communities around the world. As sea levels rise, protection infrastructure such as seawalls, dykes and pumps will be tested more frequently. These engineered systems are complex, expensive and sometimes controversial, resulting in projects that may take decades to progress from conception to execution[1]. Meanwhile, many policymakers demand a certain level of protection from flooding to be maintained. When faced with changing climate conditions, this means that planners may have little time left to set plans in motion if they are to successfully fulfil their mandate. Writing in *Nature Climate Change*, Tim Hermans and colleagues[2] shed light on when and how frequently current degrees of protection will be compromised by rising sea levels.

Previous research at the global scale has focused on characterizing variations in the rate of current sea-level rise (SLR) around the world[3,4], quantifying the uncertainties in future SLR[5,6] and projecting the consequences if further action is not taken to mitigate risks[7–9]. This field of study provides a fair picture of what coastal communities can expect to experience if climate change remains unchecked, but it has not always explained these conditions in a manner to provide actionable guidance for how to respond. Much of this scholarship emphasizes arbitrary time horizons, such as projecting SLR to the year 2100, or analyses extreme sea levels with arbitrary annual exceedance probabilities, such as a return frequency of 1 in 100 years. Design standards for flood protection infrastructure are commonly based on this '100-year event', but many jurisdictions aspire to provide protection against 1-in-1,000-year or even 1-in-10,000-year floods.

In their study, Hermans and colleagues[2] analyse the amplification factor of future extreme sea levels around the world, a measure indicating how much more frequently events with a certain probability today may occur in future. Using protection standards estimated for 523 locations across the globe, they estimate when the probability of design-level flood events would increase tenfold. For example, in London, where design standards for the Thames Barrier aim to protect against sea levels with a 1-in-1,000 chance of being exceeded in a given year, they find that today's 1,000-year flood would become a 100-year flood by 2060, even under the IPCC's strong climate change mitigation pathway SSP1-2.6. Changes in risk like this depend not only on the rate of local relative SLR but also on the variability in sea levels, due to tidal action and storm surges, and adopted flood protection standards.

These measures improve on existing analyses by presenting projections of climate change in a manner that can convey to local decision-makers not only the rate at which sea levels are rising but also the rate at which protection levels are degrading. This provides useful information about how much time is left to take action, and as the authors point out, different adaptation decisions may be preferred when protection standards are likely to be violated in 10 years versus 50 years. This gives flexibility for selecting interventions that require varying lead times for implementation (that is, planning, design and construction) and that are consistent with local risk aversion (as reflected in current protection standards).

The study does have some limitations, such as an assumption of stationarity in extreme sea levels (that is, that the probability distribution of extreme water elevations above mean levels remains constant over time). Global analyses have limited ability to incorporate local knowledge about the performance of existing flood protection infrastructure or policies that should be reflected in a status quo or business-as-usual future scenario. It is also challenging to extrapolate findings beyond the localities of observation sites with adequate historical data. Nonetheless, Hermans and colleagues have presented a useful alternative for how to conceptualize future coastal flood risk in a way that will help planners better translate scientific projections of SLR to their policy implications and inform policymakers about when action is needed.

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Competing interests

The author declares no competing interests.