

# When sea levels rise, damage costs rise even faster

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Damages from extreme events like floods are even more relevant than the mean sea level itself when it comes to the costs of climate impacts for coastal regions. However, while it is now rather well understood how sea-levels will rise in the future, only small progress has been made estimating how the implied damage for cities at the coasts will increase during the next decades. A team of scientists from the Potsdam Institute for Climate Impact Research (PIK) now provides a method to quantify monetary losses from coastal floods under sea-level rise. For the first time, the scientists show that the damage costs consistently increase at a higher rate than the sea-level rise itself.

"When sea levels rise, damage costs rise even faster, our analyses show," explains Markus Boettle, lead author of the study published in the journal *Natural Hazards and the Earth System*. Rising sea levels as a major impact of [climate change](#) pose a risk for coastal regions - the mean regional [sea level](#) rise takes effect by more frequent and more intense coastal flood events. "At the same time, the severity of flood impacts is not only determined by environmental factors, but also to a significant extent by human decisions: flood defense measures can counteract the increasing flood risk," says Boettle. "Our study illustrates that the complexity of climate change, adaptation, and flood damage can be disentangled by surprisingly simple mathematical functions to provide estimates of the average annual costs of [sea-level rise](#) over a longer time period."

The scientists developed a method that translates the occurrence

probability of flood events into the probability of inundation damage. Expected regional sea level rise is taken into account by separating two components, namely the increasing number of events and the increasing severity of each one. Moreover, potential flood defense measures like dikes or sea walls can be included into the calculations as they prevent or mitigate damages from storm surges.

## **Flood risks, damages, adaptation**

Although coastal cities are different around the world and also flood-related threats have their own characteristics at different coasts, the scientists found general results. "Our equations basically work in Mumbai, New York, Hamburg - Pacific, Atlantic, or North Sea. In any location worldwide the same simple and universal expressions hold true," says co-author Jürgen Kropp, deputy chair of PIK research domain Climate Impacts & Vulnerabilities. For an exemplary implementation of their method, the scientists applied it to the city of Copenhagen in Denmark: They found that a moderate mean sea level rise of 11 centimeters until mid-century would in the same period double economic losses in this city, given no action is taken.

"A concise assessment of potential economic consequences is indispensable for appraising the efficiency of adaptation measures," explains co-author Diego Rybski. "Even when temperatures stabilize, sea levels will continue to rise and shape our coastlines for future generations. So, additional preventive measures need to be considered in addition to the mitigation of greenhouse gas emissions, to help coastal regions especially in transition and developing countries to adapt and to limit damage costs."

## **A large share of the world population lives in coastal regions**

Nevertheless, some constraints of the methodology remain, which was developed in the broader context of the European-funded RAMSES project. For instance, extreme events and attributed damages are not evenly distributed in time - there are years without any damage at all and others when quite unlikely floods may occur. The approach cannot forecast single events and associated damages, but estimates damage expectations over longer time-spans. Despite of the lack of knowledge regarding the timing of the extreme events, the statistical spreading of damage over years has been quantified by the researchers.

"A large share of the world population lives in coastal regions," says Jürgen Kropp, director of the RAMSES project. "In the light of limited funds for adaptation it is an asset to provide comparable cost assessments. While mitigation remains of vital importance to keep climate impacts on a still manageable scale, an adaptation perspective can help to limit damage costs in the right places."

**More information:** D. J. Wagenaar et al. Uncertainty in flood damage estimates and its potential effect on investment decisions, *Natural Hazards and Earth System Sciences* (2016). [DOI: 10.5194/nhess-16-1-2016](https://doi.org/10.5194/nhess-16-1-2016)

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