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Re-assessing extreme sea level events through interplay of tides and storm surges

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Flooding events pose an ever increasing threat in a warming world. Safety standards for buildings and infrastructure are often based on past observations of local sea level, as measured by tide gauges and remote sensing systems. However, sea level at a given location is not an isolated property and is determined by a combination of factors. For extreme sea level events, there are two factors that of particular importance: the astronomical tide, and storm surges. In this work, we analysed measurements from 21 stations in the Norwegian tide gauge network, disentangling the factors contributing to the previously observed extreme events.

By separating the observed sea level into a tidal component and a storm surge component, we found that in many cases the observed extreme sea level events were caused by an extreme storm surge coinciding with only a moderate tide, or an extreme tide coinciding with only a moderate storm surge. This raises the possibility of a 'super-flooding' event, where an extreme storm surge may occur with an extreme tide. Even in the short records examined in this study (less than 40 years), the combination of the highest observed tide with the highest observed storm surge would greatly exceed in the 1000-year return level event at many locations. This is often used as a national standard for critical infrastructure.

We further complement the work by analysing the storm tracks close to Norway. By relating the storm surges with the individual storms giving rise to them, we found that many storm surges during extreme sea level events were related to cyclones of only moderate intensity. Combined with the previous findings, this work suggests the need to assess extreme sea level return values for future construction and infrastructure planning as the result of a multi-variable system. This is in contrast to basing such assessments on the single variable of observed sea level as it is done today.