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Sea level much higher than assumed in most coastal hazard assessments

Key message

Sea level along the world's coastlines is often much higher than previously assumed. Most sea-level studies do not reflect reality because they do not use direct measurements of sea level or combine sea level and land elevation data incorrectly. This is most apparent in Southeast Asia and the Indo-Pacific.

Please watch the 2-minute explainer animation: https://vimeo.com/1162103411/bf1308bb65

Research context

- To predict how much sea-level rise will affect the coasts of the world in the future, satellites are used to measure the elevation of the land. **Land elevation is measured with respect to a global reference level**, called a geoid model, which is often **assumed to represent actual sea level**. **There are also other satellites that accurately measure the height of the sea itself**.
- To be reliable, **coastal hazard assessments require correctly combined measured coastal land elevation with sea level**. However, this is not straightforward and most of the time assessments assume sea level based on global gravitational models.

Research overview

- **We systematically evaluated peer-reviewed sea-level rise impacts and coastal hazard assessment studies** published in the last 15 years on how they handle coastal elevation and sea level data.
- Using meta-analyses, **we quantified the most-frequently encountered issues and their impact** on consequent sea-level rise impact assessments.

Research findings

1) Systematic evaluation of scientific literature

- **More than 90 %** of the evaluated scientific publications **only used land elevation measurements** with their elevation referenced to a gravitational model, a so-called geoid model. These assessments **assume sea level to equal the model**.
- **Ca. 9 %** of the existing scientific publications **did combine land elevation and sea-level measurements** but suffer from **shortcomings** in the data alignment procedure.

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- **Less than 1 %** of the existing scientific publications **did combine land elevation and sea-level measurements properly** and refer to **actual measured sea level**.
- **Our findings make it necessary to re-evaluate** and, in most cases, **update** the underlying methodology of **all existing coastal hazard studies**.

2) <u>Quantification of most-frequently encountered issues</u>

- **Measured global coastal sea level is on average 0.2 to 0.3 m higher than commonly assumed**.
- **Discrepancies are largest in Southeast Asia and the Indo-Pacific** where coastal sea level is even up to more than 1 m higher than commonly assumed.

3) <u>Quantification of the impact of most-frequently encountered issues on the assessment of sea-level rise impact</u>

- **Using an assumed sea level** instead of measured sea level (>90 % of studies) results in **underestimates of coastal population** below sea level following 1 m relative sea-level rise **by up to 68 %**.
- **Mimicking the issues in data handling** of studies that did use sea-level measurements (9 % of studies) revealed that these **underestimated coastal population** below sea level following 1 m relative sea-level rise by **up to 12 %**.

Important notes when reporting – mind the nuance in the wording

- **Our study addresses the relation between measured and assumed coastal sea level** and investigates whether and how the existing scientific literature combined coastal elevation and sea-level datasets needed to assess sea-level rise impact. Our study does not address global sea level elevation or sea-level rise itself.
- **The majority of the evaluated studies does not make errors but use a common assumption of sea level**. This assumed sea level turns out to be much less accurate in providing coastal sea level around the world than was thought.
- **Our study does not reproduce previous studies 1:1 but uses meta-analyses to mimic the issues most-frequently detected during the literature evaluation** and compares the results between assumed and measured sea level through a hypothetical 1 m relative sea-level rise impact.
- **Our study evaluates which of the evaluated studies are cited in the latest IPCC reports** to assess the relevance of the studies evaluated. The majority of the evaluated literature cited in the IPCC reports uses an assumed sea level. **Our study does not assess whether the quantifications of the evaluated studies were used in these reports**, nor does it claim or imply the IPCC reports to be wrong or containing errors. This is outside the scope of our study and requires further research.

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