Waves do not contribute to global sea-level rise

To the Editor — In a recent Article, Melet et al.[1] claim that the contribution of wind waves to coastal sea-level rise has been under-estimated. Although we agree with the overall premise that coastal wind-wave dynamics are important when assessing the full coastal impacts of sea-level rise, we argue that the Article is misleading.

First, the importance of wave contributions to coastal flooding events in the context of regional to global sea-level rise has already been investigated at interannual to decadal timescales by including mean wave set-up in total water level estimates[2–4]. Melet et al. assert that waves also directly contribute to mean sea-level rise by considering a total wave run-up that includes not only mean wave set-up but also extreme swash motions. We argue that waves can indeed contribute to extreme water level events on wave-exposed shorelines; however, treating wave run-up (including swash motions) as equivalent to mean sea-level changes is misleading. This distinction is important, as wave-driven water level extremes require different mitigation strategies compared to long-term sea-level rise.

Even if the premise was appropriate, the large contribution of waves found by Melet et al. can be explained by the inclusion of the 2% exceedance run-up value in their total water-level estimation. The impact of wave run-up is typically omitted in global studies[3] and only included when investigating the localized effects of waves on coastal flooding in specific coastal areas. In recent papers[2–4] on extreme flooding events, only the wave set-up contribution was considered as an analogous mean quantity to sea-level rise. The addition of extremes in swash excursion to global predictions of sea-level rise artificially inflates the wave contribution.

The parameterization used by Melet et al.[1] further amplifies the wave contribution. In particular, as revealed by the sensitivity analysis (Supplementary Figs. 6–8 in ref. [1]), the 0.1 beach slope value adopted by Melet et al. is paramount for obtaining their results; a choice of beach slope of 0.05 would decrease the wave contribution to TWL by 35%, and a choice of 0.02 would decrease the wave contribution to total water level by a factor of two. Given that a document from the French Navy Hydrographic Service[5] indicates that ~50% of the world's beaches have slopes smaller than 0.02, we argue that the 0.1 value used by Melet et al. is unjustified. Moreover, the parameterization used by Melet et al. is only valid for sandy beaches, which represent only a fraction of the global coastline.

The contribution of waves to total water level is also highly sensitive to the parameterization used. In Melet et al., the contribution of waves to extreme events (Fig. 2 in ref. [1]) is higher by a factor of five than the contribution of waves calculated with the parameterization used in Vitousek and co-authors[2], with all other components of total water level being equal. Thus, we argue that the parameterization chosen by Melet et al. leads to wave contributions that are two to five times higher than contributions obtained with other equally justifiable parameterizations.

The second issue arises due to unsupported results. The authors claim their approach is validated by comparing their formulation to global tide gauge records. However, the authors show that including the wave contribution reduces the correlation between tide gauge records and their water level formulation (Supplementary Fig. 4 in ref. [1]). They further claim that the validation of their method is impossible due to a lack of long-term wave set-up and swash time series. Because they use an already validated offshore wave model, the only validation needed is between the offshore wave conditions and wave run-up observations, of which many records exist at research facilities in Asia, Europe, North America and Australia.

Additional problems arise due to the lack of statistically significant trends. Supplementary Fig. 9[1], for example, demonstrates that trends in the wave contribution to total water level are not significantly different from those expected from natural variability only. This should have prevented the extrapolation of the trend results as the basis for statements in the Article. The lack of significant trends in the contribution of waves is also not surprising, as no consensus on trends in wave height over the 23-year period (1993–2015) have been documented and wave responses to climate change are still highly uncertain[6].

We therefore question the robustness of the conclusions presented by Melet et al. Although we appreciate that it may be a first-order attempt at a global-scale analysis of long term total water-level variability, we are concerned that this study may be misleading to coastal managers and policymakers who are planning for climate change. We argue that it does not present a correct view of the contribution of waves in the context of global and regional sea-level rise trends. ❐

Jerome Aucan[1]*, Ron K. Hoeke[2], Curt D. Storlazzi[3], Justin Stopa[4], Moritz Wandres[5] and Ryan Lowe[6]

[1]LEGOS, Université de Toulouse, IRD, CNRS, CNES, UPS, Nouméa, France. [2]CSIRO, Melbourne, Victoria, Australia. [3]US Geological Survey, Santa Cruz, CA, USA. [4]School Of Ocean And Earth Science And Technology, Ocean Resources And Engineering, University Of Hawaii At Manoa, Honolulu, HI, USA. [5]Geoscience, Energy & Maritime Division, Pacific Community, Suva, Fiji. [6]Oceans Graduate School and UWA Oceans Institute, University of Western Australia, Crawley, Western Australia, Australia.

**e-mail: Jerome.aucan@ird.fr*

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