DSCIM-Coastal v1.1: An Open-Source Modeling Platform for Global Impacts of Sea Level Rise

Dear Dr. Phipps,

Thank you for the opportunity to revise our paper further to incorporate our responses to Dr. Le Cozannet's second round of comments. In particular, you asked for two responses to be incorporated.

First, you suggested that we include text highlighting to readers that inundation costs in the model are a function of parameters beyond population, such that it is possible to experience non-zero costs in unpopulated regions. We agree that the lack of clarification regarding the CIAM methods for estimating the value of lost, potentially unpopulated, land to permanent inundation from SLR warranted attention. To address this, we have added the following paragraph in Section 2.2.1 (Inundation Costs):

> *Value of land lost permanently to inundation is estimated in accordance with the Diaz (2016) methodology, which approximates land values based on country-level assumptions of non-coastal land value from the integrated assessment model FUND (Tol, 1996). We assume that these national land values appreciate over time as a function of projected per capita income and population density growth in future years for each country. Equation 7 of Diaz (2016) Supplemental Information details the total cost of inundation as a function of land values and immobile capital loss. Because pyCIAM, like CIAM, estimates land to have value even in unpopulated regions, non-zero inundation costs are still incurred in unpopulated segments due to lost land (or lost wetland area, see Sec. 2.2.4), despite the absence of any immobile capital losses. As expected, the magnitudes of these inundation losses tend to be much lower than in highly populated segments exposed to SLR.*

Second, you suggested that we address Dr. LeCozannet's comments that "investigating ways to improve the resolution would be relevant" that "it would be good to investigate the implementation of a GIS approach to limit the maximum extent of flooding in extremely low lying areas and avoid the overestimation of losses due to the bathtub approach."

Here, our original response indicates that we do indeed implement a GIS approach, overlaying multiple raster and vector datasets at various resolutions in combination with our "local bathtub" model that assumes homogeneous water levels within each coastal segment. Our paper includes a discussion of the limitations of the bathtub approach, as well as the challenges of implementing more sophisticated, hydrodynamic modeling approaches, in Section 3.3 Model Limitations and Planned Improvements. This text is reproduced for reference below:

> *Our reflection of local mean and extreme sea levels is limited by the resolution of our local MSL projections (1 degree in FACTS, 2 degrees in LocalizeSL) and our ESL distributions from CoDEC (50km coastline spacing). Because of the desire to build a globally consistent model using these inputs, we employ a ``local bathtub'' model in which all points nearest to a given pair of ESL and MSL prediction points receive the same mean and extreme sea level projections. While this local model preserves the substantial large-scale spatial heterogeneity in SLR and ESL, sub-grid-scale variation is ignored. In particular, bathtub models are known to overestimate storm surge in inland areas largely due to the deceleration of flows caused by surface roughness (Bootsma, 2022; Vousdoukas et al., 2016). A more sophisticated, dynamic representation of ESL based on local hydrodynamic simulations for each MSL/ESL combination is beyond the computational scope of this analysis but may yield improved future results and could be incorporated either "on-the-fly'' within the pyCIAM model or in a pre-processing step that updates the ESL distributions in SLIIDERS.*

To comment further on the resolution limitations, we have also added the following paragraph to that same section:

> *Future development that refines the spatial resolution of our coastal segments from the current 50 km spacing would enable a finer analysis of the local dynamics of hazard, exposure, and potential adaptation decisions for hyper-local decision making entities. At present, such an effort is hampered by a lack of more granular global inputs used to generate the SLIIDERS dataset. In particular, the 50 km-resolution CoDEC ESL dataset and the one (FACTS) or two (LocalizeSL) degree resolution of the SLR projections represent the best available observations and projections of sea levels at global scale. Using finer-resolution coastal segments would provide limited gains in model precision as the only sub-50km variation would be from enabling decision-making to occur at finer scales, rather than the incorporation of higher-resolution hazard information. The resolution at which protection and retreat decisions are and will be made likely varies substantially around the world, and thus it is unclear whether such an approach would yield more or less valid adaptation projections. As the quality and resolution of related input datasets evolve, SLIIDERS and pyCIAM can be updated to reflect these advances.*