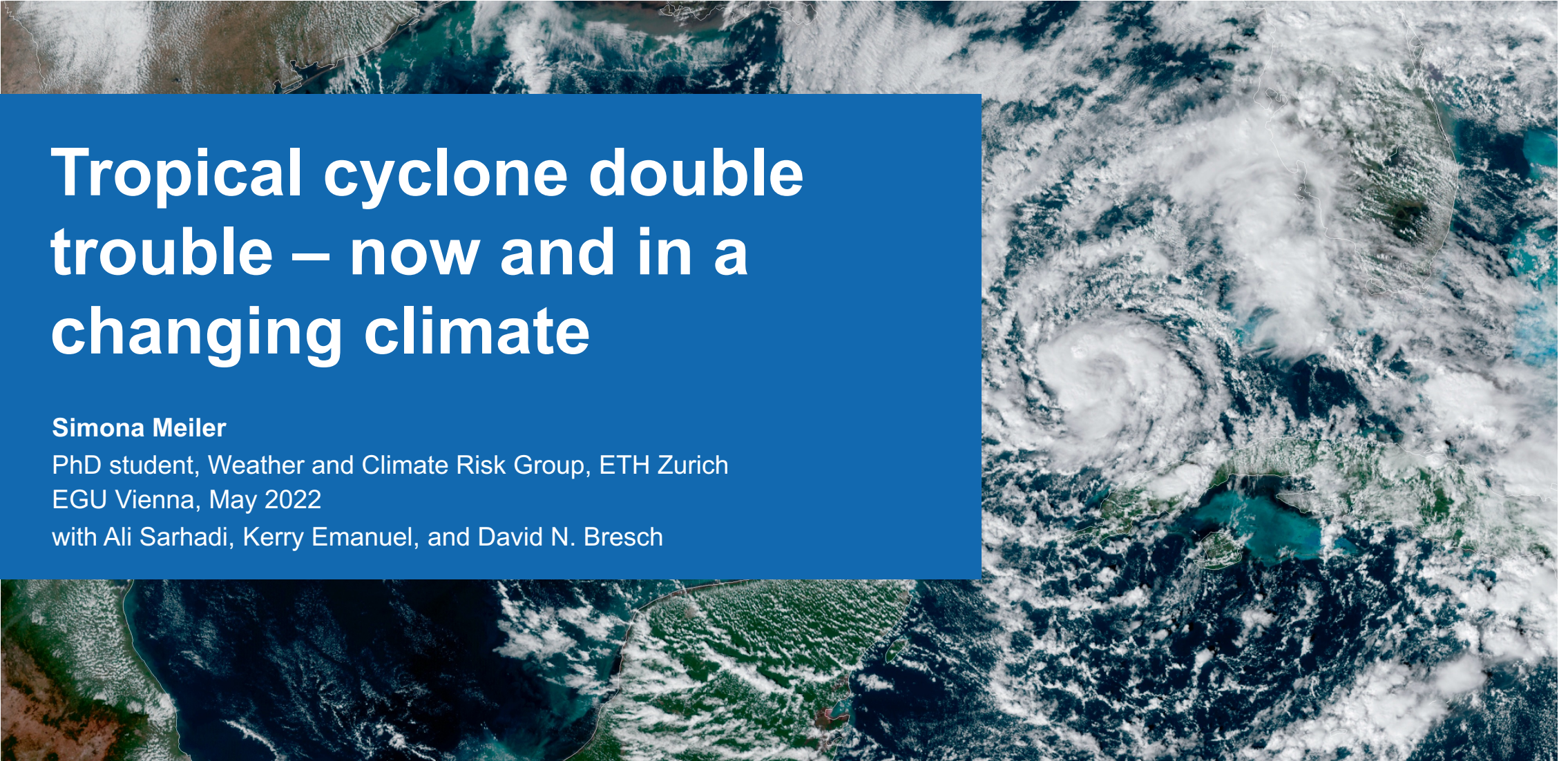


Tropical cyclone double trouble – now and in a changing climate

Simona Meiler

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EGU Vienna, May 2022

with Ali Sarhadi, Kerry Emanuel, and David N. Bresch



**Advancing compound modelling of TC
wind, rain and surge impacts
– now and in a changing climate**

Key take-away messages

MOTIVATION:

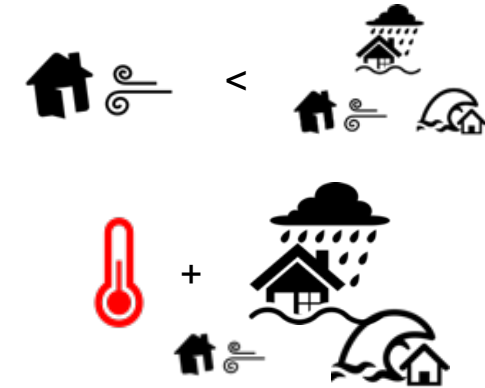
- Current TC risk assessment: wind as driving hazard → underestimate impact
- Future shift of TC sub-hazards in a warming climate

MODELLING APPROACH:

- Coupled, physics-based modelling framework of TC wind, rain, surge incl. climate change

NOVELTY:

- Translate (compound) TC flood and wind hazard into impacts



Background & Hypotheses



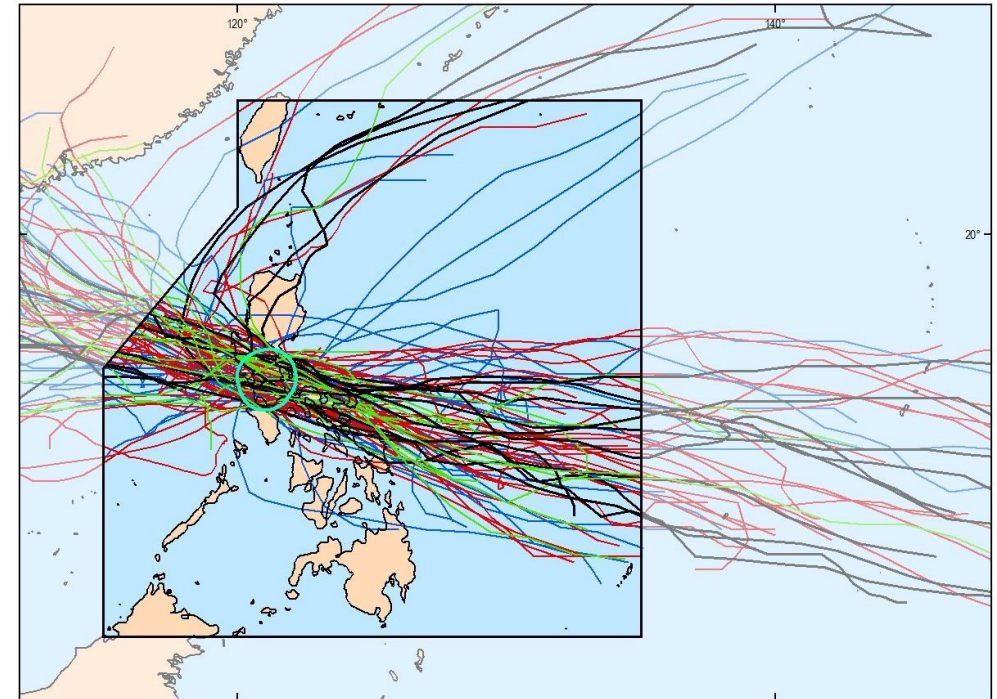
WHERE:

Metropolitan Manila as study region:

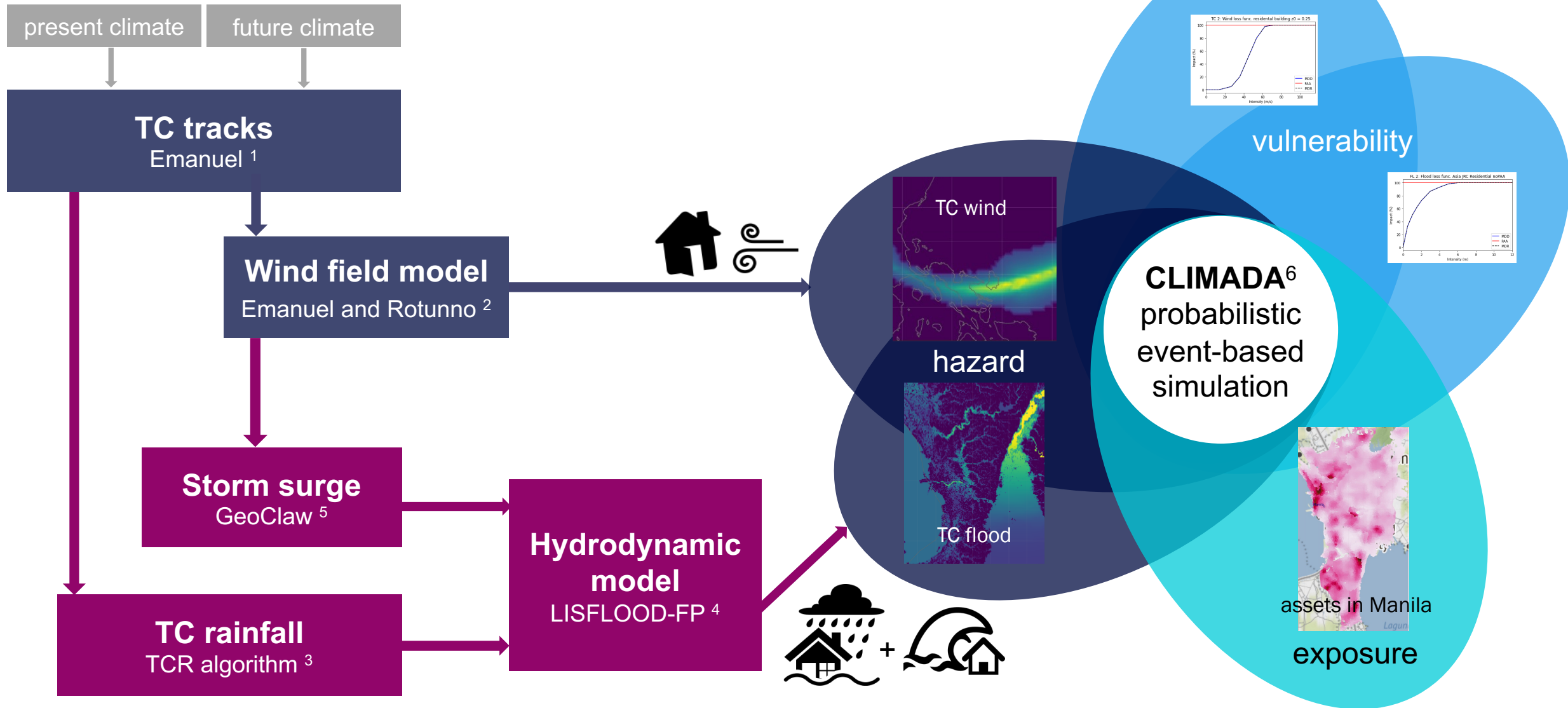
- High TC risk in the Philippines/Metro Manila; incl. rainfall extremes
- Population today ~13 million
- Manila is the world's most densely populated city

HYPOTHESES:

- Modelled losses from TC flood and wind are more accurate than from TC wind alone
- Spatial pattern of TC sub-hazards (wind vs. flood) is not the same
- Double trouble today $\neq$ double trouble future



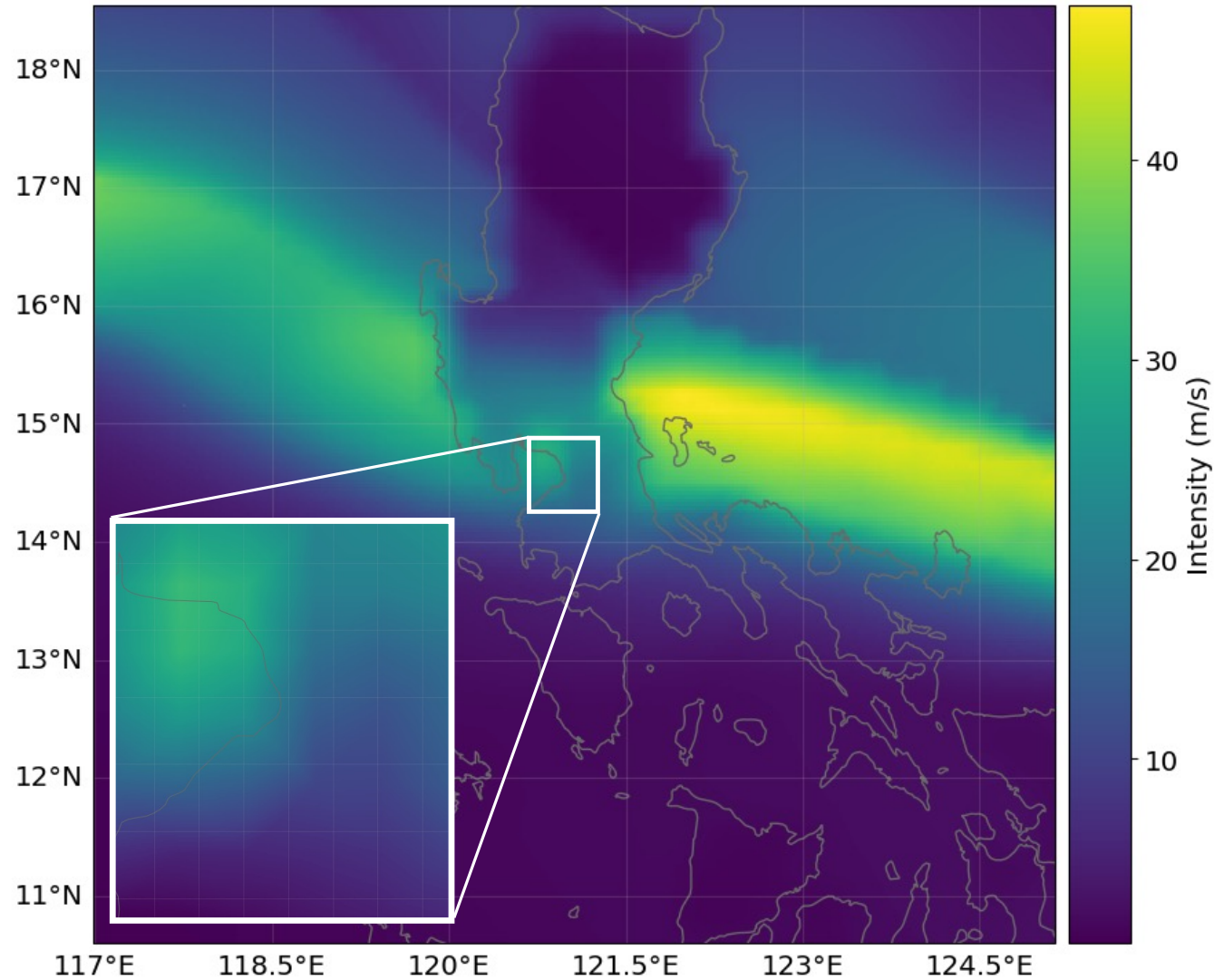
Modelling approach



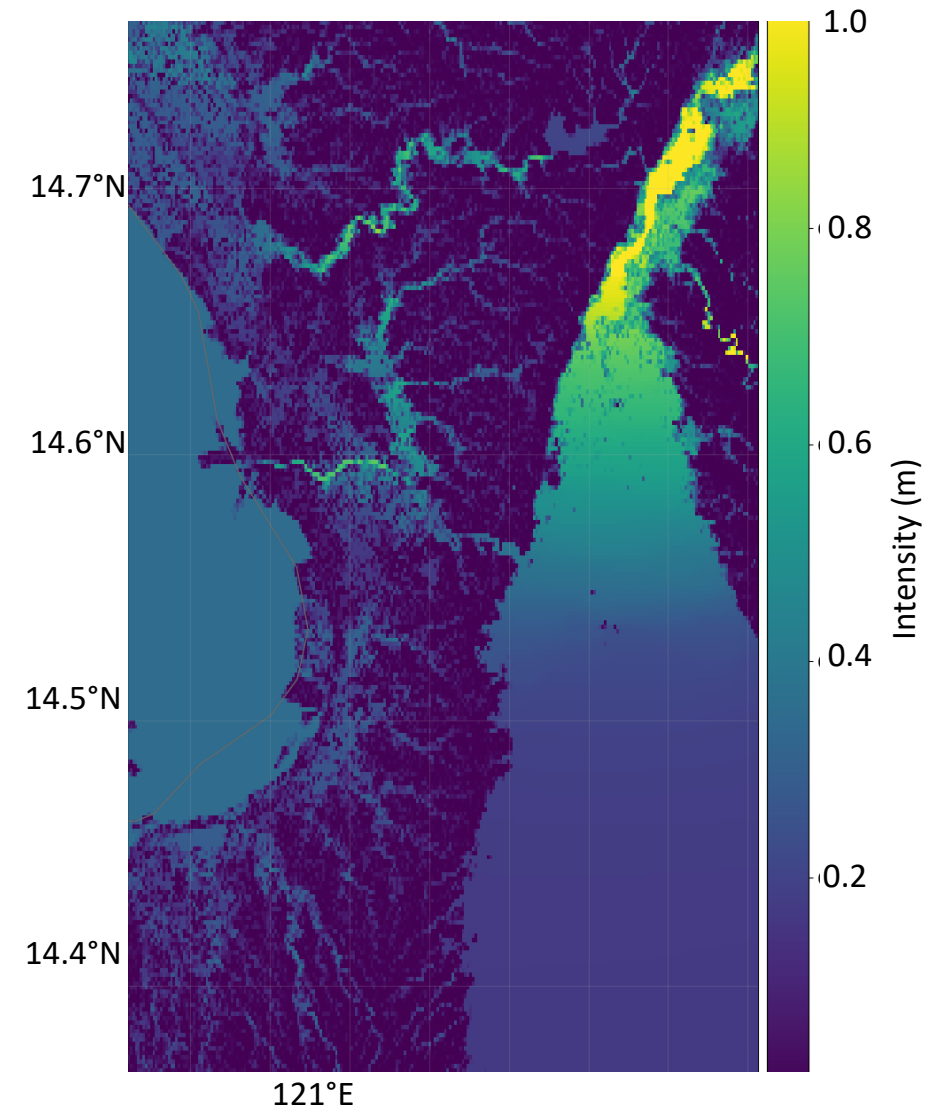
Hazard – example TC Vamco 2020



Wind



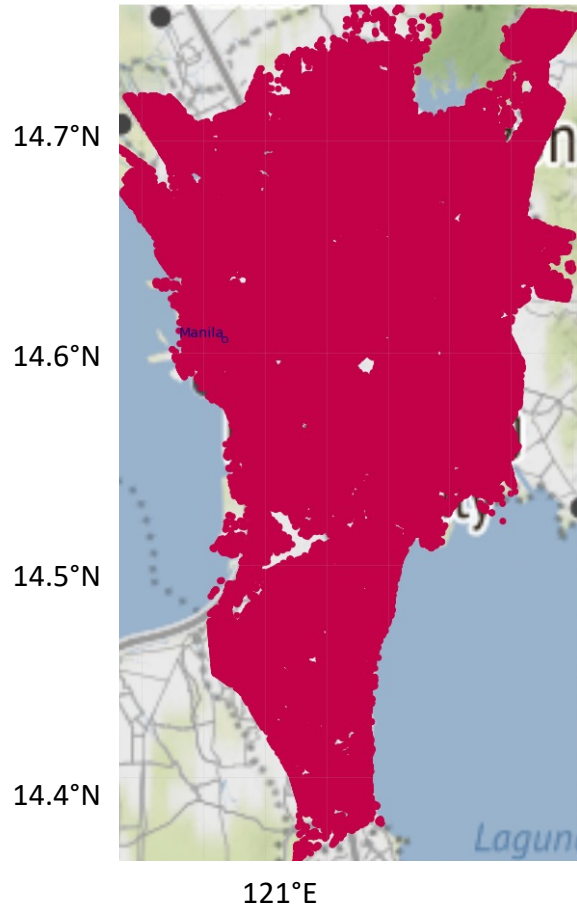
Flood



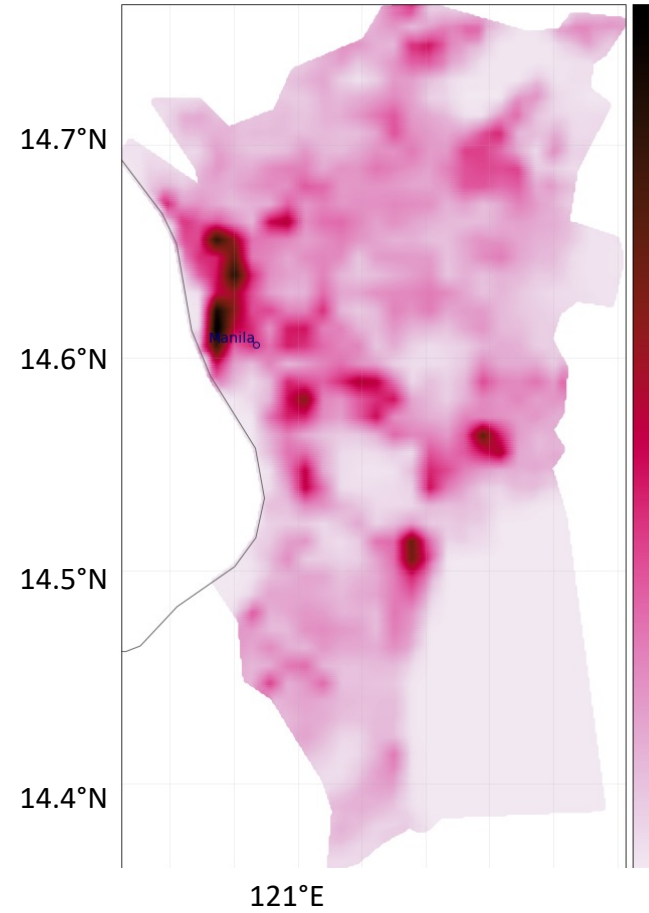
Exposure – Metropolitan Manila



OSM building stock



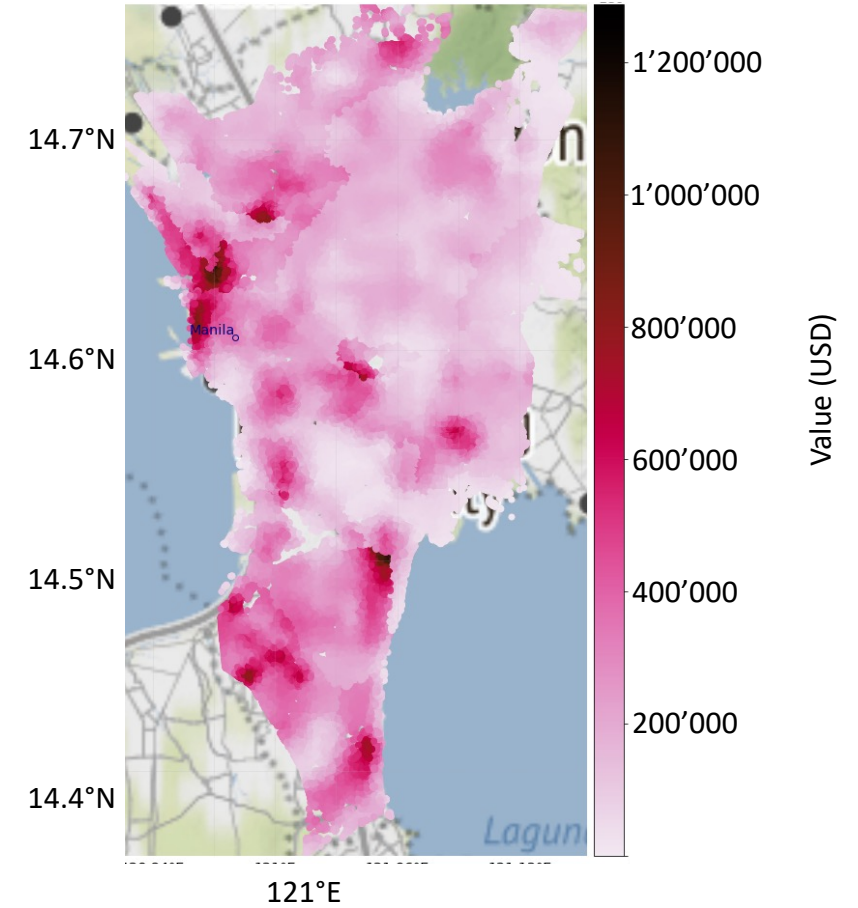
LitPop exposure value



+

=

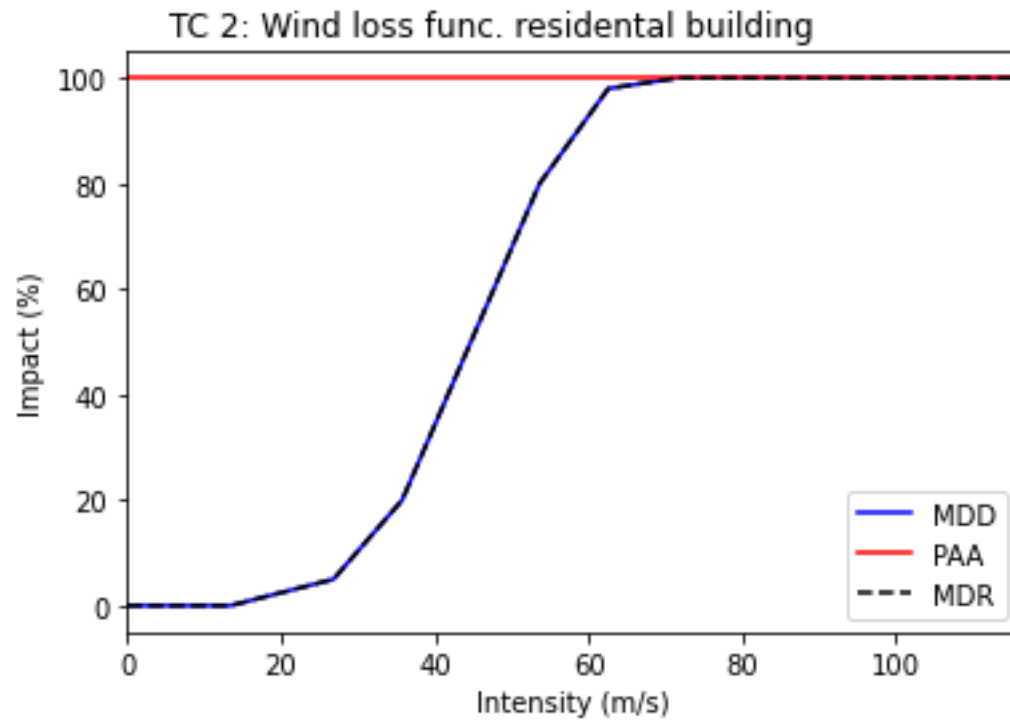
Disaggregated LitPop building value



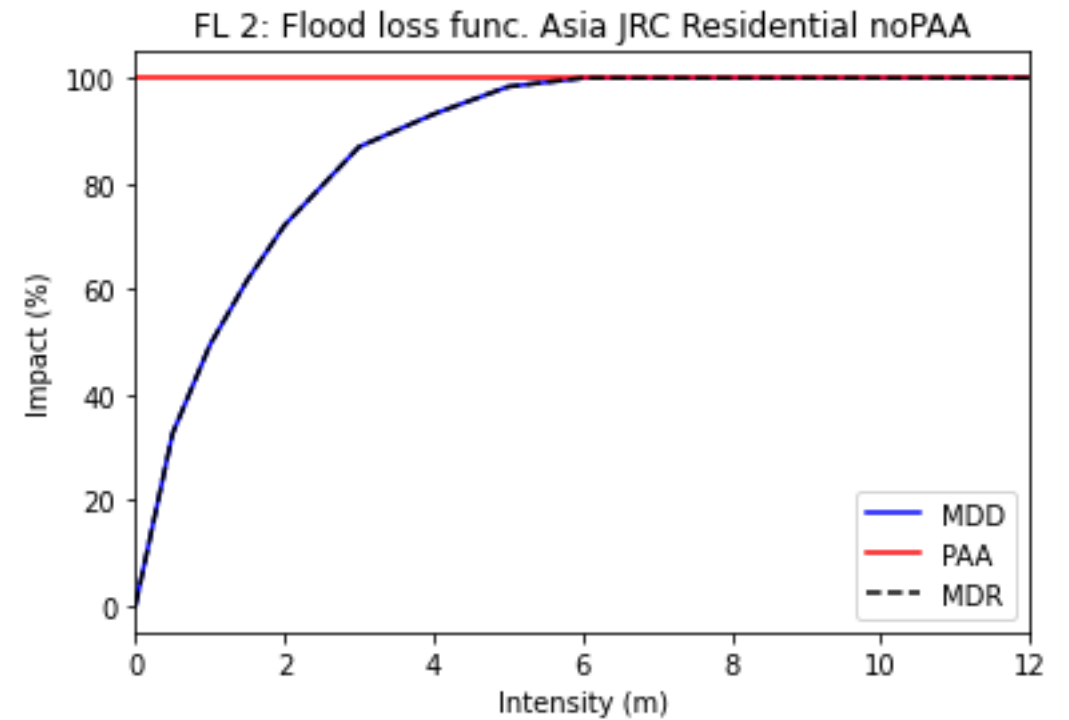
Vulnerability curves



Wind



Flood

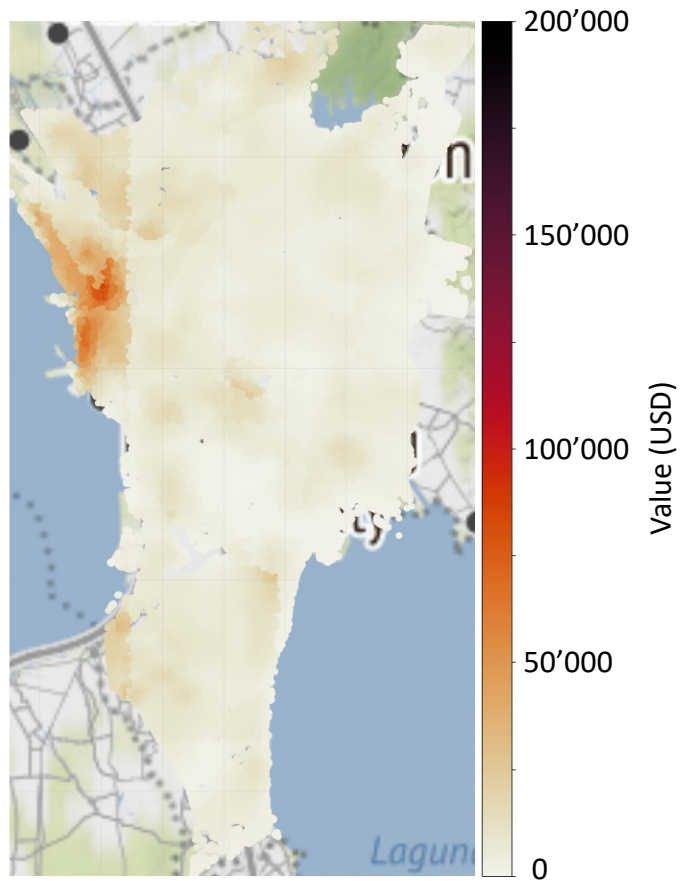


Impacts - example TC Vamco 2020

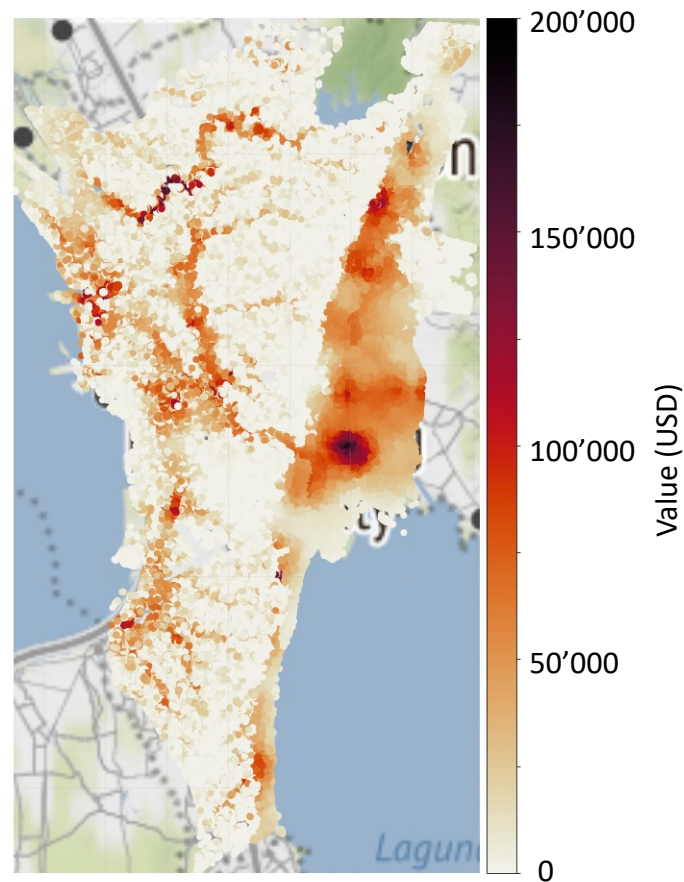


Approach 1: sum of sub-hazards, cap at 100%

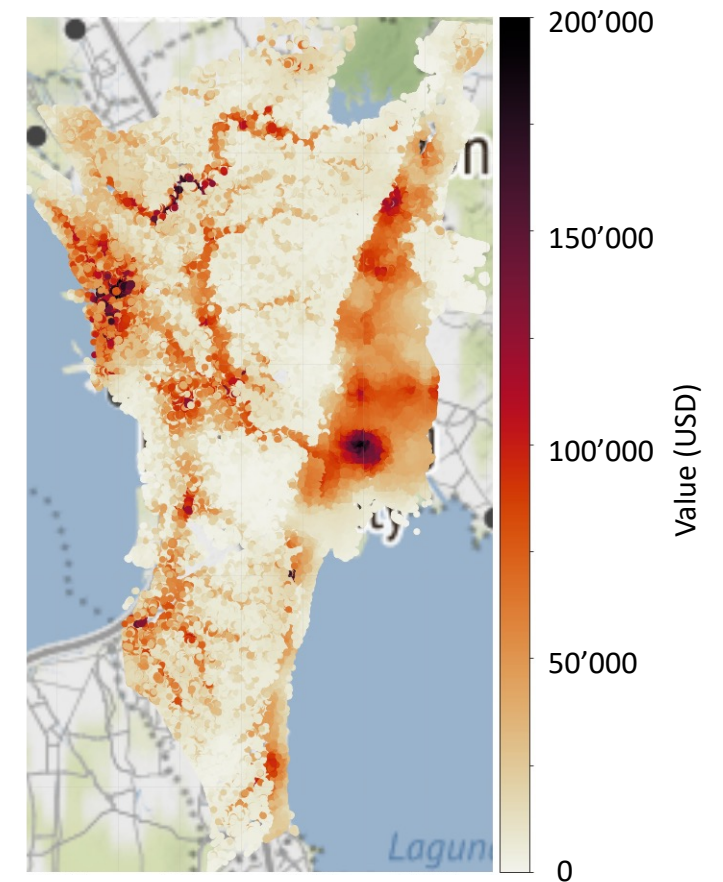
Wind



Flood



Total



References

1. Emanuel, K., Sundararajan, R. & Williams, J. Hurricanes and global warming: Results from downscaling IPCC AR4 simulations. *Bulletin of the American Meteorological Society* **89**, 347–367 (2008).
2. Emanuel, K., & Rotunno, R. Self-stratification of tropical cyclone outflow. Part I: Implications for storm structure. *Journal of the Atmospheric Sciences* **68(10)**, 2236–2249 (2011).
3. Feldmann, M., Emanuel, K., Zhu, L. & Lohmann, U. Estimation of atlantic tropical cyclone rainfall frequency in the United States. *Journal of Applied Meteorology and Climatology* **58**, 1853–1866 (2019).
4. Bates, P., Trigg, M., Neal, J., Dabrowa, A. LISFLOOD-FP User manual (2013).
5. Clawpack Development Team. Clawpack Version 5.7.1, <http://www.clawpack.org>, doi: 10.5281/zenodo.4025432 (2020).
6. Aznar-Siguan, G. & Bresch, D. N. CLIMADA v1: A global weather and climate risk assessment platform. *Geoscientific Model Development* **12**, 3085–3097 (2019).

A satellite image of the Atlantic Ocean, showing the eastern coast of North and South America on the left and the western coast of Europe and Africa on the right. The ocean is dark blue with white clouds and swirling patterns. A semi-transparent blue box is overlaid on the right side of the image.

Questions?

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