EARTH OBSERVATORY OF SINGAPORE

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SEA² Program

How non-asset-based disaster loss models better quantify risk:

A case study of coastal flooding in the Philippines

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Non-asset-based disaster loss models better support equitable planning outcomes.

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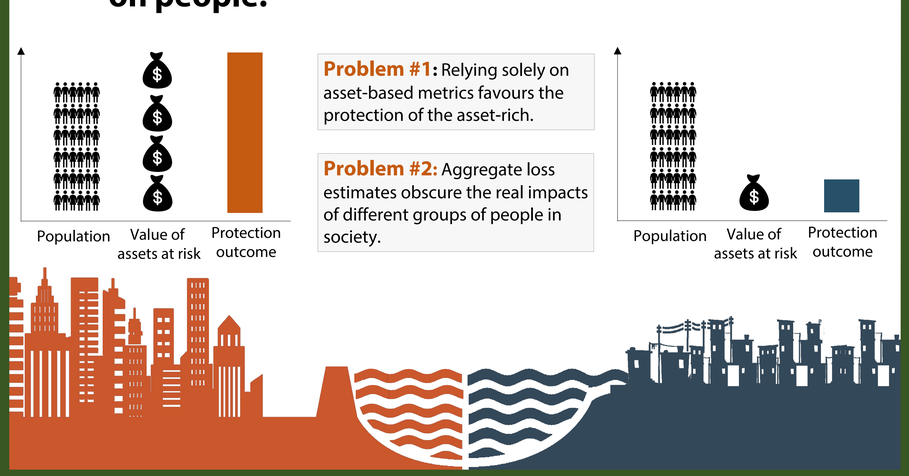
1 Background: Current disaster risk/loss metrics do not account for disparate impacts of disasters on people.



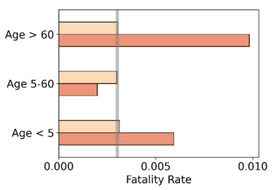
Problem #1: Relying solely on asset-based metrics favours the protection of the asset-rich.

Problem #2: Aggregate loss estimates obscure the real impacts of different groups of people in society.

2 Metrics matter! Types of non-asset-based models

EQUITY DISAGGREGATION

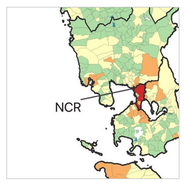
Ascribes losses to particular social axes (e.g. age, gender, disability)



Source: Soden et al.(2022), in review

INDEX-BASED

A multicriteria weighted analysis based on selected social indicators (e.g. Social Vulnerability Index [SoVI])

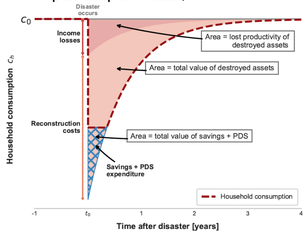


Source: Lloyd et al. (2022)

SVI
- ≤ -1.5 SD (very low vulnerability)
- -1.5 SD to -0.5 SD (low vulnerability)
- -0.5 SD to 0.5 SD (moderate vulnerability)
- 0.5 SD to 1.5 SD (high vulnerability)
- ≥ 1.5 SD (very high vulnerability)

ECONOMICS-BASED

Models impact on sectors of an economy and individual/household well-being (e.g. Welfare loss model, input-output model)



Source: Walsh and Hallegatte (2019)

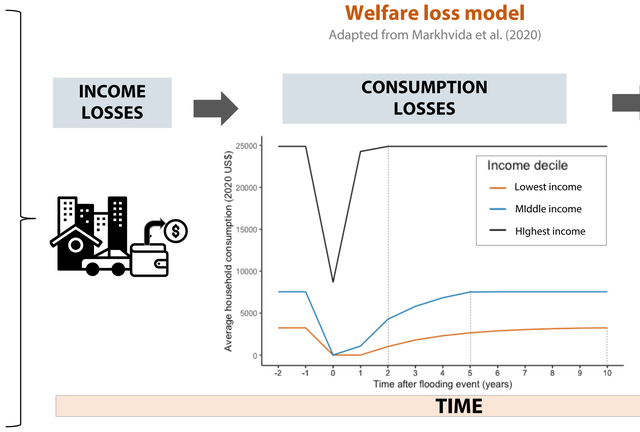
3 The welfare loss approach models how a disaster impacts household consumption & well-being over time.

Main model inputs

- Income distribution
- Savings — *PSA (2018)*
- Coastal flood map — *Wagenaar et al. (2022)*
- Building footprints — *Microsoft Bing Maps (2022)*
- Damage-depth function — *Huizinga et al. (2017)*

Welfare loss model

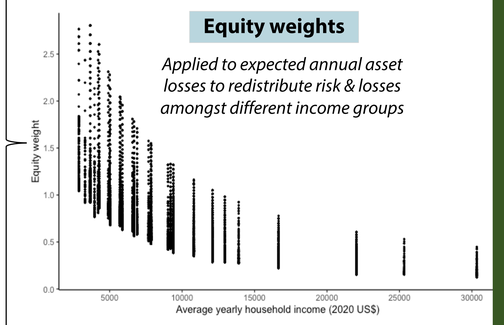
Adapted from Markhvida et al. (2020)



Main model output

Equity weights

Applied to expected annual asset losses to redistribute risk & losses amongst different income groups



4 Results: Comparing asset and non-asset losses for coastal flood losses around Manila Bay, Philippines

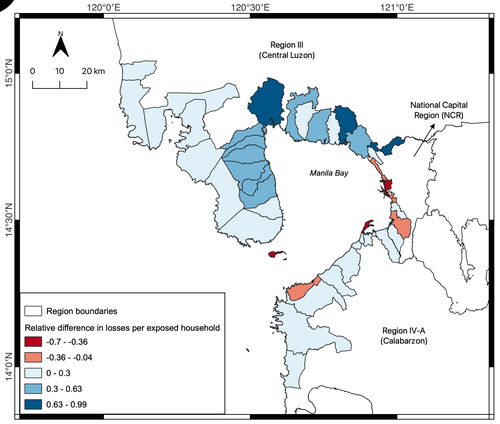


Figure 1. Normalised difference between current day (2020) welfare and asset losses for an average flood-exposed household in each municipality. **Red** areas are where decision-makers would have prioritised based on asset losses alone (i.e. asset-rich areas). **Blue** areas are the new priority areas for flood protection, based on welfare losses.

1. Accounting for impact on household well-being leads to different decision outcomes

2. Welfare loss metrics are more useful for decision-making than SoVIs

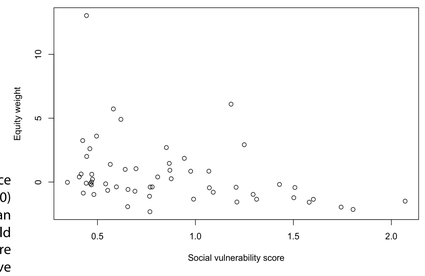


Figure 2. Social vulnerability scores of each municipality from Lloyd et al. (2022) were compared with equity weights for each municipality from the welfare loss analysis. We expected that areas with higher social vulnerability would have higher equity weights.

Possible reasons:

- Social vulnerability indices (SoVI) are non-hazard specific.
- The choice and weighting of individual components of the SoVI are subjective.
- SoVIs are relative, i.e. unable to inform decision-makers about the magnitude of social vulnerability.
- Welfare losses are tangible monetary values, i.e. easy to integrate into decision-making tools like cost-benefit analyses.

5 Broader implications & future work

- How we account for inequity in disaster risk assessments have long term consequences for vulnerable groups, especially in Southeast Asia where many countries experience high disaster risk and high levels of social inequities and inequalities.
- The unexpected negative relationship between equity weights and SoVIs provide an opportunity for future studies into the social axes by which coastal flood risk should be disaggregated *(e.g. gender, age, disability, income, etc.)*
- Need to better understand the sensitivity of the welfare loss model to various inputs
- To scale up analysis spatially and temporally to include future risk to sea level rise in the Philippines

References & data sources:

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