Earth Observation-Driven Spatial Disaggregation of Exposure Models for Seismic Risk Analysis

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GLOBAL EARTHQUAKE MODEL
working together to assess risk

OPENQUAKE
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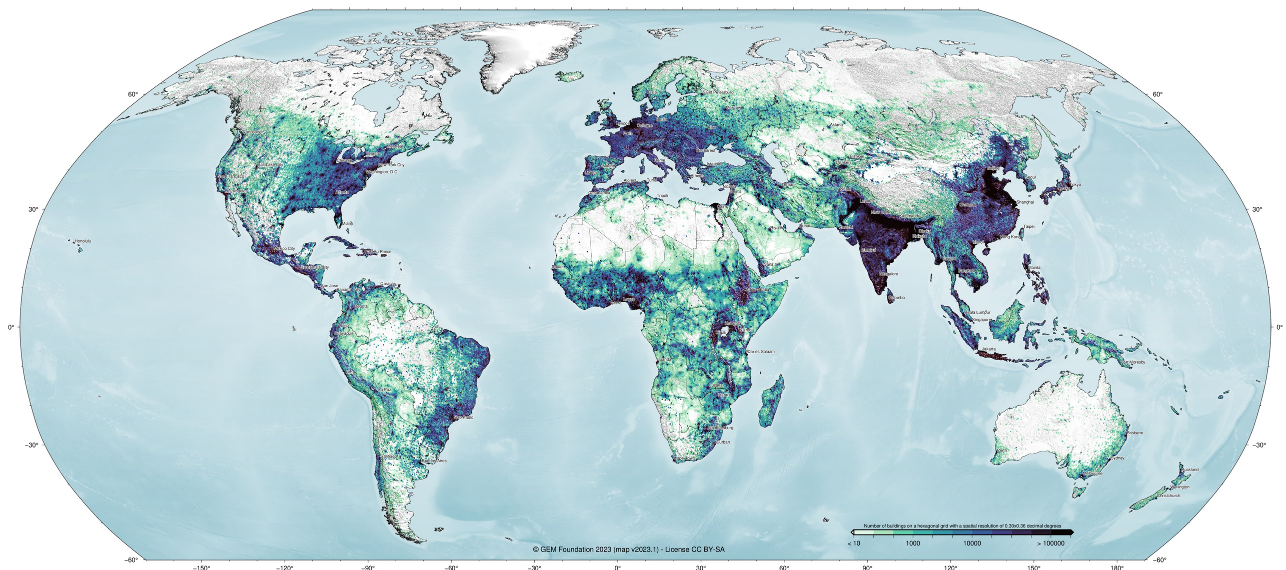
1 Motivation



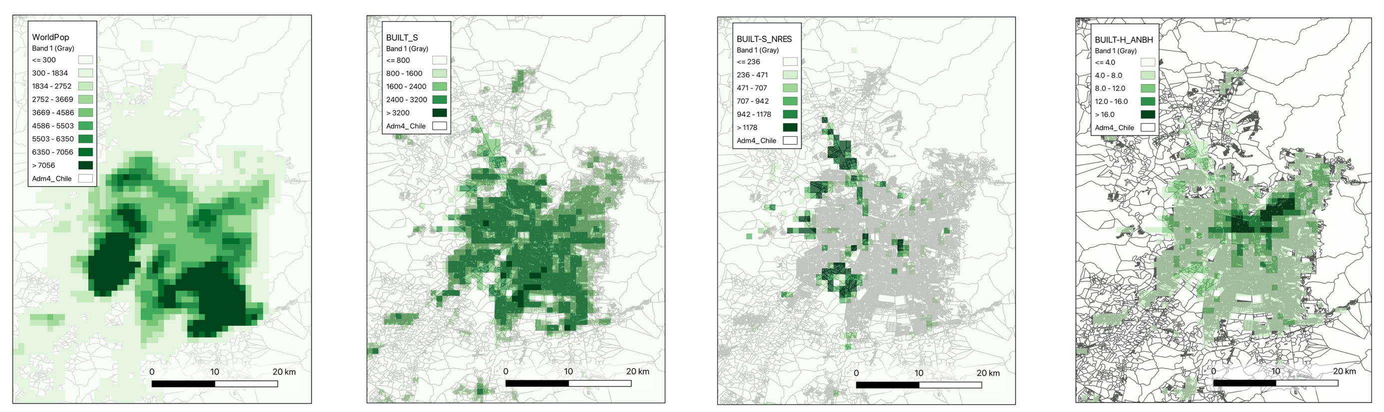
Scan to explore the GEM Global Exposure Model

- **Spatial resolution matters**: Finer spatial resolution of exposure data improves the accuracy of seismic risk assessments.
- **GEM's Global Exposure Model**: Exposure data is typically aggregated at the smallest administrative level available.
- **Need for spatial aggregation:** Exposure models often need to be disaggregated to finer resolutions to reduce estimation errors.

2 Spatial Disaggregation

- Traditional disaggregation methods rely on readily available data like population density.
- Newer approaches leverage **earth observation (EO)**, incorporating built-up area and building height from remote sensing.

Aim → Analyse the sensitivity of seismic risk estimates to different EO-based disaggregation methods



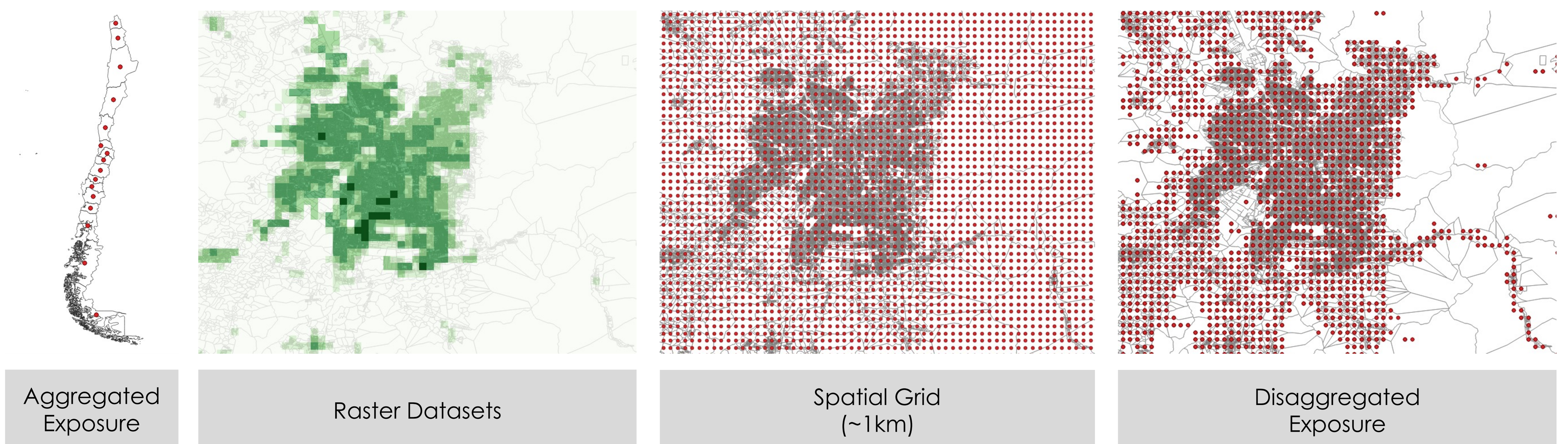
Earth observation raster data

Santiago (Chile)

Population density | Built-up area | Built-up area (non residential) | Building height

3 Methodology

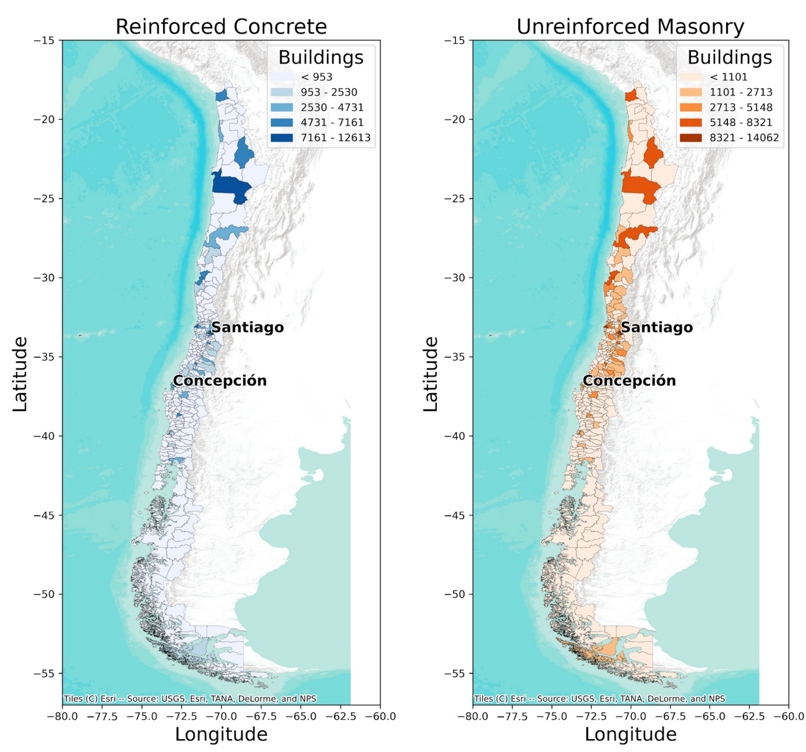
Buildings are randomly allocated across a grid based on weights from **global raster datasets** with selection probability proportional to each grid cell's weight. **Three workflows** are tested.



Workflow (wf)	Raster type	Filtering	Weights	Resample Method
A	• Population density	< 5th percentile	**A1.** w = (pop)^1.5 **A2.** w = pop	• Weighted random sampling
B	• Population density • Residential built-up area • Non-residential built-up area	< 5th percentile < 5th percentile > 75th percentile	**B1.** w1 = (pop)^1.5 **B2.** w1 = pop w2 = bu_res	• Weighted random sampling
C	• Population density • Residential built-up area • Non-residential built-up area • Building height	< 5th percentile < 5th percentile > 75th percentile Not applied	**C1.** w1 = (pop)^1.5 **C2.** w1 = pop w2 = bu_res	• Weighted random sampling • Sampling conditioned on building height (for specific building classes)

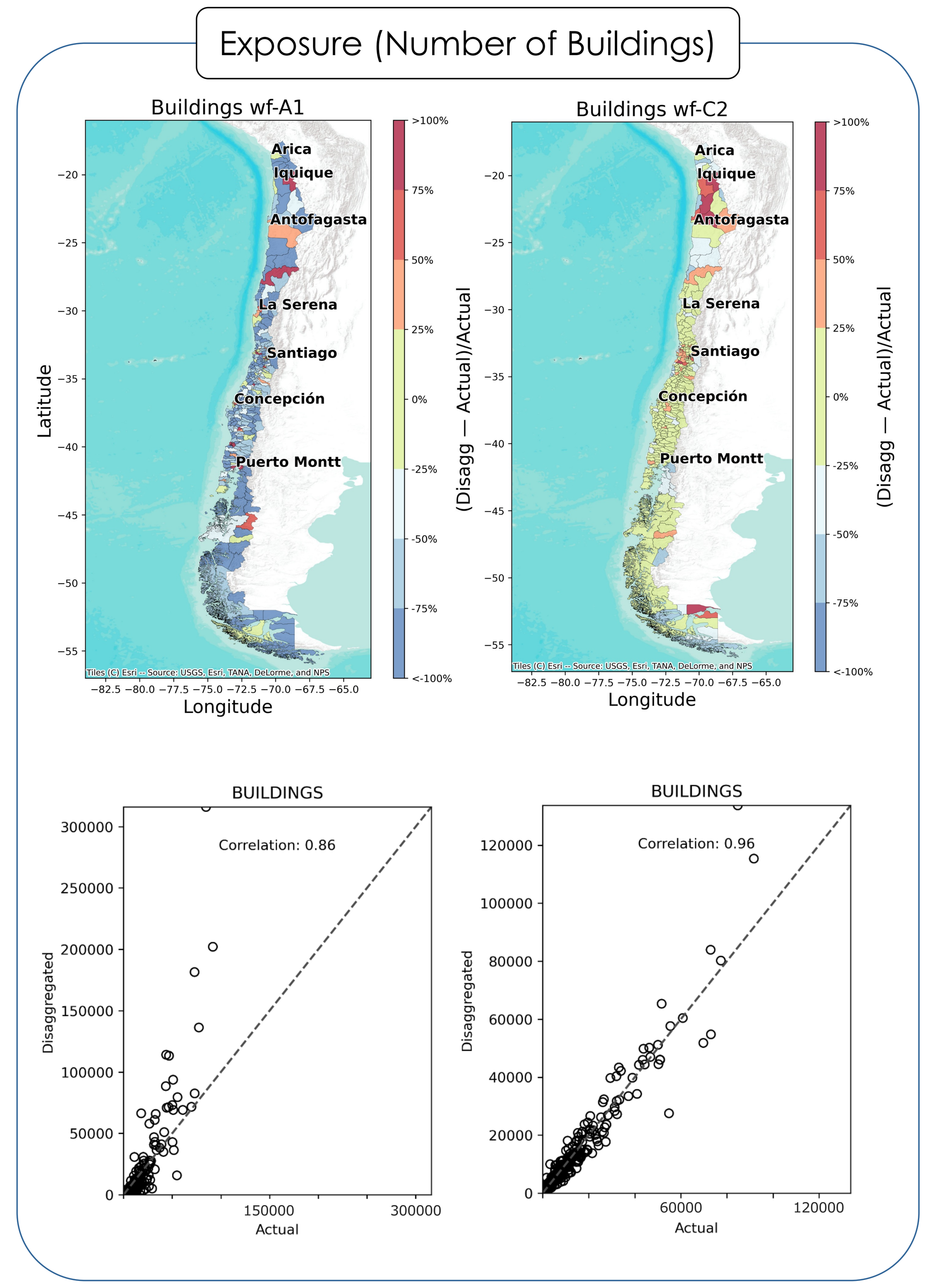
4 Case-study Countries

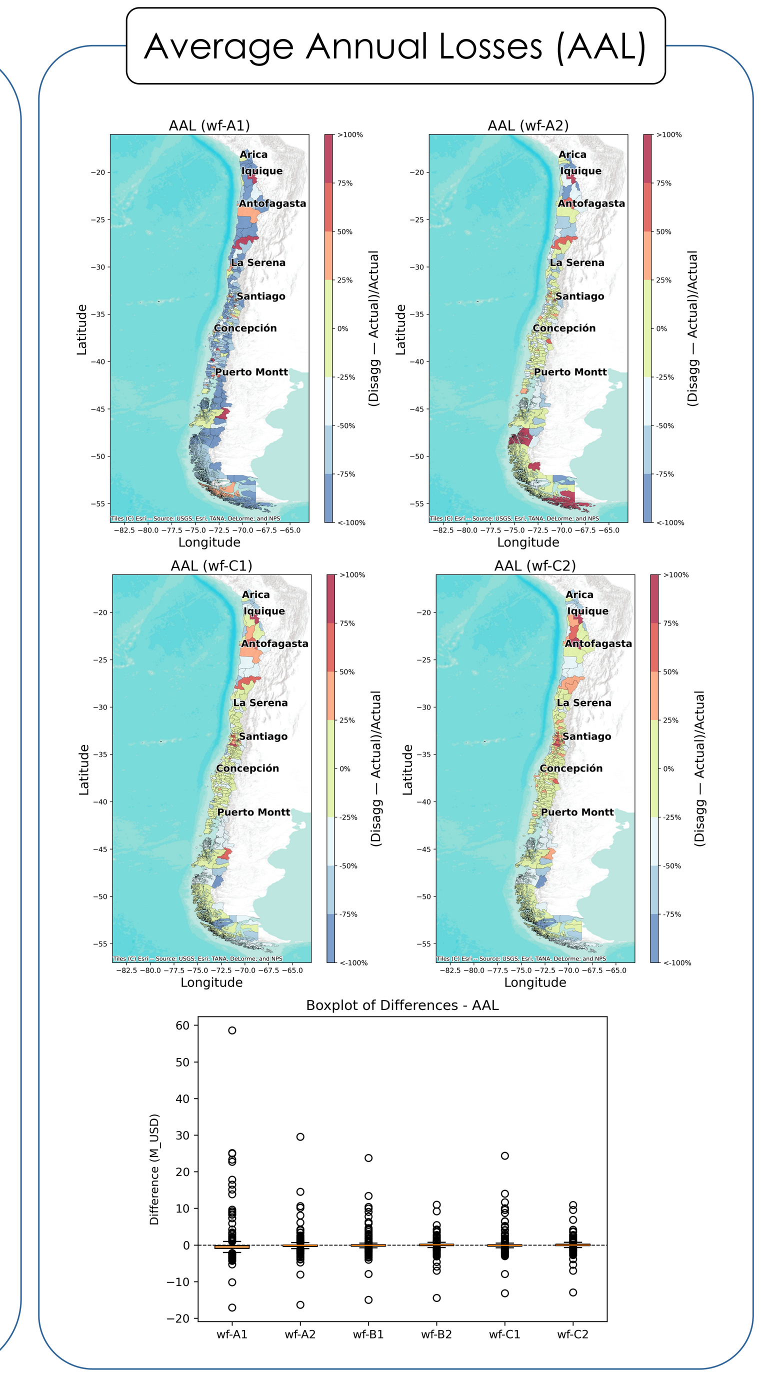
Benchmark residential exposure datasets from GEM's Global Exposure Model – here is the example of **Chile** – are re-aggregated at the first administrative level, then spatial disaggregation workflows are applied.



5 Sensitivity analysis

Each disaggregated model is compared to the benchmark at the smallest administrative division, focusing on key **exposure data** (eg. buildings) and **loss metrics** (Average Annual Loss). Losses are estimated using the risk calculator of the **OpenQuake Engine**.





6 Conclusions & Future Work

- Combining population and built-up area data **improves exposure spatial distribution** and **reduces loss errors**.
- EO-based methods with fine resolution grids enhance risk modelling and are applicable to **other hazards like floods**.
- Spatial disaggregation can directly support exposure model development.

GEM