Global Dynamic Exposure and the OpenBuildingMap

A Crowd-Sourced Approach to Disaster Risk Assessment and Reduction

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Description

The substantial reduction of disaster risk and loss of lives is a major goal of the Sendai Framework of the United Nations Office for Disaster Risk Reduction (UNISDR). Our Global Dynamic Exposure (GDE) model is a powerful tool for disaster risk assessment that builds upon the involvement of communities in the mapping of their built environment, which is another objective specified within the goals of the Sendai Framework. We create GDE by continuously retrieving and processing data about buildings that are mapped by contributors to OpenStreetMap (OSM) and combining it with open aggregated exposure models (AEMs) and engineering judgement to produce a high-resolution exposure model on the building scale or tiles (~100m size) that can be used for seismic risk assessment and damage prediction. Whether all buildings that exist in reality are mapped or not in OSM is assessed in our completeness modules, both via the manual assessment of volunteers through **Clickpleteness** and an automatic **gap analysis** carried out with the aide of remote-sensing estimates of built-up area. The handling of the highly complex dependencies that exist between the different components of the GDE system is only possible thanks to **Rabotnik**, our asynchronous task management ecosystem. To complete the seismic risk chain, we are also developing a **loss calculator** specifically tailored to work with the building- and tile-level at which the GDE model is defined. All our code is open source and can be found in
https://git.gfz-potsdam.de/dynamicexposure

OpenBuildingMap (OBM)

OpenBuildingMap (OBM), a sibling product of GDE, is created from the continuous processing of OSM buildings and their attributes for the determination of parameters that are relevant to characterise their structures. OBM is updated whenever a building or attribute is added to OSM thanks to **Rabotnik**, which also implements rules, for example, to define the occupancy of the building based on its tags and points of interests enclosed within.

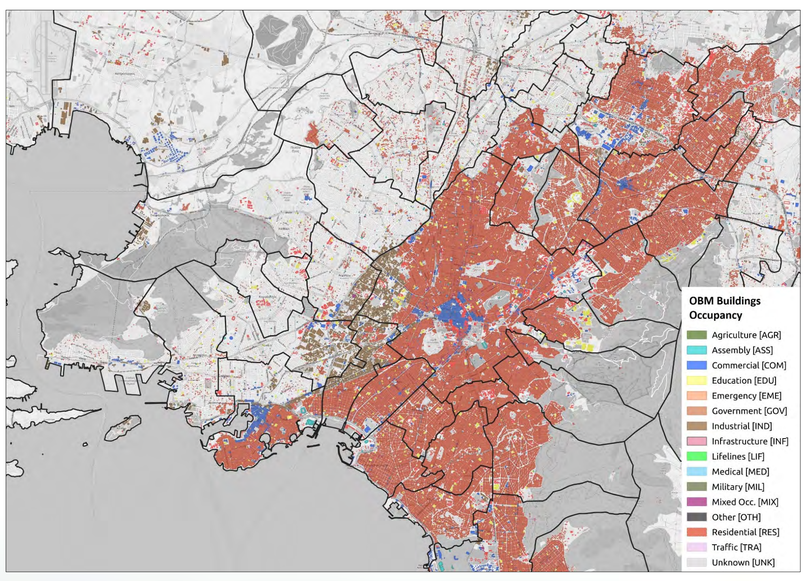
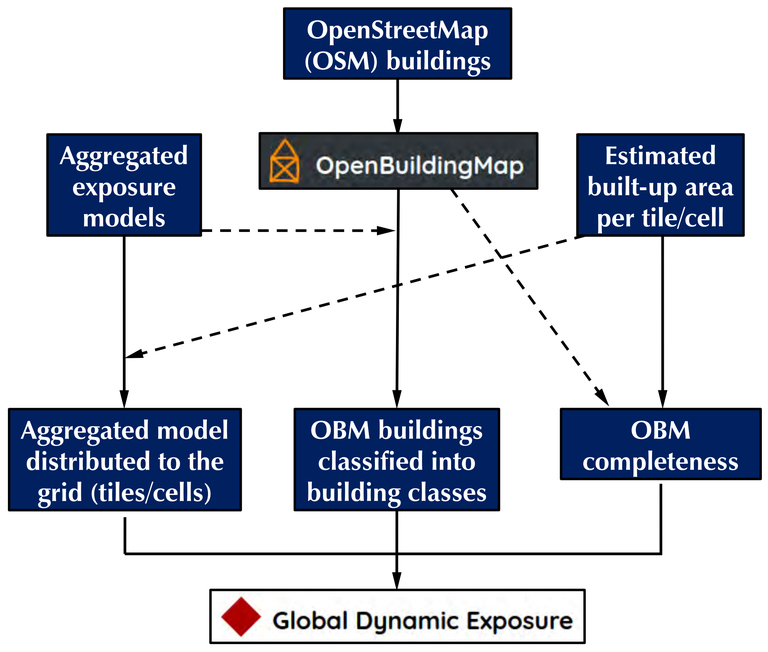


Figure 1: Classification of OBM buildings in Athens, Greece, per occupancy case.



OBMGapAnalysis and Clickpleteness

While some regions and cities are mapped in OSM in great detail, others are missing several or most of their features. We refer to the extent to which real buildings are mapped in OSM as completeness. As knowing whether a certain tile is complete or not is relevant for incorporating OBM data into GDE, we developed two complementary strategies to assess completeness: **Clickpleteness** and the **OBMGap-Analysis**. **Clickpleteness** is a web application in which volunteers can indicate whether a tile is complete or not and which also allows the possibility for importing relevant third-party completeness data. The **OBMGapAnalysis** is a processing chain that compares the area of OBM building footprints per tile against built-up areas estimated through remote-sensing techniques and outputs the resulting ratio. We envision that these tools may not only feed GDE but also encourage OSM contributors to fill in the gaps.

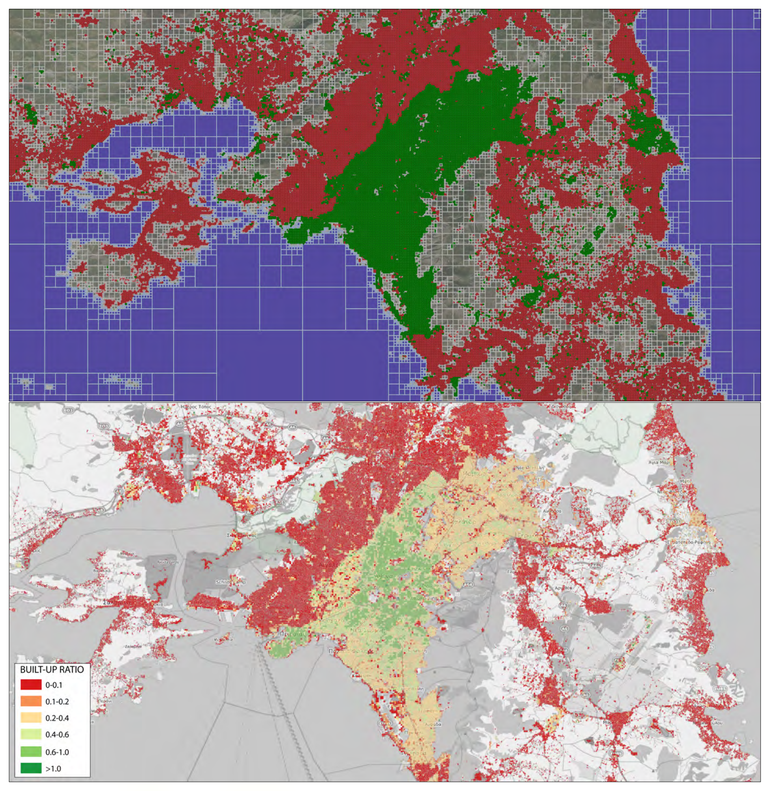


Figure 2: Completeness in Athens; clickpleteness (a) and OBMGapAnalysis (b).

Aggregated Exposure Models (AEMs)

At the European level, the GDE model incorporates data from the European Seismic Risk Model 2020 (ESRM20; Crowley et al., 2020). However, we are also developing exposure models aggregated per administrative unit for other regions of the world, such as Japan, based on censuses and open data. We make these openly available with the aim of encouraging collaboration across the scientific community.

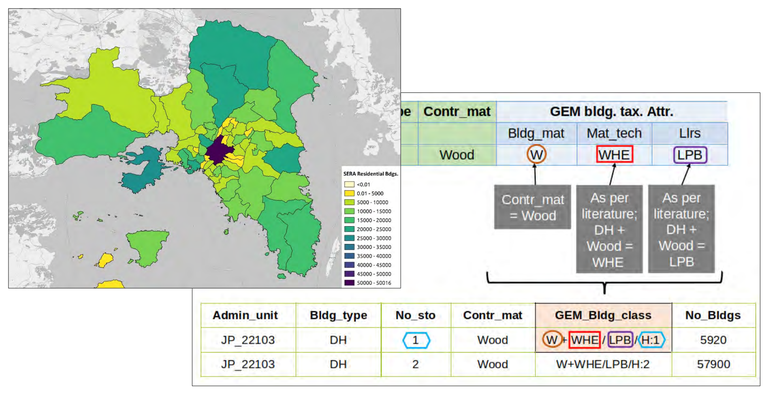


Figure 3: Example of number of buildings in Athens from ESRM20 (aka SERA) and mapping of Japanese census attributes to the GEM Building Taxonomy.

Combining Aggregated Exposure with OBM

The AEMs, defined by administrative unit, are distributed onto tiles in proportion to the built-up area estimated from remote-sensing techniques. If the tile is complete, the total number of buildings is retrieved directly from OBM, while if it is incomplete it is defined from both OBM and the AEM. Buildings get assigned the distribution of possible structural classes associated with the administrative unit in which they are located in the AEM, narrowed down in the case of OBM buildings as per known properties of the structure.

The Loss Calculator

We are developing a **loss calculator** that can work both via a direct connection to the GDE model database and independent input files. The calculator delivers the damage/loss results both per tile and per building.

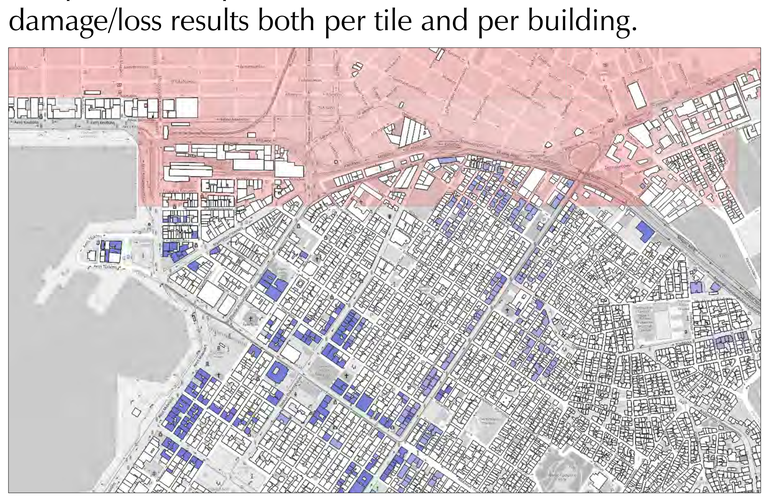


Figure 4: Damage calculated per tile (red scale) and building (blue scale).

Crowley, H., et al. (2020). **Exposure model for European seismic risk assessment**, Earthquake Spectra 36(1_suppl):252-273. doi:10.1177/8755293020919429.
Official Statistics of Japan: https://www.e-stat.go.jp/en

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