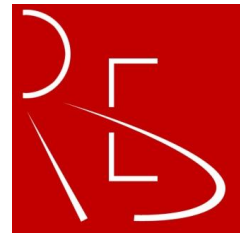


RISK
ENGINEERING
+ DESIGN



Seismic Risk Model for Europe

Seismic Risk Model for Europe

1

Geographical Coverage

2

Hazard Model

3

Exposure Model

4

Vulnerability Model

5

Contents + BI

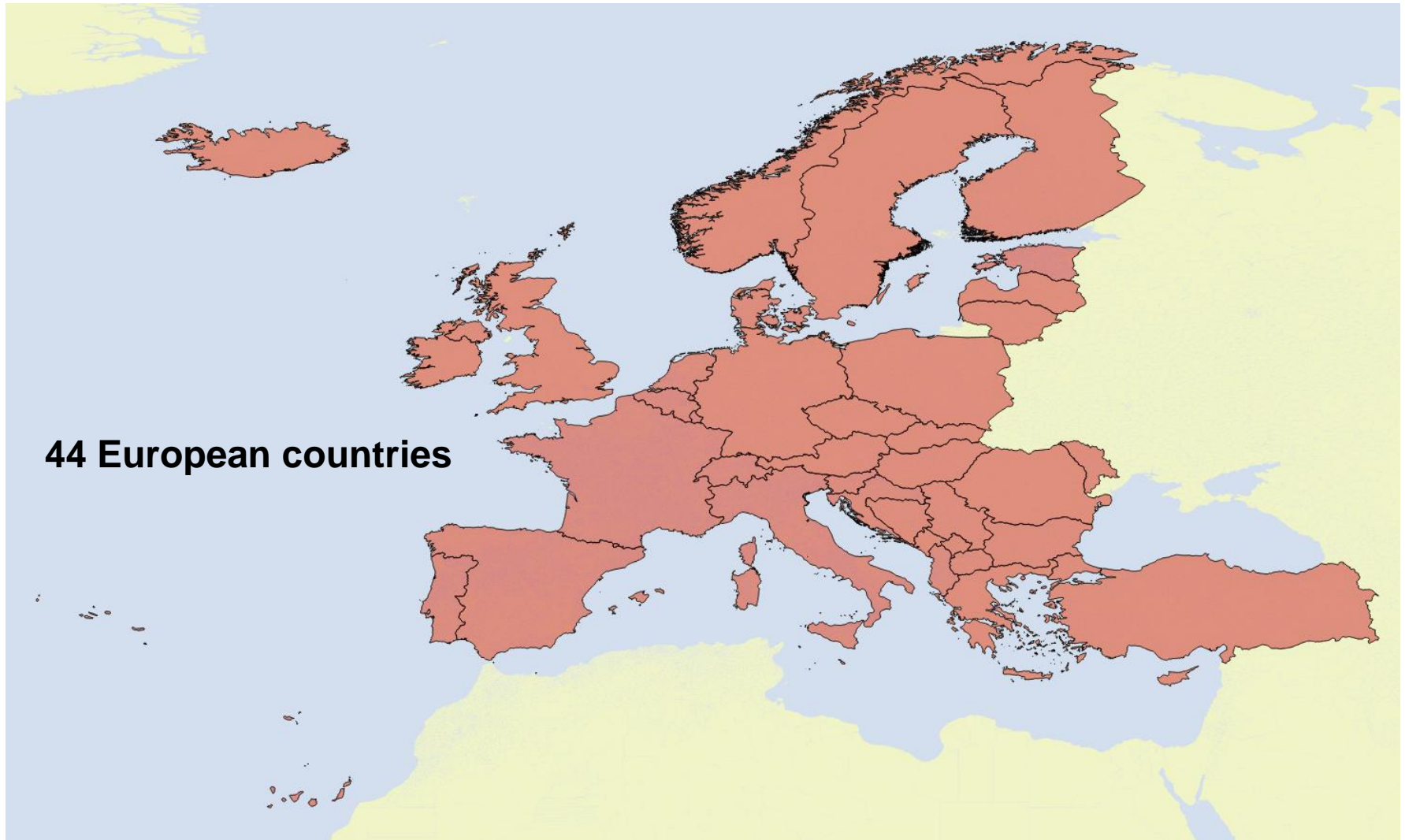
6

Validation

7

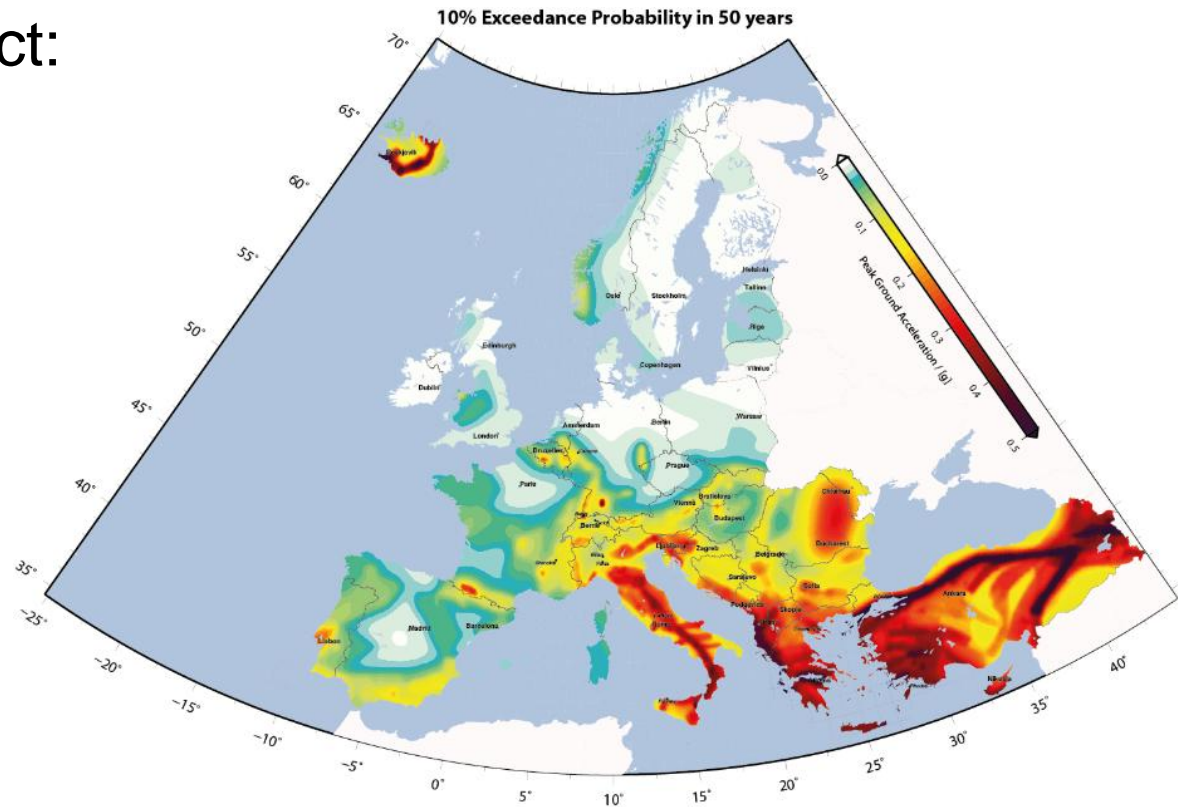
Financial module

1 Geographical Coverage



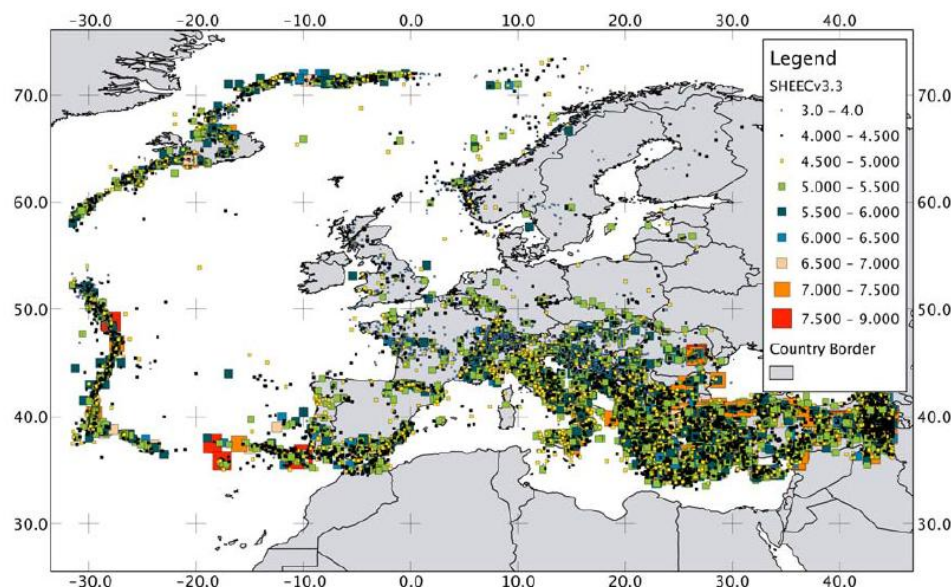
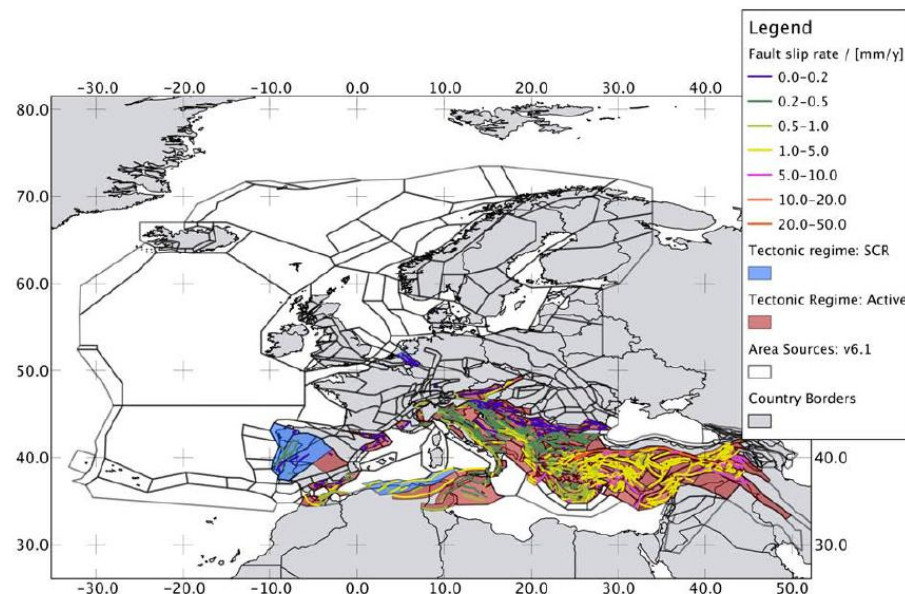
2 Hazard Model

- Fully consistent with the 2014 UE-funded project: **SHARE**
(<http://www.share-eu.org/>)
- Incorporates multiple alternative views of European seismicity.
- Very large catalog of simulated future earthquakes (**4 million events**)



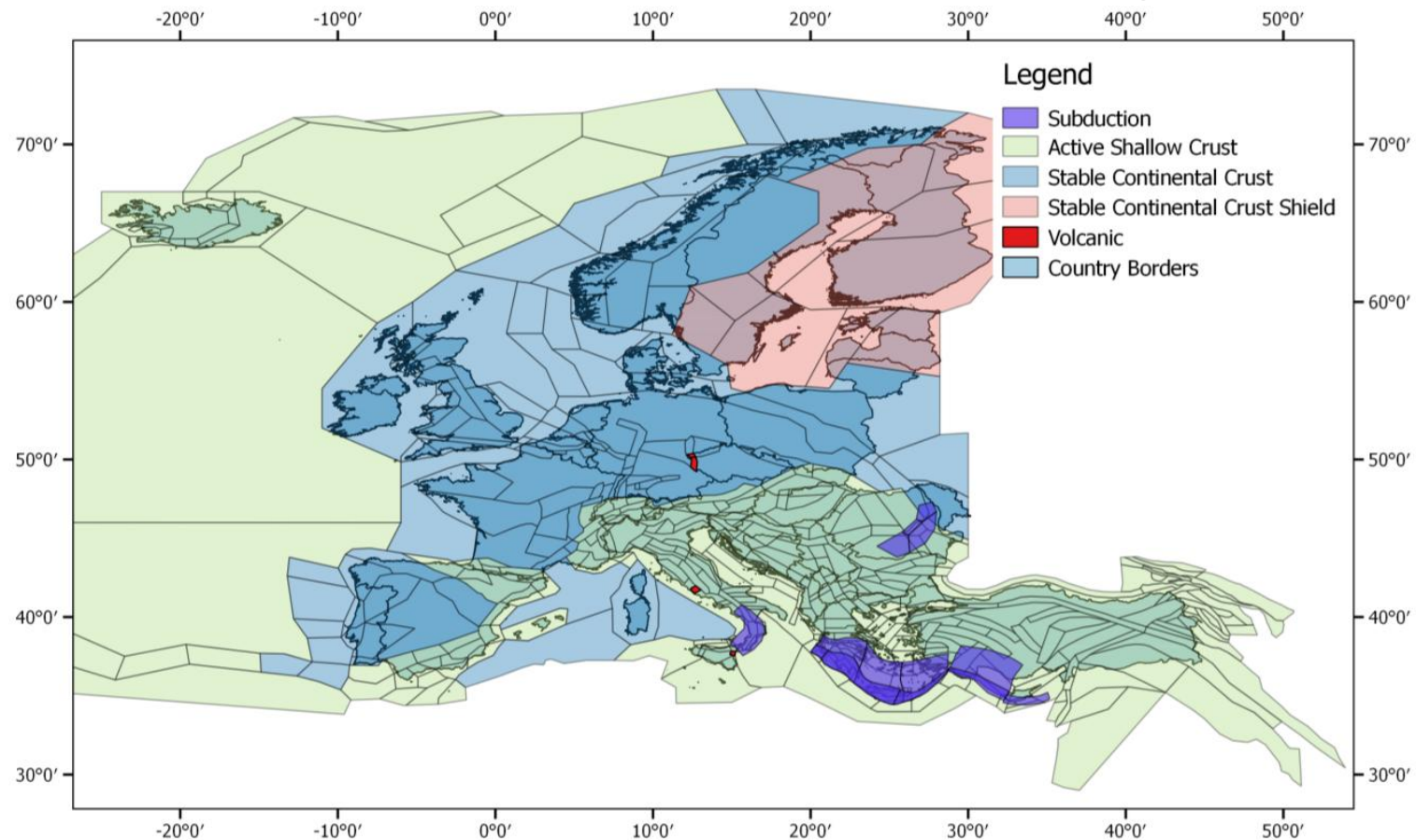
Based on:

- More than 400 distinct seismic sources
- Unique harmonized historical earthquake catalog for Europe



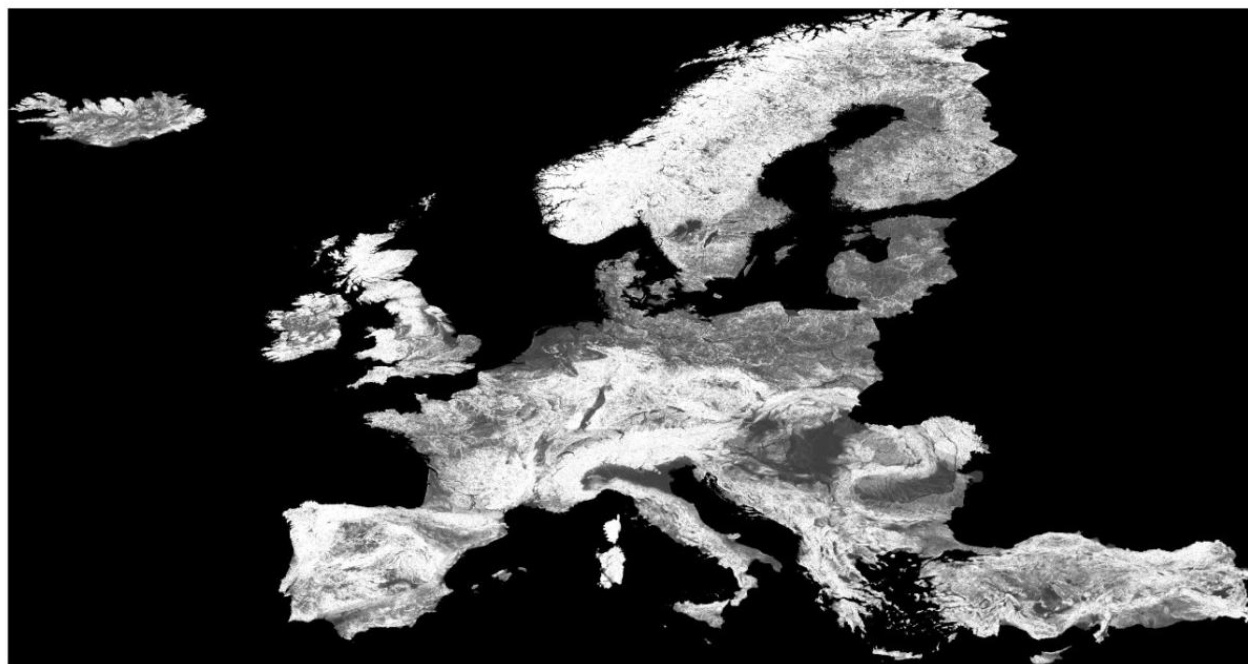
2 Hazard Model

- Shaking intensity defined by means of spectral acceleration
- Ground motion modeling done via multiple ground motion prediction equations (GMPEs)
- GMPEs are specific for the different tectonic regions



Strong ground motion modeling

- Soil amplification approach is based on the average shear wave velocity in the top 30m of soil, V_{s30}
- V_{s30} data is derived from topographic slope
- Nonlinear amplification dependent on incipient level of bedrock ground motion level



3 Industry Exposure Database Model

- Lines of Business: Residential, Commercial, Industrial and Public
- High-resolution IED (30-arcsec)
- Exposure data sources includes
 - national and international housing statistics
 - all the main recent EU-funded projects along with other sources
 - Satellite imagery



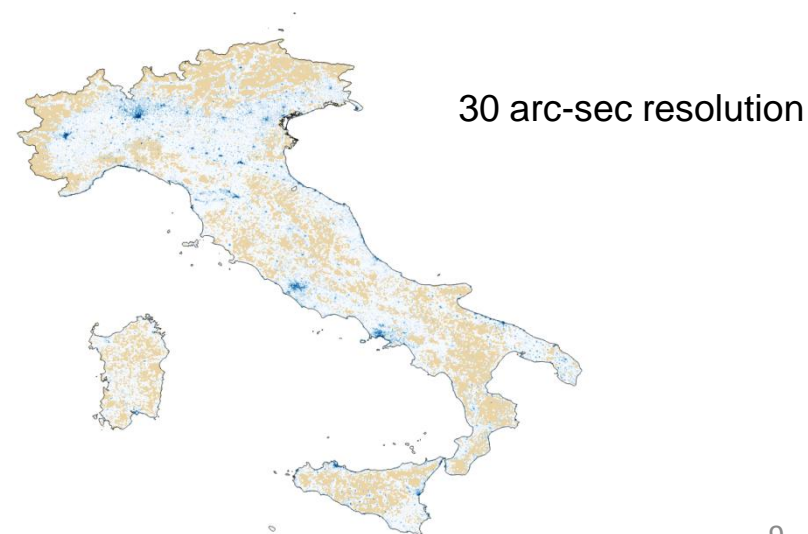
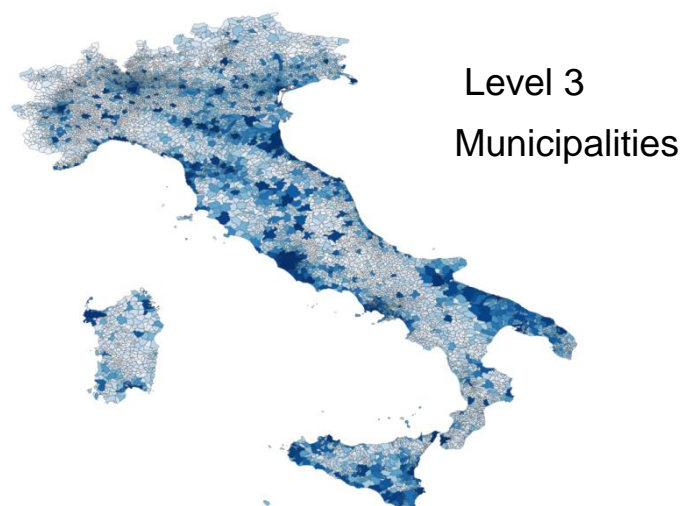
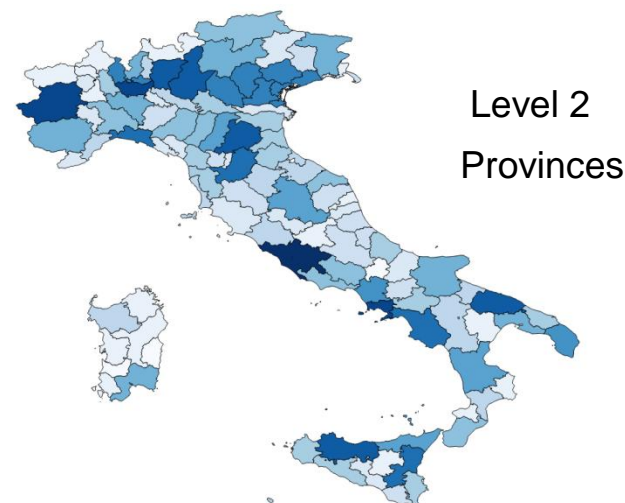
Building Census

Local Surveys

Inference Algorithms

Exposure is available at different levels of granularity

Example: Residential buildings distribution in Italy



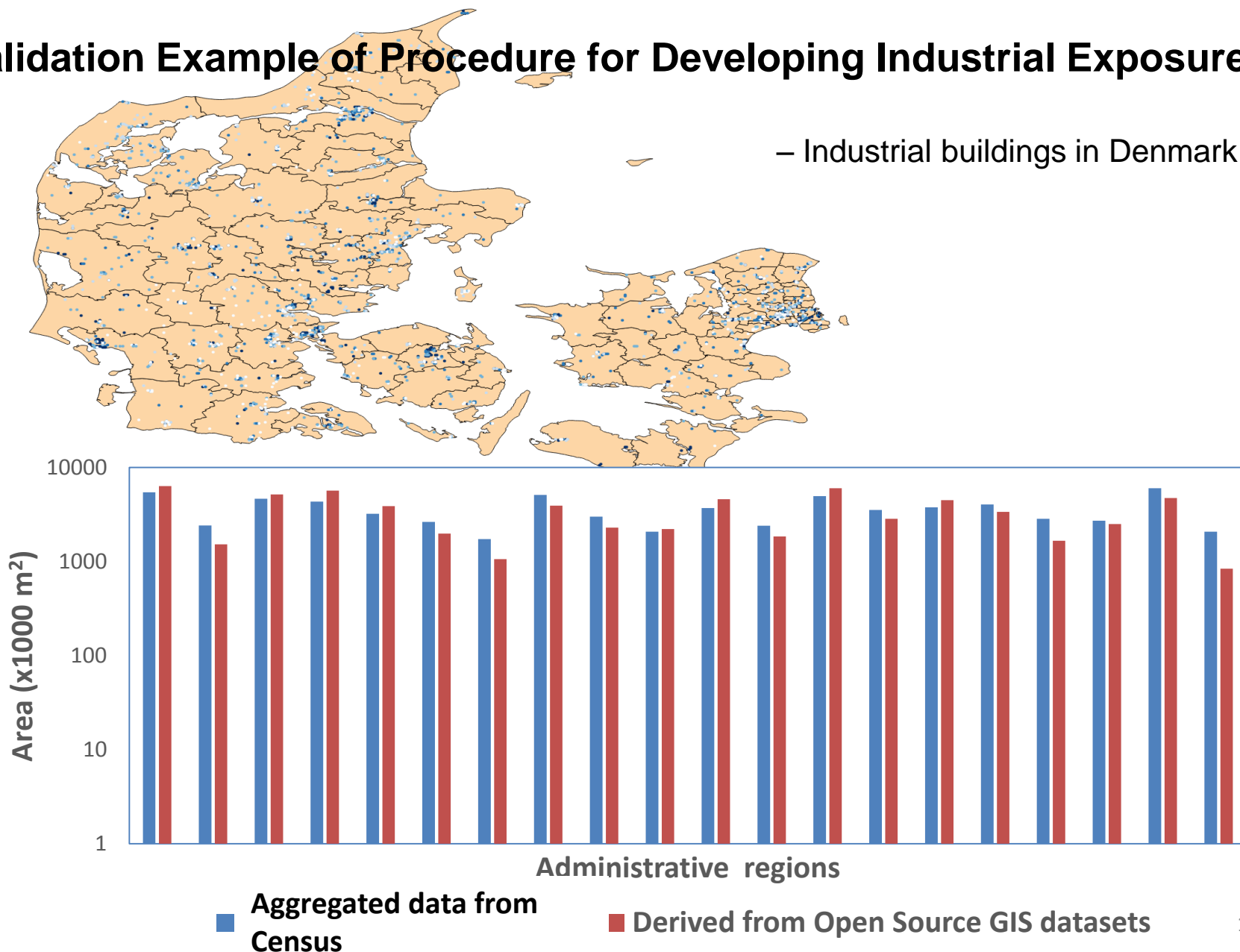
3 Industry Exposure Database Model

Non – Residential Buildings are modeled at a very fine granularity with the aid of Open-Source GIS datasets



Validation Example of Procedure for Developing Industrial Exposure

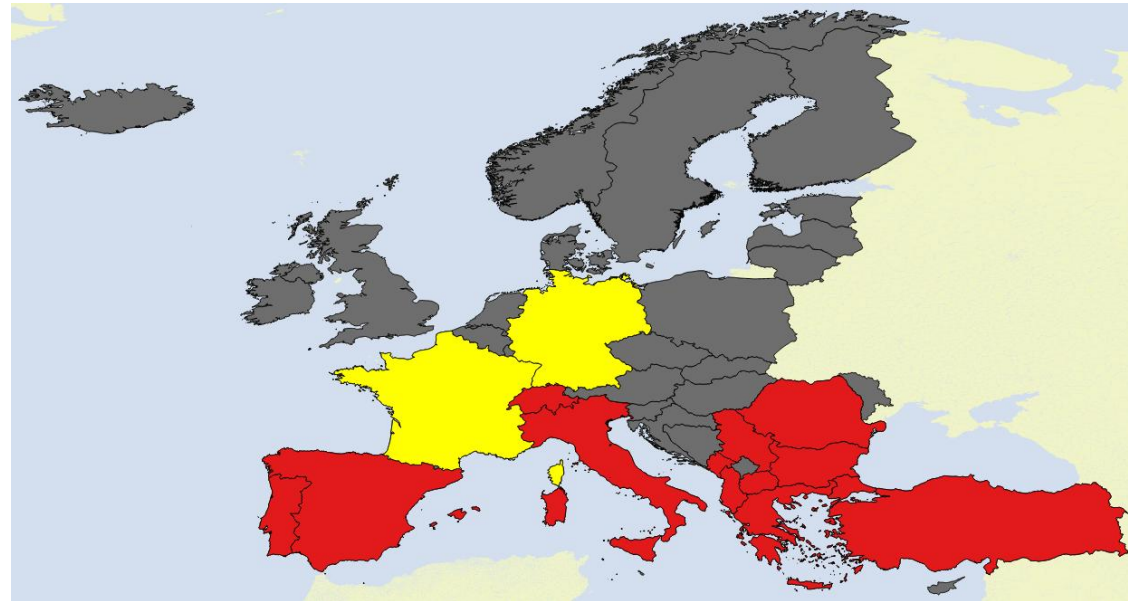
– Industrial buildings in Denmark



Based on:

- Harmonization of more than 300 vulnerability functions from all the major studies about building vulnerability across Europe, comprising large (Risk-UE, LessLoss, Syner-G)
- Vulnerability in countries where no empirical data was available has been defined by
 - comparing building codes and construction practice with those of countries with reliable empirical and research data
 - Limited analytical data

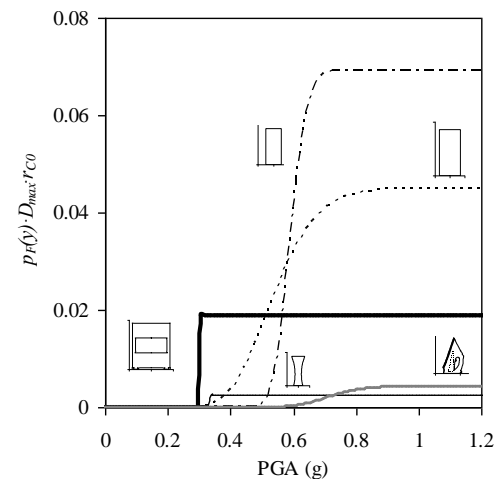
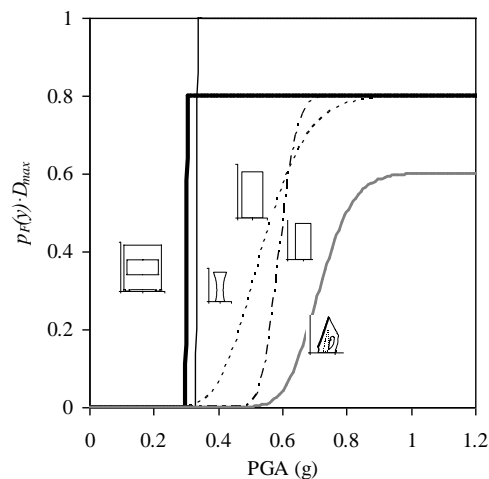
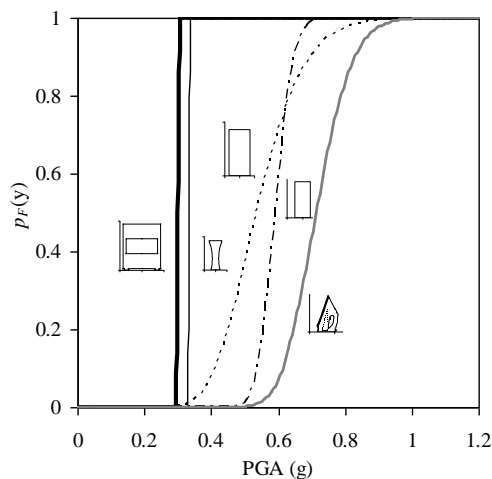
Coverage of Empirical Vulnerability Data



- Average quality empirical data
- High quality empirical data
- Analytical data and engineering judgment



Model of Contents (Detailed computation)

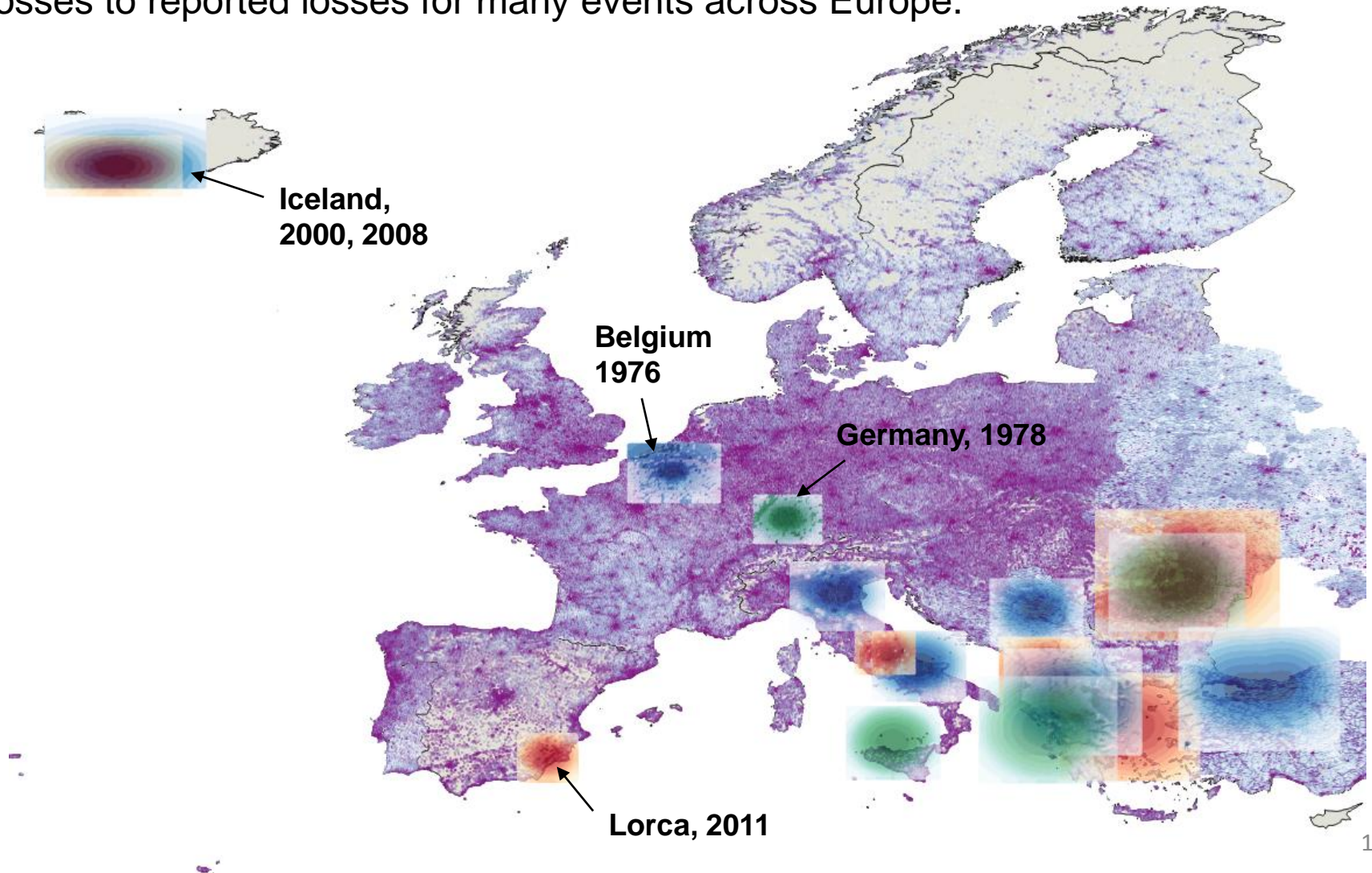


Tests performed in a vibrating table for different types of blocks

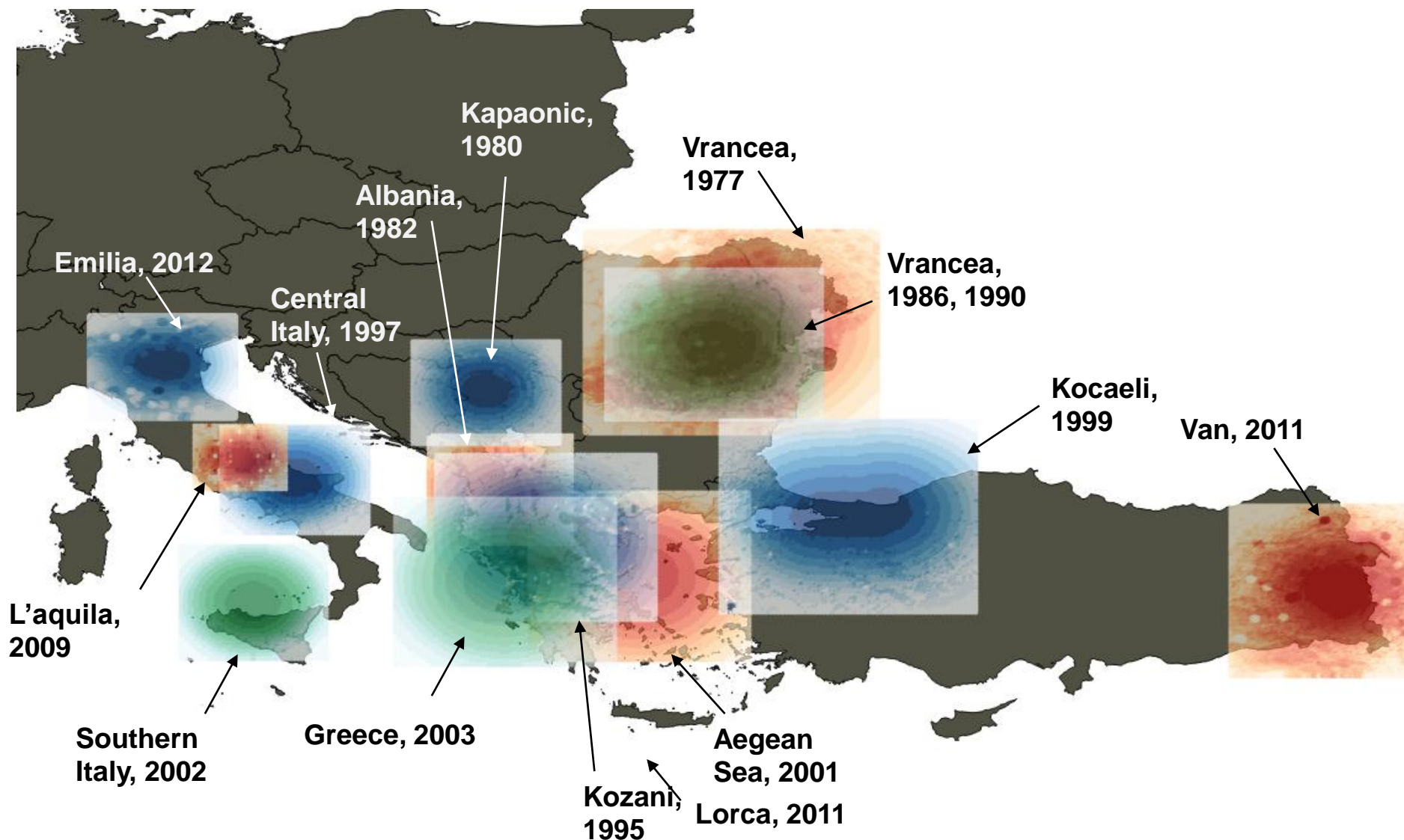
Classification	Examples	D_{max} (%)
Null	paper roll, security boxes	5
Not very vulnerable	wooden furniture, food boxes	30
Vulnerable	computers, radios	80
Very vulnerable	glassware, art, porcelain	100

Past earthquakes used for model validation

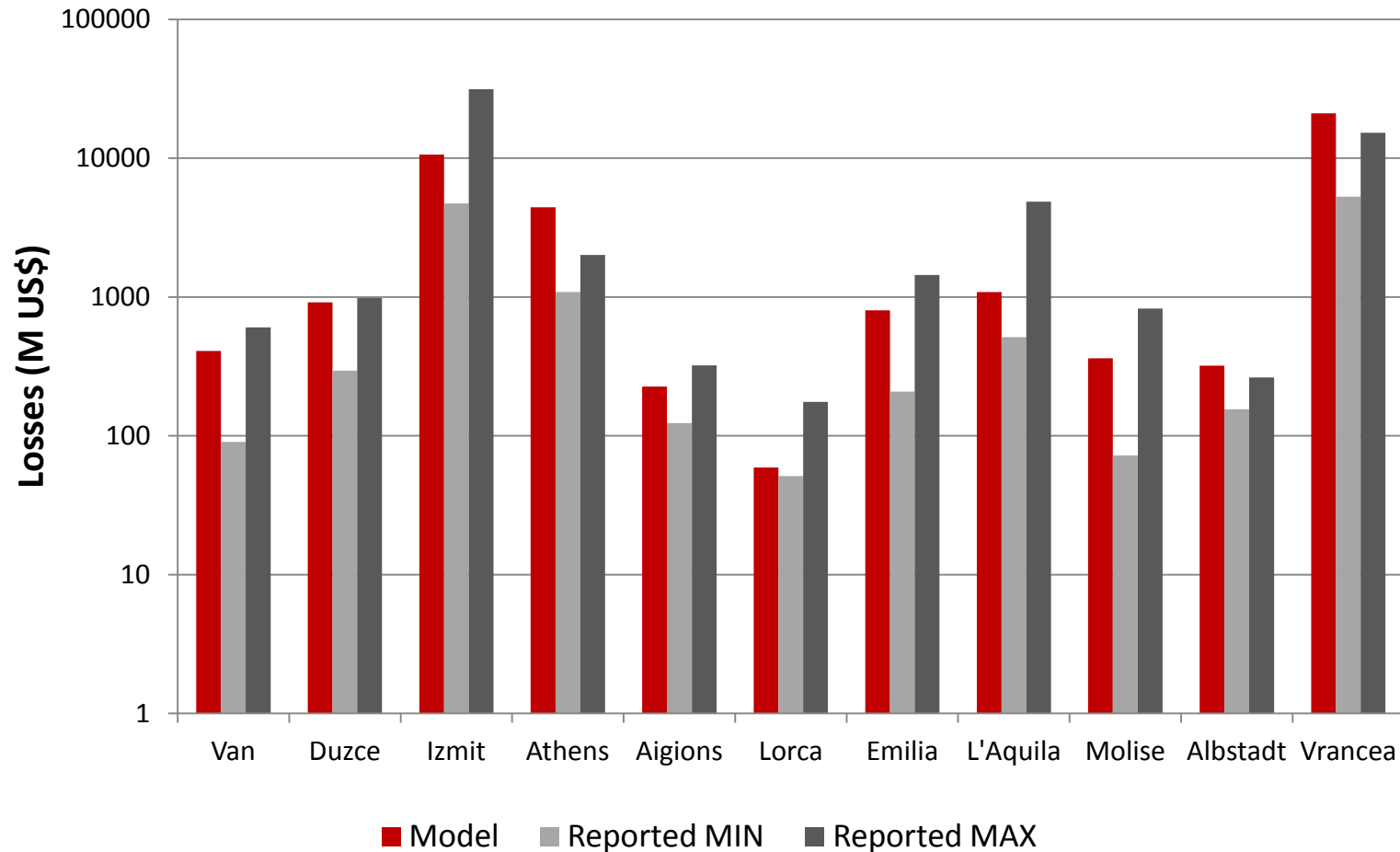
Comprehensive validation carried out comparing modeled losses to reported losses for many events across Europe.



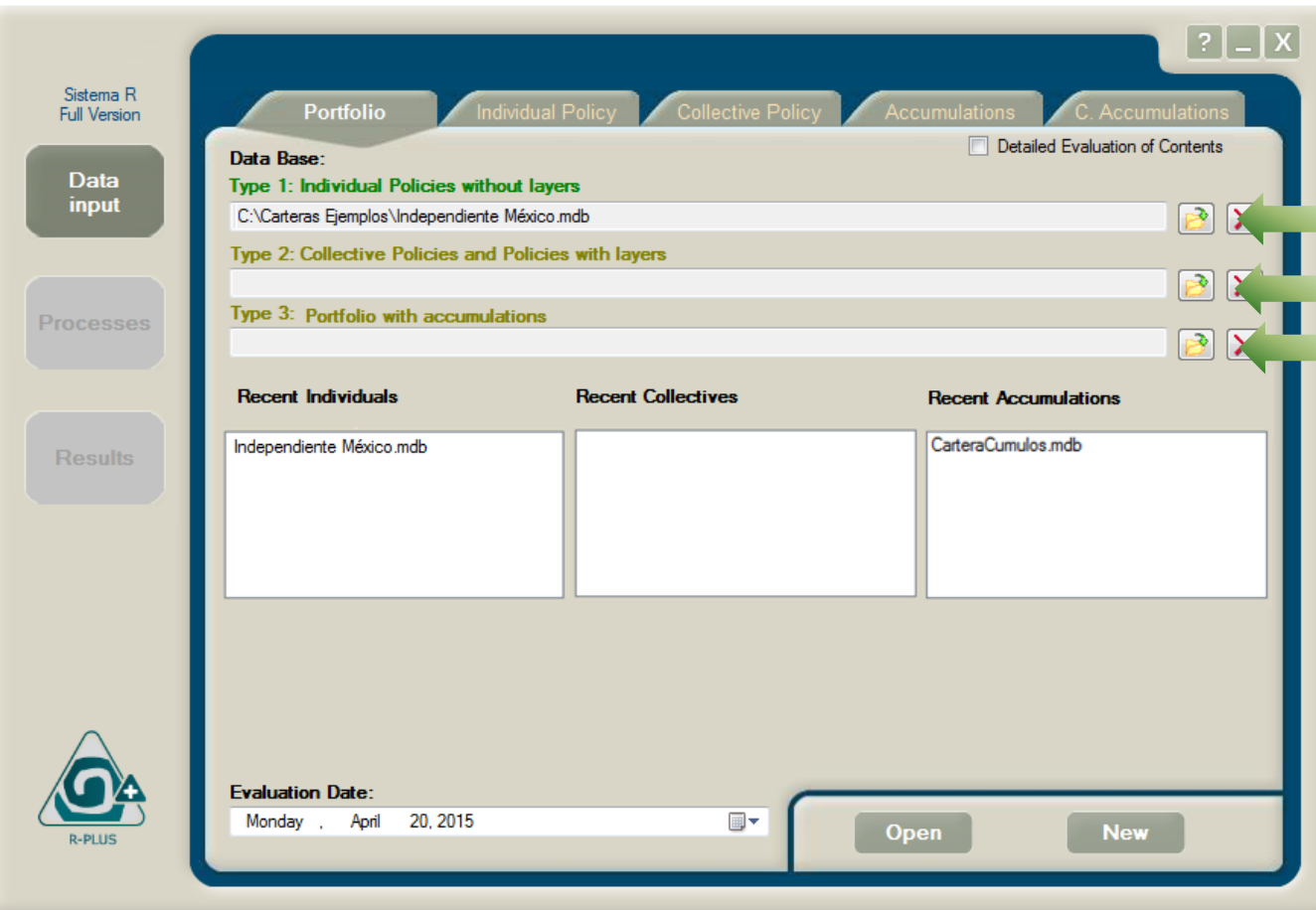
Past earthquakes used for model validation



Model Residential Losses vs. Reported Residential Losses



Types of policies that can be modelled:



1. **Independent policies**
Facultative. One property per policy
2. **Collective policies**
Facultative. Many properties per policy
3. **Aggregated portfolio**
Treaties. Data given at aggregated level
4. **Excess-loss coverage**
Portfolio-level coverage

- Seismic risk model for Europe: 44 countries covered
- Based on the most recent exposure, hazard and vulnerability research and data available in Europe
- Hazard model with an extended stochastic catalog of simulated earthquakes fully consistent with the SHARE model
- Refined residential and non-residential exposure model (resolution 30-arcsec)
- Vulnerability model specifically developed for European countries
- Extended validation effort vis-à-vis observed loss and damage data for about 20 earthquakes
- Sophisticated financial module
- Expected release date: July 2015