SEISMIC RISK AND REAL ESTATE PRICES

An analysis of revealed and stated preferences in Lisbon (Portugal)

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SEISMIC RISK AND REAL ESTATE PRICES

Contents:

- Motivation and goals of PhD Work
- Case study
- Exploratory Data Analysis (EDA)
- Revealed Preferences
- Stated Preferences
- Joint Regression Model
- Final Remarks

Motivation

- Real Estate is the largest store of value and prices have been increasing in recent years.
- Lisbon considered to be of moderate seismicity.
- 63,9% of Lisbon's building stock built before any seismic code
- Unawareness of risk to investors and homeowners

3 Research Questions

- **R1:** Do market values reflect a preference for properties less vulnerable to earthquakes?
- **R2:** How do residents and investors in Lisbon perceive risk?
- **R3:** Does their risk perception affect their willingness to pay for property?

Pratical application:

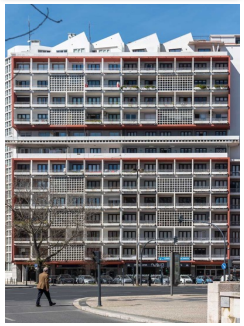
- Homebuyers
- Investors and Developers
- Insurance Companies
- Policymakers

Case Study – Lisbon's Real Estate Market | Housing stock

< 1755

1870-1930

< 1961 / 85



>2000

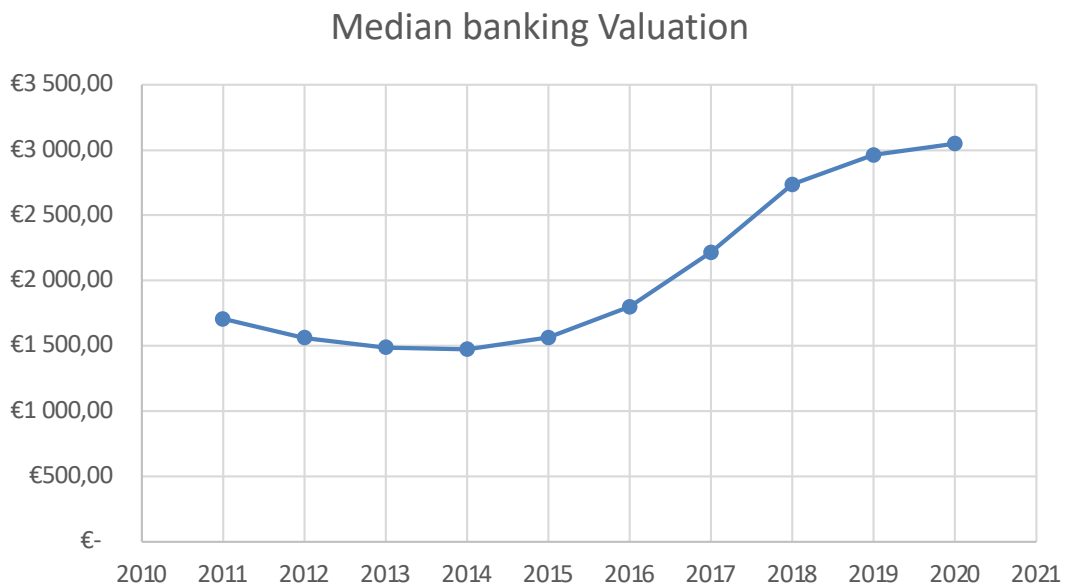
Pre-pombalinos | Pombalinos | **Gaioleiros** | "Placa" | Early RC | Modern RC | Modern RC II

> 1755

1930-1960

1985-2000

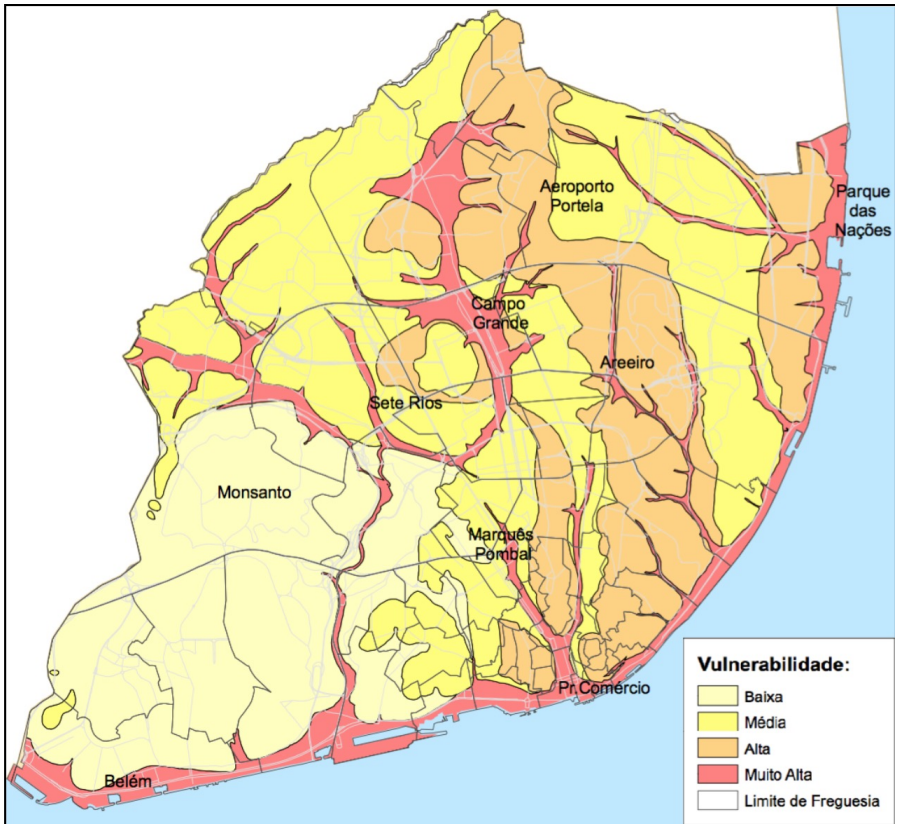
Case Study – Lisbon's Real Estate Market | Price Increase



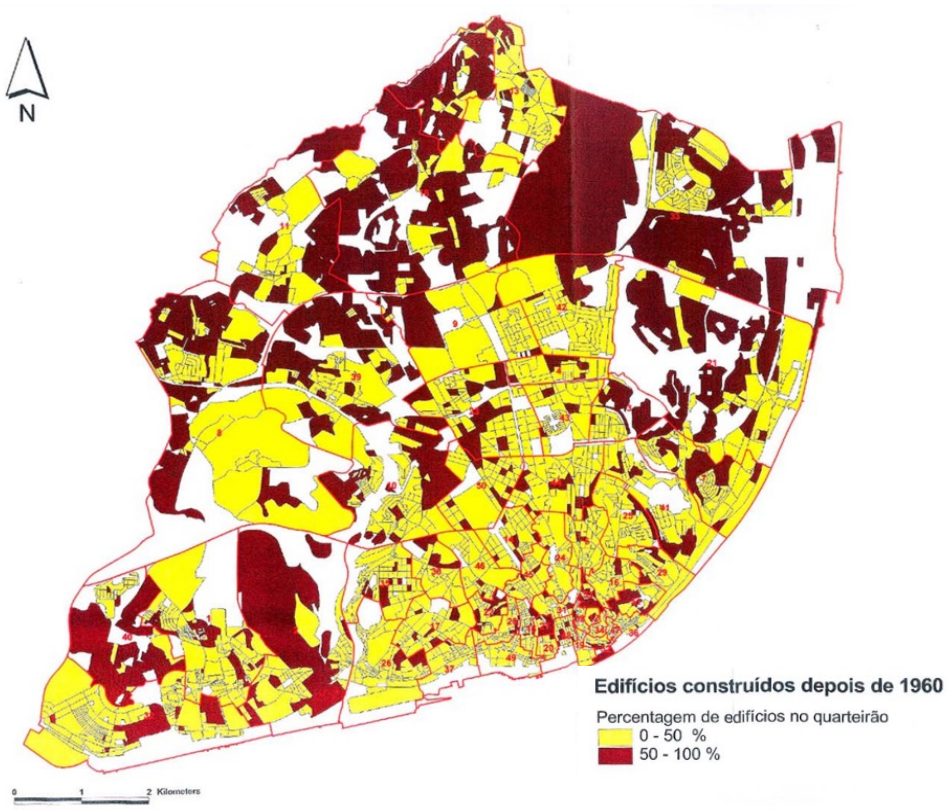
Median Banking Valuation for Lisbon County. Source: INE

As of 2018, according to the Portuguese Insurance Association, **only 16% of dwellings have an insurance coverage for earthquake risk**

Case Study – Lisbon's Real Estate Market | Vulnerability



Lisbon Seismic Vulnerability Map (CML 2008)

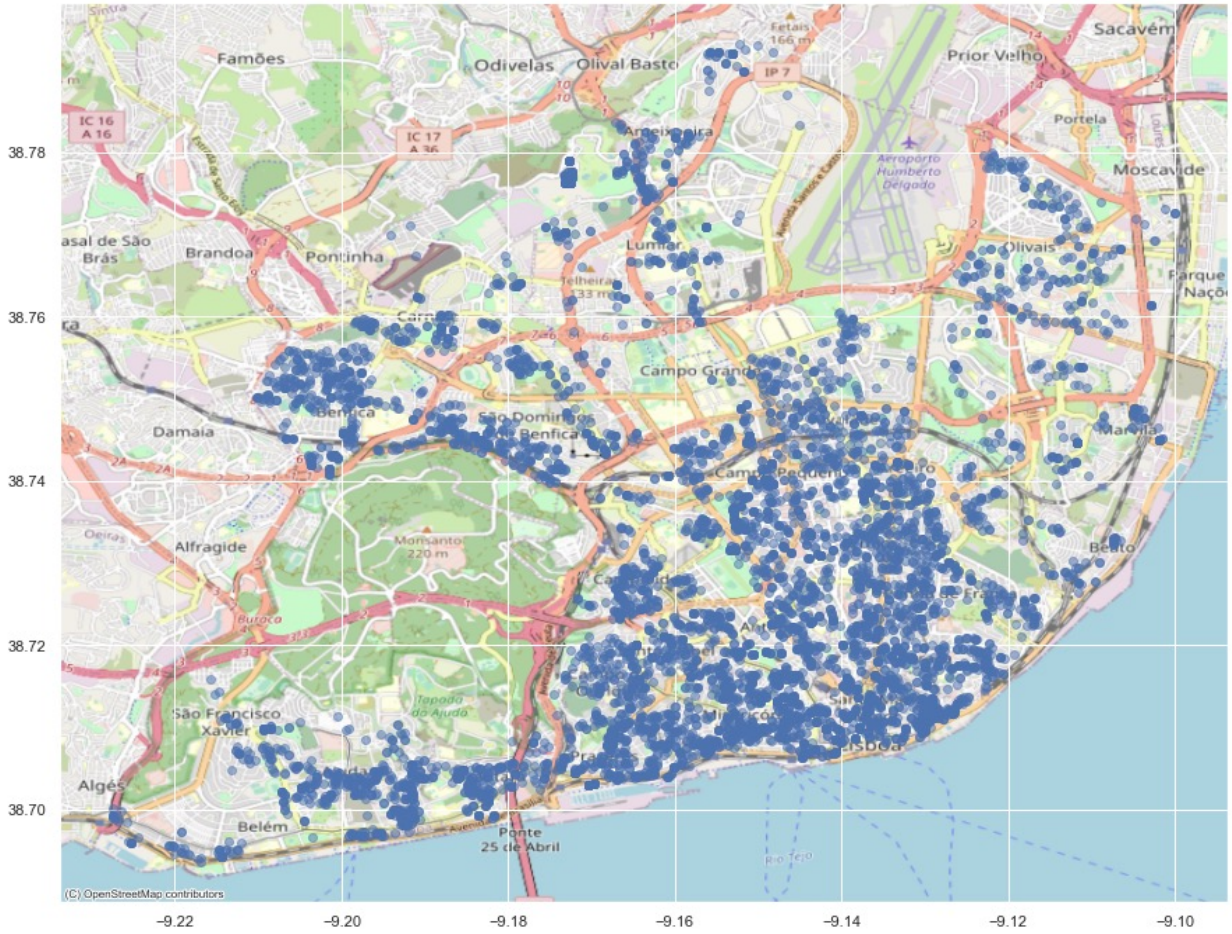


Percentage (%) of buildings (per block) built after 1960. Source: CMLisboa

↑ VALUATIONS + ↑ VULNERABILTY + ↓ AWARENESS = **HIGHER VALUE-AT-RISK** ⚠

Exploratory Data Analysis

| Overview

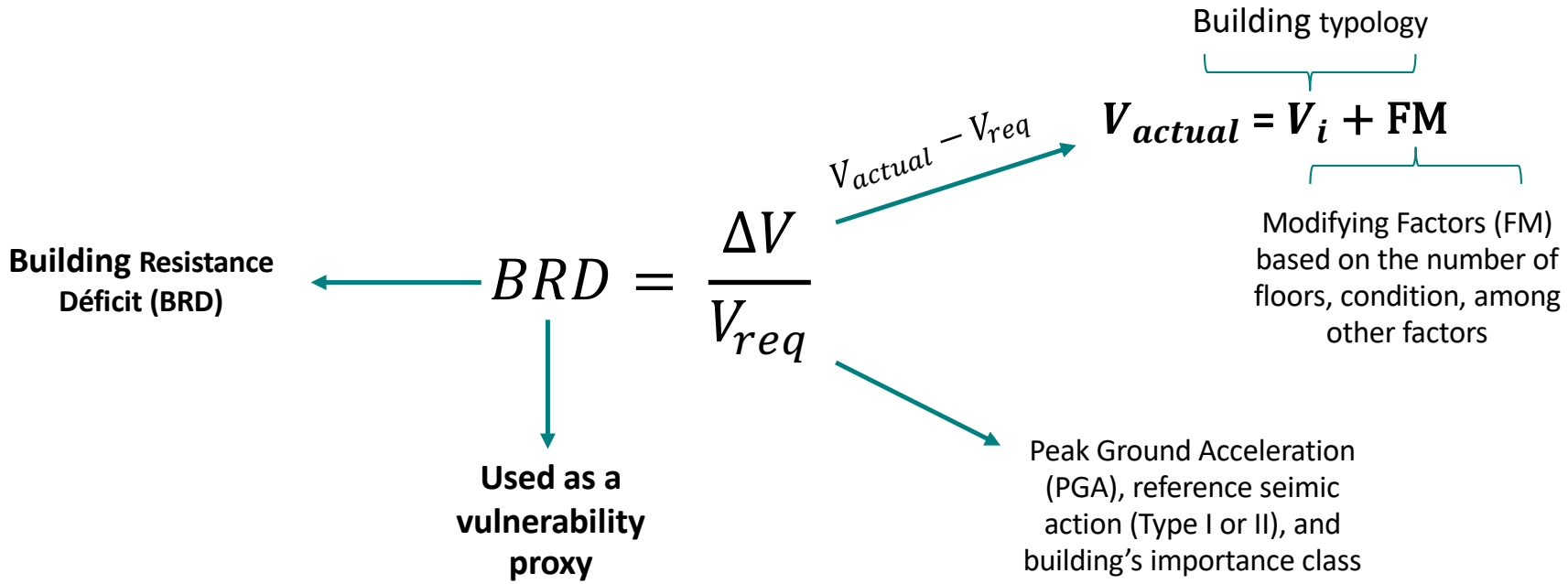


Database of more than 8.000 properties sold in Lisbon between 2008 and 2018, containing the location and several property features

During EDA, a spatial distribution of values, spatial correlation analysis (Moran-I and LISA indicators) and a Principal Component Analysis (PCA) were also conducted

Building Resistance Déficit index (BRD)

Based on existing literature, a Building Resistance Déficit index (BRD) was developed, which indicates the expected behaviour of a building for a given level of seimic activity. It compares it expected behaviour to the ideal vulnerability (requirement of no collapse) (Sá, Oliveira e Ferreira 2010; Ferreira 2012; Sá, Oliveira e Ferreira 2013).

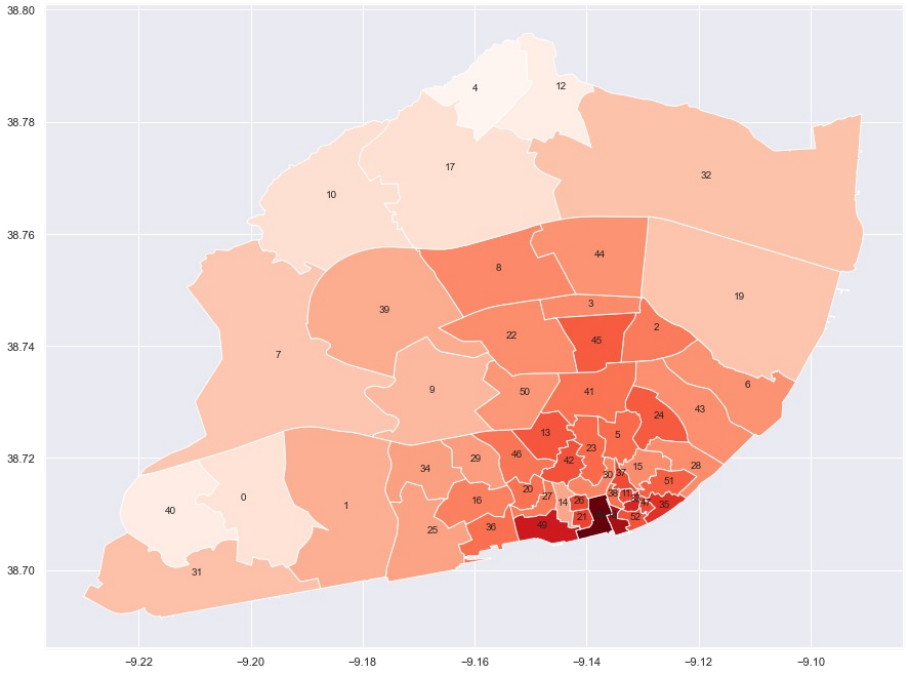


References: (Lagomarsino and Gionvinazzi 2006; Sá, Oliveira e Ferreira 2010; Ferreira 2012; Sá, Oliveira e Ferreira 2013)

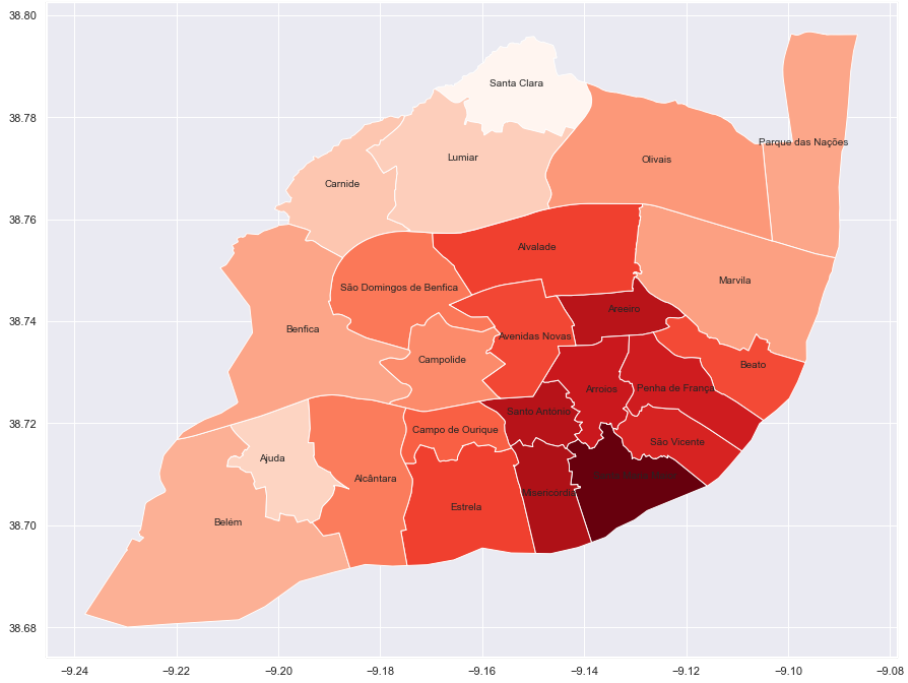
Revealed Preferences

| BRD Distribution

BRD – Old Parishes (53)



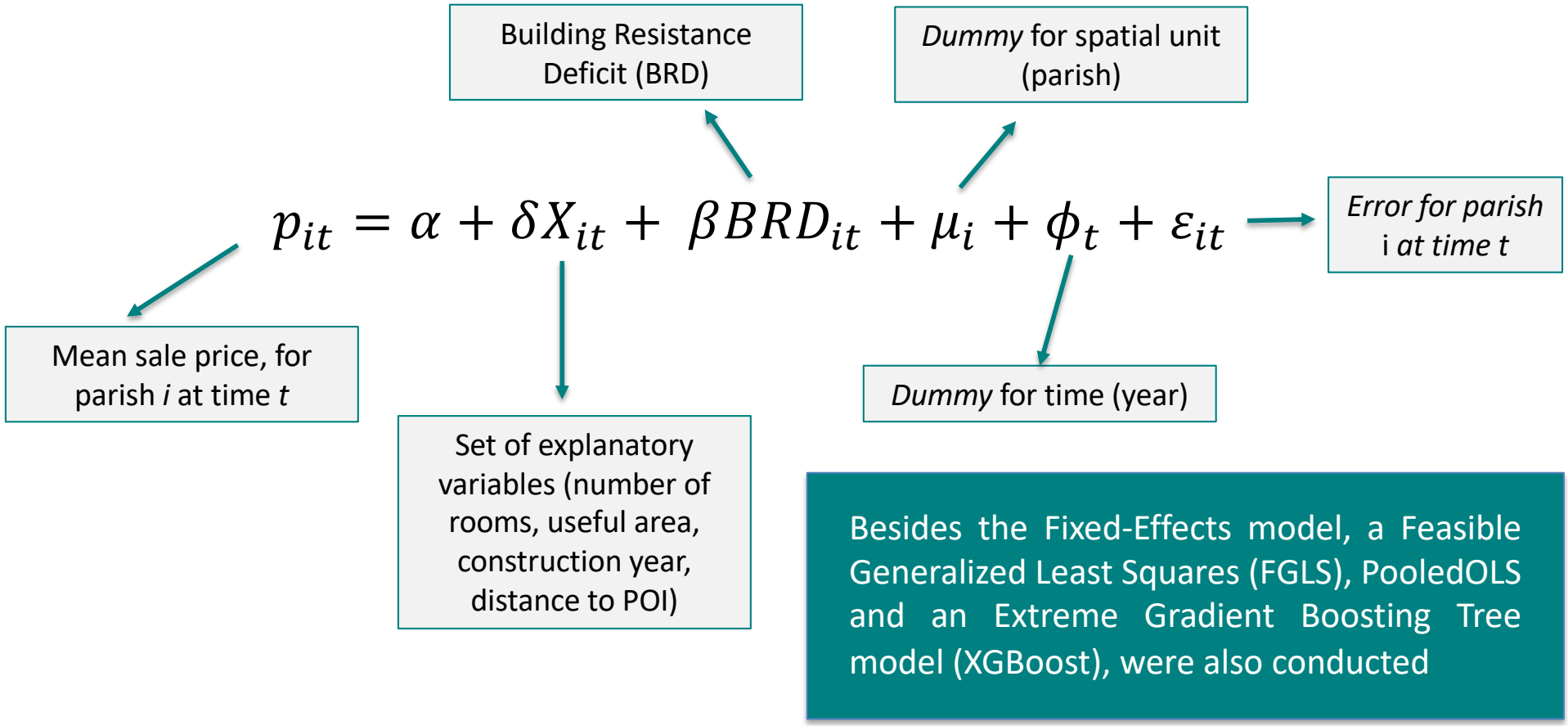
BRD – New Parishes (24)



Methodology

| Steps taken

Base Fixed-Effects Model (Space and Time)



Besides the Fixed-Effects model, a Feasible Generalized Least Squares (FGLS), PooledOLS and an Extreme Gradient Boosting Tree model (XGBoost), were also conducted

References: (Lagomarsino and Gionvinazzi 2006; Sá, Oliveira e Ferreira 2010; Ferreira 2012; Sá, Oliveira e Ferreira 2013)

Revealed Preferences

| Fixed-Effects Results

	BRD - First approach				BRD - second approach			
	Old Parishes		New Parishes		Old Parishes		New Parishes	
const	0.597***	0.519***	0.662***	0.594***	0.475***	0.403***	0.578***	0.484***
BUILDING_2	0.159***	0.155***	0.075**	0.083**	0.151***	0.153***	0.095***	0.108***
APARTMENT1	0.078**	0.076**	0.051*	0.049*	0.112***	0.112***	0.052*	0.052*
AREA	-0.001	--	-0.0001	--	-0.0005	--	9.18e-5	--
FLOOR	0.022*	--	-0.0005	--	0.020	--	-0.012	--
BRD_PROXIMO	-0.436***	-0.427***	-0.177	-0.207	-	--	--	--
BRD_PROXIMO_POND	--	--	--	--	-0.223**	-0.221**	-0.0002	0.002
BUILDING_F	--	0.014***	--	0.011***	--	0.014***	--	0.009*
Entities	53	53	23	23	52	52	23	23
Periods	11	11	11	11	11	11	11	11
R^2	18.86%	19.13%	8.49%	10.61%	20.48%	21.39%	9.54%	10.57%
Spatial Autocorrelation of Residuals	No	No	Yes	Yes	No	No	Yes	Yes

***p-value<1%; **p-value<5%; *p-value<10%

Area, construction year, floor number, number of total floors and number of rooms have been found as the most importante features to explain valuations

Stated Preferences | Overview

Online survey :
- 40 questions
- 325 respondents (ME: 5.44% and CI: 95%),
- From March 7th to April 11th

A. Demographics

- 75% Lisbon residents
- 50% are 2-to-3 person households
- 3 123€ average income
- 88% hold BSc or MSc

B. Housing

- 70% homeowners, 26% renters
- 2-to-3 bedroom apartments
- Good area and price estimation
- 64% knew construction year

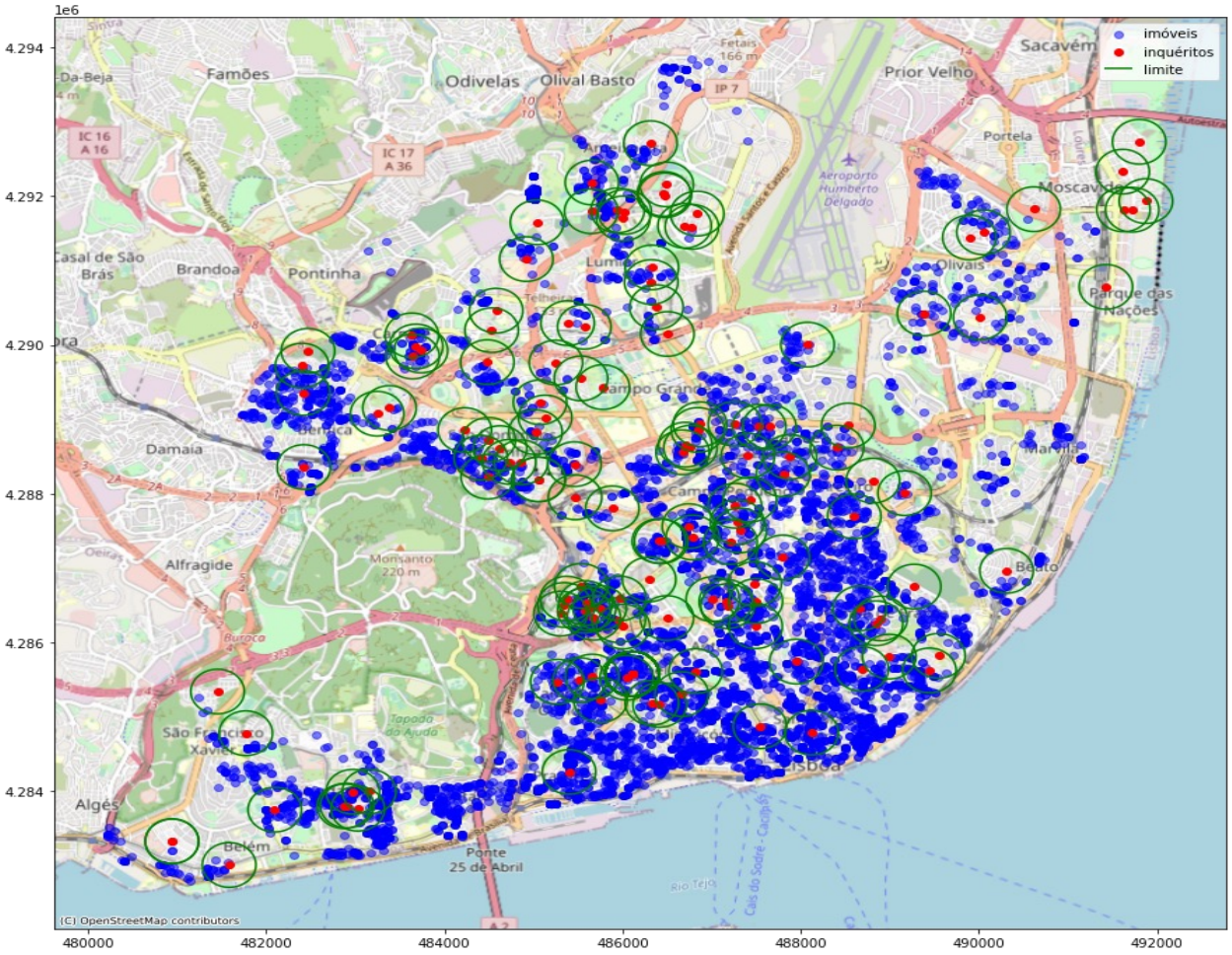
C. Perception and action towards risk

- Earthquakes, fires, home robberies
- Disbelief in public instiutions
- Lack of knowledge on buildings vulnerabiliy

D. Willingness to pay for measures

- 80% were willing to pay for a higher seismic resistance (most up to 5%)
- 73% were willing to pay for structural retroffiing (most 5%)

Joint Regression Model



| Remarks

- Perceptions statement responses used to predict average price in a 300m radius
- Neither fatalism nor the trust in the government and insurance companies has significant effect on market values.
- Demand in the market, and property prices, are mostly defined by the socioeconomic conditions of the household and not by their perception of risk

Remarks

1 **R1:** Do market values reflect a preference for properties less vulnerable to earthquakes?

Remarks

- Market does not prioritize earthquake-resistant properties.
- Show preference for newer, better buildings (that may present less vulnerability).
- Location is most important.

Policy Implications

- Municipalities must take a serious and structured approach to risk communication.
- It should be mandatory for rehabilitation projects to account for structural retrofitting.
- Buildings being built or rehabilitated in high-risk areas should be closely monitored by inspectors due to their added layer of risk.
- Municipalities should collaborate with insurance companies to define hazard maps that should be reflected in the insurance premiums and coverage policies.

Remarks

2 **R2:** How do residents and investors in Lisbon perceive risk?

Remarks

- Age, marital status, children, culture, media exposure all can affect our perception.
- Earthquakes (3.74), fires (3.64), home robberies (3.21), floods (2.55) and others (1.87).
- Slight inclination for a fatalist attitude (earthquakes). Demand action from the government but don't believe in their current ability to handle a post-earthquake.

Policy Implications

- Standardized system of seismic risk ratings or certificates.
- Media coverage should address governments investments in emergency preparedness, strengthening the government's image next to the population.
- Insurance companies should provide affordable coverage solutions and post-earthquake assistance policies.

Remarks

| RQ 3

3 R3: Does their risk perception affect their willingness to pay for property?

Remarks

- Increased vulnerability perception doesn't necessarily lead to action or WTP.
- Decrease in housing affordability has a significant impact on household's WTP.
- Direct payment to contractors with tax benefits for homeowners is prefered

Policy Implications

- Financial incentives and tax breaks should be given to property owners who voluntarily retrofit their buildings.
- Governments should partner with academia to provide specialization courses in rehabilitation and seismic resilience to private construction and design companies.

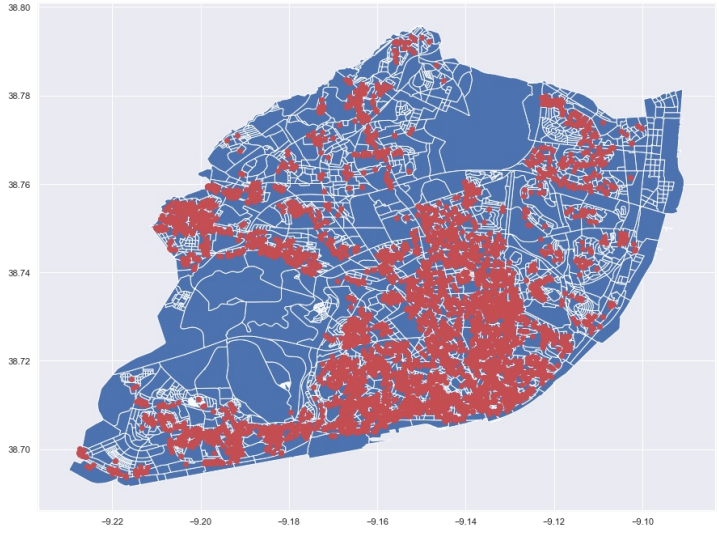
EFFECT OF EARTHQUAKE RISK ON THE REAL ESTATE MARKET

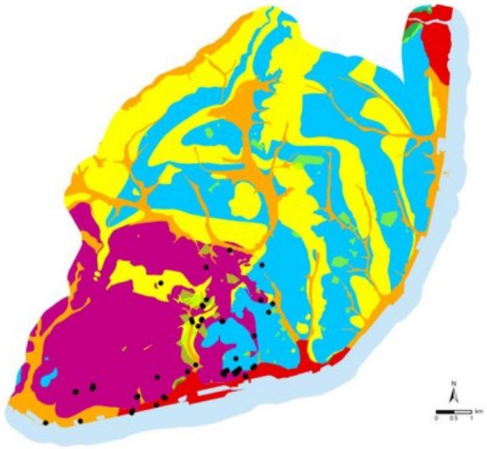
An application to Lisbon

Thank you!

Methodology

| Steps taken





(Oliveira et al. 2019)

All data georeferenced

New and Old Parishes

Crossed data with old and new (2012[1]) administrative limits

Setting #Floors

Crossed data with altimetry map, containing the number of floors (3m floor to floor)

Setting PGA

Crossed data with soil type to determine Peak Ground Acceleration (PGA)

[1]Law n.º 56/2012, 08-11

Methodology

| Steps taken

Two approaches to assess vulnerability

$$V_{actual} = V_i + \mathrm{FM}$$

Building Typology	V_{actual}
Masonry (<1945)	0,70
RC (1946-60)	0,60
RC (1961-85)	0,50
RC (1985-...)(≦ 5 floors)	0,40
RC (1985-...)(>5 floors)	0,44

(Ferreira 2012)

Drilling down vulnerabilty classes

- Epoch according to censos 2011
- Structural materials used

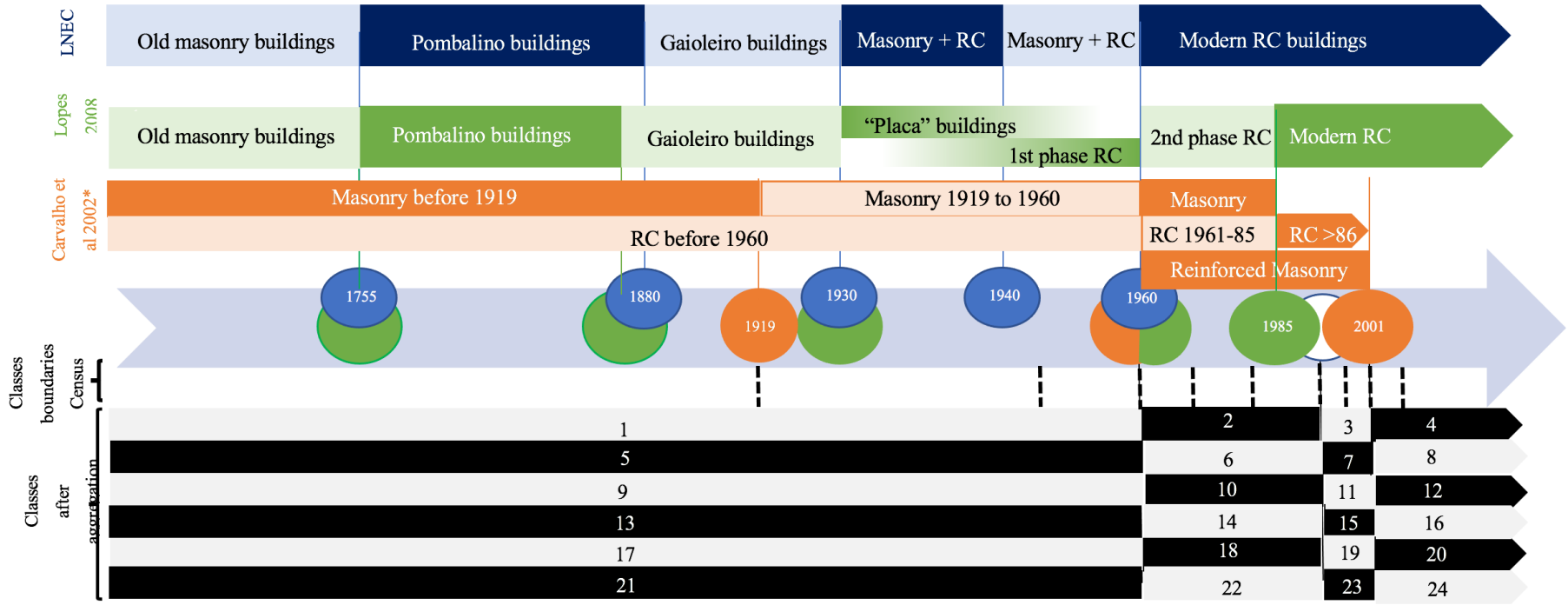
Estimated vulnerabilty class (EMS-98)

- Aggregated to 24 classes from 60
- Attributed vulnerability value

References: (Lagomarsino and Gionvinazzi 2006; Sá, Oliveira e Ferreira 2010; Ferreira 2012; Sá, Oliveira e Ferreira 2013)

Methodology

| Steps taken

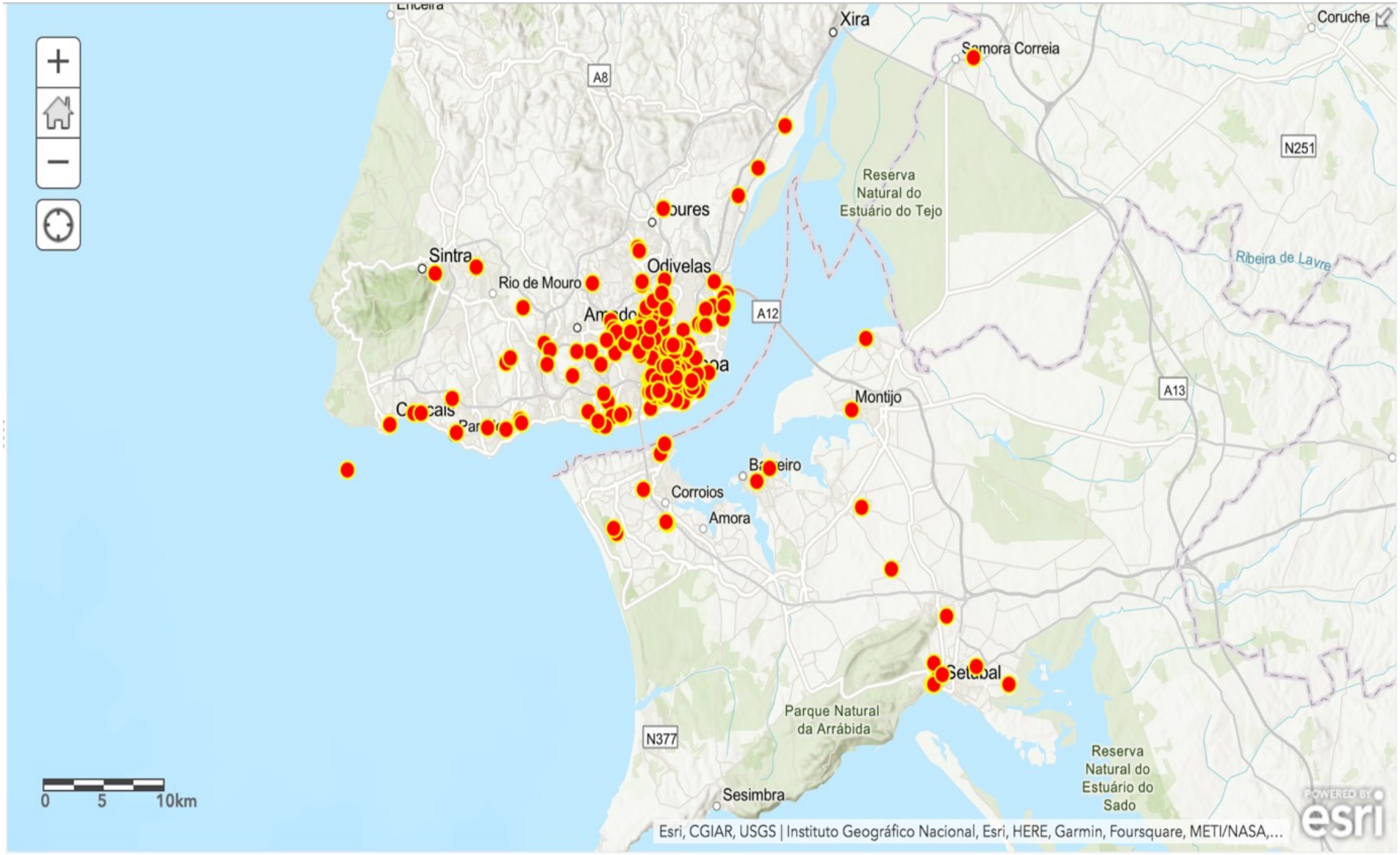


*Primary classes. Each one is subdivided into seven other subclasses

**weighted values from distance to class limits

References: (Lagomarsino and Gionvinazzi 2006; Sá, Oliveira e Ferreira 2010; Ferreira 2012; Sá, Oliveira e Ferreira 2013)

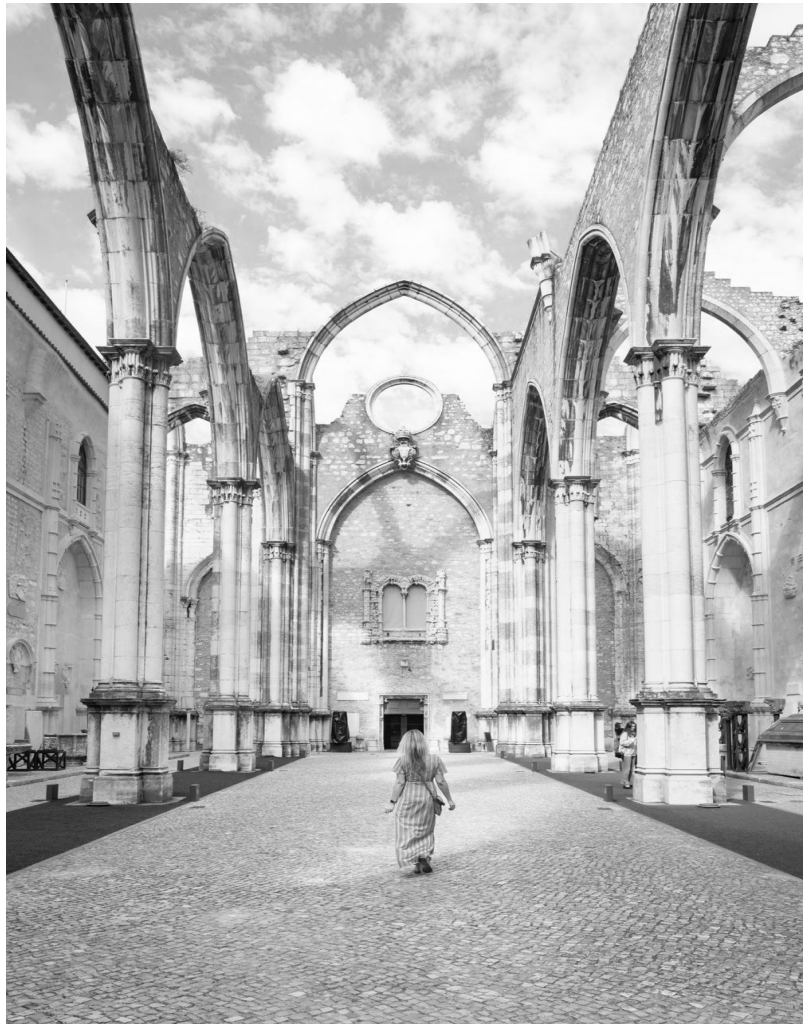
Stated Preferences | Locations



Stated Preferences

| Remarks (C)

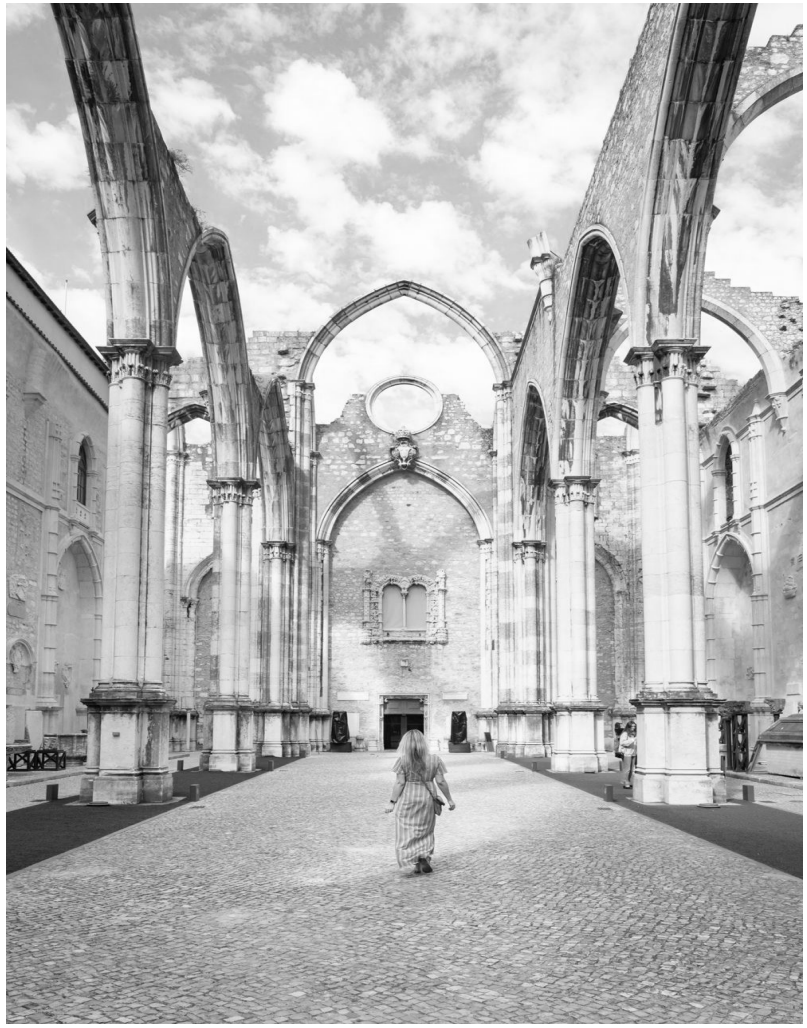
- Notably, while fatalism is not significant in home-robberies, opinions are divided regarding earthquakes, with a slight inclination for a fatalistic attitude.
- Most respondents believe that local government institutions can lessen the effects of floods and earthquakes by taking action to minimize risk.
- Disbelief in the ability of the government to take care of the response to disaster situations and a distrust of insurance institutions to cover their needs in the aftermath of an earthquake.



Stated Preferences

| Remarks (C)

- People living in older buildings tend to disagree with the statement “My building is safe against earthquakes” (especially for buildings built from 1755 to 1880 and from 1930 to 1985)
- The analysis also reveals a tendency to believe that a more expensive apartment should be less vulnerable to earthquakes
- Respondents who experienced an earthquake are not significantly more willing to buy earthquake insurance



Stated Preferences

| Remarks (D)

- 80% of respondents were willing to pay more for a more resistant building to seismic events. Of those who were not willing to pay for a more resilient property, 21% claimed they do not worry about seismic risk, 20% say their building is already safe.
- 73% would be willing to pay for structural retrofitting of their building. Married and older individuals, and those with children living at home were more willing to pay for it.
- Wealthier households are willing to pay more for retrofitting.