

Modeling of the socioeconomic consequences of an earthquake at the urban scale and responsibilities



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Abstract

In moderate-to-low seismic hazard regions, the estimation of the socio-economic consequences of an earthquake at an urban scale is a costly, difficult but essential task, since the necessary resources become insufficient for seismic evaluation. However, public authorities have the duty to take into account this risk and mitigate it according to their resources. Thus, the positioning of the acceptable level of responsibility in the implementation of the earthquake regulations and the induced economic cost is a key issue. The responsibility of the public persons but also that of insurers in their approach to prevent is at the forefront when natural disasters happen. The modification of the seismic regulation has a direct impact on the level of responsibility. In this study, the impact of prevention's policies implemented is translated in terms of decision variables thanks to the qualitative analysis of the interviews conducted with elected representatives, insurers, technicians, lawyers and first-aid workers. Consequently the decision variables selected are damages to structures, the number of deaths, injuries, homeless people to be managed, the repairing's costs for damaged buildings or their destruction / reconstruction, the impact on economic activity (business interruption) and responsibility. Thus, in this study, by analyzing the existing global earthquake data bases as well as the literature, a loss database listing all the world earthquakes between 1906 and 2018 with a magnitude greater than 4.5 has been updated and prepared showing the social losses (dead, wounded...) and economic losses (direct and indirect costs, number of buildings destroyed or damaged...), in relation with the ground motion footprint provided by USGS Shake-Map.

Definition of the decision-making variables

Method

Analysis based on national and international case law on natural risks

Survey on seismic risk in France:

- 5 target audiences (Elected officials, Technicians, Lawyers, Insurers, Rescuers);
- 3 main themes: Knowledge of seismic risk and regulation / Decision-making criteria for planning policy / Actor's responsibilities.

Conclusions

Information (Sendai Framework, 2015) : Risk culture difficult to implement.

Prevention (Barnier Law, 1995) : The state is not proactive in setting up action against the seismic risk. *CEDH req. n°54774/12, Grèce, 2012.*

Regulation (Decree n°2010-1254): Failure to implement on existing buildings and lack of control. *CEDH req. n°4975/11, Grèce, 2016 ; CEDH req. n°15245/05, Séisme d'Izmit, 1999 ; Cass., 3ème civ. 25 mai 2005, n°03-2047.*

Institutional Management (Hyogo Framework, 2005) : Disorder between levels of governance. (L'Aquila, 2009)

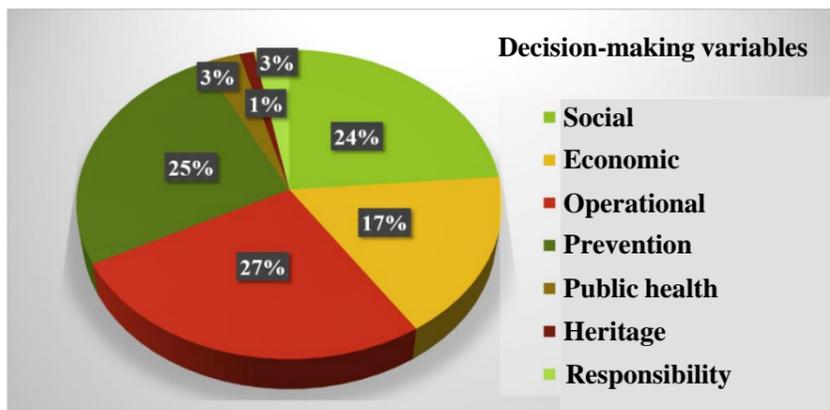
Responsibility: Existence of damage and demonstrate a causal link.
 - Linked to the knowledge of the risk and the measures implemented to contain it.

Obligation :

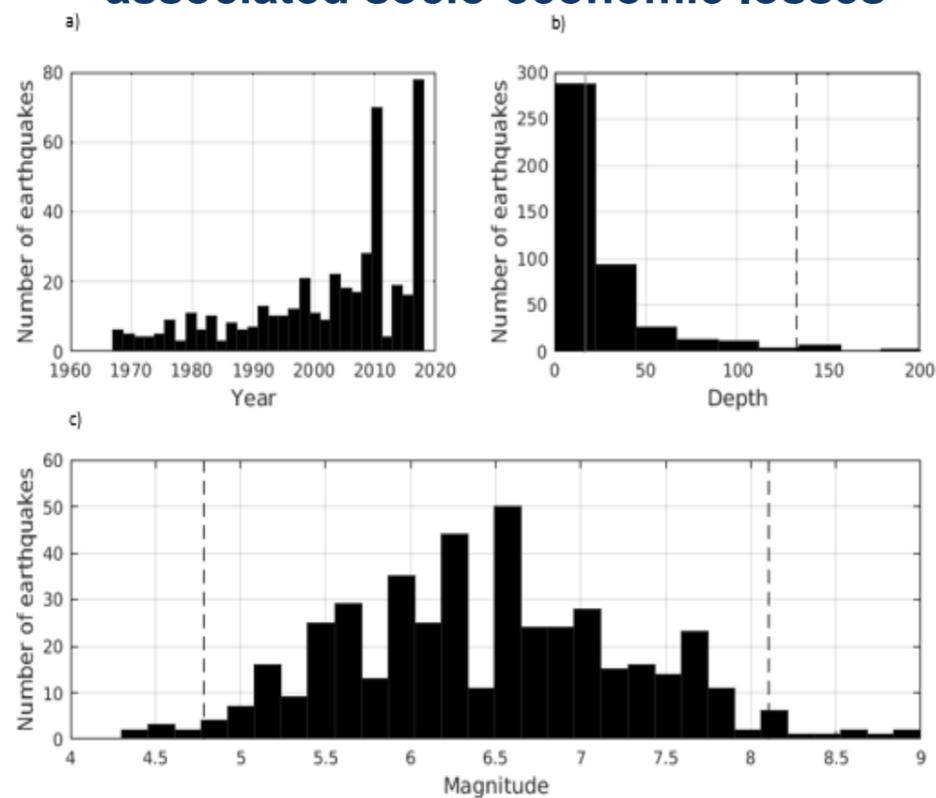
- "State's obligation to adopt appropriate measures in the face of natural risk to reduce their effects" (Art. 2 of the European Convention of Human Rights).

A seismic legal scenario in reflection:

- Need a representation of the consequences of an earthquake;
- Need to know the impact of their decisions and their responsibility.

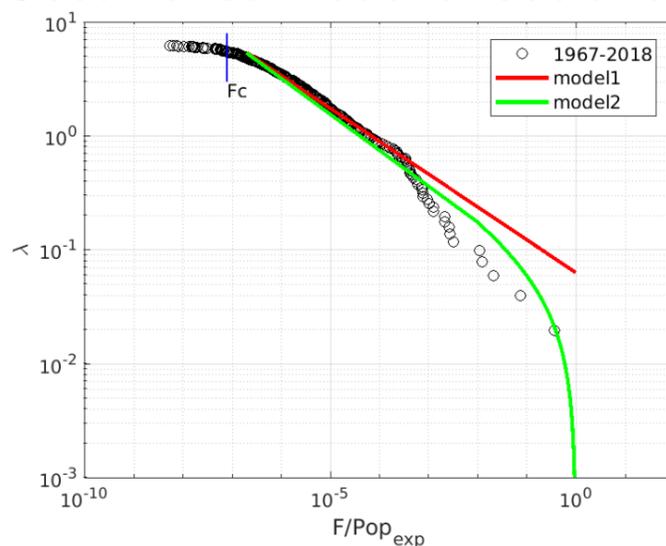


Database of global earthquakes and associated socio-economic losses

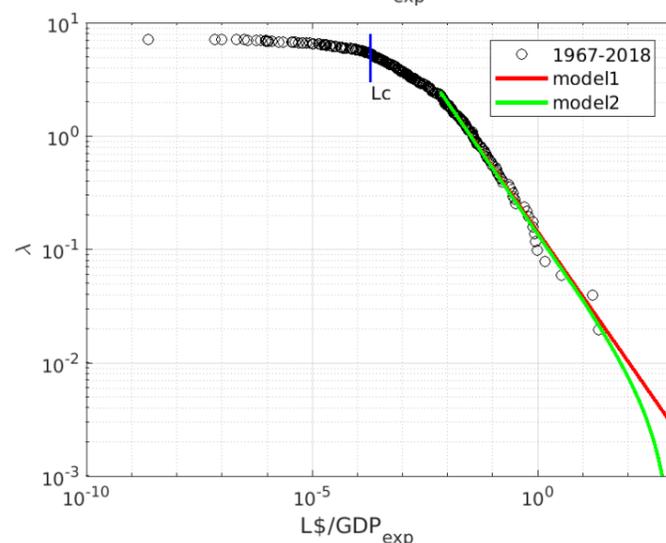


Distribution of the number of 445 seismic events of the database; (a) by year. (b) by depth, the white line represented the median depth of seismic events located at 17km. (c) by magnitude. Black dashed lines represent the 95% confidence interval.

Occurrence model of social-economic losses



The annual rate of social losses globally is **1 fatality per 10 000 exposed people.**



The annual rate of economic losses globally is **3. 10⁻² \$US 2016 scaled. by exposed GDP.**



Références

Gutenberg, B., & Richter, C. F. (1949). Seismicity of the Earth. 273 pp.
 Anderson, J. G., & Luco, J. E. (1983). Consequences of slip rate constraints on earthquake occurrence relations. *Bulletin of the Seismological Society of America*, 73(2), 471-496.
 Scotti, V. (2014). The sentence in the L'Aquila earthquake trial. *IEEE Instrumentation & Measurement Magazine*, 17(2), 41-45.

Representation of the frequency-loss distribution of seismic events. With λ the annual rate of losses according to the exposure, F the number of deaths; Pop_{exp} , the exposed population; $L\%$ the economic losses in \$US 2016 and GDP_{exp} , the exposed GDP.