

Seismic Risk Modeling Including Human Behavior

An integrated modeling approach applied to the case of Beirut, Lebanon

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Context

Seismic risk doesn't only depend on the physical elements that control it (ground shaking level and damage to the structures), it is also highly dependent on the social conditions of the affected populations. This concept is often disregarded in seismic risk assessment studies.

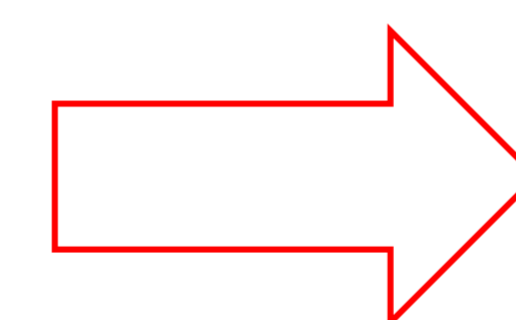
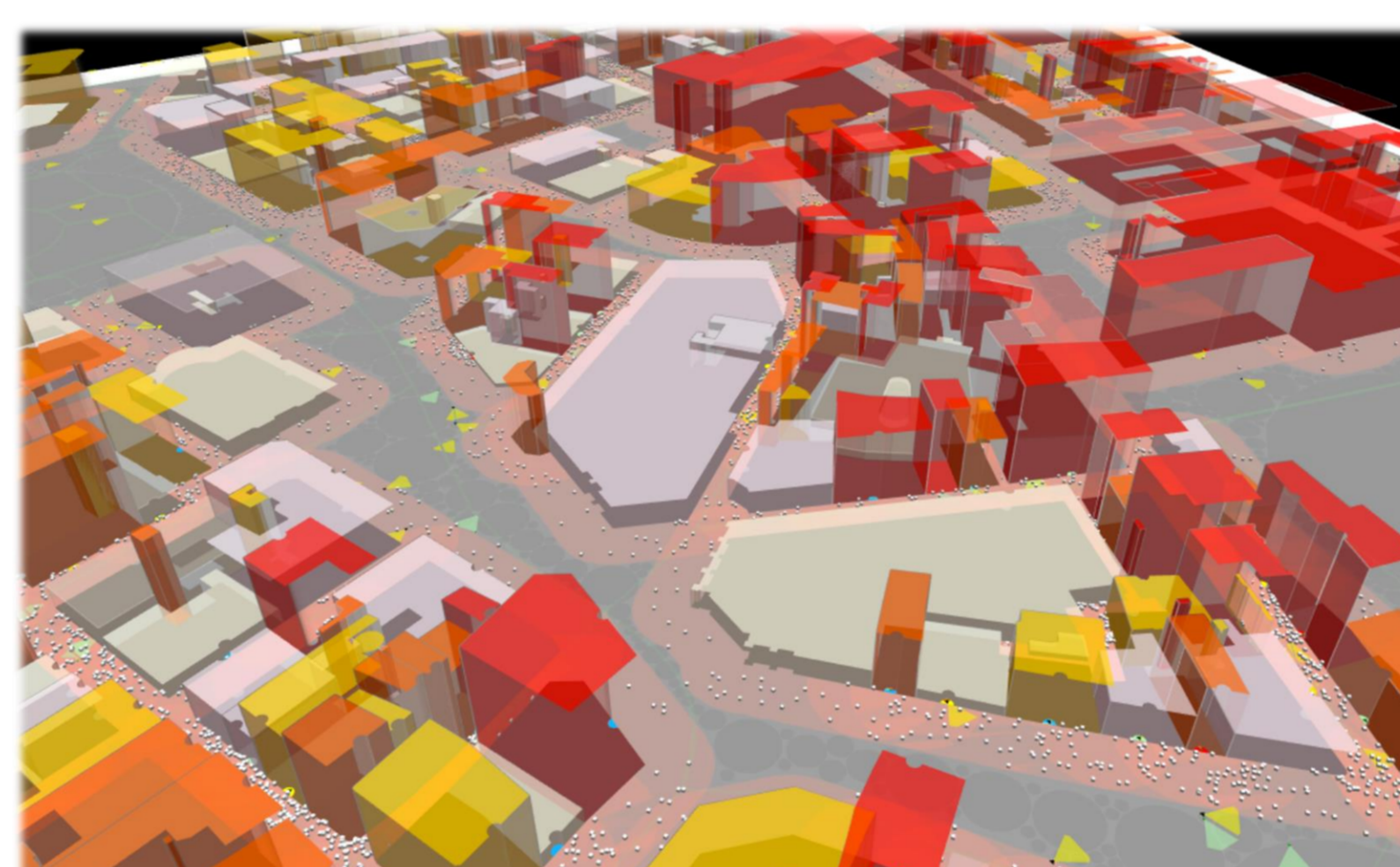
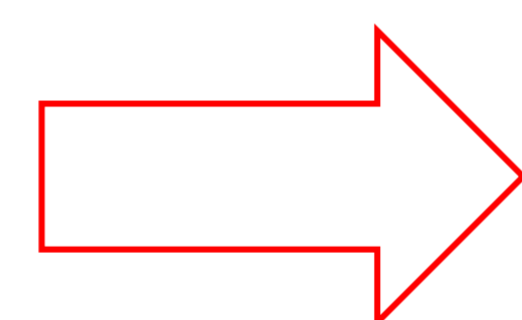
Objectives of the PhD

- Use a **multi-agent** model to model seismic risk, considering different levels of **hazard, physical** and **social vulnerabilities**.
- Include the impact of people's **perception** and **behaviors** towards risk.

Case study: Beirut, Lebanon which exhibits high levels of heterogeneity in soil and building properties, and a fuzzy perception of seismic risk at the population's level [1].



Methodology



- Use high-resolution **satellite images** to infer building properties and population distribution at urban scale.
- **Estimate** building damages for different seismic scenarios.

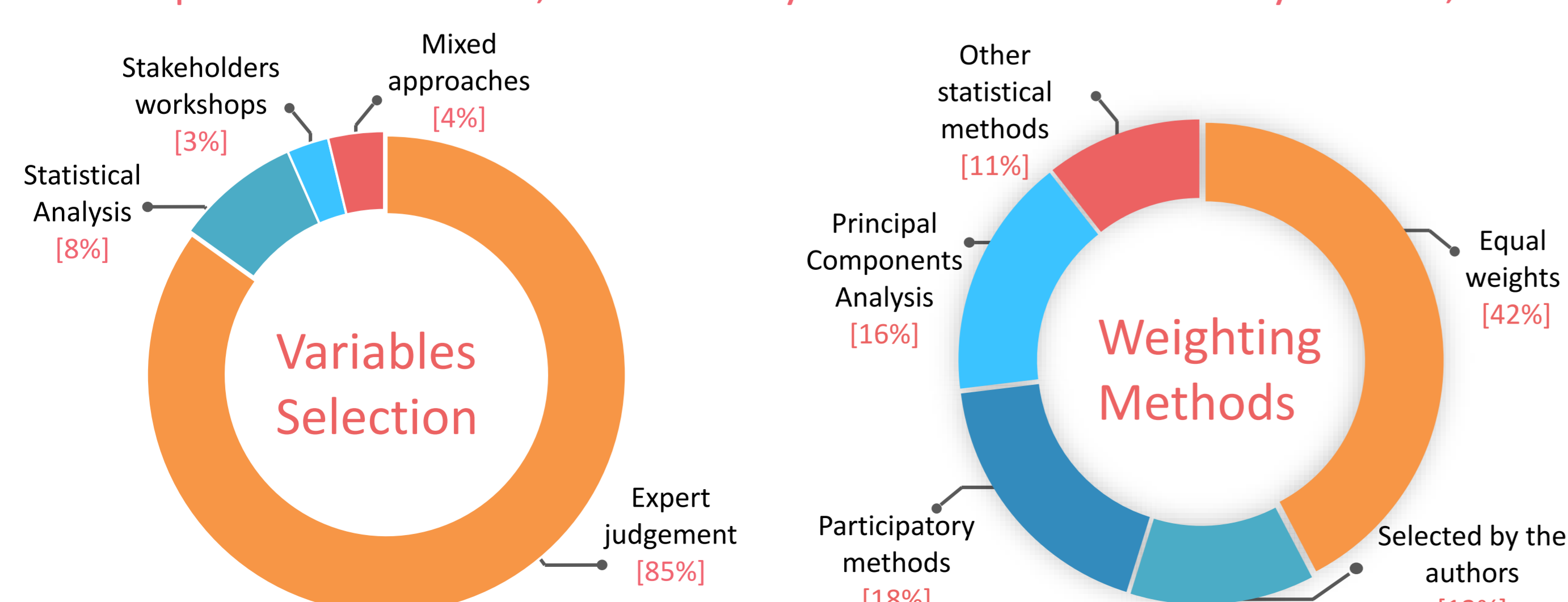
- **Adapt** the **multi-agent** simulator developed by LIG/PACTE [2] to the case of Beirut.
- **Run** simulations with varied parameters for the different scenarios.

- **Analyze** statistically the patterns observed in the different simulations.
- **Identify** and **rank** the key **vulnerability** factors and related uncertainties that control the seismic risk.

Work in Progress

- Processing satellite images to extract Beirut's buildings properties: location, dimensions, height...
- Literature review on social vulnerability and risk indices.

Comparison of 106 risk, vulnerability and resilience indices by Beccari, 2016 [3]



Expected Results - Applications

Develop a **seismic risk index** that quantitatively incorporates the social component of risk, adapted to different levels of ground shaking.

References:

- [1] Beck, E., Dugdale, J., Truong, H.V., Adam, C. and Ludvina Colbeau-Justin. (2014) Crisis mobility of pedestrians: from survey to modelling, lessons from Lebanon and Argentina. Information Systems for Crisis Response and Management in Mediterranean Countries. Lecture Notes in Business Information Processing. Volume 196, 2014, pp 57-70. Springer.
- [2] Bañgate, J., Dugdale, J., Beck, E. and Carole Adam. (2017). SOLACE a multi-agent model of human behaviour driven by social attachment during seismic crisis. International Conference on Information and Communication Technologies for Disaster Management (ICT-DM'2017).
- [3] Beccari, B., (2016). A Comparative Analysis of Disaster Risk, Vulnerability and Resilience Composite Indicators. PLoS Curr 8.