PEAK Urban

Evolving existing cities towards sustainability: assessing seismic risk

This briefing explores new methods of seismic risk assessment, which can inform better disaster risk planning.

EAFIT University

Seismic risk assessment is normally a complex and expensive process, involving physical examination of individual buildings. New methods using open access images and artificial intelligence models can help planners undertake more frequent assessments, put in place more effective mitigation and management strategies, and better protect citizens and their homes.

Urban sustainability in existing cities

Latin America and the Caribbean (LAC) is the second most urbanised region in the world, with 80% of its population living in cities.[1]

But urban population growth in the region is now declining and is expected to grow below the world average over the next decades – limiting the need for development of new urban areas.[2] Many existing cities are characterised by informal settlements, fragile, disaster-prone locations, and poorly planned development. How then can LAC cities become more sustainable?

Research and analysis by EAFIT University's Research in Spatial Economics (RISE) group explores a range of evidence and possible interventions which could evolve infrastructure and services to improve life for citizens and protect the environment in existing cities.

The 'Urban Sustainability' project is supported by the PEAK Urban Programme and informed by a research framework which seeks to predict, plan, and adopt new approaches, to address current and future urban challenges – drawing on expertise from across the disciplines and engaging with policy makers and practitioners at every stage.

This series of policy briefs captures key findings and insights for policy and practice – showing that working with what is there (even where it is not ideal), and making evidence-based interventions can transform cities.

Whilst based on research from Latin America, the briefing will also be of interest to policy makers in other parts of the world as urban redevelopment, improvement, and renovation become the most significant ways that cities change.

1 https://www.worldbank.org/en/topic/urbandevelopment/overview#1 (Accessed Jan 2022)
2 https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf (Accessed Jan 2022)

The challenge

SDG 11: Make cities and human settlements inclusive, safe, resilient, and sustainable. SDG 11.5: Reducing the impact of disasters, with a focus on protecting the poor and people in vulnerable situations.

Colombia, and indeed the whole of Latin America, experiences frequent earthquakes. Assessing the likely risk of seismic events, and their expected impact on buildings and infrastructure, is vital in designing effective disaster risk mitigation and management policies.

Seismic risk is calculated by looking at three factors. **Hazard** – the severity and frequency of quakes. **Exposure** – the nature of the building stock (materials, design, etc) as well as population location and density. And **vulnerability** – the ability of buildings to sustain the impact of earthquakes.

Whilst the severity and frequency of earthquakes in places such as Japan is high in comparison to Latin America, the **impact** of seismic events in the region is much greater because of the **exposure** of the building stock, much of which is not built to withstand movement.

Although Colombia, has required buildings to be quake resistant since 1984, many buildings were constructed before this and so do not meet these standards. The movement of displaced people into the city in recent decades has also resulted in the development of many low-income, informal settlements which again don't comply with the building code.

Assessing seismic exposure is normally a slow and difficult process which requires engineers to observe and analyse individual buildings in person. This makes assessment expensive and discourages authorities from frequently updating their assessments and plans.

Research and findings

Initially, researchers quantified the exposure of buildings in Medellin by individually assessing more than 10,000 open access images from Google Street View. Later they used artificial intelligence to automatically classify the exposure of the buildings in a fraction of the time.

Research finding 1: Artificial intelligence can identify buildings at risk. Using artificial intelligence to analyse open access images is around 95% accurate in identifying the 'nonductile' buildings most likely to be damaged in an earthquake.

Research finding 2: The model is highly transferable. The model, developed to analyse buildings in Medellin, can be applied to other contexts, with similar building stock and conditions.

"There are already well-used models for assessing the 'hazard' and 'vulnerability' elements of seismic risk but, to the best of our knowledge, this was the first approach to evaluate 'exposure' by analysing publicly available data with artificial intelligence."

Juan Carlos Duque, Director of the RISE research group, EAFIT University

Implications for policy and practice

Policy implication 1: Using open access images and artificial intelligence makes 'exposure' risk assessment rapid and easy.

Planners wanting to use artificial intelligence in risk assessment, should contact Juan Carlos Duque and the RISE team at EAFIT University to discuss their needs (see below).

"When we were looking at images 'by hand' we could identify how buildings were designed, what materials were used, and whether they were likely to withstand an earthquake – but it was painstaking and slow work. Using artificial intelligence makes it fast and it's easy to transfer to other contexts."

Ana Acevedo, Professor of Civil Engineering Department, EAFIT University

Policy implication 2: This will allow more frequent risk assessments, leading to better disaster planning and response.

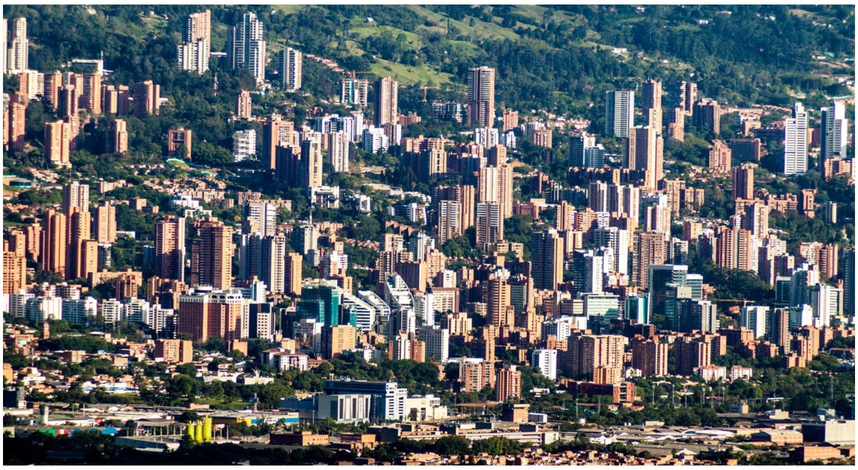
Building stock in urban areas changes constantly, as new buildings are erected – often in marginal areas, as part of informal settlements, and using non-optimal building materials and designs. Being able to conduct rapid, cost-effective risk assessment for 'exposure' means that authorities can run assessments more frequently, developing a more accurate picture of the changing risk over time and modifying their disaster planning accordingly.

Support from the RISE group

Planners and policy makers interested in support for exposure risk assessment should contact Juan Carlos Duque and the RISE group at EAFIT University. Contact **juanca.duque@eafit.edu.co**

Policy engagement and impact:

Findings from the models have been shared with policy and practice stakeholders, including the World Bank and UN Habitat. The RISE group is now developing a proposal for public risk management bodies, looking at how the model could support their ongoing risk assessment and resilience work.



Further information

• Gonzalez, D., Rueda-Plata, D., Acevedo, A. B., Duque, J. C., Ramos-Pollan, R., Betancourt, A., & Garcia, S. (2020). Automatic detection of building typology using deep learning methods on street level images. Building and Environment, 177, 106805. **https://doi.org/10.1016/j.buildenv.2020.106805**

• Rueda-Plata, D., González, D., Acevedo, A. B., Duque, J. C., & Ramos-Pollán, R. (2021). Use of deep learning models in street-level images to classify one-story unreinforced masonry buildings based on roof diaphragms. Building and Environment, 189, 107517. **https://doi.org/10.1016/j.buildenv.2020.107517**

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About us

The PEAK Urban programme aims to aid decision-making on urban futures by:

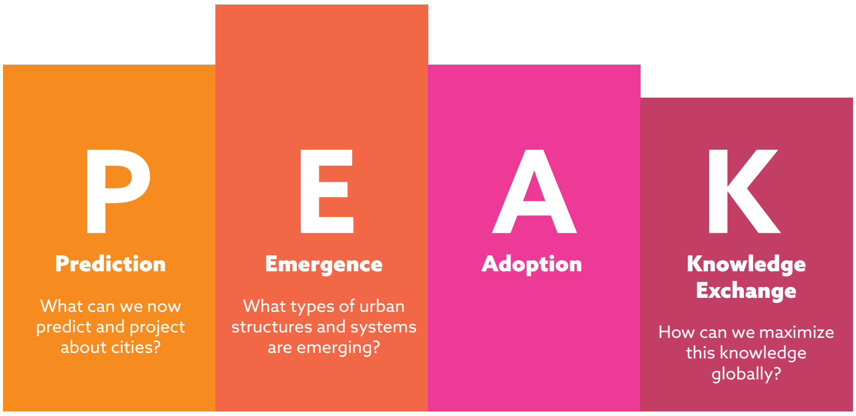
1. Generating new research grounded in the logic of urban complexity;

2. Fostering the next generation of leaders that draw on different perspectives and backgrounds to address the greatest urban challenges of the 21st century;

3. Growing the capacity of cities to understand and plan their own futures;

In PEAK Urban, cities are recognized as complex, evolving systems that are characterised by their propensity for innovation and change. Big data and mathematical models will be combined with insights from the social sciences and humanities to analyze three key arenas of metropolitan intervention: city morphologies (built forms and infrastructures) & resilience; city flux (mobility and dynamics) and technological change; as well as health and wellbeing.

Our framework



The PEAK Urban programme uses a framework with four inter-related components to guide its work.

First, the sciences of **Prediction** are employed to understand how cities evolve using data from often unconventional sources.

Second, **Emergence** captures the essence of the outcome from the confluence of dynamics, peoples, interests, and tools that characterize cities, which lead to change.

Third, **Adoption** signals to the choices made by states, citizens and companies, given the specificities of their places, its resources and the interplay of urban dynamics resulting in changing local power and influence dynamics.

Finally, the **Knowledge** component accounts for the way in which knowledge is exchanged or shared and how it shapes the future of the city.

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