

ReSist - A municipal policy to increase awareness on seismic risk

ReSist - Une politique municipale pour accroître la sensibilisation au risque sismique

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ABSTRACT: Lisbon has a dense urban occupation with more than half a million inhabitants, not accounting for the daily commutes of workers and students who enter the municipality, which increases this value up to 70%. Since most of the national economic and political decision-making centres are in Lisbon, the emergency response could be constrained in case of a high-impact event. The risk factor is further aggravated due to an old building stock. Considering this context, a municipal program was implemented to assess and promote seismic resilience. Within the scope of the ReSist framework, the City Council intends to carry out assessment campaigns aiming at achieving seismic resistance of the city's buildings and infrastructures. Implementing these targeted actions can accelerate the achievement of the United Nations 2030 Agenda for Sustainable Development, particularly the goal nr. 11 - to make cities and communities inclusive, safe, resilient, and sustainable, while improving people's well-being. Several studies and risk mitigation activities are being conducted by several action plans in different sectors, bringing together stakeholders from academic and research institutions, national administration entities, professional orders and associations, real estate, consultancy and insurance companies, and citizens. Dissemination strategies and workshops were also promoted, to raise awareness and prepare civil society for a seismic event.

RÉSUMÉ: Lisbonne présente une occupation urbaine dense, avec une population de plus d'un demi-million d'habitants, sans compter les déplacements quotidiens des travailleurs et des étudiants qui entrent dans la municipalité, augmentant ainsi cette valeur jusqu'à 70%. La plupart des centres de décision économique et politique nationaux se trouvent à Lisbonne. En cas d'événement à fort impact, la réponse d'urgence pourrait être entravée. Ce risque est exacerbé par un parc immobilier vieillissant. Dans ce contexte, un programme municipal a été lancé pour évaluer et promouvoir la résilience sismique. Dans le cadre du projet ReSist, le conseil municipal prévoit une évaluation rapide de la résistance sismique des bâtiments et infrastructures de la ville. La mise en œuvre de ces actions peut accélérer l'atteinte des objectifs de l'Agenda 2030 des Nations Unies pour le développement durable, en particulier l'objectif 11 de rendre les villes et les communautés inclusives, sûres, résilientes et durables, tout en améliorant le bien-être des habitants. Plusieurs études et mesures d'atténuation des risques sont menées dans le cadre de plans d'action et de formations impliquant divers secteurs, réunissant des acteurs issus d'établissements académiques, d'entités administratives centrales, d'ordres et d'associations professionnelles, d'entreprises immobilières, de cabinets de conseil et d'assurances, ainsi que des citoyens. Des stratégies de diffusion et des ateliers visant à sensibiliser et à préparer la société civile à un événement sismique ont également été promus.

Keywords: ReSist program; seismic resilience; retrofitting; inter-municipal communities.

1 INTRODUCTION

Lisbon's high exposure to active seismogenic sources, combined with the high population density in an urban context and the services located here, make the city extremely vulnerable to the impacts of earthquakes, also leading to a very high-risk factor.

It is recognized that the intense rehabilitation of buildings recorded over the past decade has improved the general conservation state of the city's buildings. Nonetheless, these might not have considered the necessity to maintain or reinforce the structure's resistance to damage during a near-future seismic event. Furthermore, according to the most recent

census data (INE, 2021), 60% of existing houses were built prior to seismic-resistant regulations, which coincidentally are in the most populated areas. In 1958, Portugal introduced its first design codes that explicitly included seismic provisions (RSCCS, 1958).

The context presented above led to the necessity of defining and applying a local strategy leading to the creation of the ReSist Program, a municipal program aiming at the promotion of seismic resilience to the private and municipal buildings and municipal urban infrastructures.

2 FRAMEWORK

The ReSist Program stems from the need to respond to the various programs and strategies of the city as part of a broader effort to promote Lisbon's seismic resilience.

Given the importance of the subjects approached by the program, in June of 2021 the Lisbon City Council unanimously approved it and set up a Project Team with the mission of implementing and monitoring the execution of the municipal program. In addition to the permanent members, the team has the support of the Advisory Structure (AS), the Technical-Scientific Council (TSC), and an Inter-municipal Technical Structure (ITS). The AS is composed by municipal technicians representing different services, while the TSC is composed by external entities or individuals with expertise in this domain, whose function will be the guidance and optimisation of the actions to be developed. The most recent addition to the project team was the establishment of the ITS (which is ongoing), aims to share knowledge and good practices between other municipalities through the intermunicipal communities.

2.1 ReSist Project main goals

The project is based in specific main goals materializes in 47 actions to be implemented, which will be presented generically throughout this article:

- Methodology development to define the criteria and tools to support preventive inspection and seismic vulnerability assessment to private and public buildings;
- Tools to support the prior control of urban planning operations and the subsequent execution of successive inspection actions;
- Submission of proposals for incentives or support, particularly at a technical level, to encourages owners to promote technical inspection in order to identify vulnerabilities and, therefore, adopt measures to buildings structural reinforcement;

- Development of information platform for monitoring purposes and to inform citizens;
- Development of methodologies and support tools that allow the assessment of the seismic vulnerability of the city's infrastructures (road network, artworks and sewage);

2.2 ReSist base vectors

These ReSist actions will be developed according to three base vectors (Figure 1).

2.2.1 Knowledge and modelling infrastructure

This vector frames the actions regarding acquisition, compilation, and data processing to define the most vulnerable areas in the city. A seismic resistance index of the private and public buildings and infrastructures will be proposed, as well as the definition of models and actions to enable the adoption of mitigation, prevention, and adaptation measures.

2.2.2 Society engagement

This vector comprises actions regarding the creation of municipal incentive programs aimed at involving private owners to provide technical or financial support in the inspection and reinforcement of the structural safety of private buildings.

Communication strategies and actions for the involvement of society are also included, as well as the participation in research and development projects.

The establishment of external partnerships will help guide the actions to be materialized.

2.2.3 Regulation and supervision

This vector integrates actions regarding the update of municipal regulations and territorial management instruments, procedure optimization, project quality evaluation, and the definition of standards that will regulate municipal inspection actions.

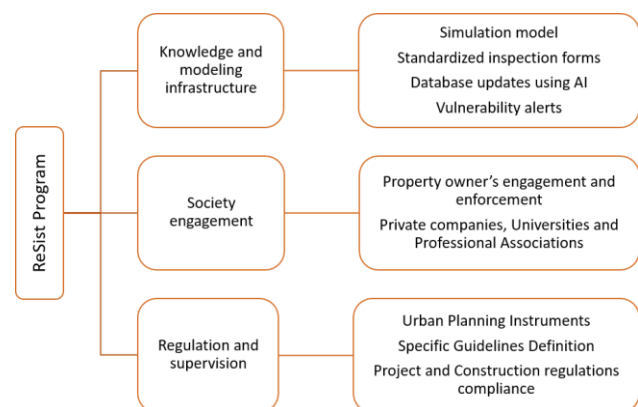


Figure 1. Base vectors of the ReSist Program.

3 RESULTS AND DEVELOPMENTS IN PROGRESS

3.1 Knowledge and modeling infrastructure

3.1.1 Development of seismic vulnerability assessment methodologies

The prompt assessment of the seismic vulnerability of the building stock was conducted by Instituto Superior Técnico (IST) and led to the production of a macroscale risk map for identify the most vulnerable areas and the early damage assessment. It also allowed the development of a methodology for assessing the seismic resistance of single buildings on a microscale approach. This methodology includes a visual

inspection of the buildings to determine its typology, structural irregularities, and state of conservation. Posterior work will involve an information update about retrofitted buildings. The municipal building inspection program was conducted along 100 inspections realized in residential and equipment buildings, in close collaboration with Gebalis, an entity that manages municipal neighbourhoods. The sample selection considered the different architectural and structural typologies, intending to replicate the results obtained in the buildings evaluated by those with identical construction characteristics. (Figure 2). Using this methodology we were able to asses around 1600 buildings.

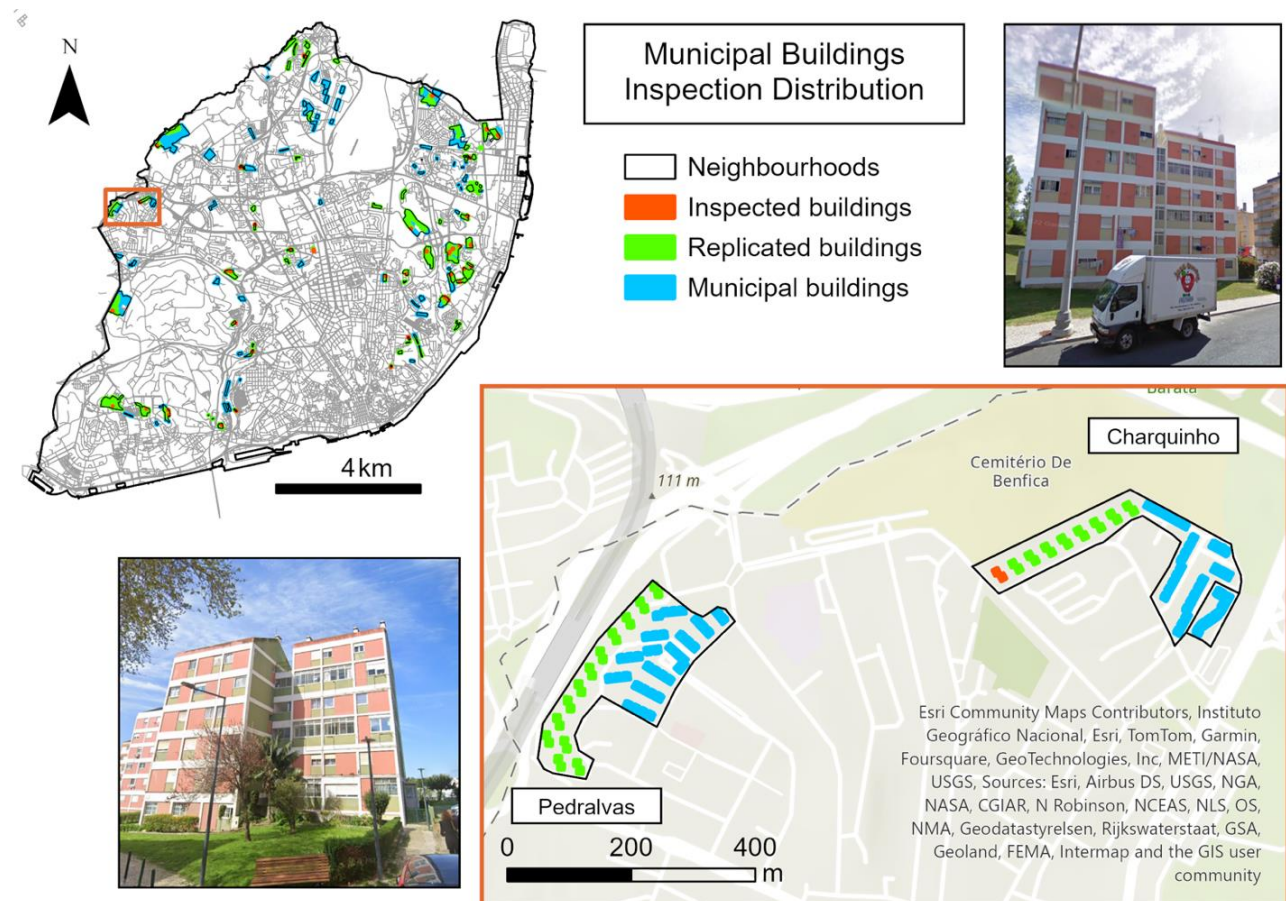


Figure 2. Map of Lisbon with distribution of municipal neighbourhoods. Example of building replication based on construction characteristics, in the Pedralvas neighbourhood based on an inspection made in the Charquinho neighbourhood.

The production and map updating, namely the geotechnical map of Lisbon and the natural and anthropic risks map available in Lisbon Master Plan, respectively, are taking place in parallel with other work, such as identifying complementary sources of information to supplement the gaps in the databases.

Other actions include a soil liquefaction and cyclic mobility study in partnership with the National Laboratory of Civil Engineering (LNEC), and the development of an application for managing inspection processes.

3.1.2 Development of a data management application

The development of a mobile application can standardize inspection surveys by allowing field technicians to do them based on observation. On the

other hand, the LxReSist website will allow citizens to get relevant information about where they live according to the inputs they provide (Figure 3).

Process digitalization and incorporation into databases facilitates access to archived information.

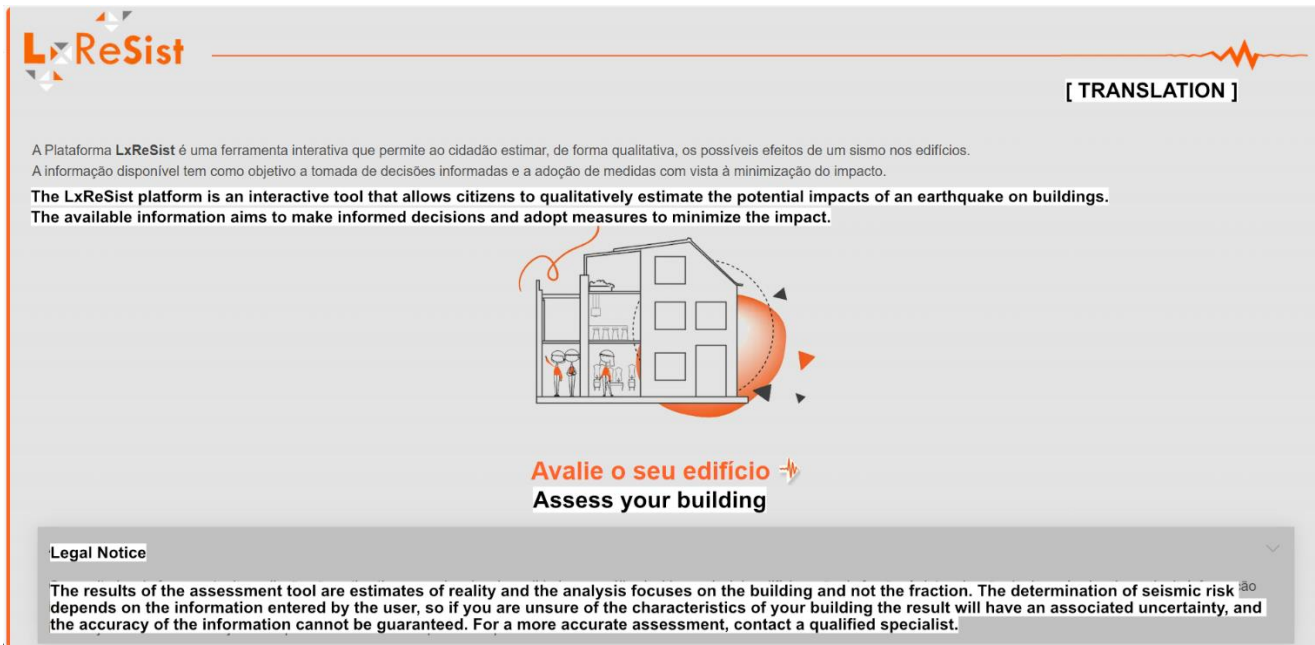


Figure 3. LxReSist platform front page.

3.2 Society engagement

Since its first public presentation in March 2022, the project team attended several events. The ReSist Journeys were developed and divided into three cycles: an Explanatory Cycle, a Capacitation Cycle, and a Training Cycle, with a total of 1183 participants. The explanatory and capacitation cycles reached diverse target audiences, while the training cycle was aimed at engineers, architects, designers and technicians in the inspection area. At the same time, some actions were carried out in schools, reaching a total of 2461 students (Figure 4), and others where 200 teachers participated.

Dissemination actions directed to the general population allowed the acquisition of skills that will lead to more efficient reactions when confronted with an earthquake, and these should be held periodically to sustain their desired effect. Concerning technical personnel, raising awareness of good practices will lead to the definition of better projects and safer buildings, with the help of methodology guides in development. Still within the scope of sharing good practices, the involvement of other municipalities located in the regions north to east of Lisbon and south of the Tagus basin is of great significance for everyone involved.



Figure 4. Actions developed in schools.

Communication strategies involved the production of several materials such as emergency kits for the students, roll-ups, flyers, as well as short and informative videos. Other dissemination and training actions are being developed, and the “Do it yourself” initiative is under expansion to raise public awareness (Figure 5).

As part of the intervention programs, the feasibility of installing gas seismic valves in new constructions is under review in partnership with the Gas Technological Institute (ITG) and General Direction of Energy and Geology (DGEG).



Figure 5. Flyer developed as part of the "Do it yourself" program. Adaptation of the original Portuguese flyer to show the icons designed and the main titles.

3.3 Regulation and supervision

In the context of standard development, a proposal for the structure and content to be included in the seismic vulnerability assessment report (RAVS) was prepared, and a procedural flow was developed to support urban

management. In April 2023, the delivery of the RAVS (Figure 6) was introduced during the approval phase of the Architectural Project to ensure that structural safety is considered at an early stage of the urban licensing process.

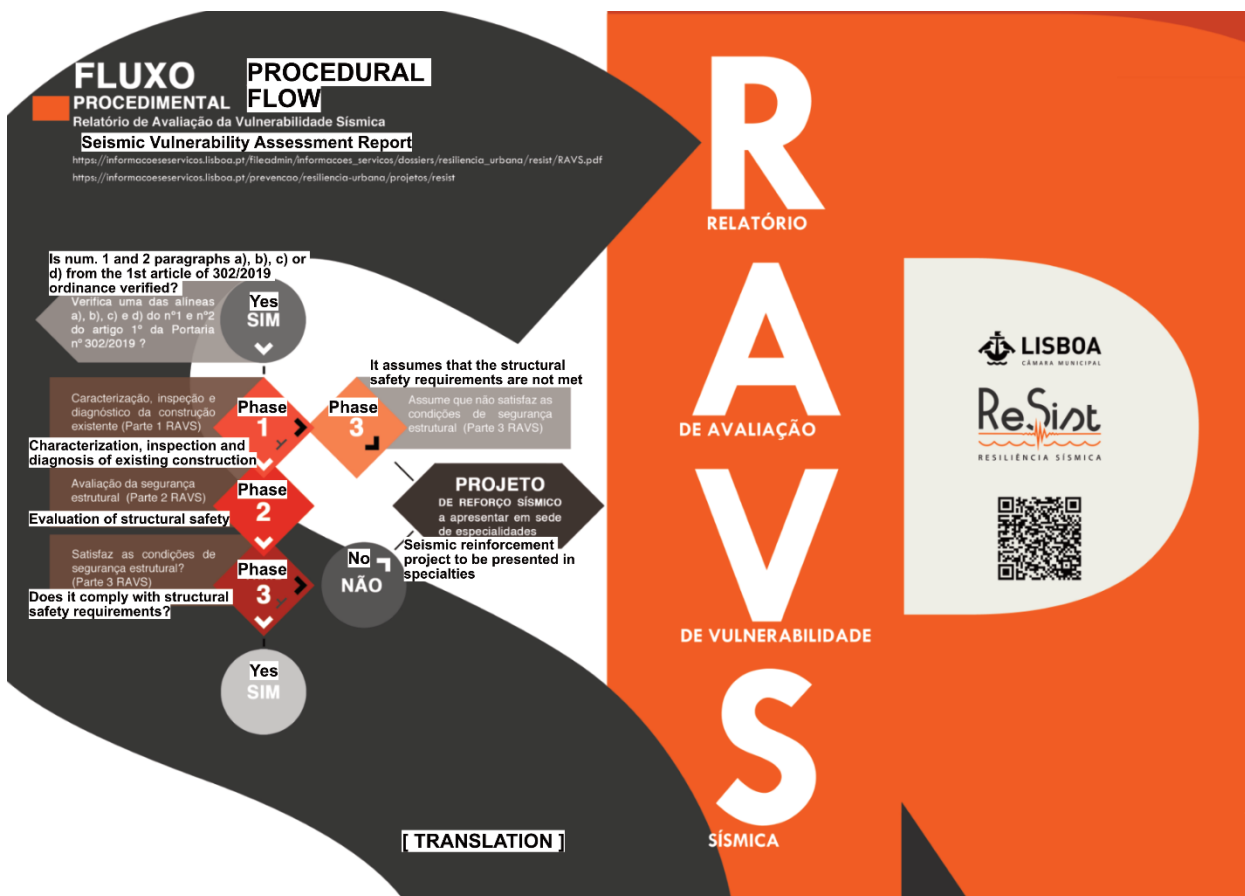


Figure 6. Seismic vulnerability assessment report: application and procedural flow (translation).

The regulation of the occupation of priority road axes and the operationalization of emergency plans are being developed with the Municipal Civil Protection Service and the Fire Department (RSB). To assess the viability and maintenance of the functionality of the road axes identified in the emergency plans, considering the collapse of the building stock after an earthquake, the development of a building collapse model (ÉRRE LRB, 2022), was contracted which will later be crossed with the sewage infrastructures. This measure also aims to identify the axes of access roads to critical infrastructures where seismic reinforcement intervention should be prioritized. The results will also lead to the definition of evacuation routes and definition of meeting points for population, serving as a support tool for planning actions.

Measures to be implemented in territorial management instruments require specific standards to be included in their regulation, accessible through the “Planning a Resilient City“ guide.

4 CONCLUSIONS

The program’s implementation relies on a governance model that emphasizes centralized management and coordination, with the ability to facilitate communication between municipal organic units, leading to flexibility and effectiveness in management. It combines technical knowledge with political and

social engagement, appropriate regulation, incentive allocation, and technical support, which materialize the three fundamental aspects of the program.

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REFERENCES

- ÉRRE LRB. (2022). Modelação do colapso do parque edificado em caso de sismo – Programa ReSist. Project Final Report. Braga, Portugal, LRB.RF.001.2022.CML01 (Modeling building collapse in an earthquake event - ReSist Programme in Portuguese).
- INE (2021). Instituto Nacional de Estatística | Statistics Portugal CENSOS 2021, Available at: www.ine.pt, accessed: 21/09/23.
- RSCCS (1958). Regulamento de Segurança das Construções Contra Sismos: Decreto-Lei nº41658, Imprensa Nacional, Lisboa, Portugal (Regulations for Building Safety Against Earthquakes: Decree-Law no. 41658 in Portuguese).

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