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The changing city: risk and built heritage. The case of Lisbon downtown

A. Nuno Martins[a] *, Catherine Forbes[b], Andreia Amorim Pereira [c], Daniela Matos[d]

[a] *Universidade de Lisboa, Faculdade de Arquitectura, CIAUD, R. Sá Nogueira, 1349-063 Lisboa, Portugal*
[b] *Australia ICOMOS, GML Heritage, Sydney, Australia*
[c] *CEGOT, Faculdade de Letras da Universidade de Coimbra, Portugal*
[d] *Institute of Archaeological Sciences (INA), Universidade de Tübingen, Deutchland*

Abstract

After the devastating earthquake, tsunami and fires of 1755, the city of Lisbon was rebuilt as a modern disaster resilient city, implementing strict planning controls and earthquake resistant construction technologies. This is reflected in the regular grid layout of the historic city, namely the Baixa Pombalina, and its built fabric. But the city has changed considerably since 1755. Through GIS mapping of the city, this study identifies the exposure of the built heritage of Lisbon Downtown to natural hazards including earthquake, tsunami, flood and landslide. It then highlights some of the changes that have occurred within the city's landscape since 1755 and the potential impacts that these may have had on the ability of the city's fabric to perform as designed. In particular, it focuses on the historic urban precinct of Baixa Pombalina, the heart of the rebuilt city and part of the tentative UNESCO World Heritage property of Lisbon. Although many studies have been undertaken to examine the seismic performance of the Pombaline buildings, few have examined the greater context in which the buildings exist and its potential impact on their performance. Will the buildings be able to withstand a similar event now or have they been compromised by the changes that have occurred in and around them? This study considers the vulnerability of the city's historic structures and sites to various hazards and identifies areas of further research needed to enable the development of appropriate mitigation strategies to strengthen the resilience of the historic city.

*Corresponding author: +351 966485234
Email: nunomartins@fa.ulisboa.pt

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1. Introduction

Broadly, risk is calculated as a product of the exposure and vulnerability of places and people to potential hazards (damaging processes, natural or human, fast or slow onset, determined by probability, scale/intensity) and the losses (lives, livelihoods, physical, emotional and financial) that may be experienced as a result of their impact [1,2,3]. The concept of risk reflects the capacity of the people to resist, respond to and recover from such major events [4,5,6].

Emergency planning involves development of mitigation strategies to minimise losses from disaster. Emergency response and recovery strategies generally provide firstly for the physical well-being of the people (through provision of water, food, shelter and medical services), and secondly for the city's economic recovery (through provision of essential infrastructure, education and livelihoods). In most cases, comparatively little attention is given to the protection of the historic form and fabric of a city and its cultural inheritance, even though this is what gives the city its distinctive character, supports the emotional and spiritual well-being of its people, and contributes to a city's economy.

This study aims to bring awareness of the relationship between risk, urban dynamics and heritage, taking as a case study Lisbon Downtown, 'Baixa Pombalina', which was rebuilt following the disastrous earthquake, tsunami and fires of 1755.

2. Filling the gap: risk and cultural heritage

The area of Lisbon and the Tagus Valley, and specifically Lisbon Downtown, has been the subject of several approaches to risk assessment and management [7,8]. There have also been numerous studies regarding the values and conservation of cultural heritage assets of Lisbon Downtown [9,10,11]. However, there are no known studies involving the systematic assessment of the interrelationship between risk and heritage in Lisbon Downtown and the role of the changing urban environment in increasing or decreasing the risk to the urban heritage.

This research integrates cultural heritage into the hazard mapping of Lisbon Downtown. Geographic information system (GIS) tools have been used to cross reference the hazard maps provided in Lisbon's Municipal Master Plan (PDM) [12] with a non-exhaustive geo-referenced inventory of the built cultural heritage of the city (based on various documentary sources, but with particular reference to the project *Lojas da Baixa & Chiado* led by Gabinete de Estudos Olisiponenses). This information has subsequently been verified in the field and emblematic examples selected for GIS analysis.

This study enables analysis of the exposure of the built cultural heritage of Baixa to various natural hazards, to highlight potential vulnerabilities of the heritage to those hazards and to raise awareness of potential risks that arise from changes in the urban environment over time. In this study 'cultural built heritage' not only includes classified (legally protected) heritage, but also places with significant associations and meanings for the city's inhabitants and visitors, forming part of the collective imagination and identity of the city.

3. Lisbon Downtown: geomorphology and historical background

Lisbon Downtown is built over two creeks, the Arroios and Vale de Pereiro, which bifurcate upstream and are now channelled under Almirante Reis (east) and Liberdade Avenues (west) respectively. The built upon area of the city has expanded over time through successive reclamations of the northern margin of the Tagus estuary and the river valley, corresponding with a 6.2km^2 elongated terminal channel watershed. The area is founded on alluvium ("Esteiro da Baixa", a sedimentary feature formed in detritus and carbonate Miocene rock) but now stands mostly on anthropogenic deposits placed to raise and level the ground for construction [13]. The debris from old Roman and Medieval periods comprise the rubble used to fill the downtown area after the 1755 disaster [14,15].

Whilst ancient Roman, Moorish and Medieval civilizations concentrated their political, social and religious centres behind a series of successive walls on the Hill of Castelo de São Jorge and its slopes, the riverfront was continuously occupied for at least over the last 2000 years. The archaeological remains show that a generalized pattern of small settlements gave way to a long evolving urban occupation around fishery and trade. The development in this area increased significantly through the fifteenth and sixteenth centuries, during the age of Discoveries and Expansion, to