ASSESSMENT OF VULNERABILITY AND RESPONSE CAPACITY TO FLOODS IN BUENOS AIRES WITH LIMITED DATA

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Aims

The determination of infrastructure lifeline vulnerability and community response to flooding is a significant aspect of hazards management. The availability of information, such as spatial and non-spatial data characterising the built environment and population, defines how detailed vulnerability assessments can be and how can they inform decision-making processes.

Flood risk areas in Buenos Aires city in Argentina have been identified geographically using modelling software, and also investigated from a socioeconomic and political perspective by analysing the level of income in those areas and management strategies (regulatory framework, land use, flood control infrastructure). However, the relationship between flood risk, vulnerability, potential damage and the city's response capacity has not been analysed deeply. Furthermore, the potential damage of properties and their contents has not been established as a function of their use (residential, commercial, or industrial). Therefore, there is a need to examine flooding vulnerability and the response capacity in Buenos Aires with limited available information. Even though Buenos Aires socioeconomic statistics are publicly available, they need to be tabulated and collated, while official data about flood impacts are nonexistent. The objectives of this study are:

- To determine the extent of community and infrastructure lifelines vulnerability to flooding with limited information available.
- To identify which factors have the greatest effect in increasing flood spatial vulnerability and emergency response capacity.
- To propose appropriate flood mitigation measures for current conditions and projected flood impacts resulting from sea-level rise over the 21st century.

Methods

These objectives will be achieved by a flood vulnerability assessment in ArcGIS software, using geographic data, depth-damage curves (Markau, H-J as cited in Sterr *et al.*, 2005; Karamouz *et al.*, 2016) and a flood model. The flood model considers the effects of climate change in various flood scenarios (1990, 2030, 2070) of different return periods (2, 5, 10 years). The vulnerability assessment includes quantification of flood damage in different scenarios, and includes the following aspects:

- Structural and contents damage to residential, industrial and commercial properties;
- Damage to infrastructure lifelines (e.g. road and electricity networks), and critical facilities (e.g. hospitals and electricity substations).

The response capacity of the city is also evaluated. The proximity of flood-prone areas to key infrastructure, such as fire stations and evacuation centres, is studied to identify which sites can offer assistance, where evacuees can be relocated, or where emergency response agencies can set up monitoring points.

Results

Current and projected flood risk affects 22.61% of Buenos Aires´ total area with flood depths ranging 0 to 7 m. Flood-prone areas are characterised by high- to medium-population density, with diverse income levels, including slums and deprived households.

Residential structural and contents damage and resulting economic losses are affected strongly by floor area, land price and housing density. In some cases, land price and population density balance each other, resulting in similar damage values.

Effects on industrial activity are concentrated on storehouses, specifically in southern neighbourhoods (Barracas, La Boca, Nueva Pompeya, Villa Soldati), where land price ranges from low to medium-low but large floor areas increase damage values. Belgrano's high land price increases structural and contents damage, even if industrial concentration is low in comparison to other areas. Impacts on commercial properties are dispersed, situated mainly in Belgrano, Palermo in the north and, Villa Soldati, and Barracas in the south. The main affected businesses are garages, warehouses, clothing stores, vehicle workshops, and food and beverage retailers (including markets and restaurants).

Differences between structural and contents damage differ mainly in building use category, as this determines a property's floor area and contents value, which represents a percentage of structural value. The damage evaluation method used (Markau, H-J, 2003 cited in Sterr *et al.*, 2005; Karamouz *et al.*, 2016) has a large influence on structural and contents damage results, as estimated percentage damage at lower flood depths differs significantly between the two approaches. Higher values were obtained using the approach of Karamouz et al., (2016) compared to Markau, H-J's method (as cited in Sterr *et al.*, 2005). The 1 metre increments used for modelling flood depths limit the accuracy of damage evaluation.

Regardless of property use category, impacts on structural and contents losses increase for each flood scenario and recurrence period because of increasing flood depth. Contents losses are greater than structural, as contents are less robust and more perishable. This is represented by depth-damage curves that assign greater damage to contents than structures in each flood scenario.

Impacts on the transport network, evaluated by the number of affected passengers and flood duration, ranged from 1 to 8 hours; the analysis included disruption to the airport, rail and bus services, and vehicles within the flood-prone areas and those from the suburbs entering the city. Damage to bridges, highway on- and exit-ramps, electrical substations and mobile phone towers will affect nearby populations and also those living outside the city that depend on the city's infrastructure lifelines and critical facilities. Therefore, flood effects on transport and key infrastructure will result in delays and disruption of supply chains and connections to areas outside the floodplain.

Risk management agencies and emergency response facilities become vital in preventing, reducing and recovering from the damage previously described. The response areas of existing fire stations cover much of the city. However, eight of them are located in the flood prone area, which would make them inaccessible. The city's capacity to accommodate evacuees is insufficient as the number of evacuation centres seems limited. Other issues in the emergency response include limited human resources and equipment, and scarce monitoring points around the flood-prone area.

Uncertainty remains in these results as documented impacts from previous floods are not always publicly available, local statistics are sometimes not comprehensive, and utilities' service areas are not specified so that the affected population cannot be determined accurately. Nevertheless, the work presented here demonstrates the feasibility of using disparate data sets, combined with reasonable assumptions and established modelling approaches, to provide preliminary damage assessment estimates and identify potential improvements for emergency response plans.

References

Karamouz, M. et al., 2016. Coastal Flood Damage Estimator: An Alternative to FEMA's HAZUS Platform. *Journal of Irrigation and Drainage Engineering*, 142(6), p.04016016/1-12.

Sterr, H. et al., 2005. *Analyses of previous vulnerability studies in the pilot site"German Bright Coast" (Task 27). Floodsite Status-Report.*, Wallingford, UK.