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
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