Regional Economic Impacts of Natural Disasters in Megacities: The Case of Floods in Sao Paulo, Brazil

Eduardo Haddad (with Eliane Teixeira)
Professor of Economics, University of São Paulo, Brazil
The city of São Paulo

São Paulo Metropolitan Region

The city of São Paulo
Climate change is said to increase the frequency and intensity of extreme events

Climate forecasts present changes in frequency and intensity of short-lasting extreme events *

Preliminary climate change studies suggests that between 2070 and 2100 a rise between 2°C to 3°C in São Paulo can double the number of days with intense rain (above 10 mm).

* Vulnerability of Brazilian megacities to climate changes: São Paulo Metropolitan Region (2010) - INPE, UNICAMP, USP, IPT, UNESP
The number of days with intense rain is expected to increase in São Paulo

*IPCC 2007*

Number of days with **rain above 80mm** in São Paulo Metropolitan Region

Source: Maria Assunção Faus da Silva, IAG/USP
Floods are recurrent in São Paulo, especially in the summer

What are the economic costs of floods in São Paulo?

Why do we need to quantify economic losses from floods?

- Gauge community vulnerability
- Evaluate the worthiness of mitigation
- Determine the appropriate level of disaster assistance
- Improve recovery decisions
- Inform insurers of their potential liability

Data: floods

EMC – Emergency Management Center

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streets flooded

frequency of floods
Data: georeferencing floods
Data: georeferenced floods (2008)
Data: firm level database (RAIS)

RAIS - Annual Relation of Social Information

Coverage: national territory
          municipality level
          97% of formal labor market

Firms: location
       total wages
       "SIC" code
Example of GIS-based influence area of flood points, for different scenarios (50m, 100m, 150m, 200m)
Example

The most severe flood point in 2008

<table>
<thead>
<tr>
<th>Influence Zone</th>
<th>Affected Firms</th>
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<tbody>
<tr>
<td>100 m</td>
<td>137</td>
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Latitude -23.57267
Longitude -46.70449
Integrating GIS and a spatial CGE model for assessing the impacts of floods in São Paulo

Fully specified interregional input-output system (trade flows)

Focus on SPMR
- 39 municipalities + rest of the State of Sao Paulo + rest of Brazil

56 sectors, 110 commodities

Basic database at the municipality level (2008)

*Mapping labor payments from place of work to place or residence*

*Different patterns of household consumption by place of residence*

Reference: Haddad and Hewings (2005)
Direct damage is estimated based on the characteristics of the affected firms

Assumptions:

- Technology based on a continuous-time production function approach
- One day of flood affects one day of production of firms within the influence zone (working days)
- Information on the average sectoral labor productivity from input-output data used to assess direct damages
- Reweighting scheme
Higher-order impacts estimated using the spatial CGE model

What if floods had not occurred in 2008?

What would have been the difference in terms of regional output?

**Estimated foregone (reweighted) labor income (in BRL thousand)**

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<thead>
<tr>
<th>Industry</th>
<th>Impact radius</th>
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<tbody>
<tr>
<td></td>
<td>50 m</td>
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<tr>
<td>Primary</td>
<td>7.08</td>
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<tr>
<td>Manufacturing</td>
<td>454.01</td>
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<td>Utilities</td>
<td>673.48</td>
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<tr>
<td>Construction</td>
<td>185.72</td>
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<tr>
<td>Commerce</td>
<td>1,057.58</td>
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<tr>
<td>Transportation</td>
<td>663.62</td>
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<td>Services</td>
<td>3,132.72</td>
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<td>Public administration</td>
<td>300.43</td>
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<tr>
<td>TOTAL</td>
<td>6,474.63</td>
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<tr>
<td># of affected firms</td>
<td>8,577</td>
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### Direct and total GRP/GDP impact (in BRL million)

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<th>Impact radius</th>
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<td></td>
<td>50m</td>
<td>100m</td>
<td>150m</td>
<td>200m</td>
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<tr>
<td><strong>Direct loss</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>São Paulo City (SPC)</td>
<td>16.63</td>
<td>43.54</td>
<td>88.30</td>
<td>143.53</td>
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<td><strong>Total loss</strong></td>
<td></td>
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<td></td>
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<tr>
<td>São Paulo City (SPC)</td>
<td>40.08</td>
<td>94.38</td>
<td>150.34</td>
<td>248.55</td>
</tr>
<tr>
<td>Rest of SPMR (SPMR)</td>
<td>3.35</td>
<td>9.05</td>
<td>12.72</td>
<td>19.66</td>
</tr>
<tr>
<td>Rest of São Paulo State (RSP)</td>
<td>9.14</td>
<td>21.04</td>
<td>32.49</td>
<td>49.86</td>
</tr>
<tr>
<td>Rest of Brazil (RB)</td>
<td>39.95</td>
<td>93.72</td>
<td>154.91</td>
<td>246.10</td>
</tr>
<tr>
<td>Brazil</td>
<td>92.52</td>
<td>218.19</td>
<td>350.46</td>
<td>564.17</td>
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**Intra-city total impact-damage ratio**

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<td>2.4</td>
<td>2.2</td>
<td>1.7</td>
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**Economy-wide total impact-damage ratio**

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<td>5.6</td>
<td>5.0</td>
<td>4.0</td>
<td>3.9</td>
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Potential GRP losses in the RMSP municipalities, 100m scenario

In % of 2008 GRP

In BRL 2008
Reaching the planner: Hotspots 2008

Source: Teixeira and Haddad (2014)
Potential GDP losses in the São Paulo wards during 2008

Source: Teixeira and Haddad (2014)
Prejuízo ao país com enchentes em São Paulo ultrapassa R$ 762 milhões por ano

15/03/2013

Por José Tadeu Arantes

Agência FAPESP - Cada ponto de alagamento formado na cidade de São Paulo após uma chuva forte provoca um prejuízo diário de mais de R$ 1 milhão ao país. Com 749 pontos de alagamento identificados na cidade, as perdas anuais no âmbito do município chegaram a quase R$ 396 milhões. E, com o esparadrapo dos efeitos pelas longas cadeias de produção e renda, o prejuízo vai a mais de R$ 762 milhões em escala nacional.

As informações fazem parte de um estudo realizado por Eduardo Amaral Haddad, professor titular do Departamento de Economia da Faculdade de Administração, Administração e Contabilidade da Universidade de São Paulo (FEA-USP), e por Eliane Teixeira dos Santos, mestre em Teoria Econômica, orientada por Haddad. Um artigo assinado por ambos, "Economic Impacts of Natural Disasters in Megacities: The Case of Floods in São Paulo, Brazil" (Impactos Econômicos de Desastres Naturais em Megacidades: O Caso das Inundações em São Paulo, Brasil), está prestes a ser publicado em número especial da revista Habitat International.

Haddad é coordenador de economia e pesquisador na área de Economia das Mudanças Climáticas...
Key messages

Need to consider both internal and external interactions of the urban system

Network effects, actions by neighbors (e.g. waste) reinforce the consequences of a seemingly local phenomenon (flood points in the city!)

Economic effects are not only local – economic impacts spread through production and income linkages

Coordination problem – policy decisions are made at either the municipality, state or federal level (no metropolitan authority with decision power in Brazil)

Financing – who pays the bill?
Thank you!

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