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

Regional Science Reaching Out to a World in Transition
The New Urban World: Demography, Climate Change and Land Use

Rabat, Morocco, October 1-2, 2012

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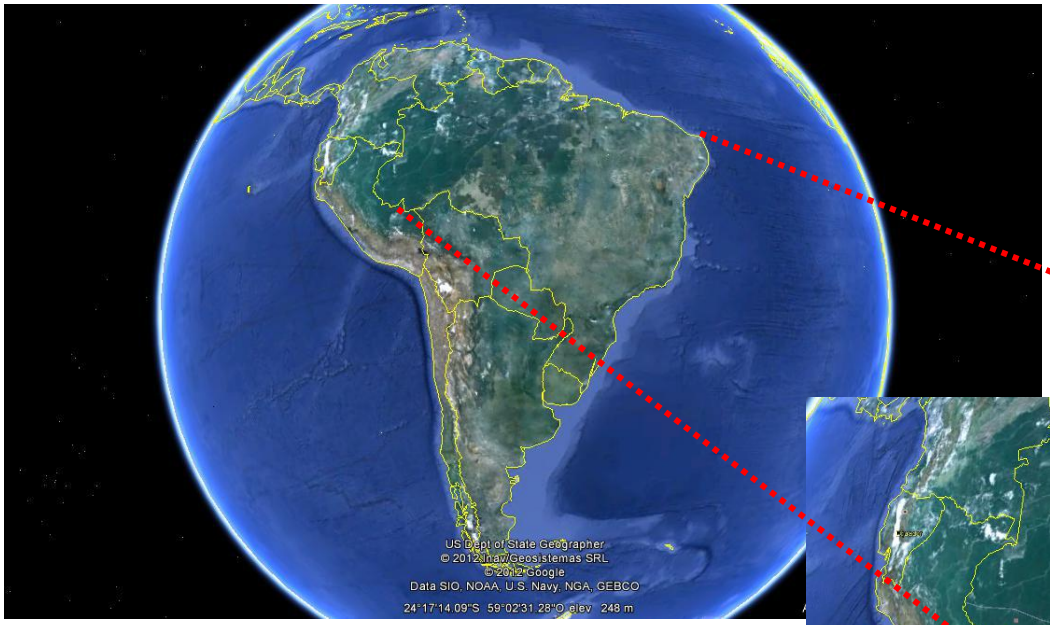
Outline

- ✓ The city of Sao Paulo
- Sao Paulo Metropolitan Region (SPMR)
- Climate change and floods in Sao Paulo
- Data
- Methodology
- Preliminary results

The city of São Paulo

South America

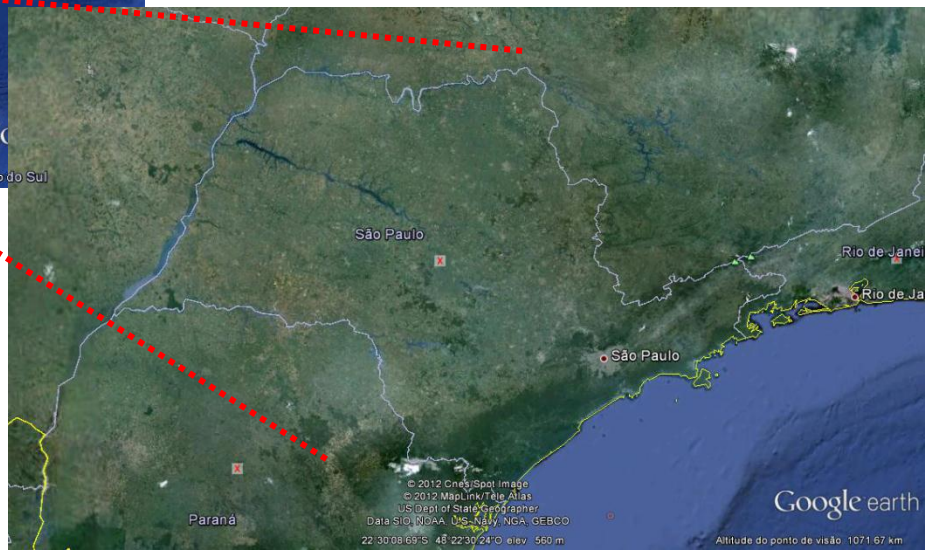


Brazil

The city of São Paulo

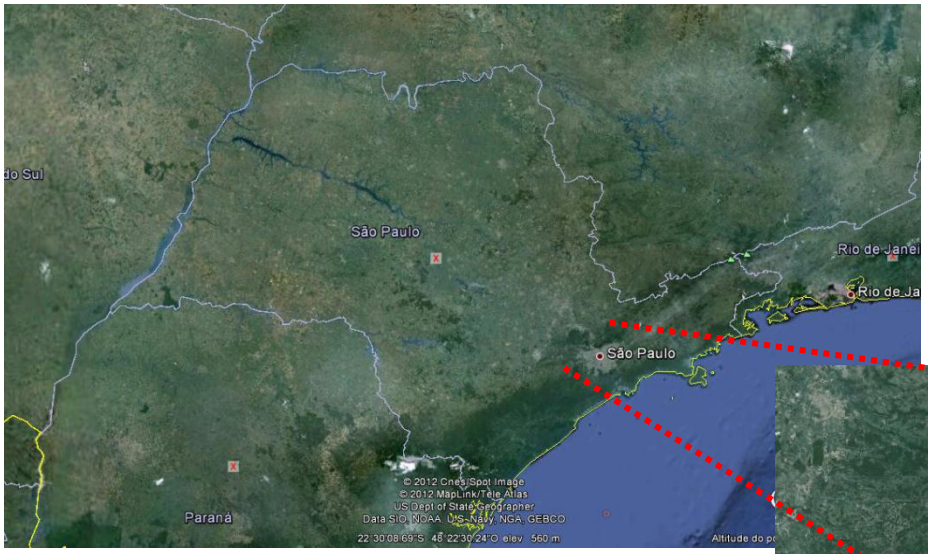
Brazil

The state of São Paulo

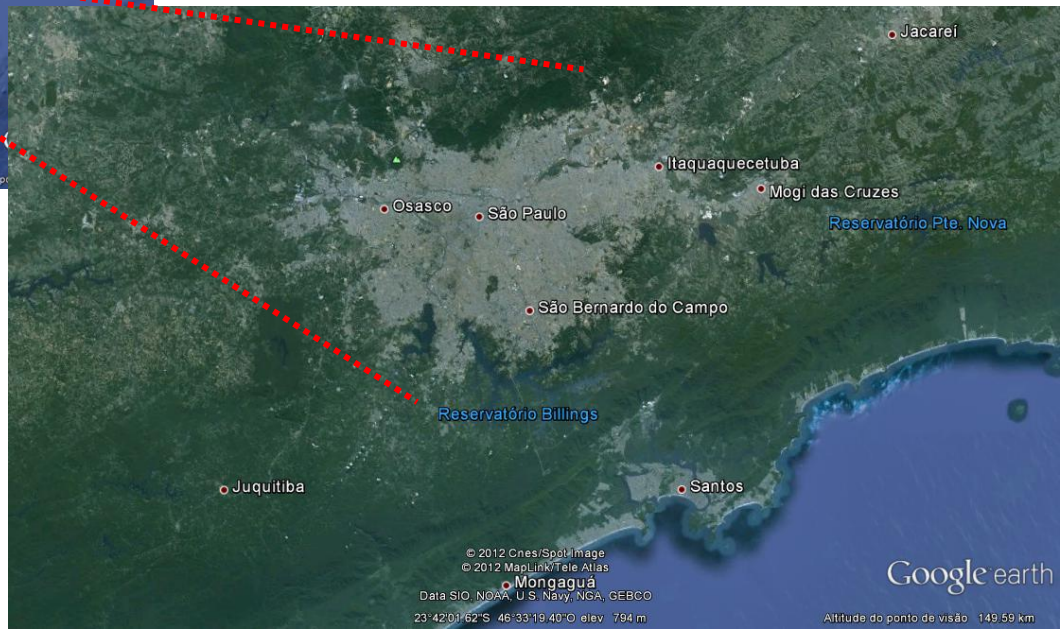


The city of São Paulo

The state of São Paulo

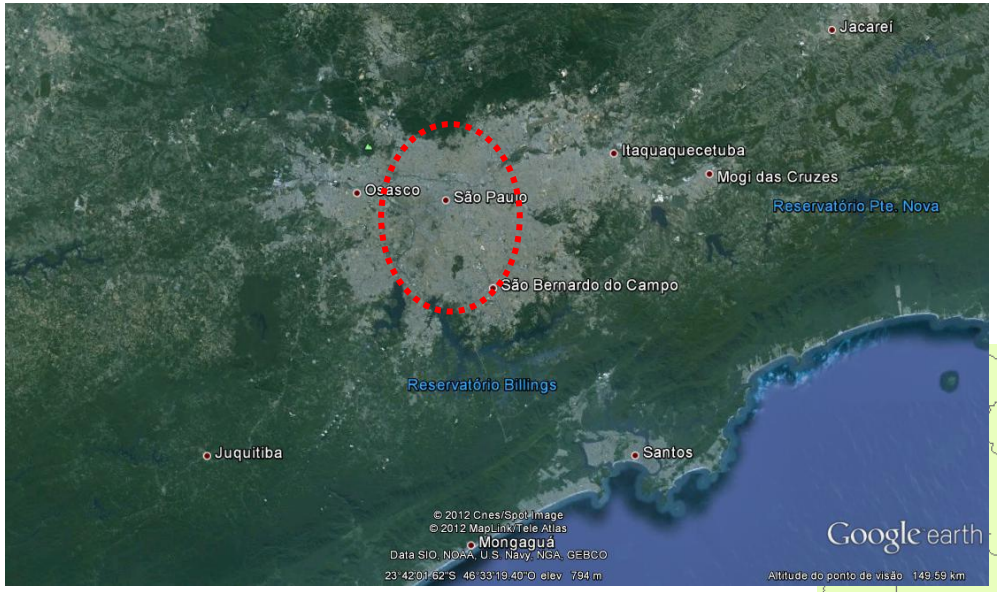


São Paulo Metropolitan Region

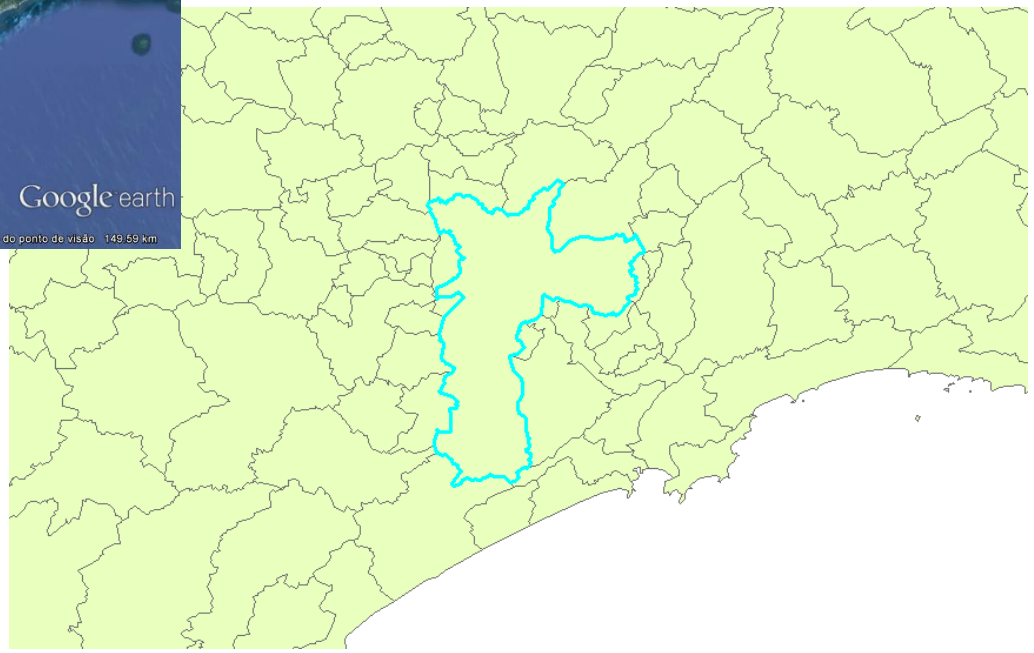


The city of São Paulo

São Paulo Metropolitan Region



The city of São Paulo



Outline

The city of São Paulo

✓ Sao Paulo Metropolitan Region (SPMR)

Climate change and floods in Sao Paulo

Data

Methodology

Preliminary results

São Paulo Metropolitan Region is the financial and economic center of Brazil

Largest urban agglomeration in the country

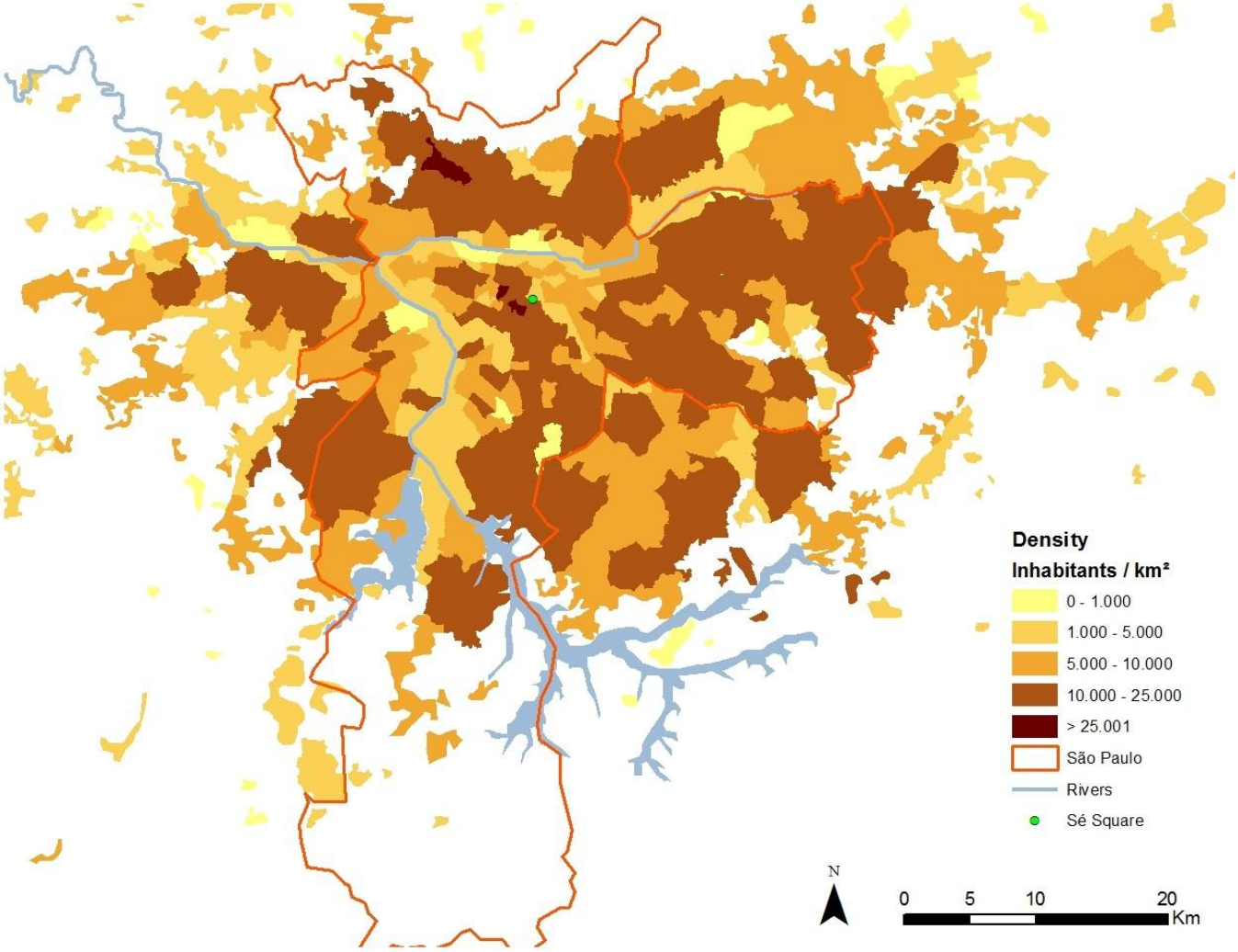
- ✓ 10.3 % of national population (2010)
- ✓ 18.9 % of Brazilian GDP (2009)

The city of São Paulo is the core of the metropolitan area

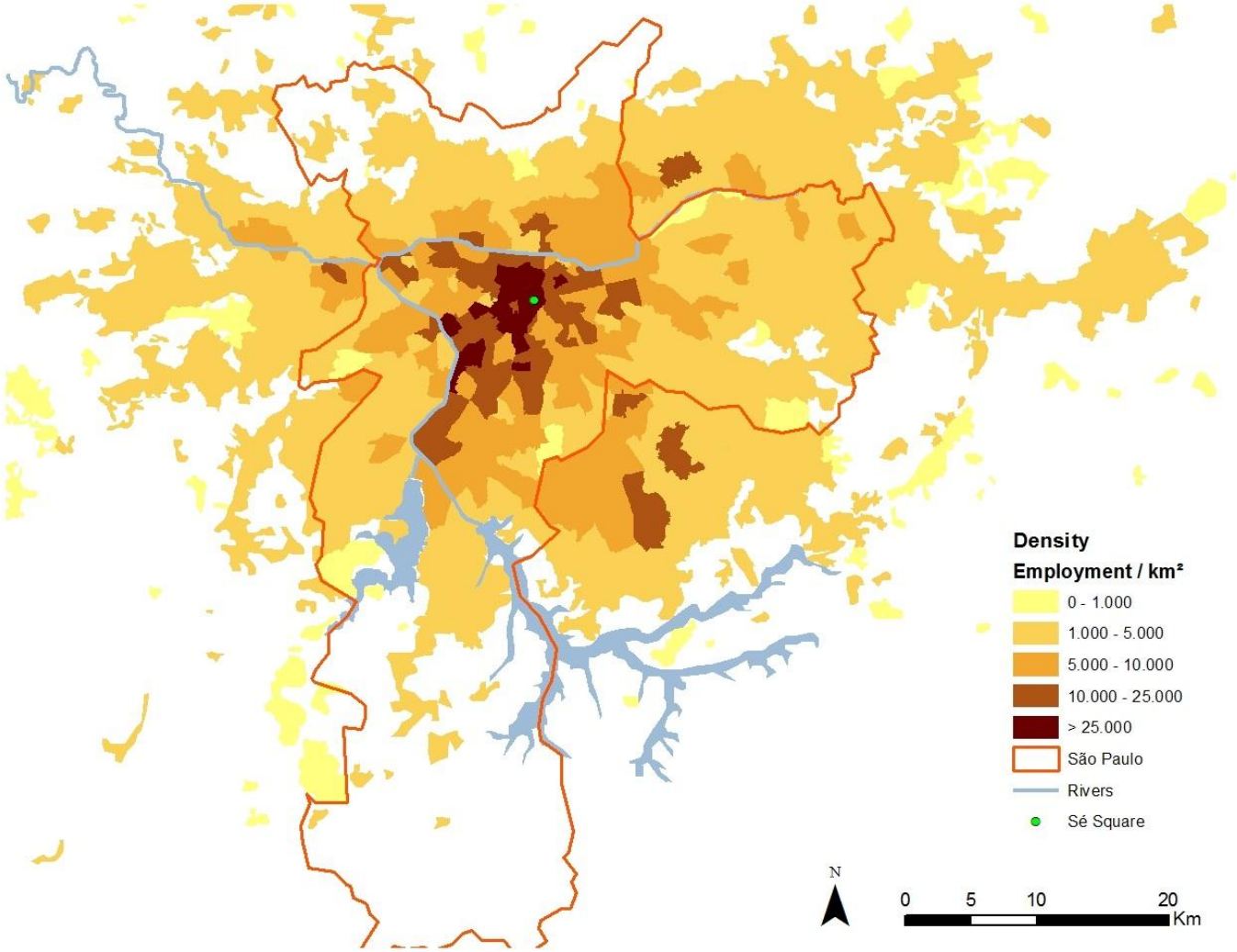
- ✓ 5.9 % of national population (2010)
- ✓ 12.0 % of Brazilian GDP (2009)

	Area (000 km²)	*Population (000 000)*	*GDP (USD billion)*	*Per capita GDP (USD)*	*HDI 2000*
São Paulo	1.5	11.3	194.6	17,221	0.841
SPMR	7.9	19.7	306.5	15,558	0.813
Brazil	8,514.9	190.8	1,619.2	8,486	0.665
Morocco	446.5	32.0	145.3	4,547	0.507

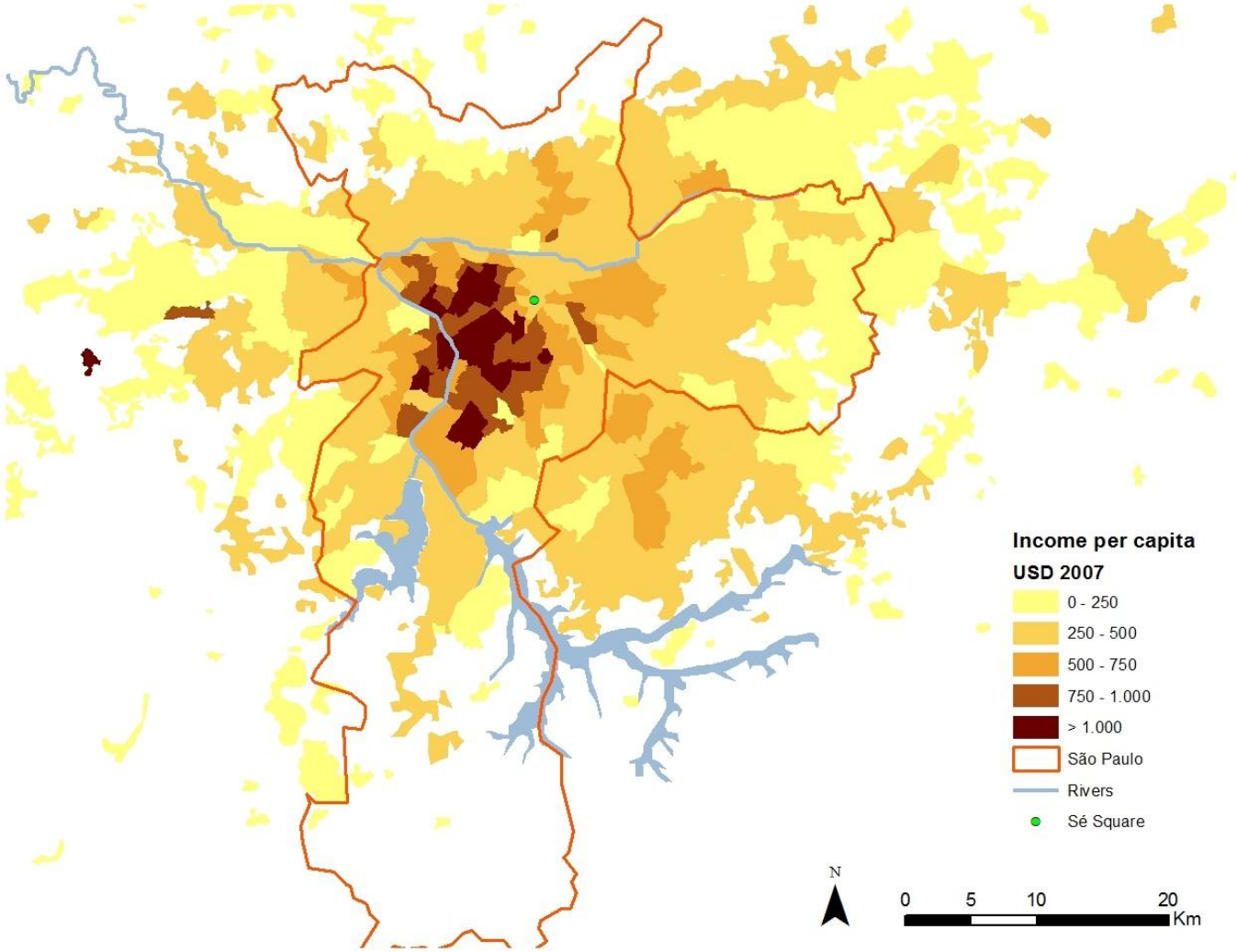
Where people live



Where people work



Where the money is



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Climate change is said to increase the frequency and intensity of extreme events

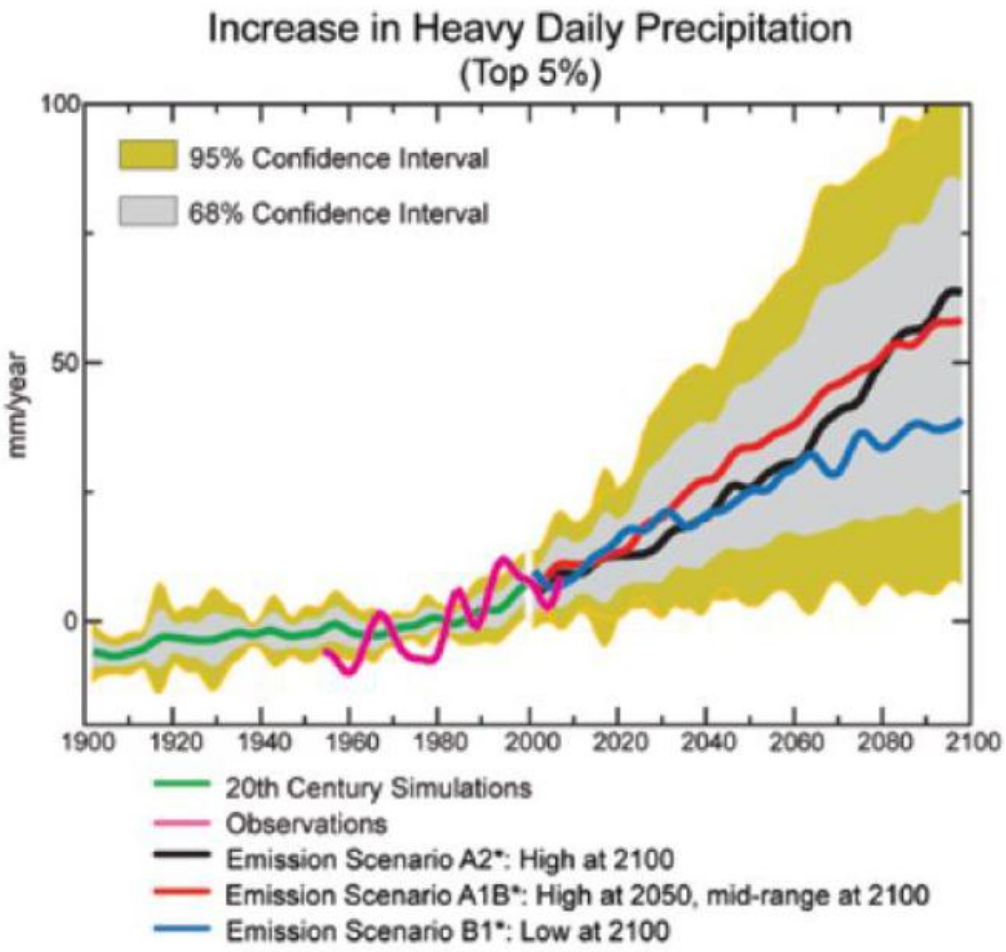
Climate forecasts present changes in frequency and intensity of short-lasting extreme events *

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).

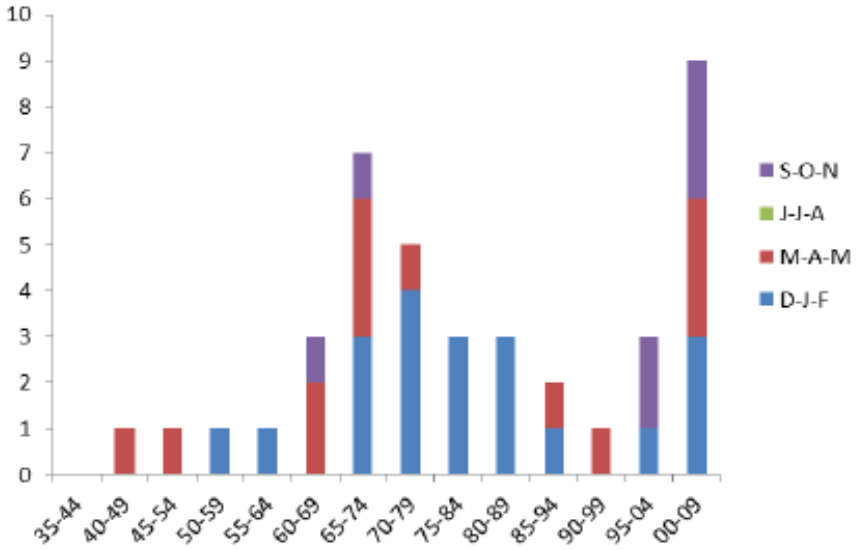
* Vulnerability of Brazilian megacities to climate changes: São Paulo Metropolitan Region (2010) - INPE, UNICAMP, USP, IPT, UNESP

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

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

Inform stakeholders

Reference: Rose (2004)

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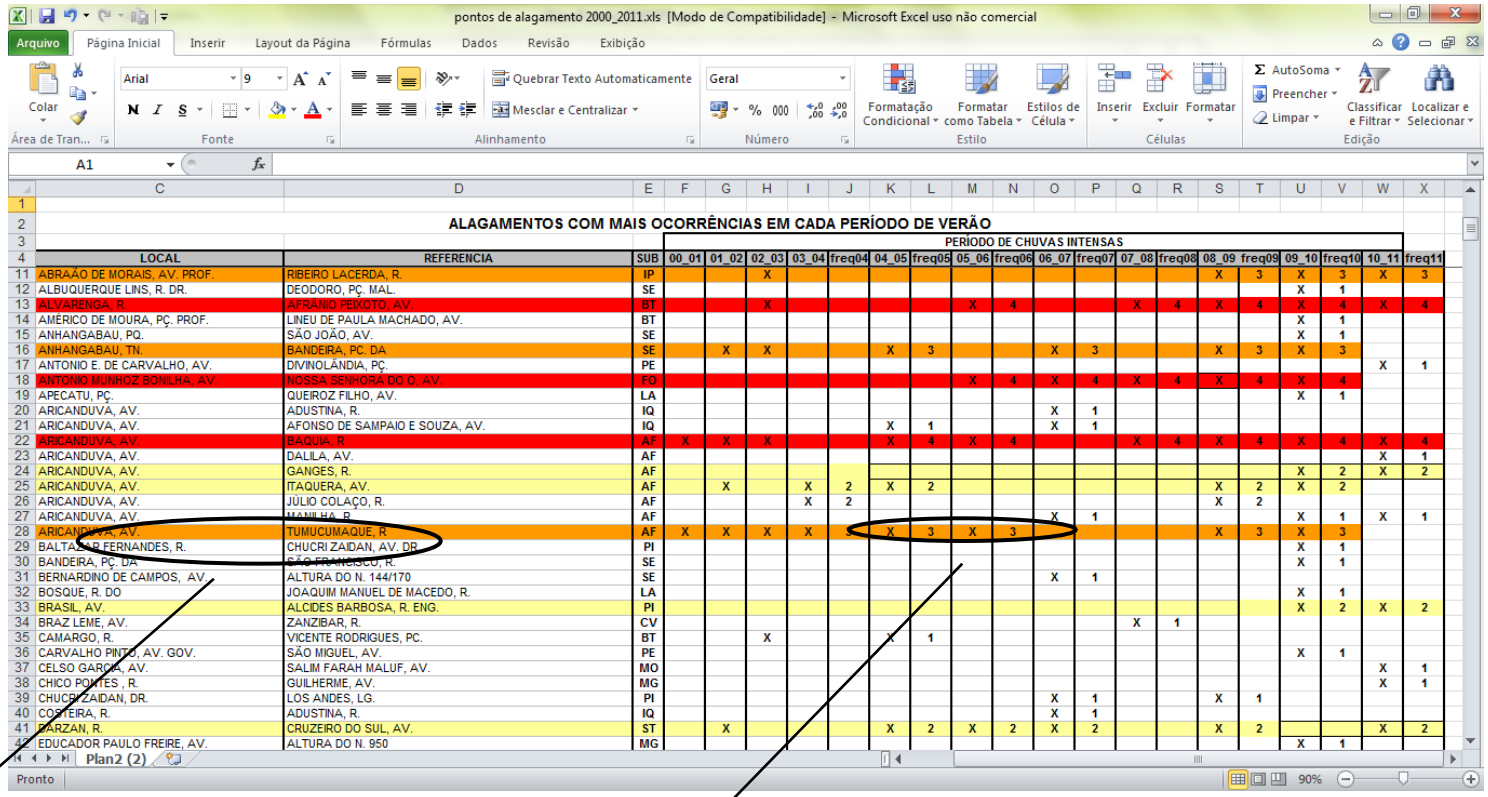
Data: floods

EMC – Emergency Management Center



pontos de alagamento 2000_2011.xls [Modo de Compatibilidade] - Microsoft Excel uso não comercial

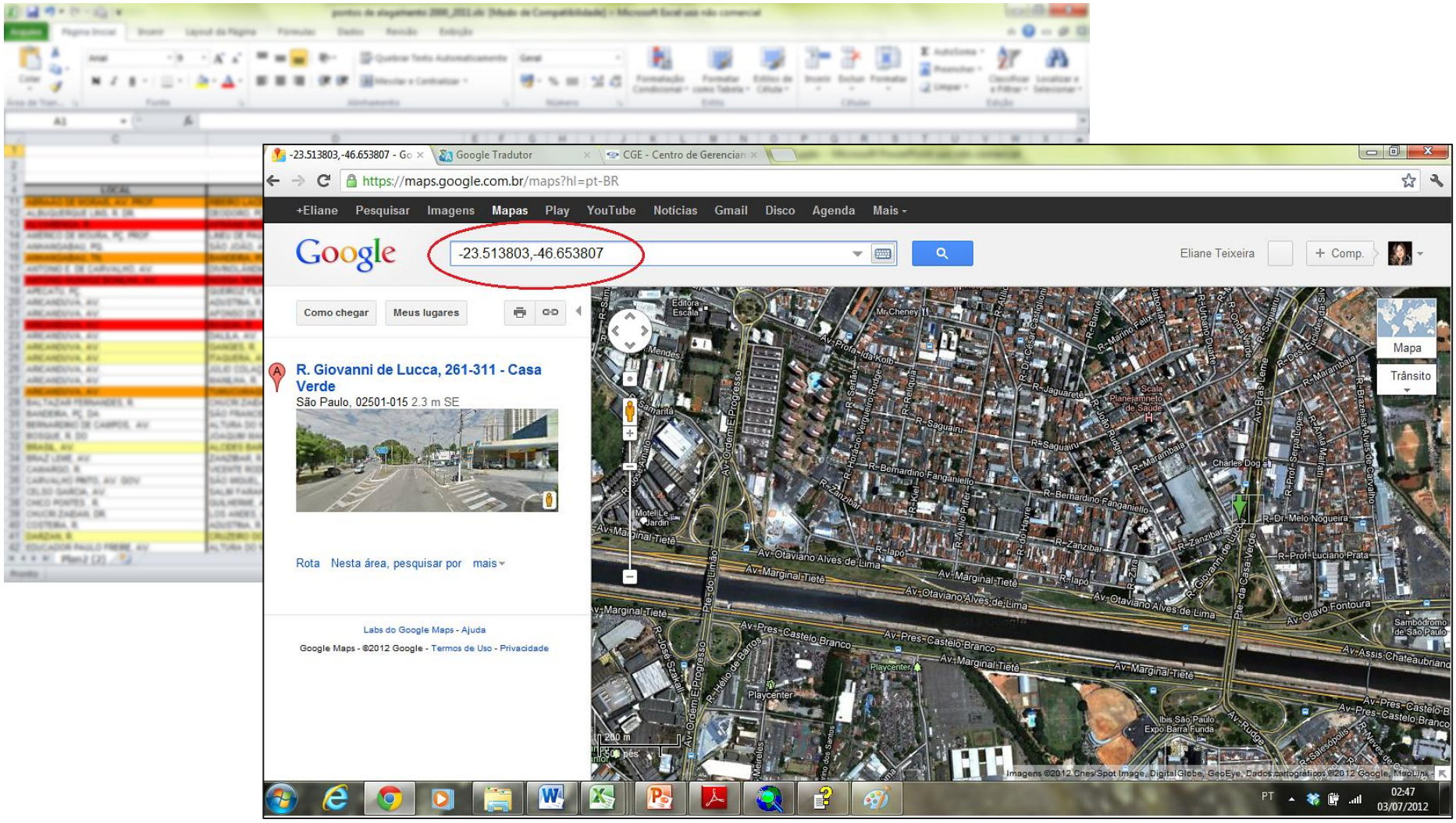
ALAGAMENTOS COM MAIS OCORRÊNCIAS EM CADA PERÍODO DE VERÃO

			PERÍODO DE CHUVAS INTENSAS																			
LOCAL	REFERENCIA	SUB	00_01	01_02	02_03	03_04	freq04	04_05	freq05	05_06	freq06	06_07	freq07	07_08	freq08	08_09	freq09	09_10	freq10	10_11	freq11
ABRAÃO DE MORAIS, AV. PROF.	RIBEIRO LACERDA, R.	IP			X											X	3	X	3	X	3
ALBUQUERQUE LINS, R. DR.	DEODORO, PÇ. MAL.	SE																X	1		
ALVARENGA, R.	AFRÂNIO PEIXOTO, AV.	BT			X					X	4			X	4	X	4	X	4	X	4
AMÉRICO DE MOURA, PÇ. PROF.	LINEU DE PAULA MACHADO, AV.	BT																X	1		
ANHANGABAU, PQ.	SÃO JOÃO, AV.	SE																X	1		
ANHANGABAU, TN.	BANDEIRA, PC. DA	SE		X	X			X	3			X	3			X	3	X	3		
ANTONIO E. DE CARVALHO, AV.	DIVINOLÂNDIA, PÇ.	PE																		X	1
ANTONIO MUNHOZ BONILHA, AV.	NOSSA SENHORA DO O, AV.	FO								X	4	X	4	X	4	X	4	X	4		
APECATU, PÇ.	QUEIROZ FILHO, AV.	LA																X	1		
ARICANDUVA, AV.	ADUSTINA, R.	IQ										X	1								
ARICANDUVA, AV.	AFONSO DE SAMPAIO E SOUZA, AV.	IQ						X	1			X	1								
ARICANDUVA, AV.	BAQUIA, R.	AF	X	X	X			X	4	X	4			X	4	X	4	X	4	X	4
ARICANDUVA, AV.	DALILA, AV.	AF																		X	1
ARICANDUVA, AV.	GANGES, R.	AF																X	2	X	2
ARICANDUVA, AV.	ITAQUERA, AV.	AF		X		X	2	X	2							X	2	X	2		
ARICANDUVA, AV.	JÚLIO COLAÇO, R.	AF				X	2									X	2				
ARICANDUVA, AV.	MANILHA, R.	AF										X	1					X	1	X	1
ARICANDUVA, AV.	TUMUCUMAQUE, R.	AF	X	X	X	X		X	3	X	3					X	3	X	3		
BALTAZAR FERNANDES, R.	CHUCRI ZAIDAN, AV. DR.	PI																X	1		
BANDEIRA, PÇ. DA	SÃO FRANCISCO, R.	SE																X	1		
BERNARDINO DE CAMPOS, AV.	ALTURA DO N. 144/170	SE										X	1								
BOSQUE, R. DO	JOAQUIM MANUEL DE MACEDO, R.	LA																X	1		
BRASIL, AV.	ALCIDES BARBOSA, R. ENG.	PI																X	2	X	2
BRAZ LEME, AV.	ZANZIBAR, R.	CV												X	1						
CAMARGO, R.	VICENTE RODRIGUES, PC.	BT			X			X	1												
CARVALHO PINTO, AV. GOV.	SÃO MIGUEL, AV.	PE																X	1		
CELSO GARCIA, AV.	SALIM FARAH MALUF, AV.	MO																		X	1
CHICO PONTES , R.	GUILHERME, AV.	MG																		X	1
CHUCRI ZAIDAN, DR.	LOS ANDES, LG.	PI										X	1			X	1				
COSTEIRA, R.	ADUSTINA, R.	IQ										X	1								
DARZAN, R.	CRUZEIRO DO SUL, AV.	ST		X				X	2	X	2	X	2			X	2			X	2
EDUCADOR PAULO FREIRE, AV.	ALTURA DO N. 950	MG																X	1		

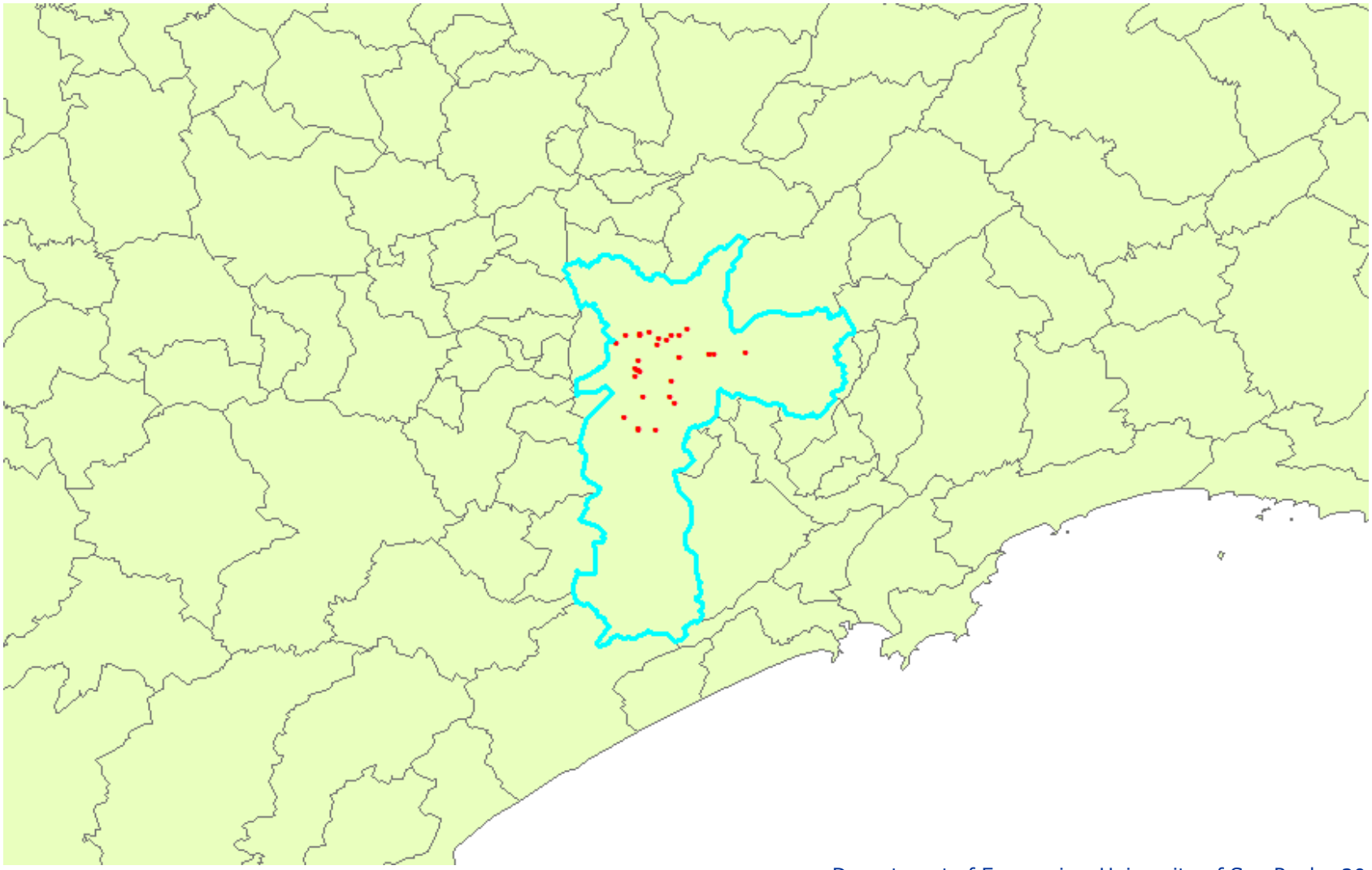
streets flooded

frequency of floods

Data: georeferencing floods



Data: georeferenced floods (2008)

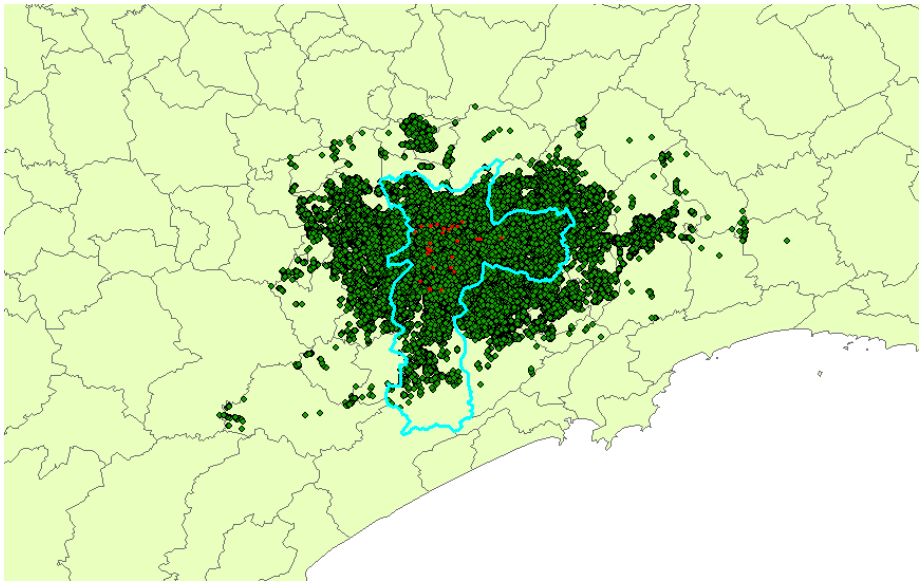


Data: firm level database (RAIS)

RAIS - Annual Relation of Social Information

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

Firms: location
total wages
"SIC" code



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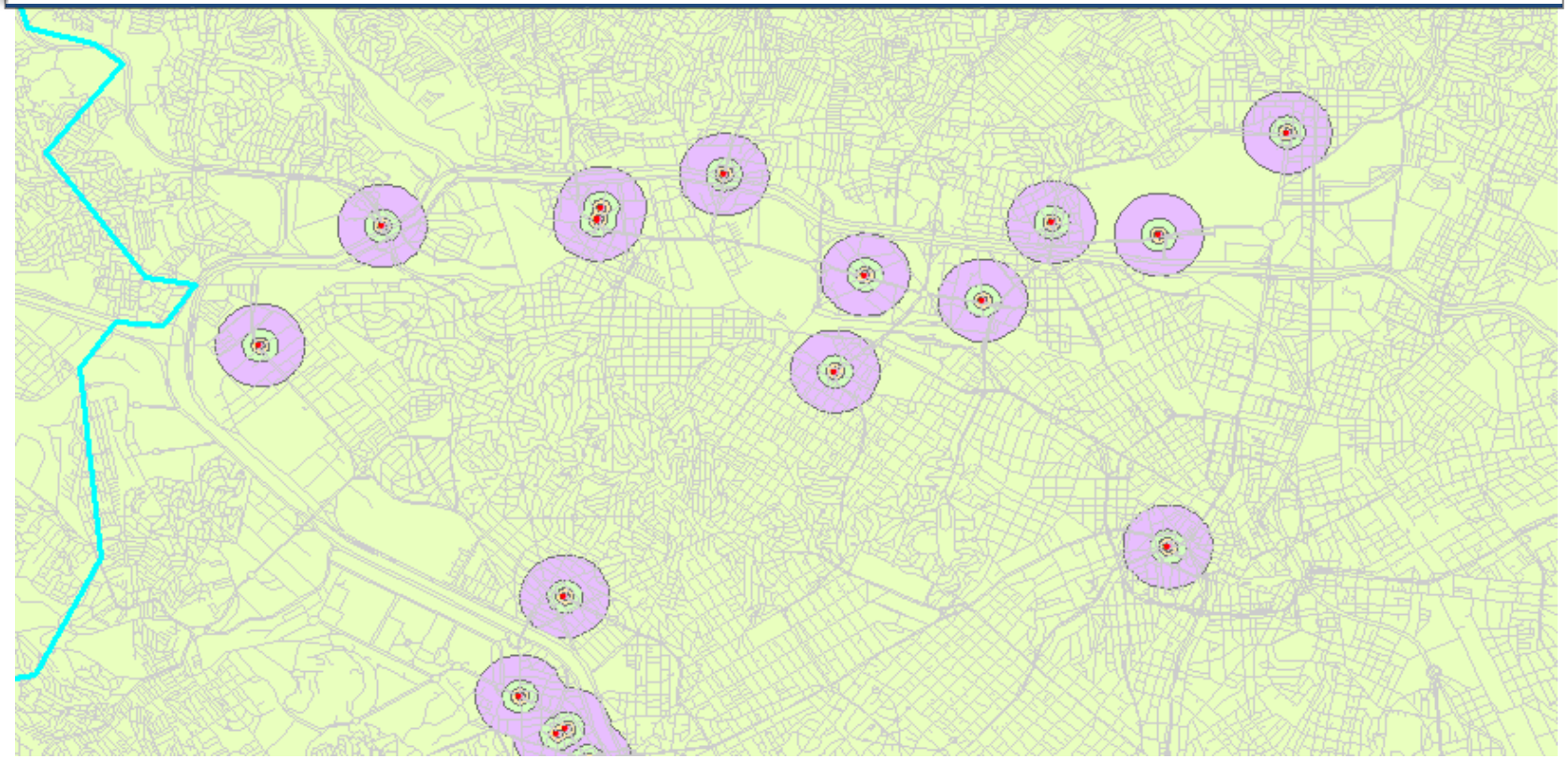
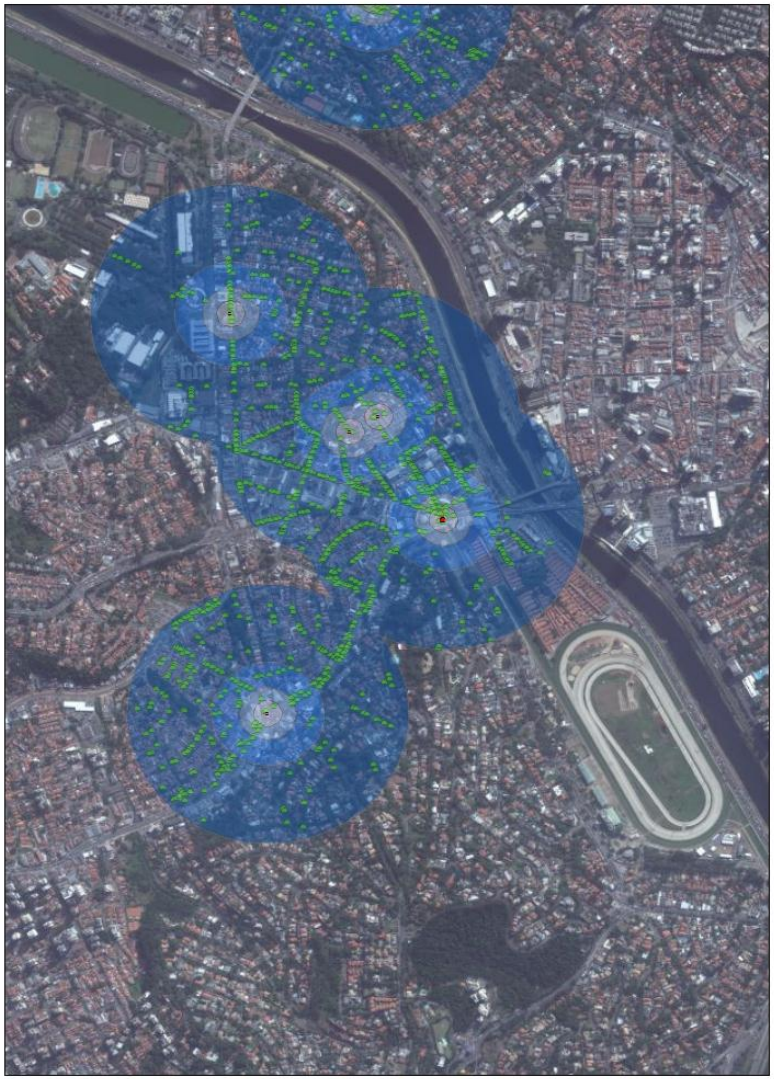
Scenarios (to be further calibrated with field research)

Scenario 1		Scenario 2		Scenario 3		Scenario 4	
Influence Zone	Affected Firms	Influence Zone	Affected Firms	Influence Zone	Affected Firms	Influence Zone	Affected Firms
50 m	**352**	**100 m**	**1.004**	**200 m**	**3.905**	**500 m**	**21.395**



Example



The most severe flood point in 2008

Latitude -23.57267 Longitude -46.70449	
Influence Zone	Affected Firms
100 m	**137**

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)

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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

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?

Potential output losses, 50m scenario, in BRL 000

	Direct damage	Total damage (CGE 1)	Damage ratio (CGE 2)	Total damage (CGE)	Damage ratio (CGE)
São Paulo	25,053	22,829	-	30,767	-
Rest of SPMR	-	3,967	-	2,923	-
Rest of the State	-	8,587	-	5,835	-
Rest of Brazil	-	13,415	-	9,667	-
BRAZIL	25,053	48,799	1.95	49,193	1.96

Obs.: CGE 1 – high resilience; CGE 2 – low resilience

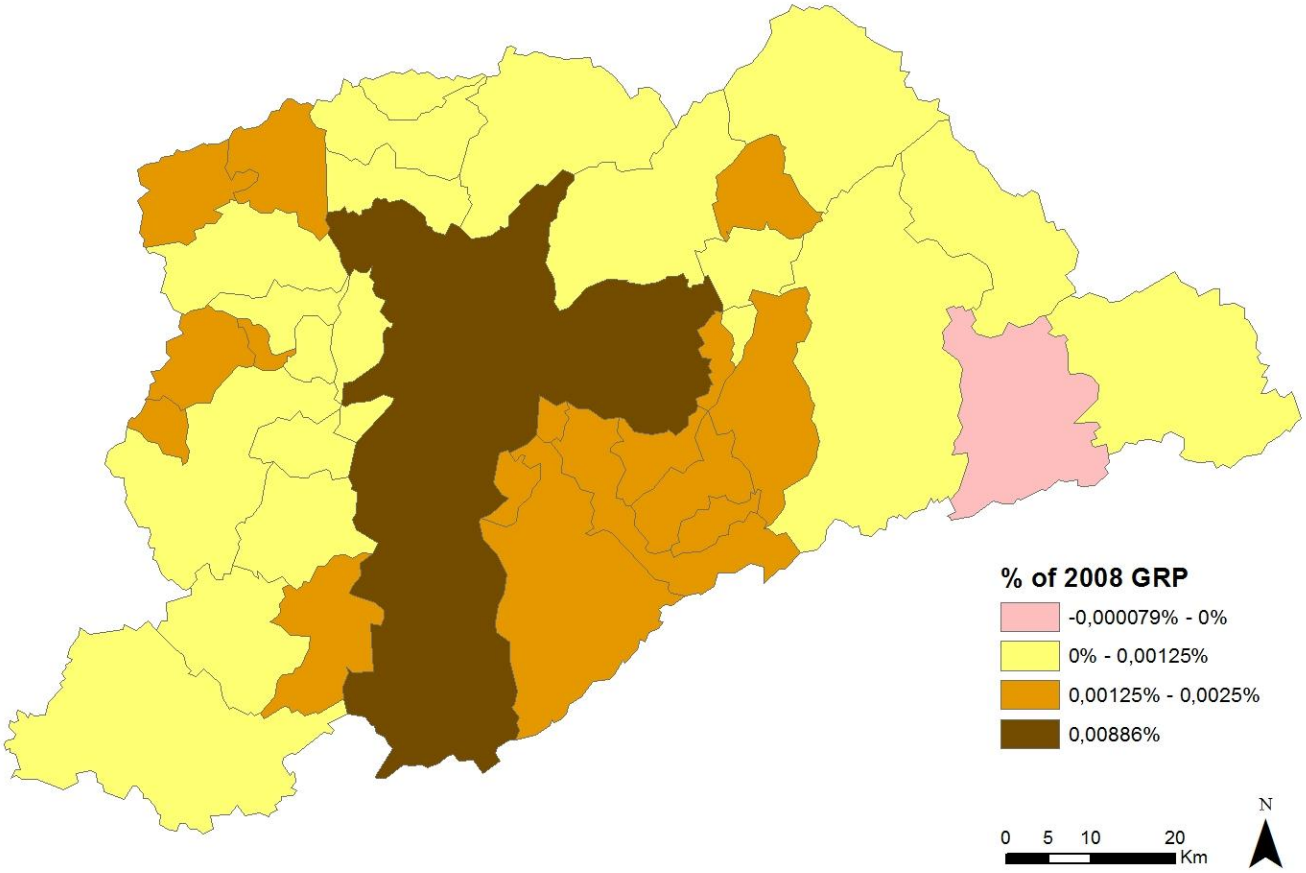
Loss in space 1…

Potential GRP losses, 50m scenario, in % of 2008 GRP

Region	Loss
São Paulo	0.0089%
Rest of SPMR	0.0012%
Rest of the State	0.0009%
Rest of Brazil	0.0004%
BRAZIL	0.0016%

Loss in space 2…

Potential GRP losses, 50m scenario, in % of 2008 GRP



Key messages

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

Actions by neighbors (e.g. waste) reinforce the consequences of a seemingly local phenomenon

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

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

Thank you!

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