

Extreme events in the Metropolitan Region of São Paulo (MRSP) - SP, Brazil: public subsidy policies.

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I. INTRODUCTION

Climate change of the Metropolitan Region of São Paulo (MRSP), may be presented as temperature increase, annual precipitation raise, heat waves and flooding events.

Ecological niche envelope modeling approaches are used to examine the effects of weather variables on the geographic distribution. The use of Geographic Information Systems (GIS) has allowed the union of different types of data (socio-economic, health, environmental). The results of associations between these variables depends, however, on the development of GIS. The choice of scales and objects of analysis should be proposed at the outset, conditioning the possible statistical and visual results truthful to reality.

The dynamics of El Niño and La Niña may influence the occurrence of extreme precipitation in the metropolitan region of São Paulo. This paper aims to emphasize the extreme weather events that have occurred in the metropolitan region of São Paulo in 2010 and correlate them with local public policies and evaluate the role of civil defense.

II. PRESENTATION OF RESEARCH

The Metropolitan Region of São Paulo (MRSP) comprises the Alto Tiete, composed by 39 municipalities, which has 34 of these located at the top of the Tiete River, from its headwaters until the dam Pirapora Reservoir, covering 133 km. The annual rate of growth of São Paulo City was 0.8% from 1991 to 2004 ("Population and Vital Statistics," SEADE Foundation). The growth rate tends to decrease, in the order of 0.45% from 2004 to 2010, 0.25% from 2010 to 2015 and 0.19% from 2015 to 2020 (SEADE Foundation, 2009).



Since the 1950's the MRSP began to expand quickly. The industrialization and job offer triggered a population convergence of the City and together with the lack of structural planning, urban green areas were gradually replaced by buildings.

This development led to changes in the pattern of rain drainage, causing flooding due to waterproofing as well as the decrease in relative humidity, resulting in raise of temperatures, a phenomenon called heat islands (LOMBARDO, 1985), compounded by the high rate heat radiated by buildings and consequently causing health problems. Moreover, the lack of riparian vegetation because of the occupation of these regions, accelerated the silting up of rivers and springs, the main fact that weaken the city water supply system composed of: Cantareira, Guarapiranga and High Tietê, remaining rare fragments of vegetation untouchable.

Based on meteorological data from weather, humidity and precipitation was used to analyze rhythmic, thus identifying the occurrences of extreme precipitation in São Paulo Metropolitan Region. Based on data from the civil defense were evaluated occurrences of damage and victim.

III. RESULTS AND CONCLUSIONS

In 2010, the months of January, February, March, September, October, November and December were characterized by extreme precipitation. Autumn and winter presented higher variability, though the environmental disaster were more common during summer and springer (NUNES, 2007). Table 1 shows the occurrence of demanges and victims during the year 2010.

Table: Occurrence of damages and victims during the year 2010.

January

Event Date	Phenomenon	Damage
02/01/2010	Heavy rains	Falling Trees
		Flooding
		24 Flooding
		Congestion
		Interdiction Thoroughfare
		Aircraft Accident
		Airport Closed
04/01/2010	Heavy rains	1 fatal victim and Landslides
		Damage to Property
04/01/2010	Heavy rains	2 Injured
		Falling Trees
		Flooding
		Fall of the Wall
		Traffic Congestion
		Vehicle Damage
		Damage in Paving
05/01/2010	Heavy rains	1 fatal victim
		36 Flooding
		Traffic Congestion
		Aircraft Accident
		Airport Closed
		Person dragged by flood
05/01/2010	Heavy rains and moderate rains	7 Homeless
		Falling Trees
		Streams and Rivers overflow
		Flooding
		Landslide
		4 Fall of the Wall
		Property Damage
		Vehicle Damage
Damage in Paving		
07/01/2010	Heavy rains and moderate rains	Overflowing Rivers and Streams
		Floods
		Landslides
		Property Damage
		Vehicle Damage
		Person dragged by flood
11/01/2010	Heavy rains and moderate rains	30 Flooding
		Traffic Congestion
		Aircraft Accident
11/01/2010		Airport Closed
17/01/2010	Heavy rains	1 Injured

		Person dragged by flood
19/01/2010	Heavy rains and moderate rains	Falling Trees
		Streams and Rivers overflow
		Flooding
		Traffic Congestion
21/01/2010	Heavy rains and moderate rains	5 Injured
		3 fatal victim
		overflow Rivers and Streams
		Floods
		Landslide
		52 Flooding
		4 Landslide
		Damage to Property
Traffic Congestion		
22/01/2010	Heavy rains	water erosion
		Landslides
22/01/2010	Heavy rains	Damage to Property
23/01/2010	Heavy rains	1 Injured
		1 fatal victims
		Falling Trees
		8 Flooding
		Landslide
		Fall of the Wall
		11 Landslides
		Damage to Property
		Traffic Congestion
24/01/2010	Heavy rains	Rivers and streams overflow
		Traffic Congestion
		Erosion
25/01/2010	Heavy rains	Flooding
		17 Landslides
		Damage to Property
		Traffic Congestion
26/01/2010	Heavy rains	Rivers and streams overflow
		Traffic Congestion
		cutting the supply of energy and wate
		Airport Closed
28/01/2010	Heavy rains	1 fatal victim
		2 Overflowing
		Rivers and Streams
		20 Flooding
28/01/2010		Traffic Congestion
31/01/2010	Strong Winds /	17 Falling Trees
		Streams and Rivers overflow

	Heavy rains and gale	Flooding
		Traffic Congestion
		Airport Closed
28/01/2010		Rivers and Streams
		20 Flooding
		Traffic Congestion
31/01/2010	Strong Winds / Heavy rains and gale	17 Falling Trees
		Streams and Rivers overflow
		Flooding
		Traffic Congestion
		Airport Closed

Febuary

Event Date	Phenomenon	Damage
02/02/2010	Heavy rains and moderate rains	25 Flooding
		Traffic Congestion
03/02/2010	Strong winds and heavy rains	13 Homeless
		1 Fatal victim
		34 Fall Trees
		Streams and Rivers overflow
		34 Flooding
		Landslides
		Aircraft Accident
03/02/2010	Strong winds , rain	2 fatal victim
		Falling Trees
		Vehicle Damage
04/02/2010	Strong winds and heavy rains	145 Fall of Trees
		Traffic Congestion
		cut the supply of power and water
06/02/2010	Heavy rains and Ray	12 Flooding
11/02/2010	Heavy rains	Flooding
12/02/2010	Strong winds and heavy rains	1 Falling Trees
		11 Flooding
		Airport Closed
15/02/2010	Heavy rains	1 Fatal victim
		Flooding
		2 Landslides
		Fall of the Wall
17/02/2010	Heavy rains	3 Homeless
		1 Fatal victim
		overflow Rivers and Streams
		78 Flooding
		Landslides

22/02/2010	Srond winds and Heavy rains	22 Flooding
		Traffic Congestion
		Airport Closed
23/02/2010	Heavy rains	2 Injured
		overflow Rivers and Streams
		Flooding
		Landslides
25/02/2010	Heavy rains	Flooding Congestion

March

Event Date	Phenomenon	Damage
01/03/2010	Heavy Rains	Falling Trees
		Traffic Congestion
04/03/2010	Strong winds and heavy rains	145 Fall of Trees
		1 Vehicle Damage
		cut the supply of power and water
06/03/2010	Strong winds and modarate rains	9 Flooding Congestion
14/03/2010	Strong winds, storms, heavy rains	71 Falling Trees
		Flooding
		Vehicle Damage
14/3/210	Strong winds, moderate rains	95 Falling Trees
		1 Fatal Victim
19/03/2010	Hail, Heavy rains and moderate rains	Flooding
25/03/2010	Heavy rains and moderate rains	Falling Trees
		Streams and Rivers overflow
		Flooding
		Landslides
29/03/2010	Strong winds and Heavy rains	Falling Trees

September

Event Date	Phenomenon	Damage
21/09/2010	Heavy rains and hail	Falling Trees
		Flooding Graded
		Traffic Congestion

October

Event Date	Phenomenon	Damage
07/10/2010	Hail, Strong Winds and Heavy rains	Falling Trees
25/10/2010	Heavy rains and hail	2 fatal victim
		6 Flooding
		Traffic Congestion
		Airport Closed

surrounding region.

November

Event Date	Phenomenon	Damage
23/11/2010	Heavy rains and moderate rains	16 displaced
		8 Flooding
		3 Fall of the Wall
26/11/2010	Strong winds and heavy rains	1 Fall Tree
		Overflow of Rivers and Streams
30/11/2010	Heavy rains	Overflowing Rivers and Streams
		4 Flooding

December

Event Date	Phenomenon	Damage
06/12/2010	Moderate rain	Homeless
		1 Landslides
13/12/2010	Heavy rains	overflow of rivers and streams
		79 Flooding
		Landslide
13/12/2010	Strong winds, storms, heavy rains	2 Fall of the wall
		1 landslides
15/12/2010	Strong winds, heavy rains	Falling Trees
		2 Landslides
16/12/2010	Heavy rains and moderate rains	Landslide
		Damage to Property
21/12/2010	Moderate Rain	5 Injured
		2 fatal victim
		overflow Rivers and Streams
		Landslide
22/12/2010	Heavy rains	Erosion
		Car Accident

In January were 249 damages and 24 victims, in February there were 399 damages and 23 victims, in March there were 339 damages and one victim, in September there were 4 damages and no victims, in October there were 12 damages and 2 victims, in November occurred 48 damages and 16 victims and in December occurred 121 damages and 29 victims.

Conclusion

In Sao Paulo Metropolitan Region needs to constructed "climate indicators" in order to represent the climate conditions that can cause extreme impact events. They are designed in consideration of social impacts rather than ecosystem vulnerability. They offer a multi-dimensional picture of changes beyond average conditions, particularly when computer from downscaled data that provides an insight into potential regional changes.

Management methods, new research and data on climate change, effective adaptation strategies developed for Sao Paulo, to manage climate change risk can be monitored and evaluated for their utility to Sao Paulo City and the

V. REFERENCES

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