

## FAPESP-PFMCG

# Assessment of Impacts and Vulnerability to Climate Change in Brazil and Strategies for Adaptation Options

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ciência para sustentabilidade

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## Objectives

- The project aims to establish the base for studies and assessments for impact, adaptation and vulnerability (IAV) in Brazil, using a combination of climate and vulnerability indices based on environmental, geographical-geophysical and social information, in view of identifying areas under risk to climate stress, and to map the vulnerability of population.
- The project constitutes a step further to the production of future climate scenarios, making use of a new generation of regional climate scenarios which have been generated at INPE. Specific studies of vulnerability and risk will be done for the Serra do Mar, Paraíba do Sul Valley and São Carlos regions, as well as to the metropolitan regions of São Paulo, Campinas and the Baixada Santista.

The specific aims of the project can be summarized as:

- (i) **The development of future climate change scenarios at regional scales, for various GHG emission scenarios, together with uncertainty assessments for the XXI Century.** (Eta CPTec 40 and 20 km lat long forced by the HadCM3 and ECHAM4 global models, new runs of IPCC AR5, MBSCG-future developments)
- (ii) **The enhancement of understanding of the impacts of climate change and identify the main regions potentially to be affected by climate change and the vulnerabilities of their populations in Brazil in the following sectors and systems: water resources, social aspects, weather related natural disasters and mega cities;**
- (iii) **The mapping of these vulnerabilities for Brazil using GIS, for the present climate and for some time slices of the present and the future (XXI Century), using vulnerability indices defined based on social, geographical-geophysical and environmental information, as well as indicators of extreme climate events**
- (iv) **The generation of high-quality scientific information to assist public policy in the areas of adaptation and mitigation, as an effective way to ensure that a broader sustainable development perspective is applied for measuring climate change policy and analysis.**

To accomplish these aims, we propose a set of components of this project

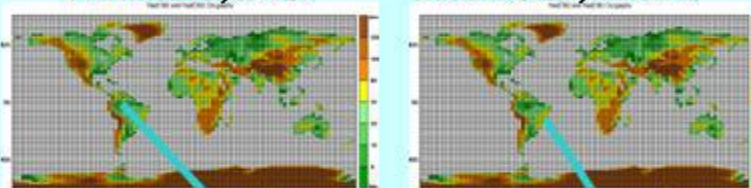
1. Next generation of high resolution climate change scenarios in South America and analyses of climate change scenarios (mean and extremes) until the end of XXI Century, and validations for present climate (*Coordinator of the project PR and PP: Dr. Jose A. Marengo, CCST/INPE*)
2. Uncertainty analyses of global and regional climate change projections for means and extremes (*PP: Dr. Iracema F.A. Cavalcanti, CCST-CPTEC/INPE*)
3. Case Study 1: Studies on vulnerability to climate change and indicators of vulnerability and impacts in the Paraíba do Sul Valley (*PP: Dr. Gilberto Fisch, IAE-CTA*)
4. Case Study 2: Study of impact and vulnerability to natural disasters due to climate change in the Serra do Mar region (in present climate and future climate change scenarios (*PP: Dr. Regina Alvala, CCST/INPE*))
5. Case Study 3: Vulnerability of the metropolitan region of Sao Paulo to climate change (*PP: Dr. Magda Lombardo, UNESP-Rio Claro*)
6. Case Study 4: Mitigation and adaptation measures of vulnerable communities to cope with water-related risks derived from climate change scenarios at river basins of Sao Carlos (*PP: Dr. Eduardo Mario Mendiolo, USP - São Carlos*)
7. Case Study 5: Vulnerability of the metropolitan regions of Baixada Santista and Campinas to climate change (*PP: Dr. Luci Hidalgo Nunes, UNICAMP*)

A final component will be the integration of all activities and products from all components, directed towards an integrated risk and vulnerability analyses and adaptive capacity for Brazil and the State of São Paulo.

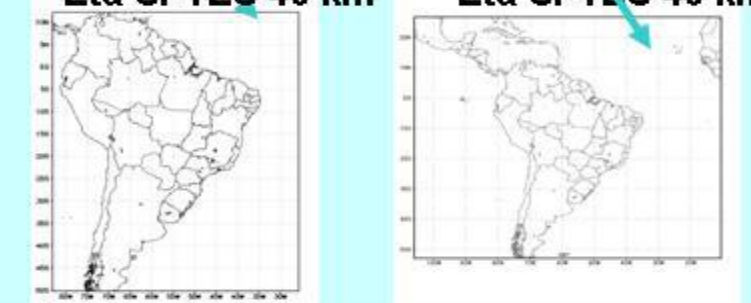
# Component 1- Regional modeling Strategy+ MBSCG

**Regional climate change scenarios 1961-90, 2010-2100**

**HadCM3, A1B**      **ECHAM4, A1B**



**Eta CPTEC 40 km**      **Eta CPTEC 40 km**



**Regional climate change scenarios 1961-90, 2010-2100**

**HadCM3, B1, A1B, A2**




**Eta CPTEC 15 km**




**Regional climate change scenarios 1961-2100**

**IPCC AR5 models, B1, A1B, A2**



**Eta CPTEC 15 km**



**Model validation (Global and regional). For the present (30 year periods) e.g. 1961-90....**

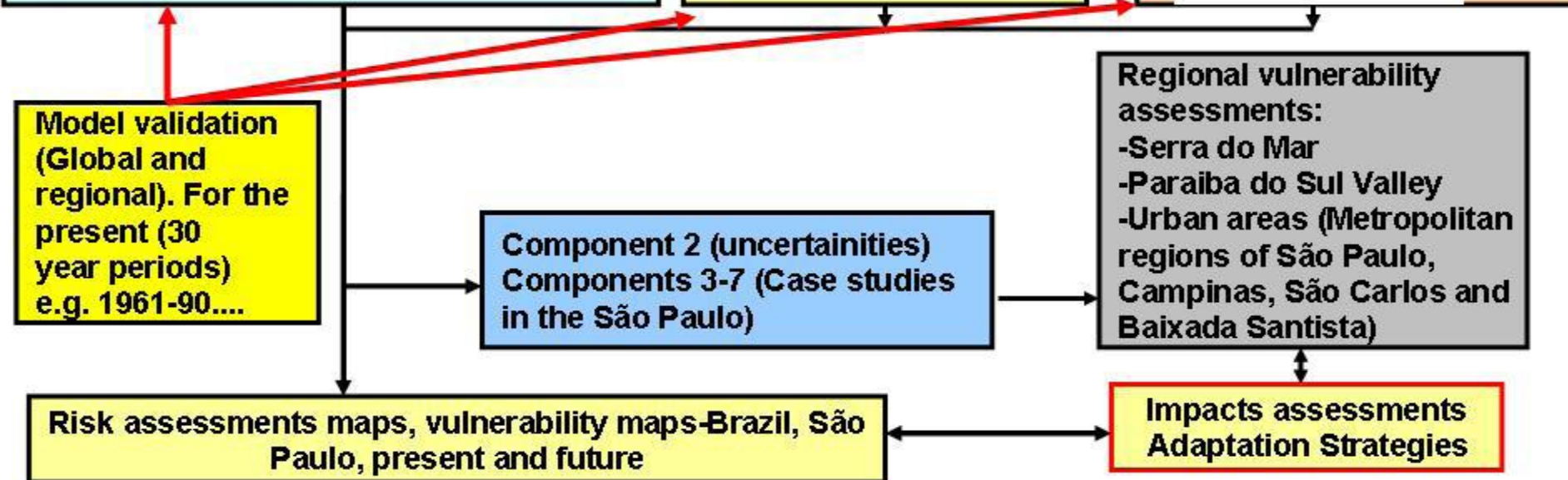
**Component 2 (uncertainties) Components 3-7 (Case studies in the São Paulo)**

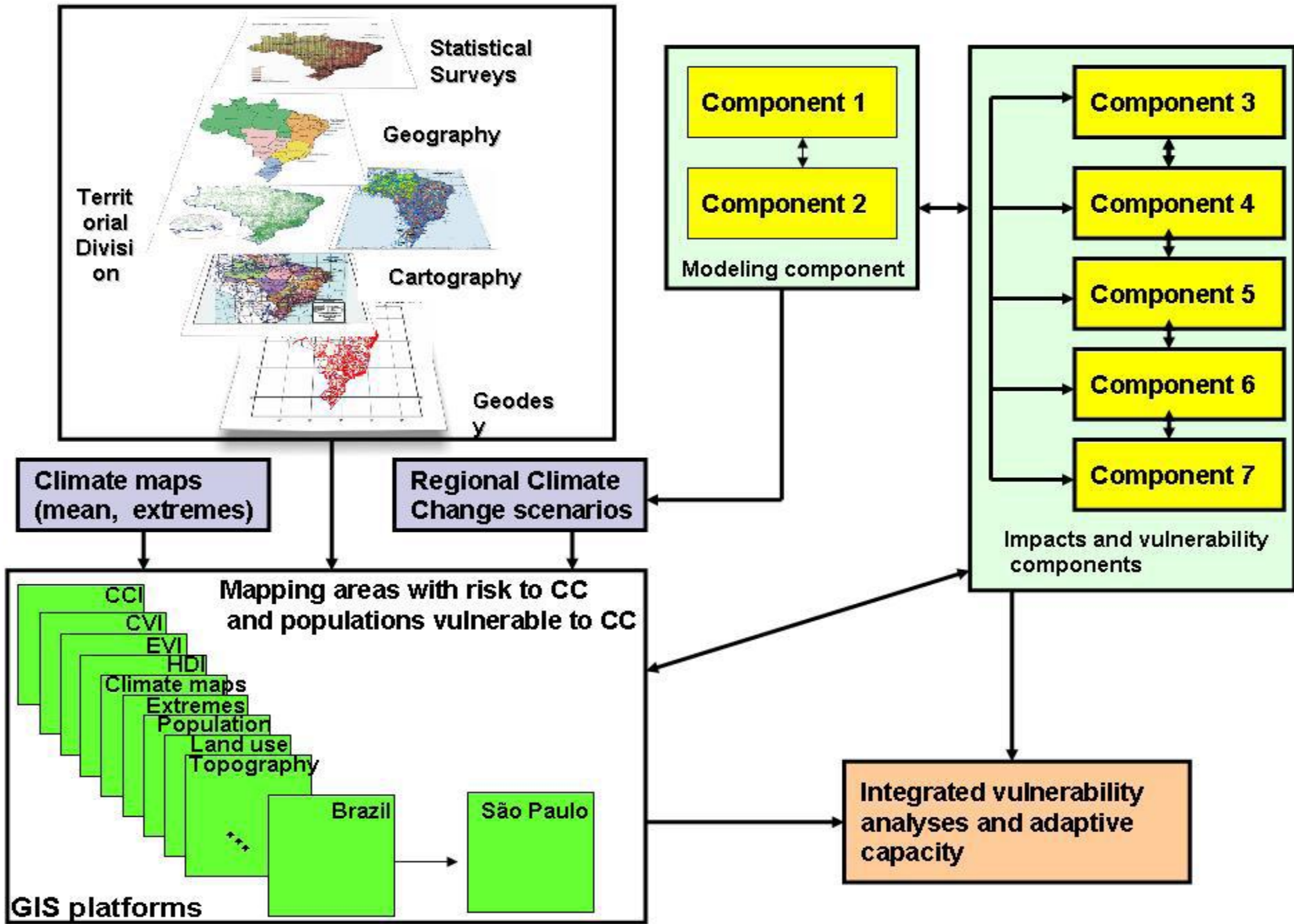
**Regional vulnerability assessments:**

- Serra do Mar
- Paraiba do Sul Valley
- Urban areas (Metropolitan regions of São Paulo, Campinas, São Carlos and Baixada Santista)

**Risk assessments maps, vulnerability maps-Brazil, São Paulo, present and future**

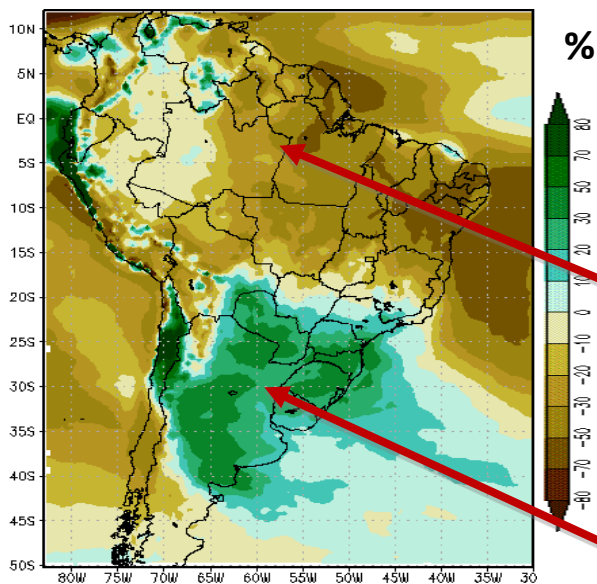
**Impacts assessments Adaptation Strategies**





# Climate variability and change, and future climate scenarios

New future climate scenarios derived from the Eta-CPTEC/HadCM3 for South America under A1B emission scenario suggest that climate change and its related impacts have regional variability



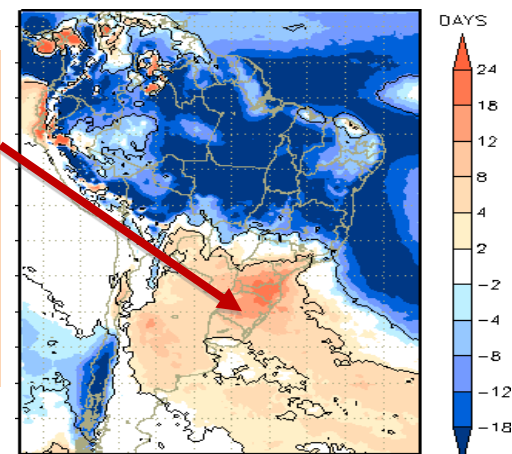
Changes in annual rainfall (%) in 2071-2100 relative to 1961-90.

northern areas of the continent rainfall deficiency

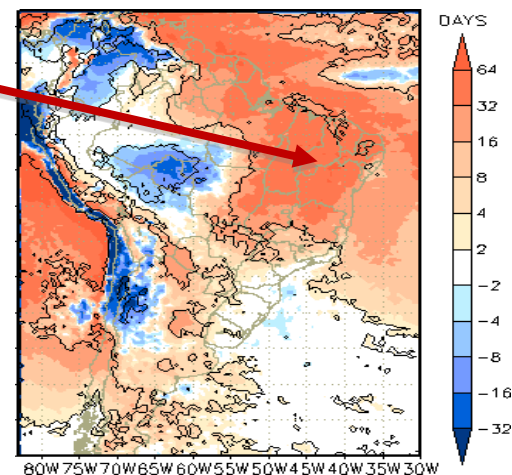
southeastern South America rainfall increase

Projections for the end of the 21<sup>st</sup> century indicate widespread increase of intense precipitation events and extreme droughts for some regions.

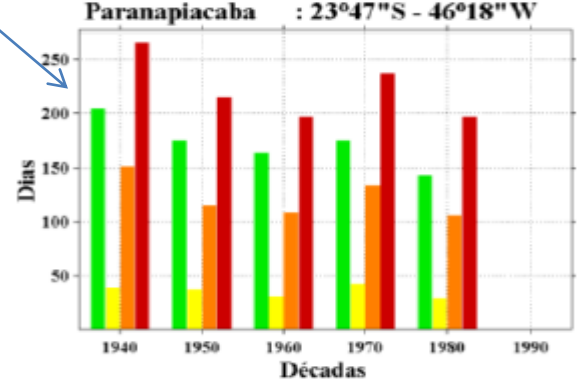
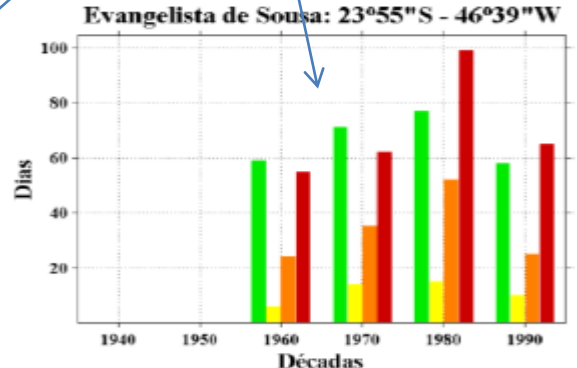
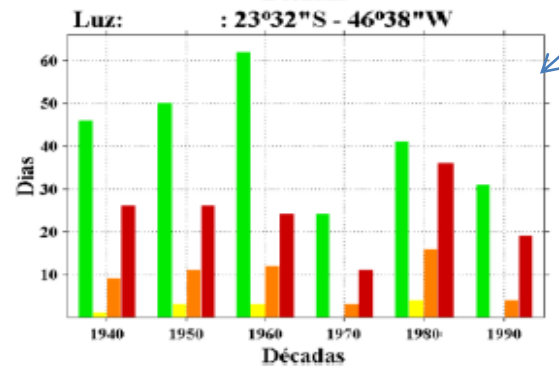
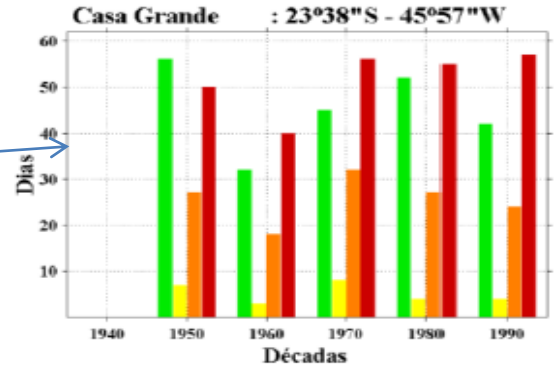
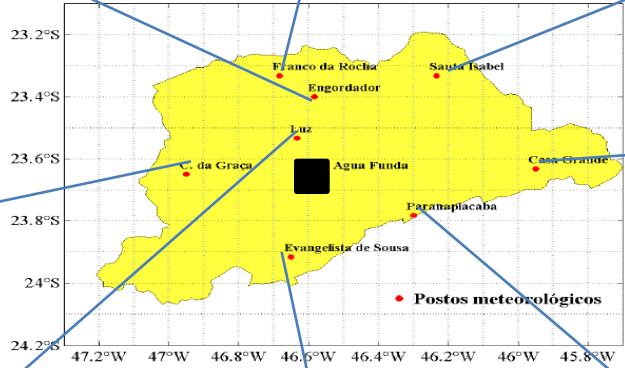
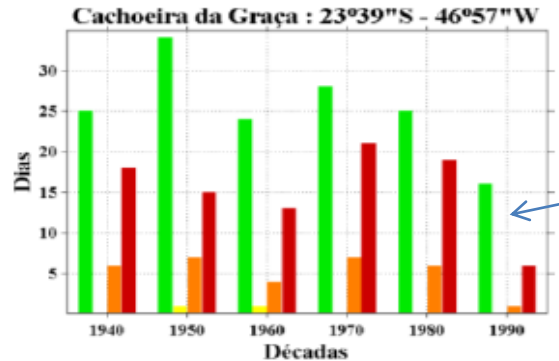
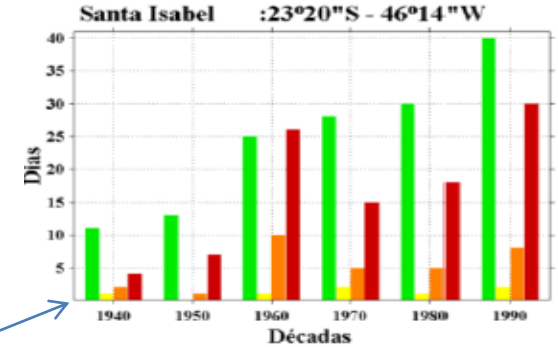
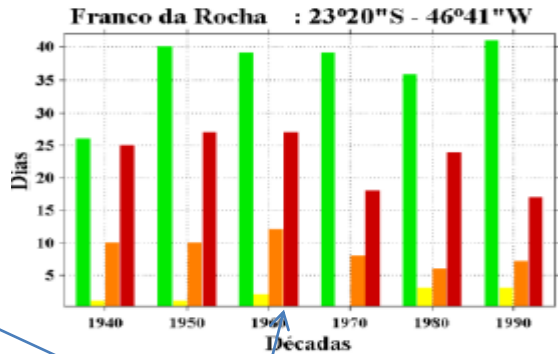
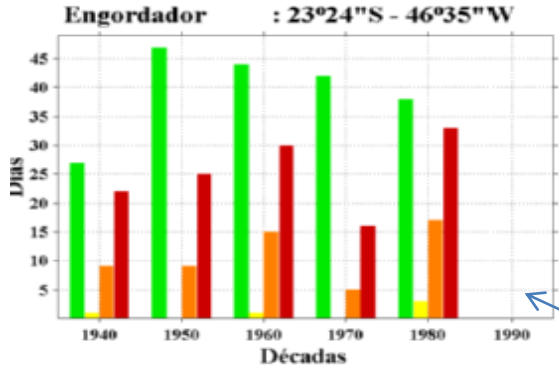
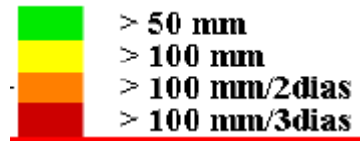
Increase in frequency of heavy precipitation in 2071-2100 relative to 1961-90



Increase in consecutive dry days in 2071-2100 relative to 1961-90



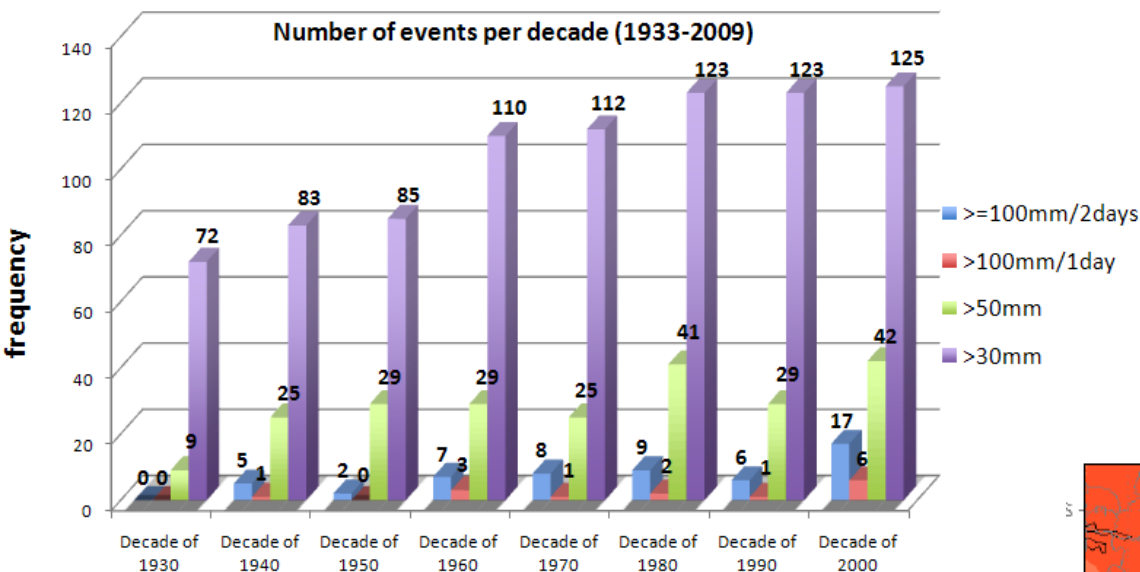
# Extremes and impacts-RMSP





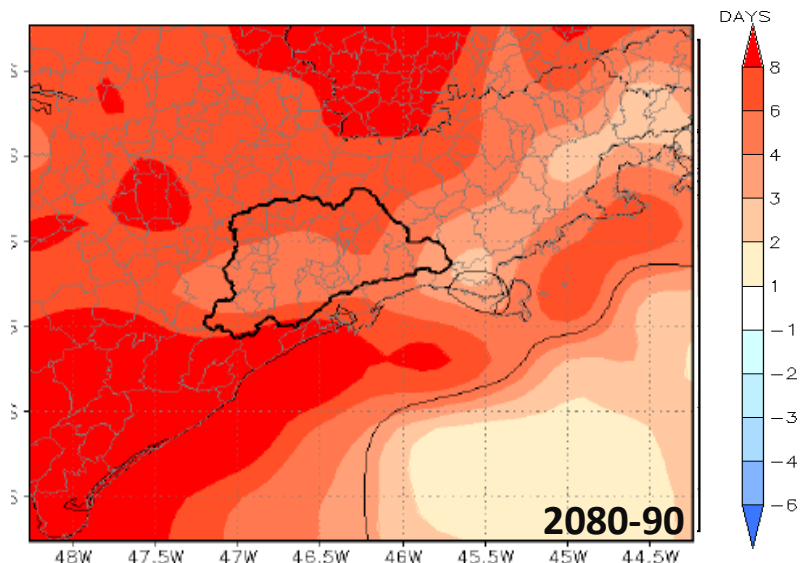
# Urbanization and Megacities-RMSP

*Intense precipitation events at the IAG-USP Agua Funda station in the city of São Paulo 1933-2010*

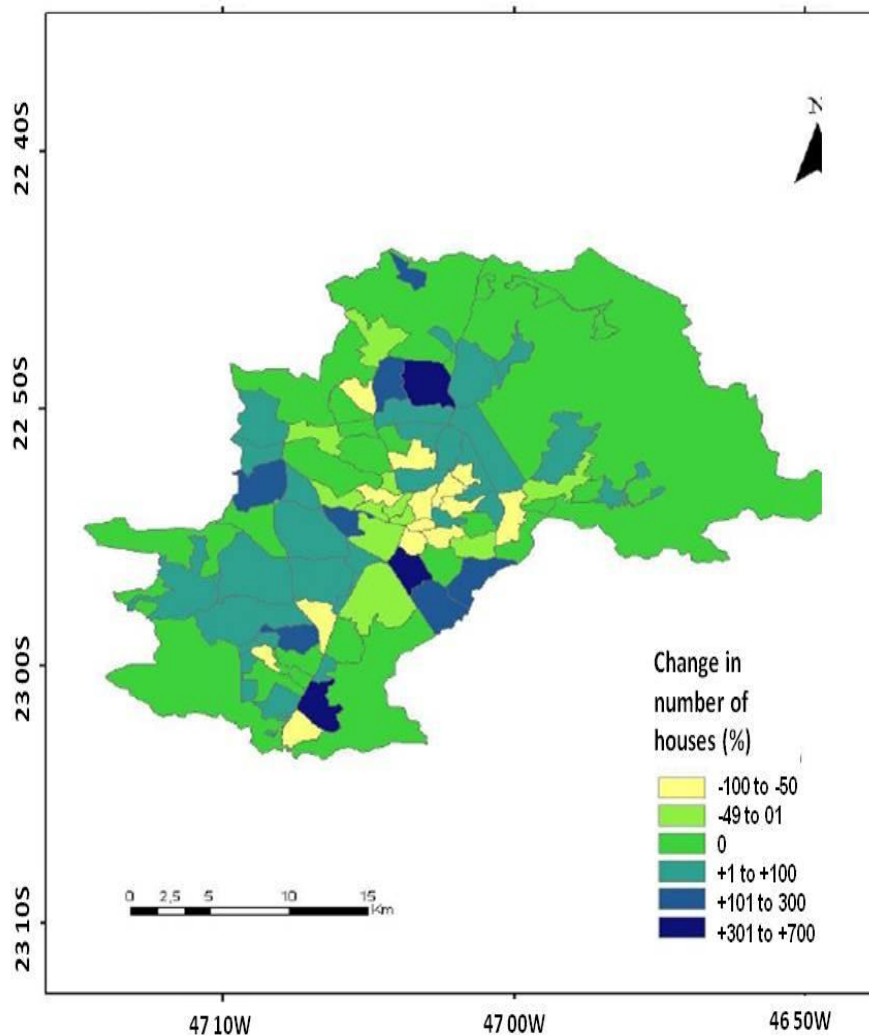


With respect to Brazil's large urban areas, studies detected that in the city of São Paulo extreme rainfall events (greater than 30 and 50 mm/day) have become more frequent and intense since 1960, and that this increase can be attributed more to urbanization rather than to climate change caused by global warming.

Projections (Eta-CPTEC 40 km) for 2080-90 show that the Metropolitan Region of São Paulo (MRSP) may experience increase in number of days with rainfall above 30 mm. The MRSP may be in the future more vulnerable to changes in extremes, with greater risk of floods, landslides and impacting the population (health, housing transportation).



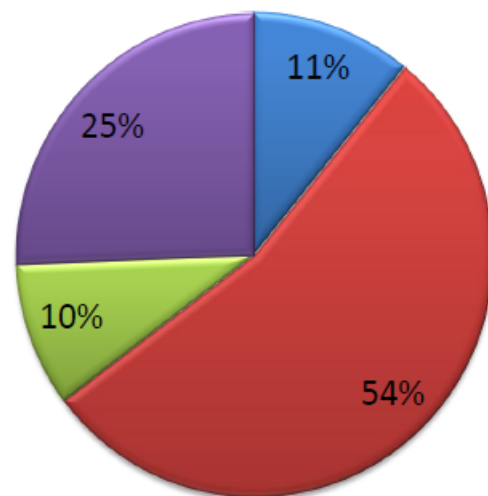
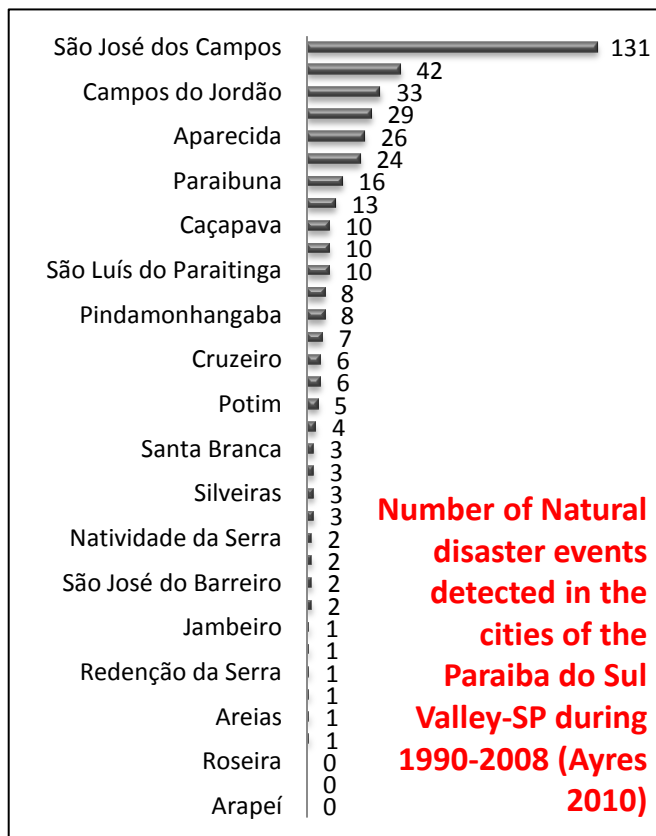
## Risk assessments-SP



Work has been undertaken to evaluate extreme events and to catalogue known hazard incidences in both areas and partial results show changes in the frequency of heavy rainfall and hazardous events for cities in the Baixada Santista and Campinas: for instance, from 1958-1967 to 1998-2007 Campinas experienced an impressive increase in the number of impacts triggered by precipitation, from 129 to 3,837. For the municipalities of the Baixada Santista partial evaluations showed that the economic development of the region is based on unsustainable practices: higher number of catastrophic events is associated with higher deforestation rates.

Impacts of intense rain in the city of Campinas, SP during 1958-2007: number of houses flooded for district: 35 districts showed increase while 25 experienced reductions in the number of cases. (Source: Castellano and Nunes 2010)

## Analysis of hazards in the Paraíba s Valley-SP during 1990-2008



Types of natural disasters during 1990-2008 (subjective analyses based in newspapers reports)

- Landslides
- Floods
- Floods and landslides
- Storms

Detailed analysis of hazards in the Paraíba s Valley derived from newspaper information from 1998 until 2008 suggest that the most frequent event (54%) was flooding, followed by severe storms (25%). Landslides accounted for 11 %, almost the same frequency of flooding and landslides (10%).

The increase of precipitation at the Paraíba s Valley (according to preliminary estimates from the UK Hadley Center global model), may lead to an increase of landslides and deaths. This association is being studied using the downscaling of the global model.

# Time table 2010-2014; Start: 1/12/2010

**Year 1**

**Year 2**

**Year 3**

**Year 4**

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**Project development (coordination)**

**1. Next generation of high resolution CC from RCMs (40 and 15 km) until the end of XXI Century**

**2. Uncertainty analyses of regional CC projections for means and extremes**

**3. Case study 1: Studies on vulnerability to CC and indicators of vulnerability and impacts in the Paraiba do Sul Valley**

**4. Case study 2: Analysis of hydrological extremes for future CC and mapping areas under climate risk and vulnerability of population to natural disasters-Serra do Mar**

**5. Case study 3: Vulnerability of the city of São Paulo to CC**

**6. Case study 4: Mitigation and adaptation measures of vulnerable communities to cope with water-related risks derived from CC-São Carlos**

**7. Case Study 5: Vulnerability of the metropolitan region of Campinas to CC, and experiences of social communication of CC risk and stress**

**Components**

CC 40 km

CC 15 km

CC IPCC AR5 15 km

Report 1

Report 2

Report 3

Final

**Milestones**

Project workshop 1

Project workshop 2

Brazilian "IPCC" report

Internat. Conference

# Synergy with other projects, programs and initiatives relevant to IAV

