CLIMATE CHANGE ADAPTATION PLAN – THE CITY OF RIO DE JANEIRO

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ENVIRONMENTAL ASSETS

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Grabriela Ushida - Centro Clima/COPPE/UFRJ

THE CITY OF RIO DE JANEIRO

- **POPULATION**
  - **6.5** million people
  - High density on the low lying area; high rate of urbanization
  - **1.035** "favelas" (slums)
- **LANDSCAPE DIVERSITY**
  - **Massifs, beaches, lagoons, bays** → "Capital Verde"
- **TRANSPORT INFRASTRUCTURE**
  - BRT, BRS, bike sharing system
- **ECONOMY**
  - **GDP (2011)** – 91,0 bi (Brazil's second largest)
- **URBAN TRANSFORMATION** – Mega events
  - **World Cup** (2014)
  - **Olympic and Paralympic Games** (2016)

CITY OF RIO DE JANEIRO

LEGACY

GOALS

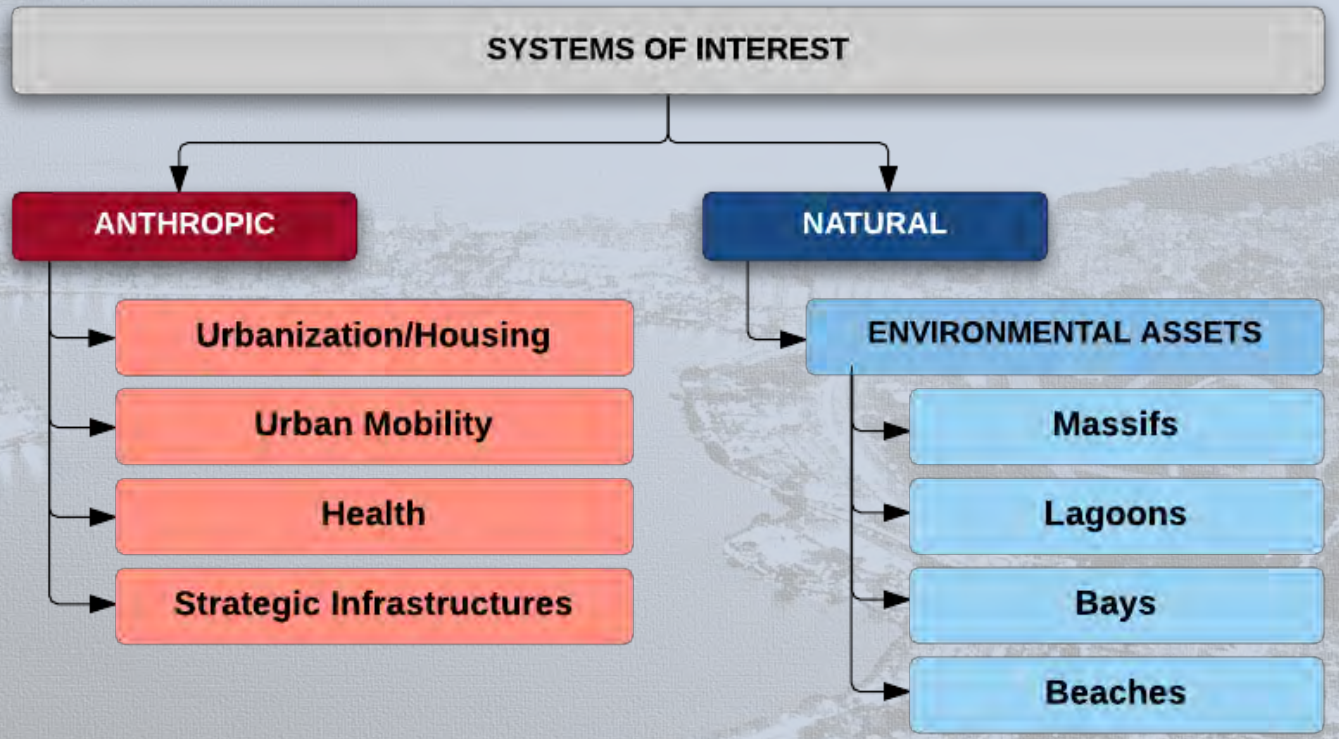
GENERAL

- **Provide technical support for Rio's City Hall in order to implement its Adaptation Plan**

SPECIFIC

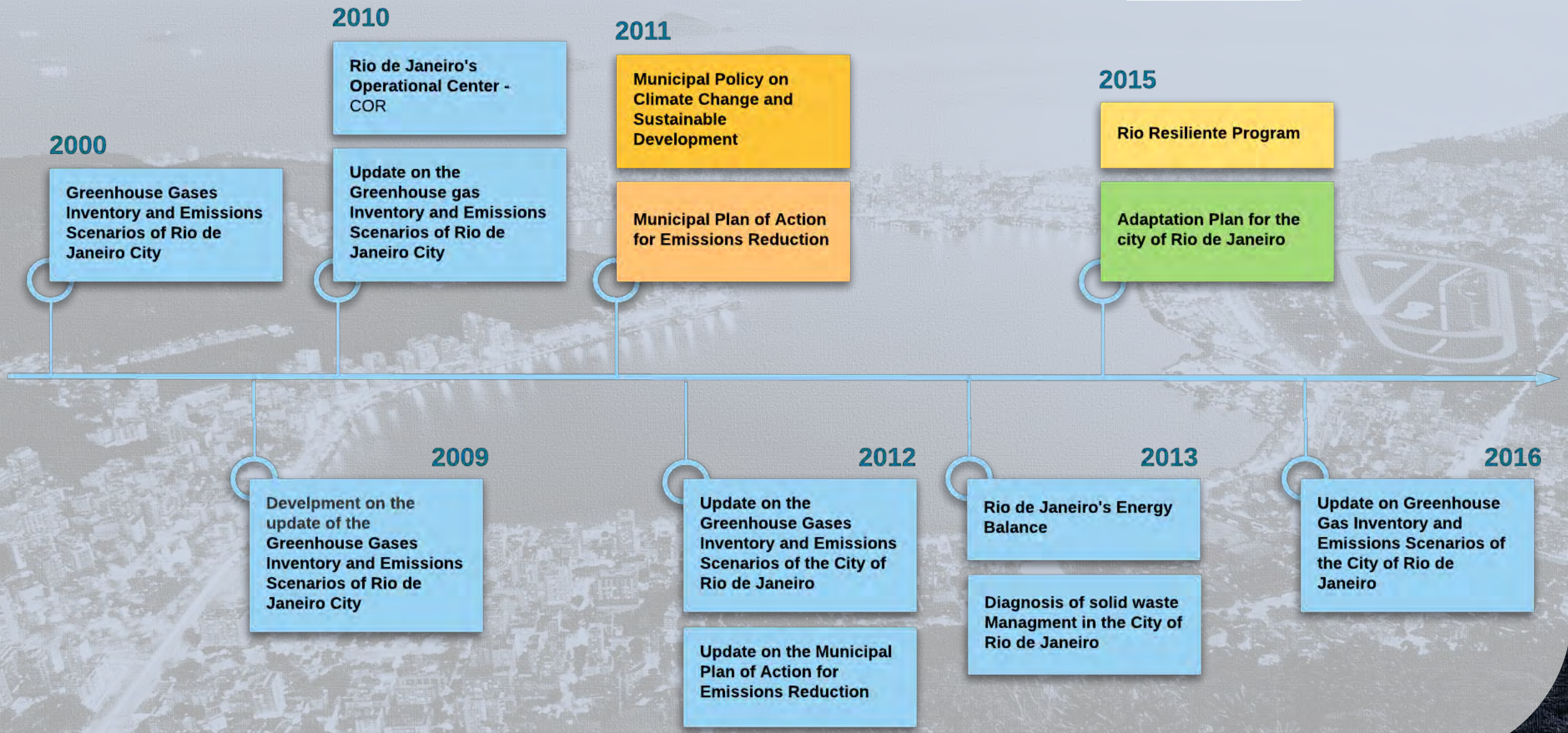
- **Evaluate Rio's vulnerability regarding its relations with human and natural systems considering the present and future climate**

- **Identify and propose adaption strategies**

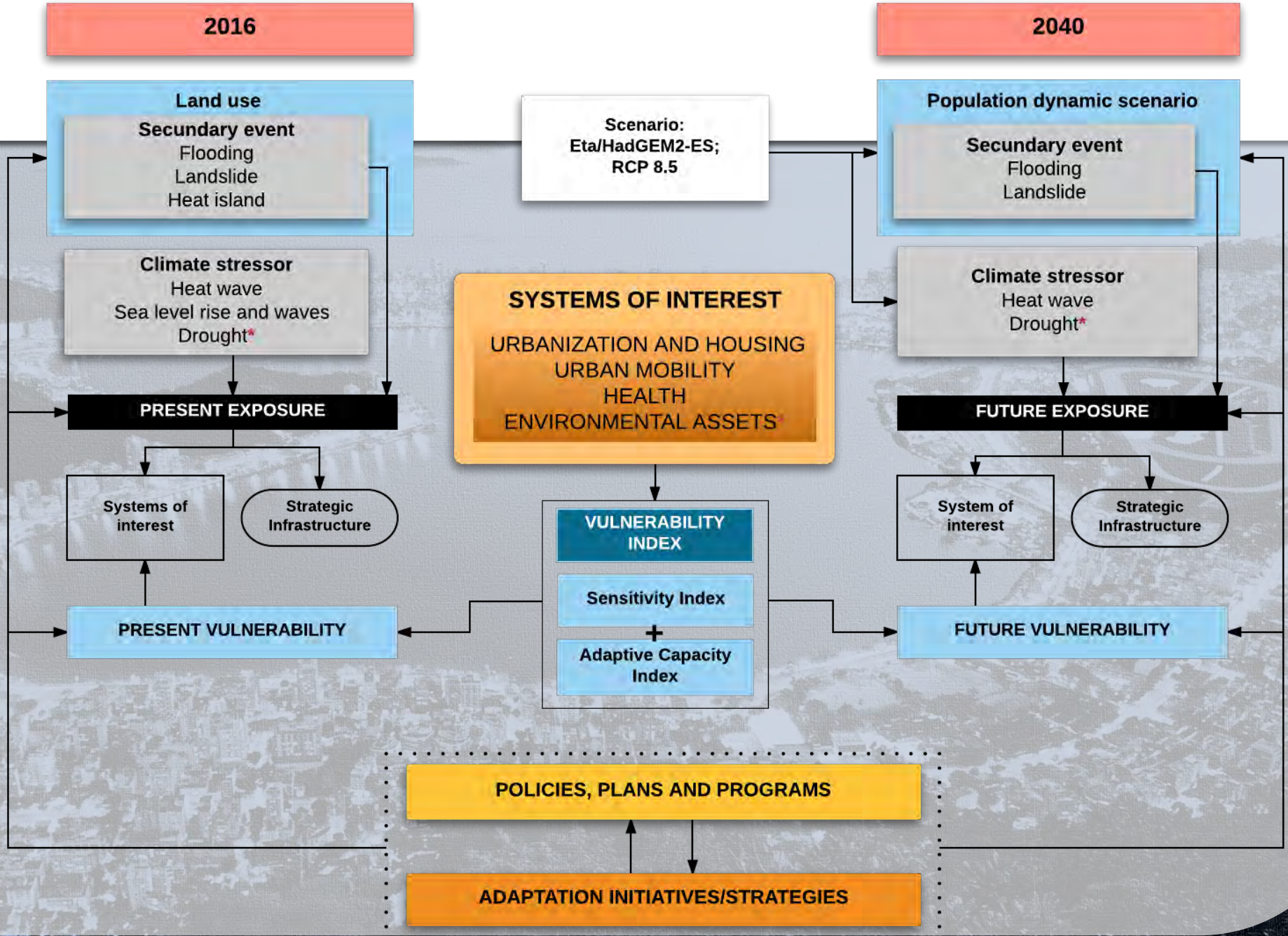


The **Climate Change and Sustainable Development Administration** of the Municipal Environment Secretariat (SMAC/PCRJ) established a close partnership with the Climate Center/COPPE/UFRJ, starting in 2000, to strengthening the **Climate Planning Agenda**. Since then, several studies on mitigation and adaptation have been developed, as well as courses and subsidies for the elaboration of **Policies, Plans, Programs and Projects**

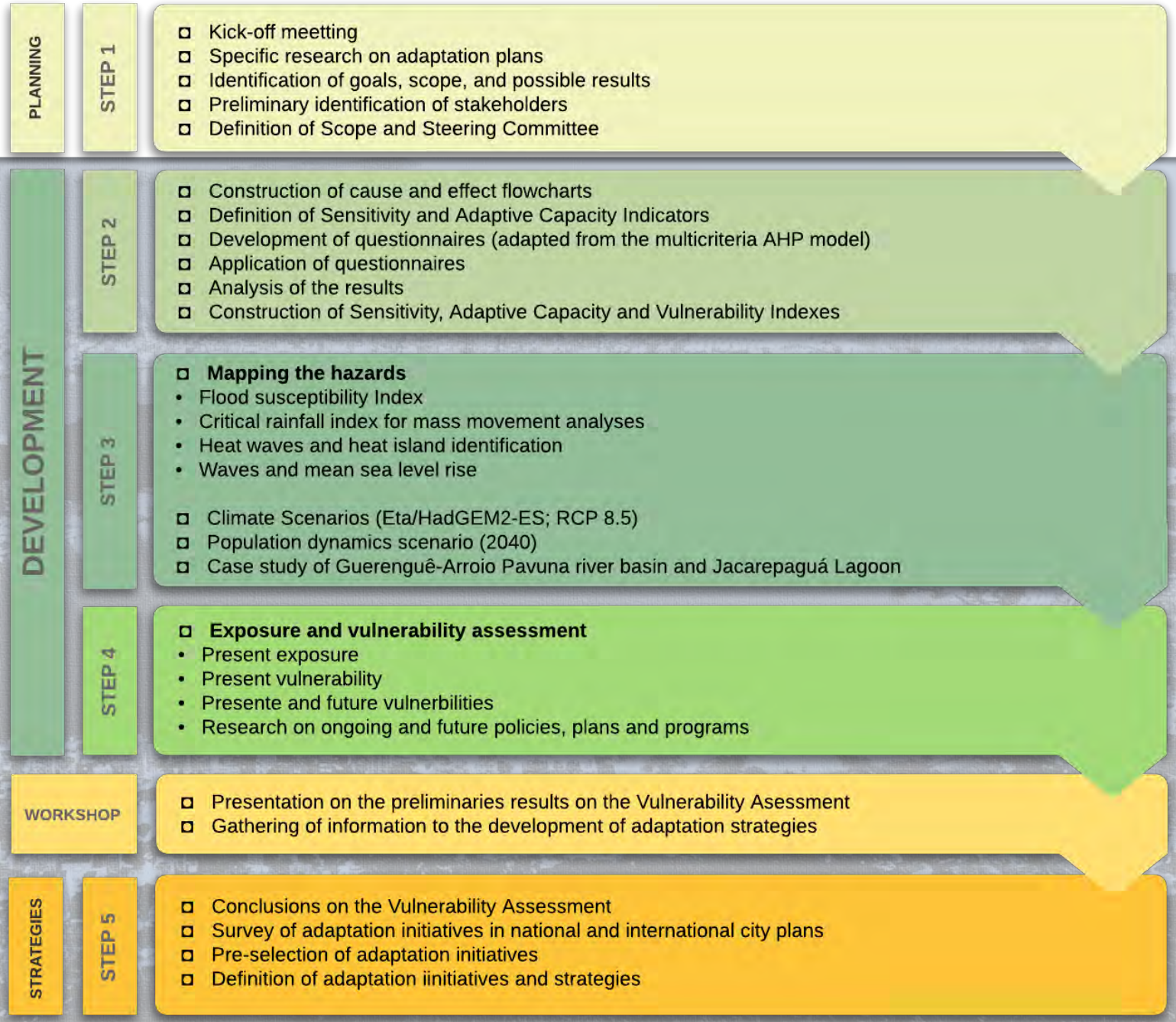
MITIGATION AND ADAPTATION



CONCEPT FRAMEWORK



CONSTRUCTION FLOW CHART



SCENARIOS – CLIMATE MODELING

MODEL

- **Eta/HadGEM2-ES**
  (Instituto Nacional de Pesquisas Espaciais - INPE)

SPACIAL RESOLUTION

- **5 km**

CLIMATE VARIABLES

- **Precipitation** (PRCP)
- **Temperatura** (TP2M)

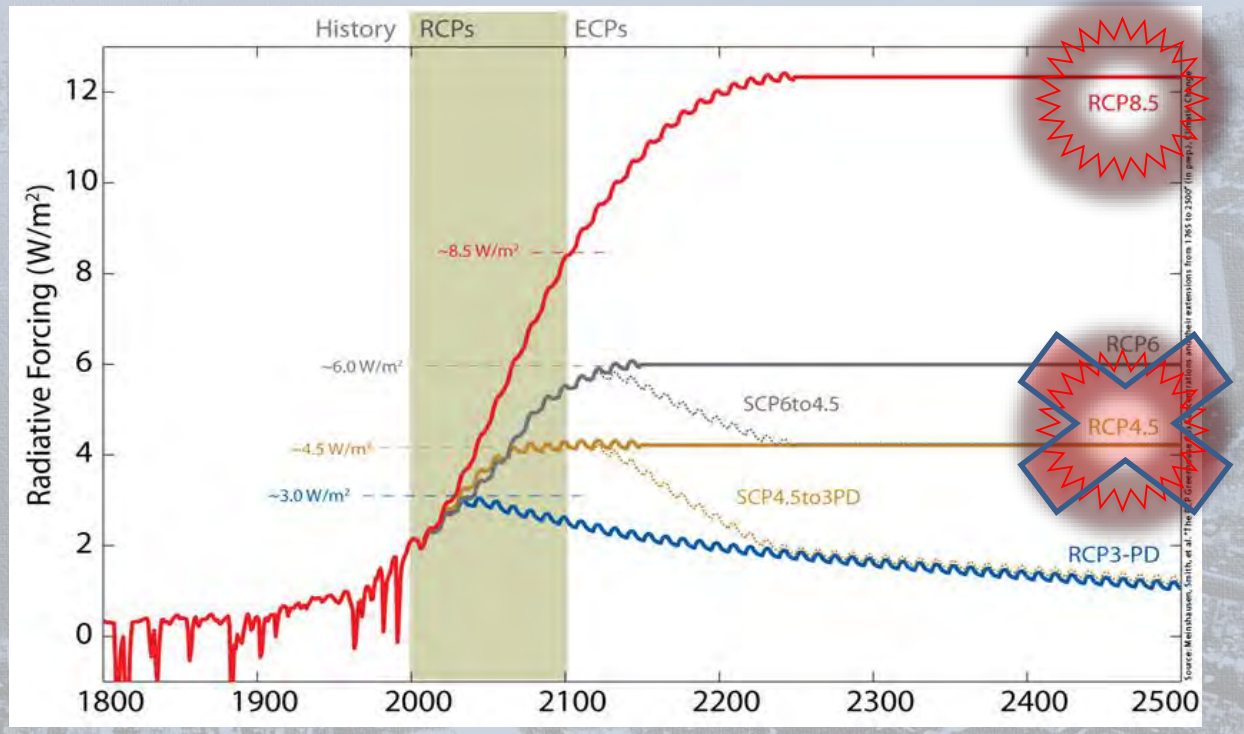
TIME SLICES

- **Present:** 1961-1990
- **Future:** 2011-2040

SCENARIO

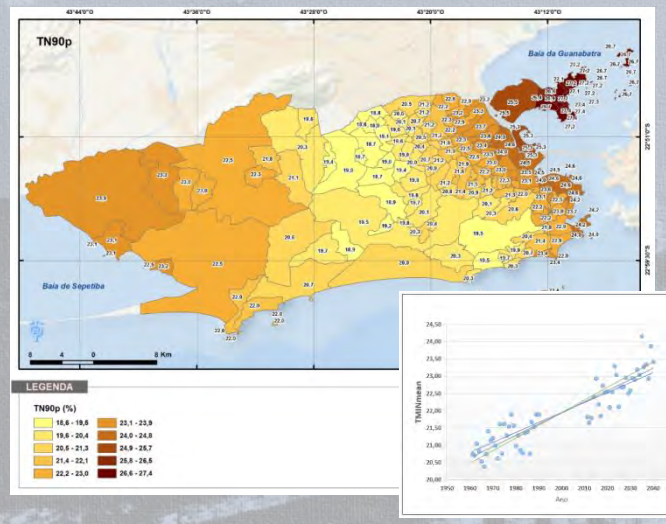
- **RCP 8.5**

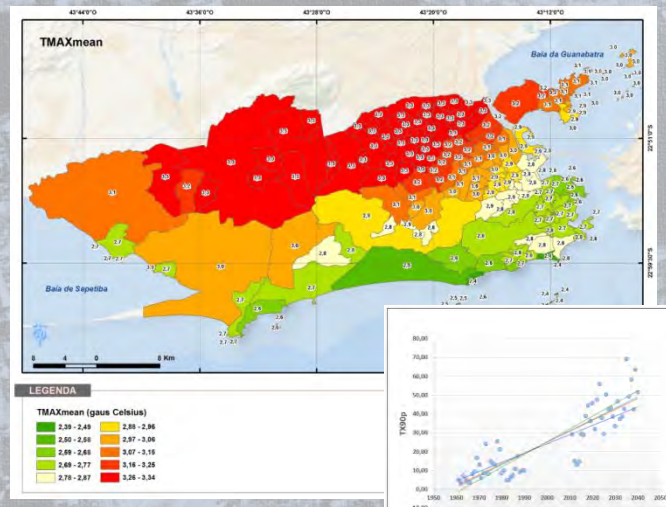
AR5/IPCC



RCP 4.5 → 1,8 ± 0,5 ºC (ΔT = 1,1-2,6 ºC)
RCP 8.5 → 3,7 ± 0,7 ºC (ΔT = 2,6-4,8 ºC)
Baseline 1986-2005; **Future**: 2081-2100

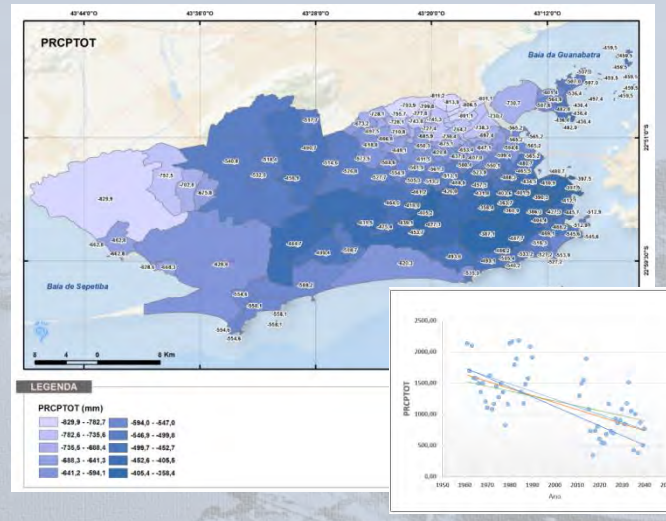
SENARIOS – Climate extremes indicators

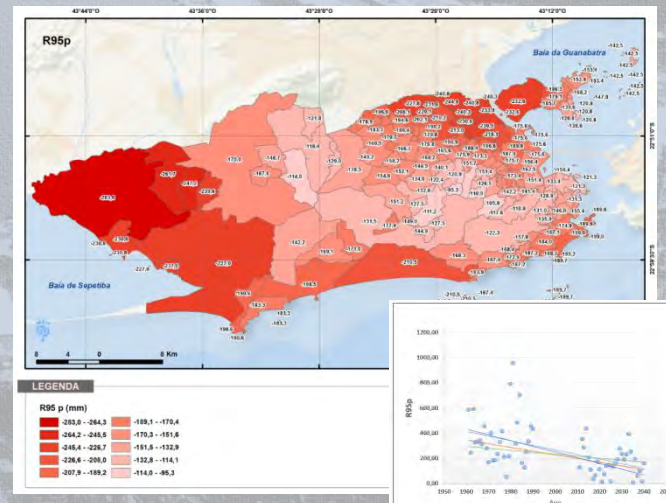




CLIMATE EXTREMES INDICATORS

- TEMPERATURE
  - TMAXmean
  - TMINmean
  - TXx
  - TNx
  - TX90p
  - TN90p
  - SU25
  - TR20
- PRECIPITATION
  - WSDI
  - PRCPTOT
  - CDD
  - RX1day
  - R95p
  - R30mm





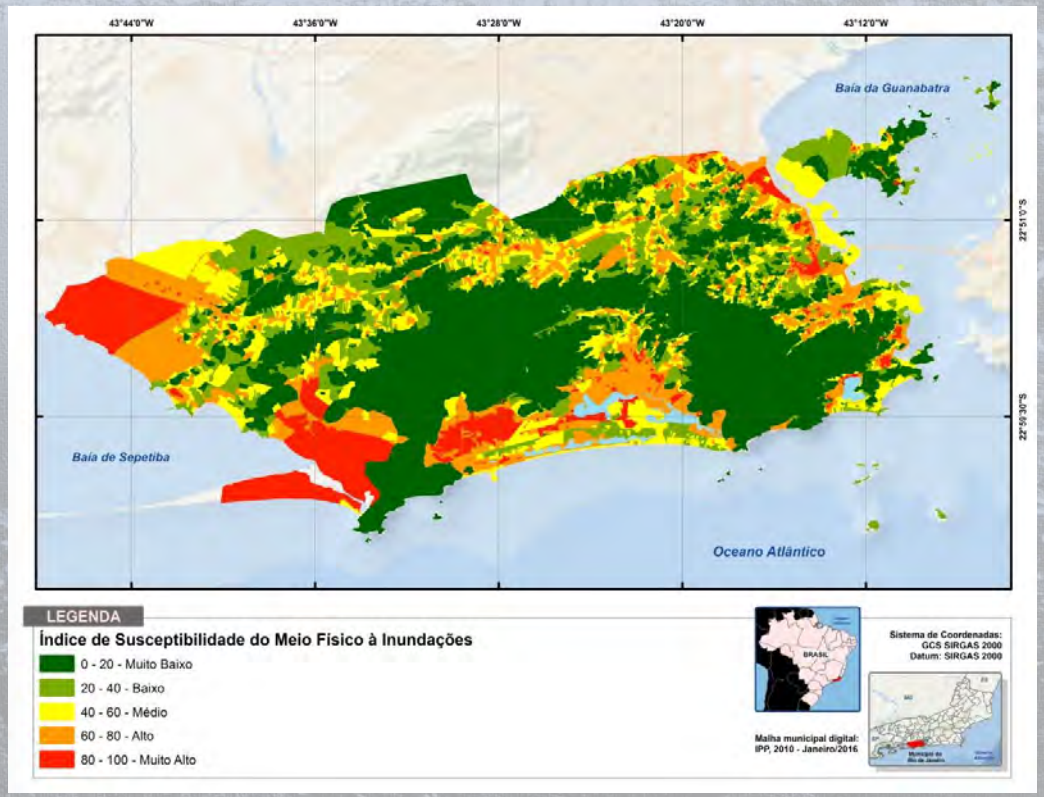
HAZARDS

FLOODING SUSCEPTIBILITY

- Map the susceptibility of the physical environment to possible occurrence of river flood → **ISMFI**: Susceptibility Index of the Physical Environment to Flooding, which represents, **qualitatively**, the areas prone to face events of precipitation

ASSESSED PHYSICAL FACTORS:

- SLOPE - **IDEC**
- ABSOLUTE ALTIMETRIC QUOTA - **ICA**
- SOIL IMPERMEABILIZATION - **IIMP**
- PROXIMITY OF WATER SOURCES - **IPROX**

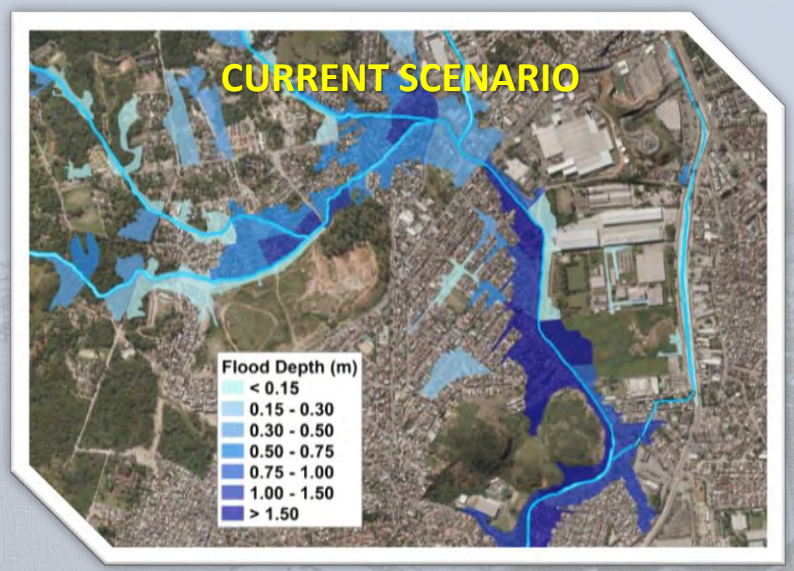


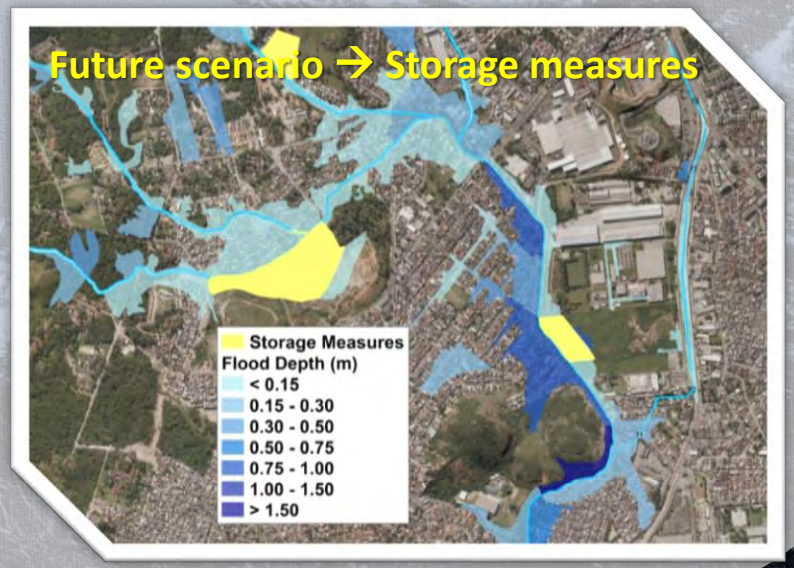
FLOODING SUSCEPTIBILITY – Case study

CHANGING URBAN FLOOD CONTROL APPROACH CONSIDERING CLIMATE CHANGES

Approach	Scenarios
Classic	Future Land Use
Resilient	Future Land Use
	Increase of the Design Rainfall intensity
	Mean Sea Level Rise

Design aims: not only the proposed project has to resist to a design rainfall, but it also has to **fastly recover** from critical events and **sustain its functions** under stress conditions

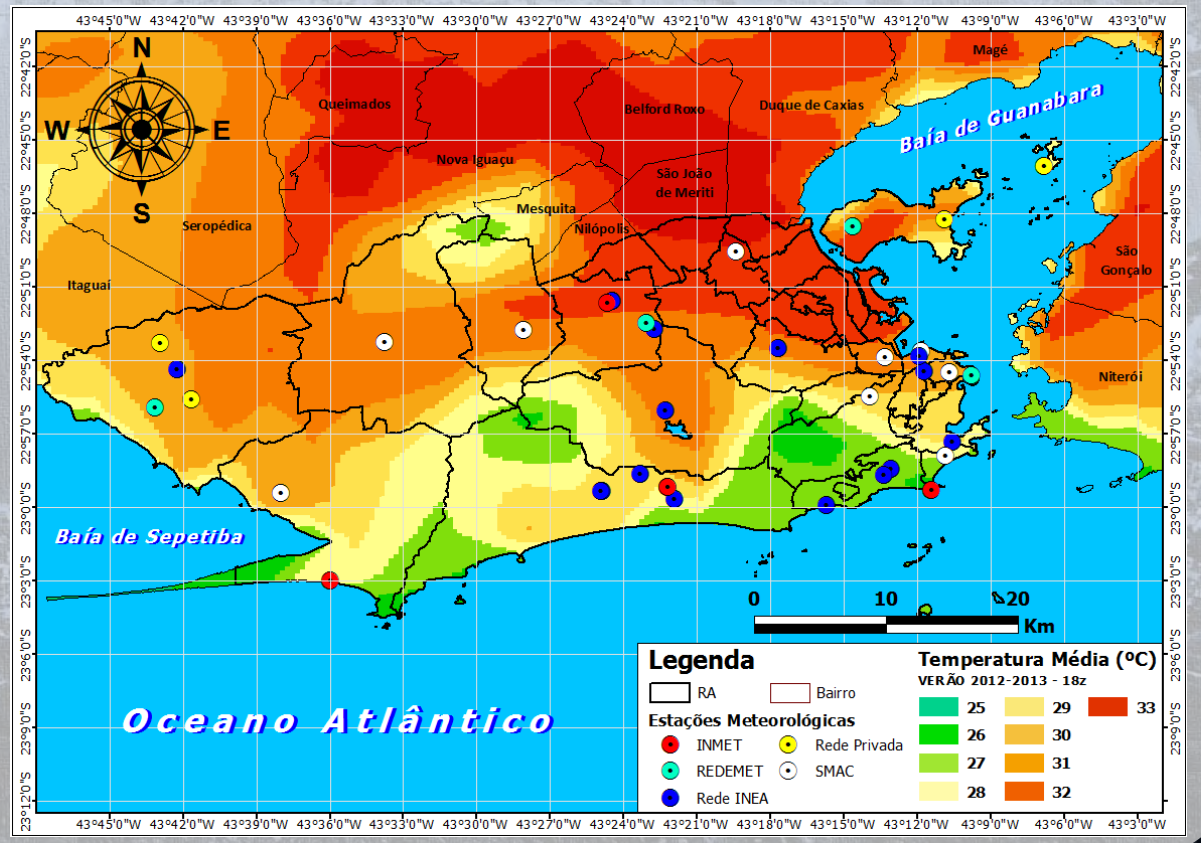




NUMERIC FORECASTING – Heat islands and heat waves

- Evaluate the influence of meteorological systems regarding **heat islands** and **heat waves** and assess the **Heat Index**, based on the Weather Research and Forecasting – WRF model

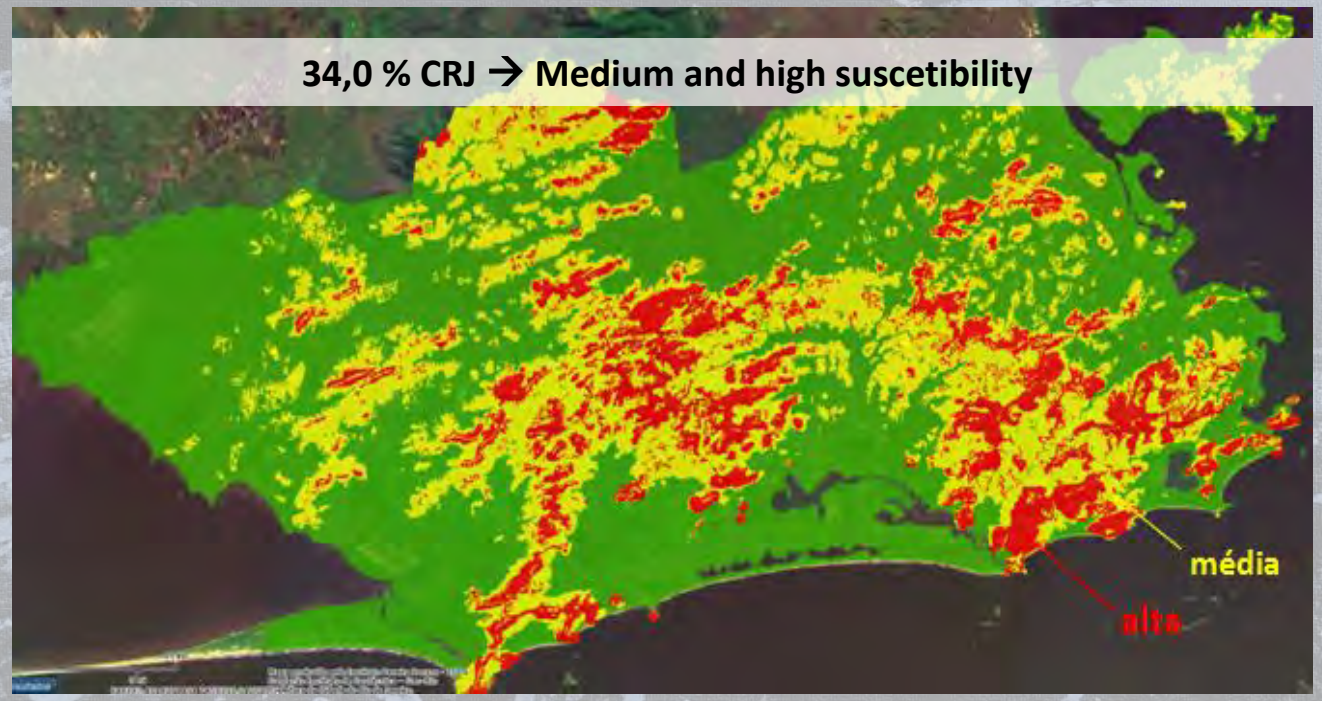
The lowest temperatures are recorded in the **forest massifs and coastal areas**, where the s**ea breeze** acts as an important cooling system

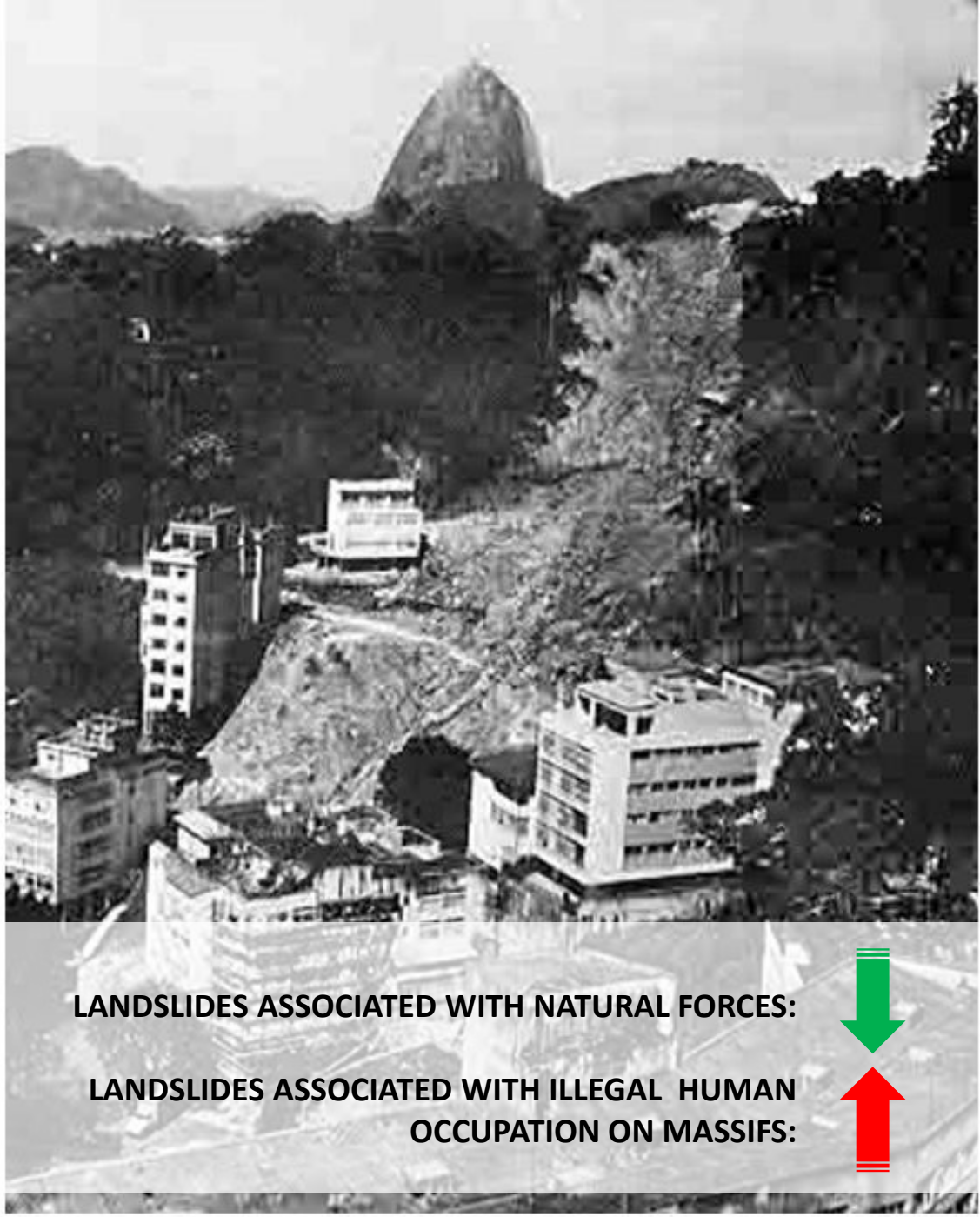


LANDSLIDE SUSCEPTIBILITY

- Determine possible changes in susceptibility of **mass movement** to pluviometric events for DJFM (2030-2040), for 3, 6, 12, 24, 96 and 720 h cumulative, considering critical curves already defined for the City

- **Obs**.: This study was conducted even under the expectation of lower levels of precipitation in the future, as indicated by the RCP 8.5 scenario of Eta-HadGEM2-ES





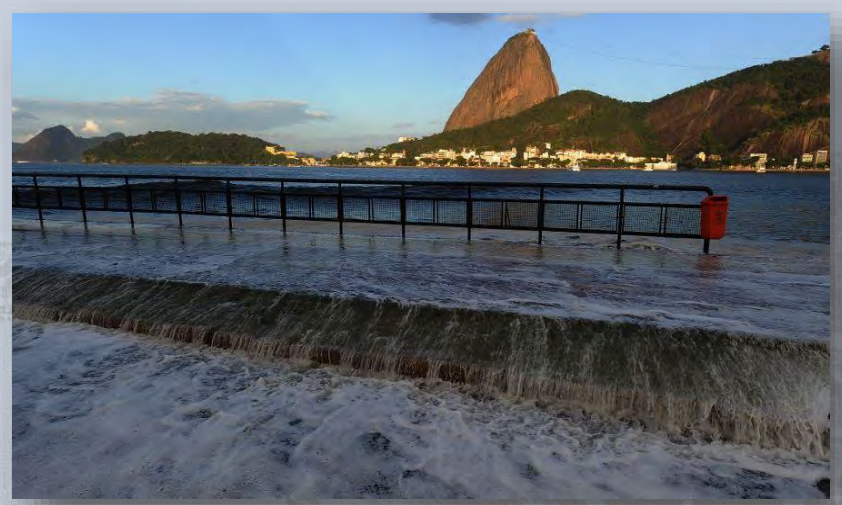
LANDSLIDES ASSOCIATED WITH NATURAL FORCES:

LANDSLIDES ASSOCIATED WITH ILLEGAL HUMAN OCCUPATION ON MASSIFS:

SEA LEVEL RISE, WAVES AND OTHERS MARINE AGENTS

- Evaluate beaches, lagoons and bays concerning its vulnerability to waves, rough sea/swells, storm surge and eustatic sea level
- **Historical survey** on waves and rough sea/swells from 1850 to 1990

- **Obs**.: **a)** The original urbanization of the shoreline did not take into account the coastal dynamics and oceanic agents; **b)** The meteorological tides already reach 1,0 m.

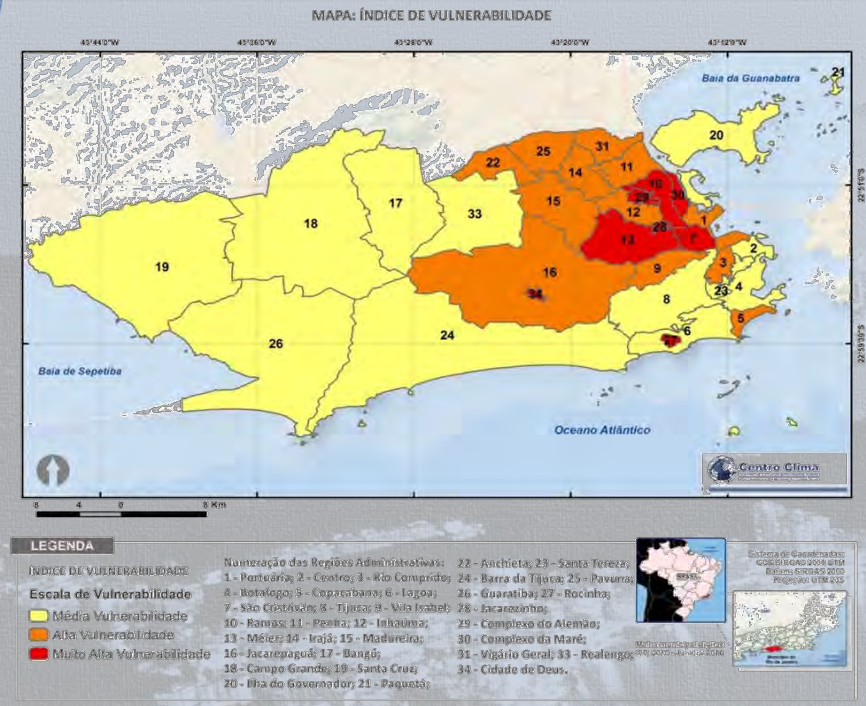


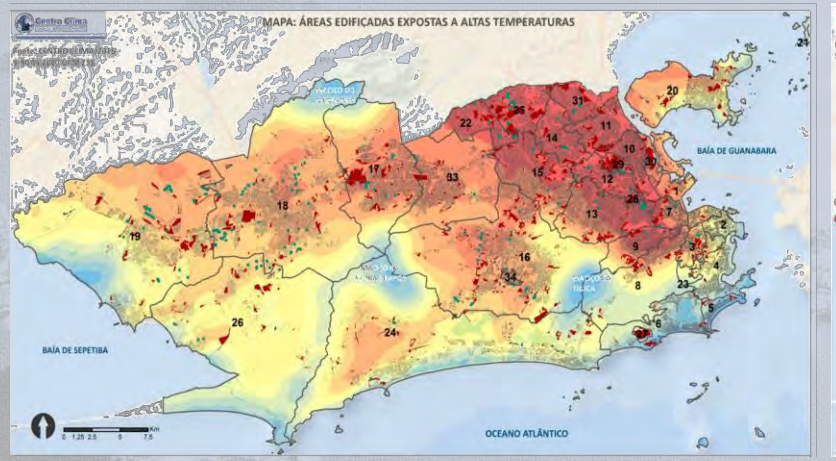
RIO PREFEITURA

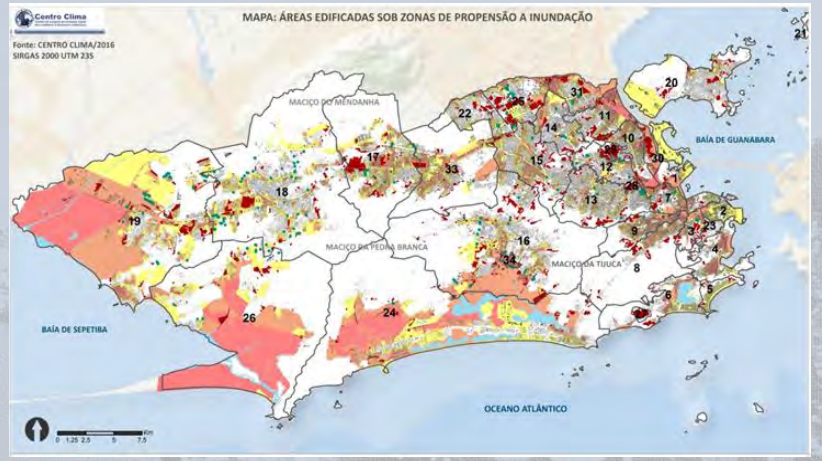
Centro Clima
CENTRO DE ESTUDOS INTEGRADOS SOBRE MEIO AMBIENTE E MUDANÇAS CLIMÁTICAS

VULNERABILITY ASSESSMENT

VULNERABILITY INDEX- Urbanization and Housing



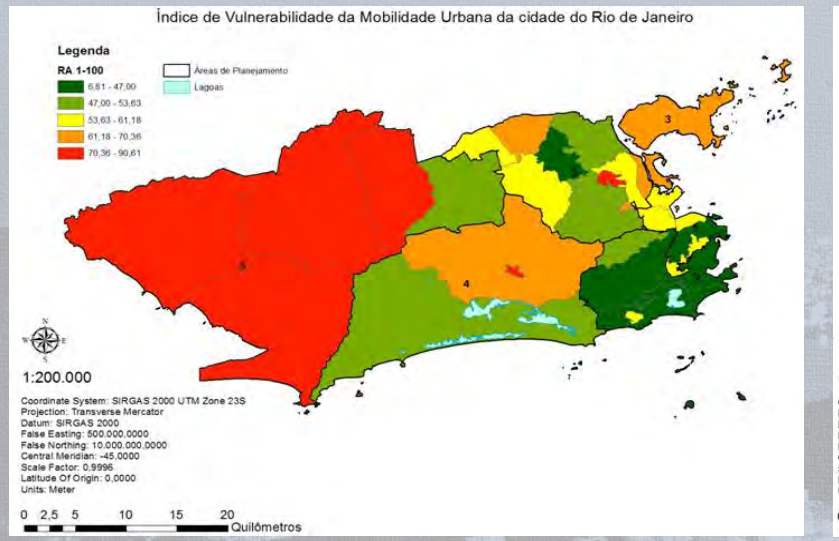


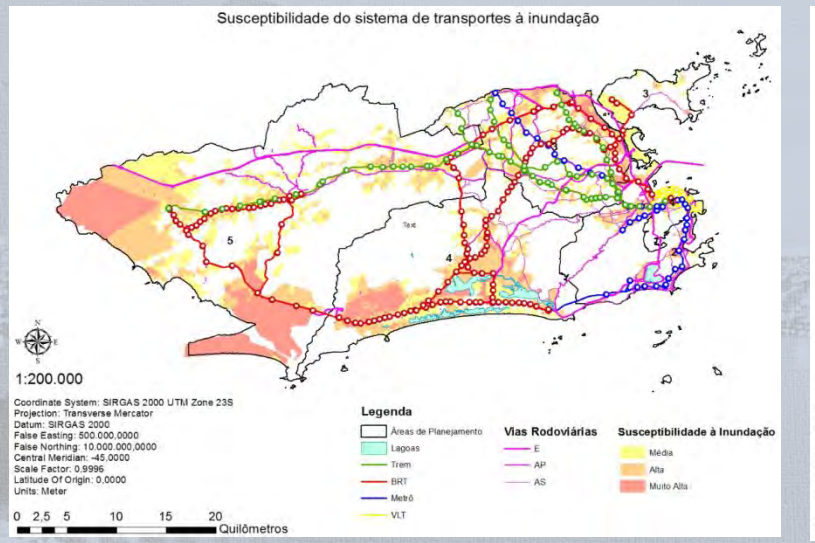


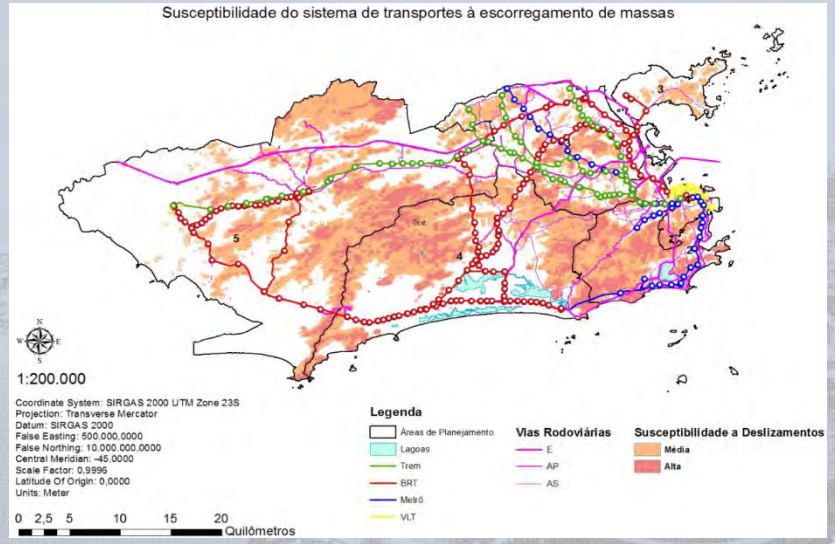
HAZARDS

FUTURE VULNERABILITY	TENDENCY
Current growth vectors are threatening areas naturally sensitive to climate change	↑
Urban densification in areas exposed to high temperatures	↑
Urban coastal area threatened by SLR	↑
Perpetuation of vulnerability standards for residents of precarious settlements	↓
Social Housing Programs in areas prone to climate change impacts	↑

VULNERABILITY INDEX - Urban Mobility



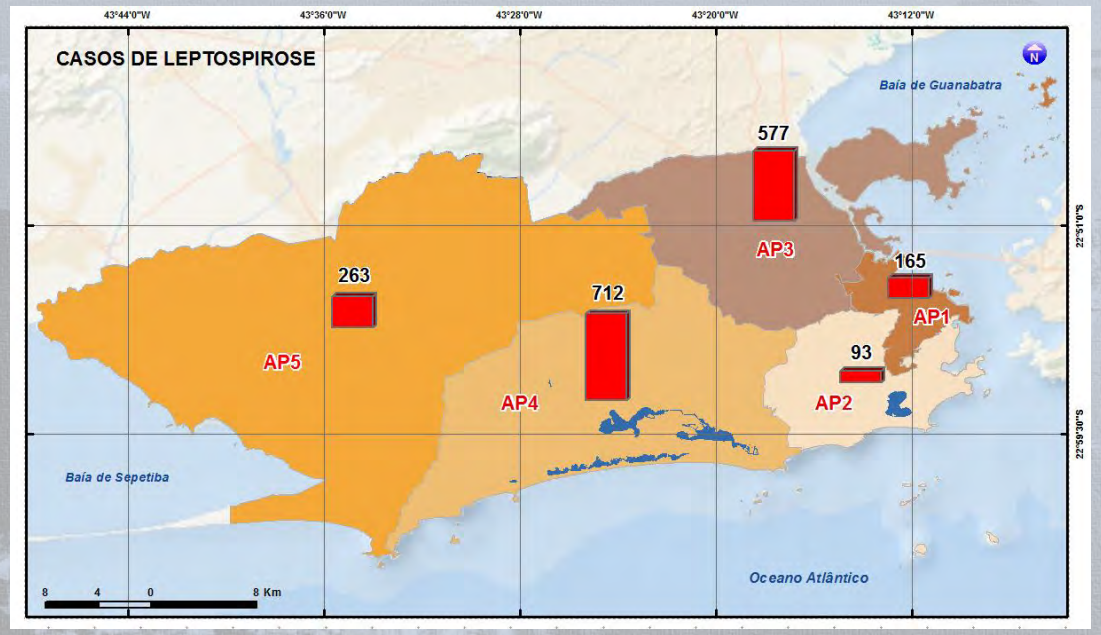


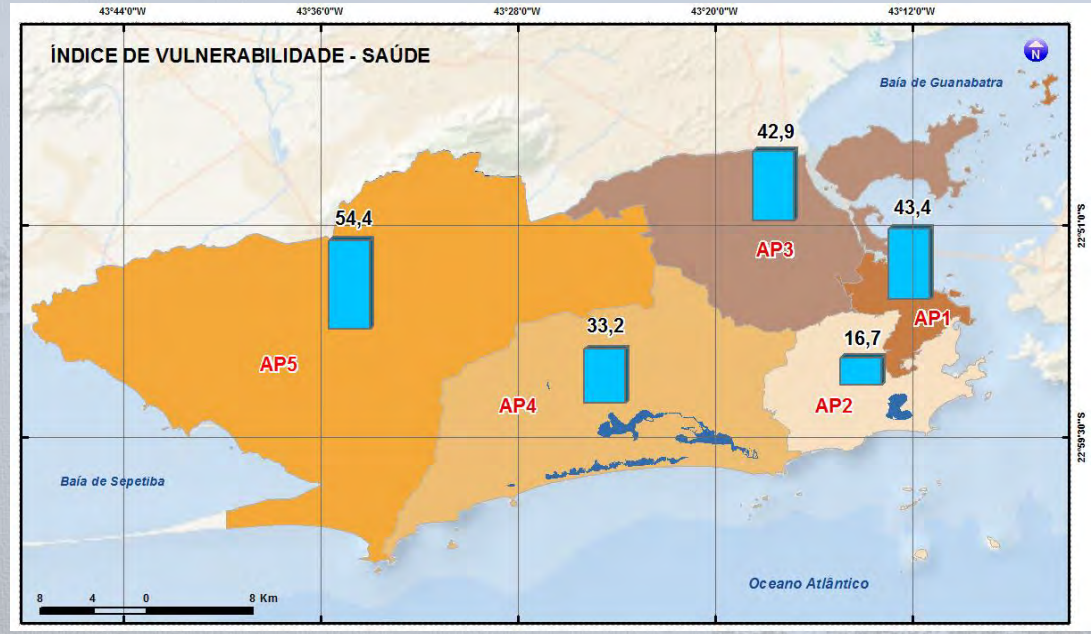


HAZARDS

FUTURE VULNERABILITY	TENDENCY
Temperature interference in road and rail systems infrastructure	↑
Thermal comfort of bus and train stations and pathways, bicycle paths and sidewalks	↓
Flooding of routes and accesses to medium and high capacity stations of the current and planned system	↑
Exposure of highways, overpass and bike lanes → Transgression of building standards	↑
Vulnerability of underground tunnels to heavy rains, combined with rough sea/swells and tides of syzygy and storm surges	↑
Susceptibility of tunnels, roads and stations to landslides by mass movements → The system expansion plan predicts the implantation of infrastructures in susceptible areas	↑

VULNERABILITY INDEX - Health





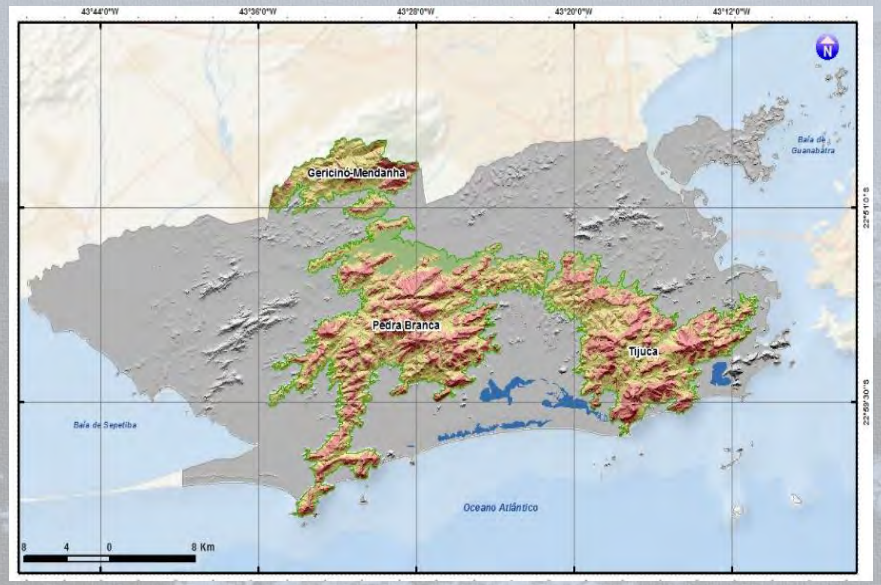
HAZARDS

- **Dengue**
- **Leptospirosis**
- **Cutaneous Leishmaniasis**
- **Visceral Leishmaniasis**
- **Diarrhea < 5 yo**
- **Cardiovascular diseases**

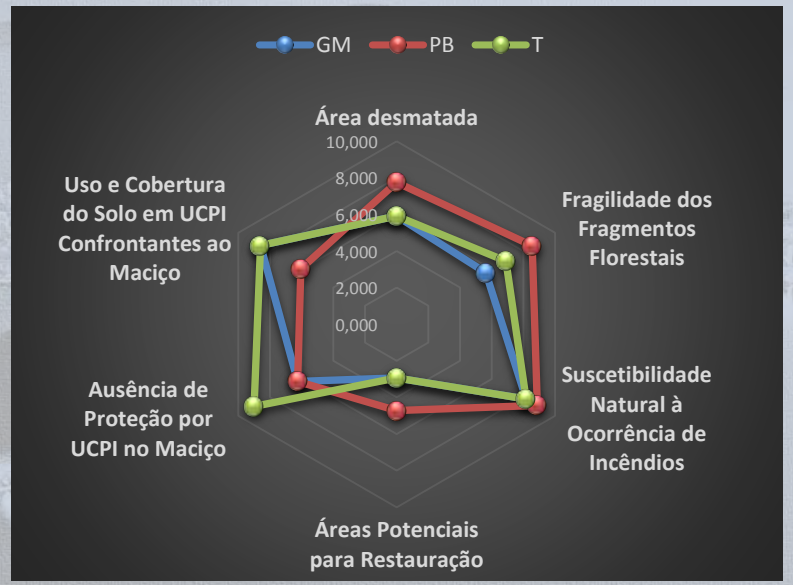
- The diseases are **multivariate** and can be influenced by factors other than climatic factors :
  - Sanitation conditions (garbage, sewage);
  - Degree of soil sealing associated with failure in the drainage system;
  - Vulnerable population exposed etc.

VULNERABILITY INDEX – Massifs

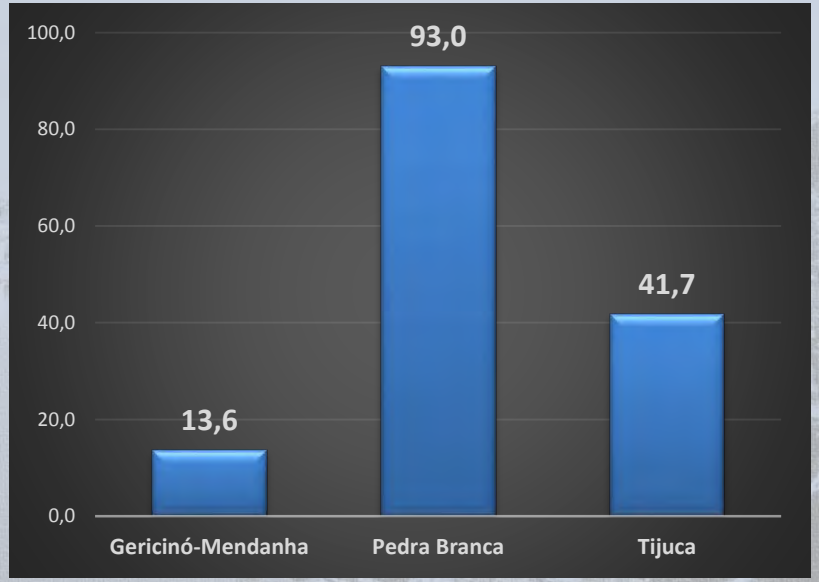
Location



Sensitivity Indicators



Vulnerability Index



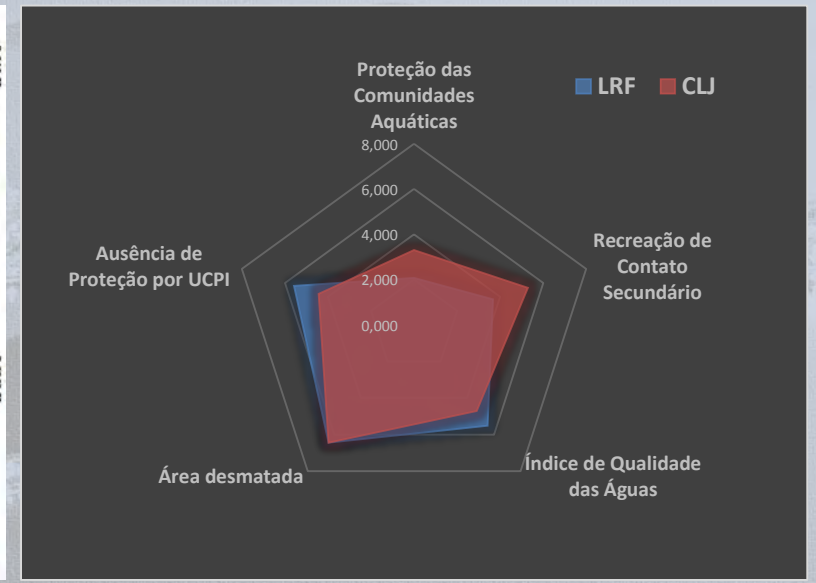
HAZARDS

FUTURE VULNERABILITY	TENDENCY
Landslide (mass movement) → Change in **extension** and **fragmentation**	↓ ↑
Diversity of *habitats*	↓
Frequency and extension of wild fires	↑
Recharge of aquifers and capacity to supply the population	↓

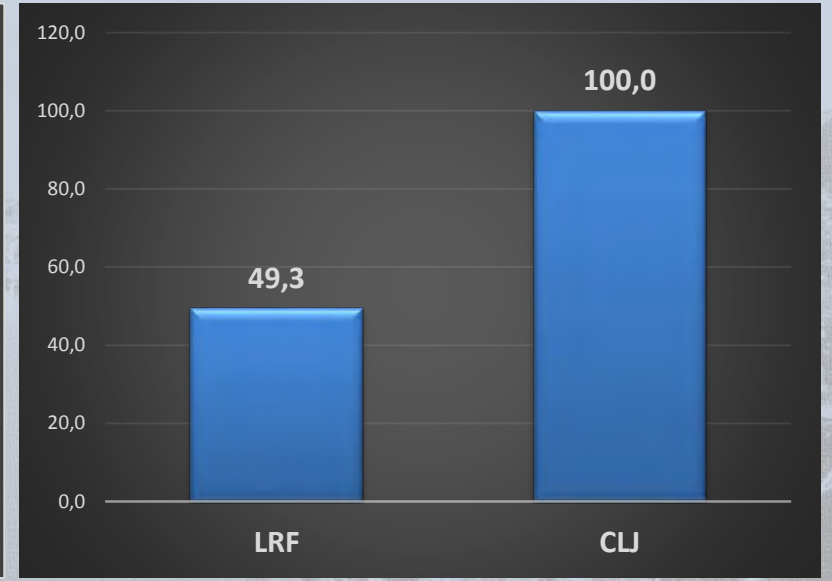
VULNERABILITY INDEX – Lagoons

Location

Sensitivity Indicators



Vulnerability Index



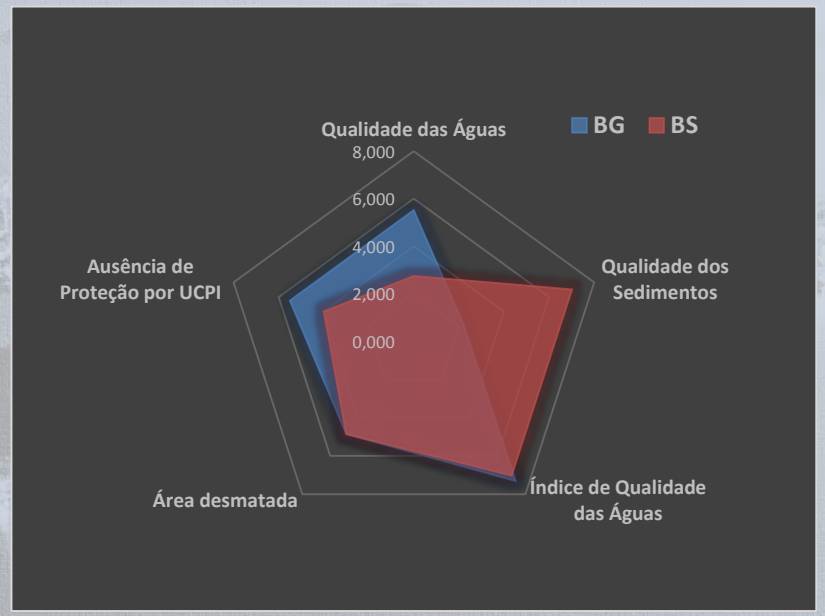
HAZARDS

FUTURE VULNERABILITY	TENDENCY
Sedimentation	↑
Artificial eutrophication (organic load) → fish mortality	↑
Changes in the distribution and composition of aquatic organisms	↑
Flooding of lower areas	↑
Intrusion of the salt wedge in the estuarine regions	↑

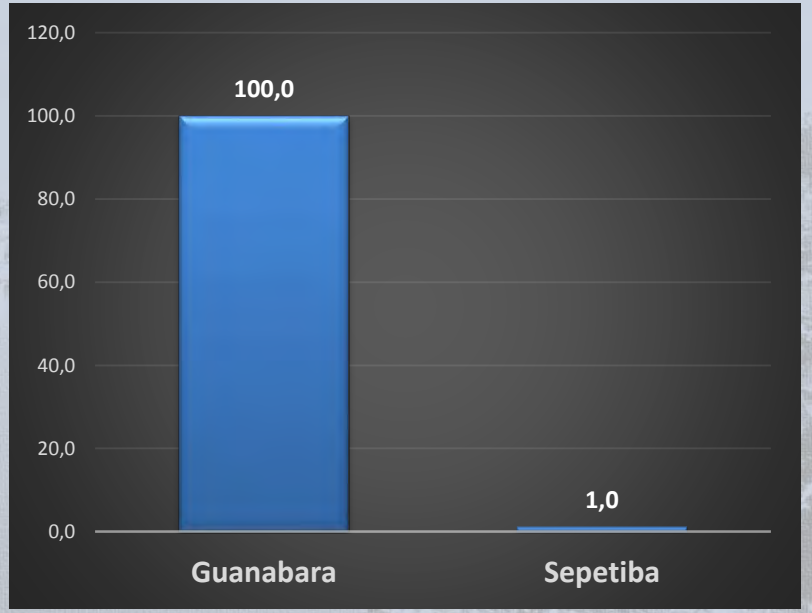
VULNERABILITY INDEX – Bays

Location

Sensitivity Indicators



Vulnerability Index

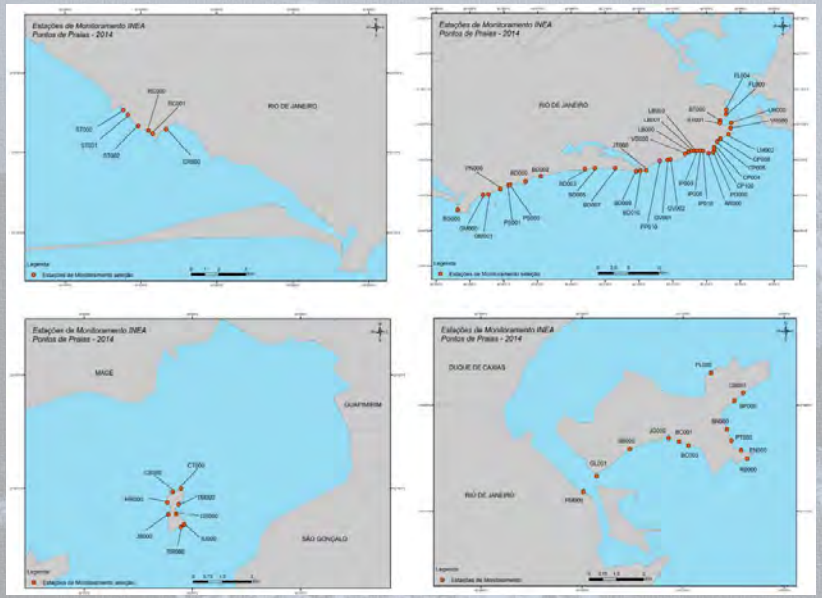


HAZARDS

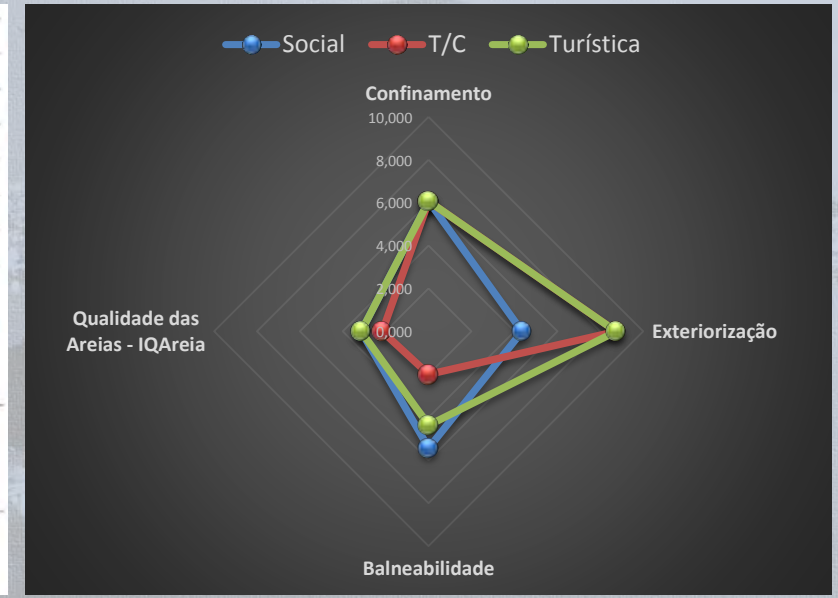
FUTURE VULNERABILITY	TENDENCY
Sedimentation	↑
Artificial eutrophication (organic load) → fish mortality	↑
Flooding of areas at the mouth of rivers and canals	↑
Intrusion of the salt wedge in the estuarine regions	↑
Erosion and destruction of structures along the coast	↑

VULNERABILITY INDEX – Beaches

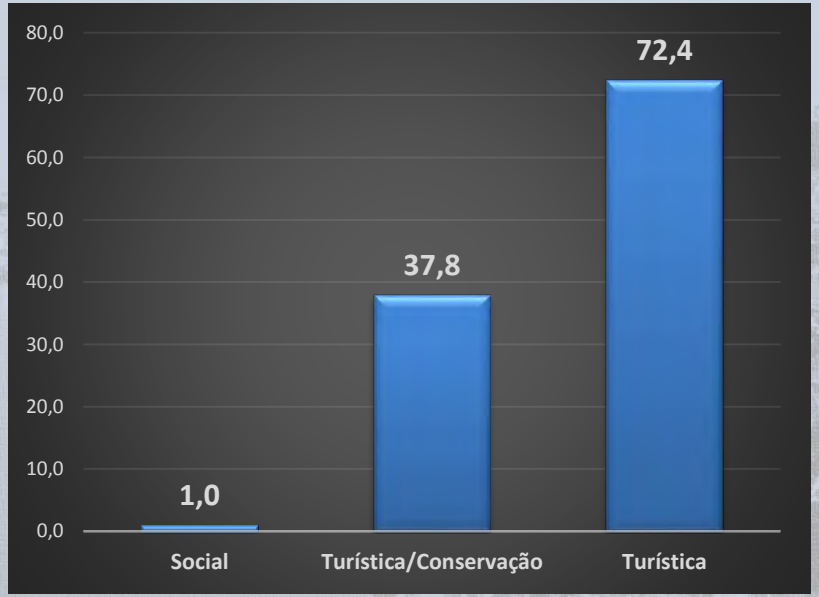
Location



Sensitivity Indicators



Vulnerability Index



HAZARDS

FUTURE VULNERABILITY	TENDENCY
"Black tongues" and red tides	↑
Erosive processes on beaches with rigid urban structures at the rear	↑
Realignment frequency	↑
Possibility of retrogradation due to alteration of the wave train	↓

EXPOSURE ASSESSMENT

STRATEGIC INFRASTRUCTURE

STRATEGIC INFRASTRUCTURE

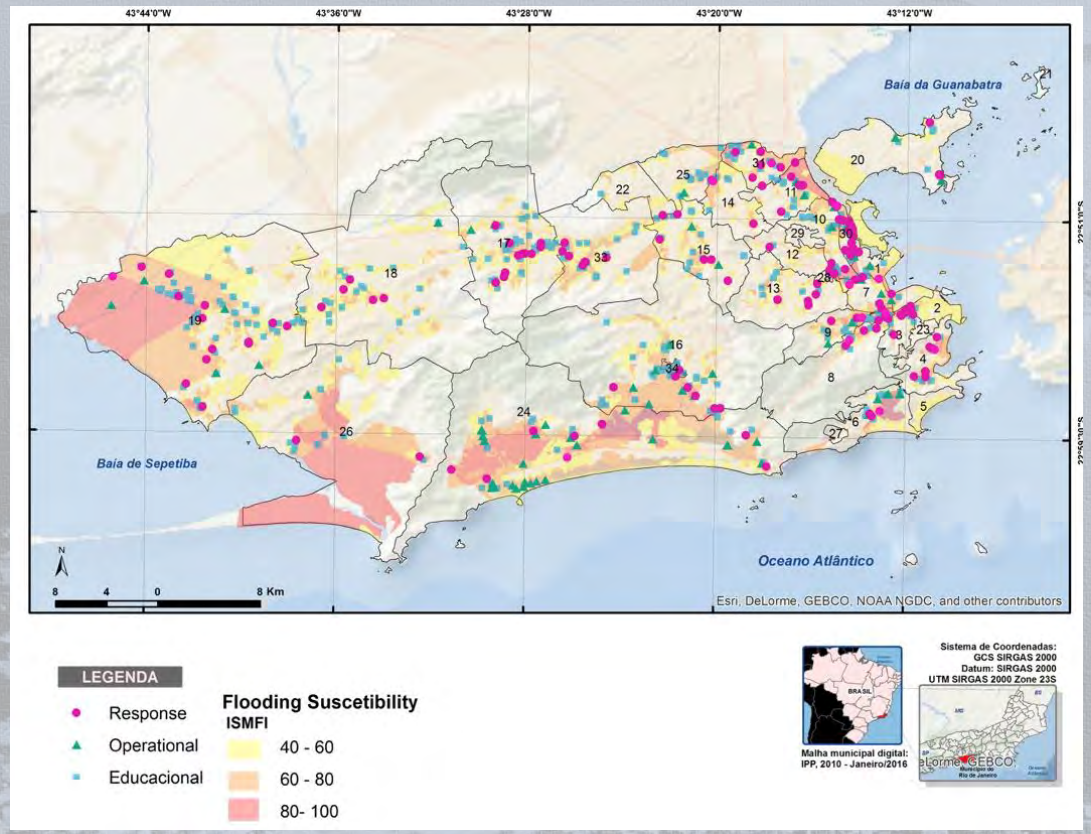
GOALS

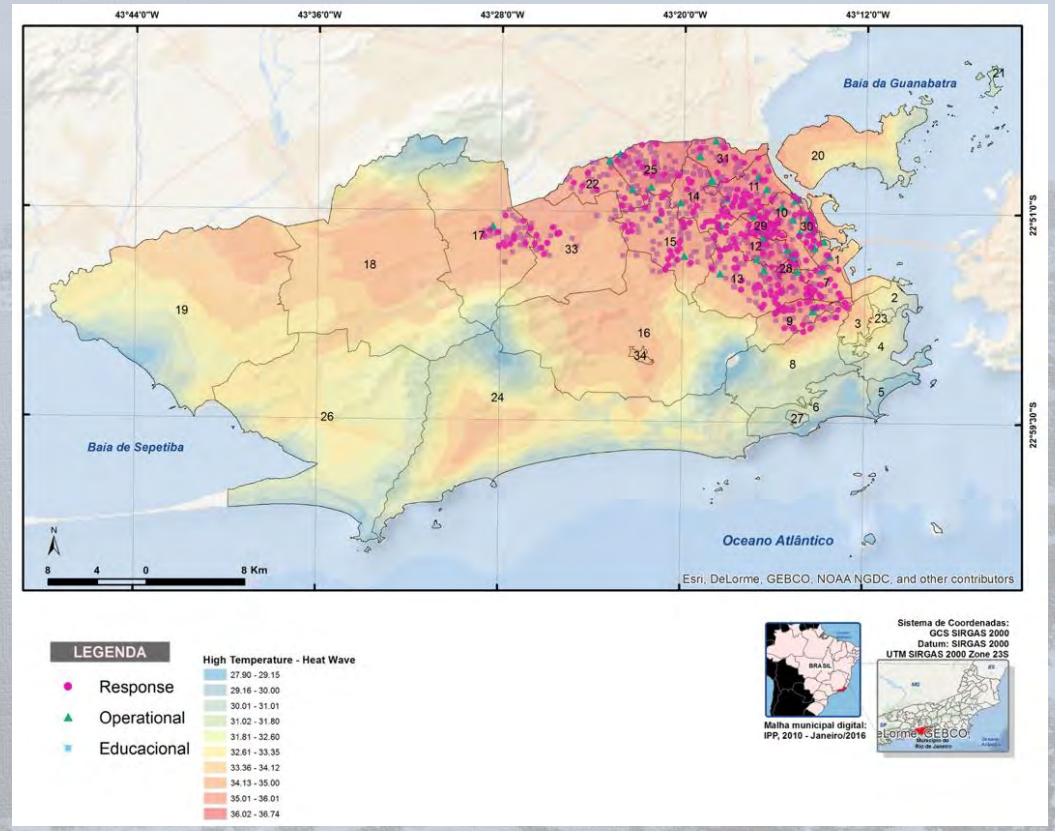
- Evaluate the potential exposure of three categories of “strategic infrastructure” regarding the **possibility of impact** on its service;

- Propose initial adaptation strategies to reduce the potential **exposure** to climate events.

RESPONSE	OPERATION	EDUCATIONAL
Center of Response and Operation (COR)	Airports and Ports	Municipal and State schools, kindergarten, special schools, centers for education
Fire Fighters	Transfer Waste Stations	
Police Force – Police Stations; Pacifying Police Units	Electrical power station and substation	
Hospitals, Municipal Clinics, Emergency, Immediate Care Center	Wastewater treatment and distribution station	
Emergency Assembly Stations	Water distribution system	
Conservation Station		

STRATEGIC INFRASTRUCTURE – Potential Exposure





HAZARDS

- **Potential exposure** of three categories os strategicinfrastructure regarding flooding susceptibility (medium, high and very high) and high temperature - heat wave proxy (>=35,0 ºC)

ADAPTATIVE STRATEGIES

ADAPTATIVE STRATEGIES

HAZARDS

- Integrate adaptation, disaster risk management, and resilience into planning
- Encourage adaptation and conscious consumption
- Promoting citizen empowerment to deal with climate change
- Capacitate/Assist/Enable/ Qualify technical staff
- Manage monitoring actions
- Advance in knowledge
- Create oportunities
- Mobilize resources

Strategic Basis A: Strengthen institutional and human capacity

- Recover and expand green areas and maintain ecosystem heterogeneity
- Expand knowledge about the coastal environment
- Prepare to act
- Promote Environmental Governance

Strategic Basis B: Ensure the conservation and integrity of ecosystems and the rational and sustainable use of natural resources

- Strengthen health programs to prevent diseases susceptible to climate change
- Establish and strengthen inter and intersetorial strategies and actions
- Enhance communication

Strategic Basis C: Enhance population's health in the face of climate change

Vision:

Seek innovative and appropriate solutions for the territorial and socioeconomic complexity and diversity, aiming at a democratic and inclusive society, with equal opportunity. To value the environmental assets, our patrimony, promoting better quality of life and well-being for people. To strive to increase resilience, so that the population has autonomy in its choices, understanding that the Carioca is the protagonist in building the capacity to adapt to climate change

Strategic Baiss D: Managing use and occupation of the territory in order to promote urban-environmental quality

- Contain the urban expansion and control the densification
- Promoting favela's urbanization
- Promote green and multifunctional free spaces
- Promote adaptation and energy/water efficiency in buildings

Strategic Basis E: Guarantee efficient and sustainable urban mobilityl

- Promote more balanced territorial development integrated it with transport systems
- Improve the safety of roads and rail infrastructures
- Encourage the adoption of strategies to reduce the demand for individual motorized transportation
- Inspire citizens on choosing better options
- Strengthen Institutional Capacity of the Transportation Sector

Strategic Basis F: Ensure the operation of Strategic Infrastructures under adverse climatic conditions

- Guide the implementation and construction of new Strategic Infrastructures
- Promote adjustement on the existent Strategic Infrastructures

THANK YOU !

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