CLIMATE CHANGE IMPACTS ON COASTAL SOCIETIES AND INFRASTRUCTURE

ASSESSING RISK AGAINST A CHANGING POPULATION IN THE NORTH COAST OF SÃO PAULO, BRAZIL




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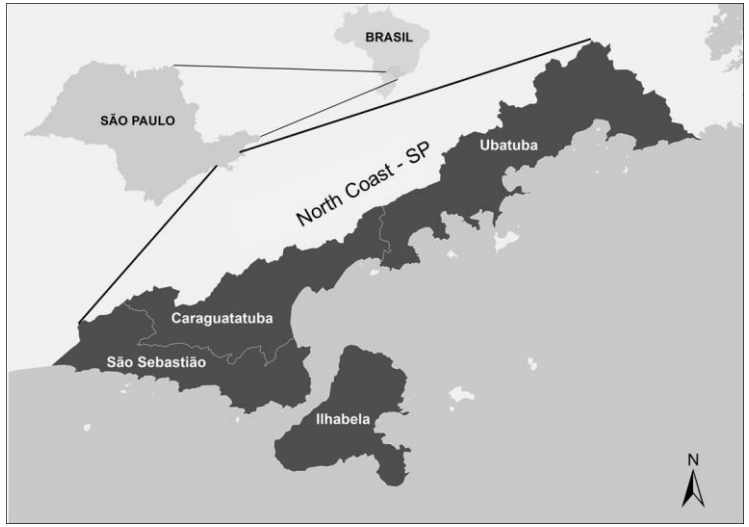
Funding: CAPES

REDELITORAL PROJECT - THE NORTH COAST OF SÃO PAULO



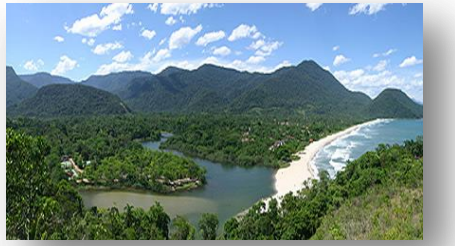
1,948 km² - Pop. 281,778 hab.
Pop. Growth 2000-2010 -25.4% (IBGE, 2010)

The irregular shape of the north portion of São Paulo coast (with pocket beaches and mountain range) in conjunction with a growing urbanization process makes the coast susceptible to extreme climate change variability.

Unprecedented rates of urbanization and population growth

Megaprojects developments - Pre-Salt exploration : expansion of São Sebastião port, Tamoios Highway, oil and gas industry

Tourism and Conservation



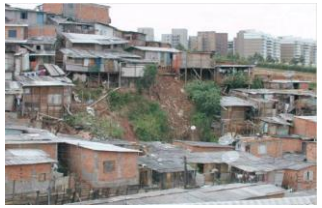
SOCIO-ECOLOGICAL FRAGILITIES

Major **RISKS** and **VULNERABILITIES**

coastline erosion
(Massaguaçú/Caraguatatuba)

landslide risks
(Barra velha/Ilhabela)

landslide risks & irregular occupations (São Sebastião)

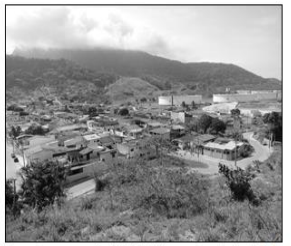


flooding events
(Ubatuba)

Brazilian Region	Landslides+Flooding Risk Mapping (municipalities) - 2012, (%)	Settlements affected (n, %)	Population affected (n, %)
North	37 (12.9)	54,650 (13.8)	205,945 (15.6)
Northest	63 (22.0)	77,692 (19.6)	317,074 (24)
Midwest	6 (2.1)	11 (0.0003)	52 (0.004)
Southest	105 (36.7)	187,752 (47.4)	582,431 (44.1)
South	75 (26.2)	76,348 (19.3)	214,001 (16.2)
Total	***286 (100.0)***	***396,453 (100.0)***	***1,319,503 (100.0)***

Table 2 : Risk Mapping of hazards to landslides and flooding, settlements and people affected in 2012. Based on data from CPRM (see SAMPAIO et al., 2013)

Box.1.5 Northern coast of São Paulo: risk amplification and interconnectedness



Petrobras terminal (TEBAR): technological risks and environmental (by A. Iwama, 2011)

The relation between a megaproject and environment aspects is complex and the situation analysed in São Sebastião and recently in Caraguatatuba illustrates how the process of urbanisation disordered can occured in some districts. The 'Itatinga', 'Olaria' and 'Topolândia' districts have arisen as a result of the Petrobras Terminal facility in the 1960s. Currently, it is predicted there will almost 400 expropriations as a result of the new road network ('Tamoios' sector road project). It is interesting to note that the districts affected by megaprojects installed in previous decades are today being looked at to understand the problems in installing new infrastructures projects. The population movements arising from the installation of large projects were not properly included in mitigation programmes for these megaprojects. These situations are cyclical and will always put the population in a situation of risk amplified, not only environmental or technological risks, this situation also raises a series of implications on the social structure of vulnerable residents.

Debris flow: Camburi district (São Sebastião city) (by A. Iwama, 2012)

Topolândia district (São Sebastião city) (by A. Iwama, 2011)

Rio do Ouro district (Caraguatatuba city) (by M. Stasiak and A. Iwama, 2012)

Morro do Algodão district (Caraguatatuba city) (by R. Souza, 2010-2012)

(Source: Iwama et al. 2014 - input paper in GAR15/UNISDR)

DAMAGES ON COASTAL BUILT INFRASTRUCTURE

SOCIOECONOMIC CONSEQUENCES

Characteristic attack due to corrosion of reinforcing walkway structures in the intertidal zone

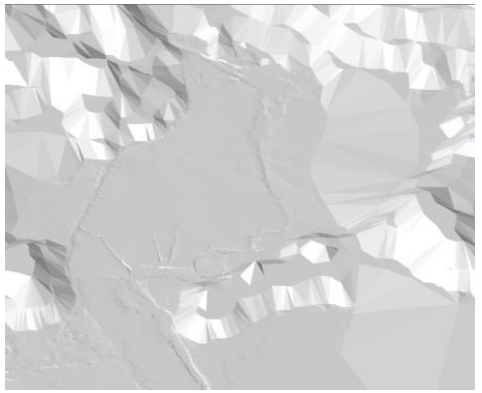
SP-55 Highway that connects Caragutatuba to Ubatuba. Work protection embankment to correct erosion and minimize flooding

Bridge damage – debris flow after a flooding events in 2012 and March 2013 - Caraguatatuba

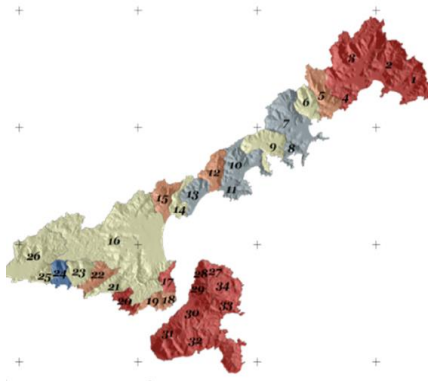
Immeasurable harm, both policatilly and socially.

FINDINGS

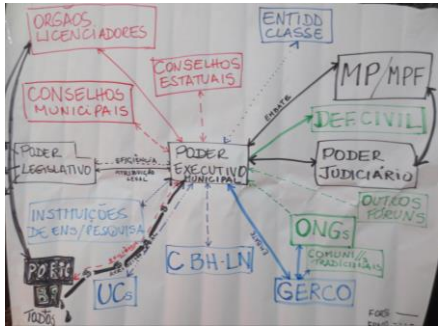
1. DEBRIS-FLOW SIMULATIONS



2. SPATIAL DYNAMICS OF URBAN GROWTH AND LAND USE CHANGES



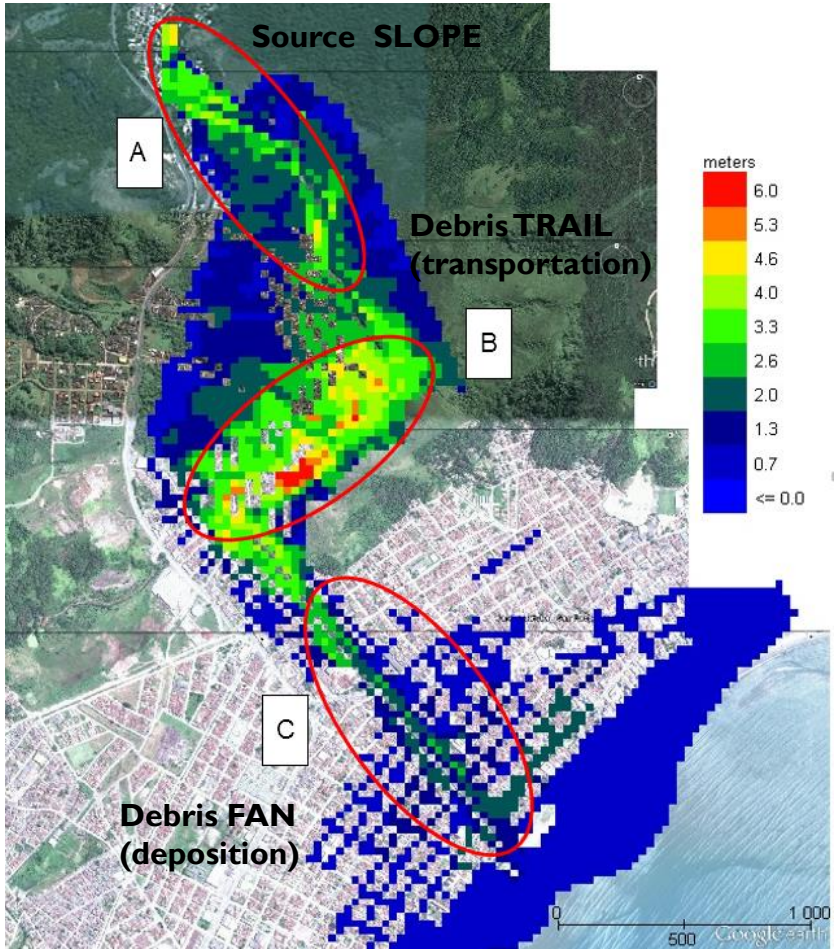
3. SOCIO-INSTITUTIONAL ISSUES



DEBRIS-FLOW MODELLING

Floodplain Santo Antônio river, after March 1967 disaster

completely urbanized in 2012 (Google Brasil 2012)



Reprojection 1967 event, Caraguatatuba

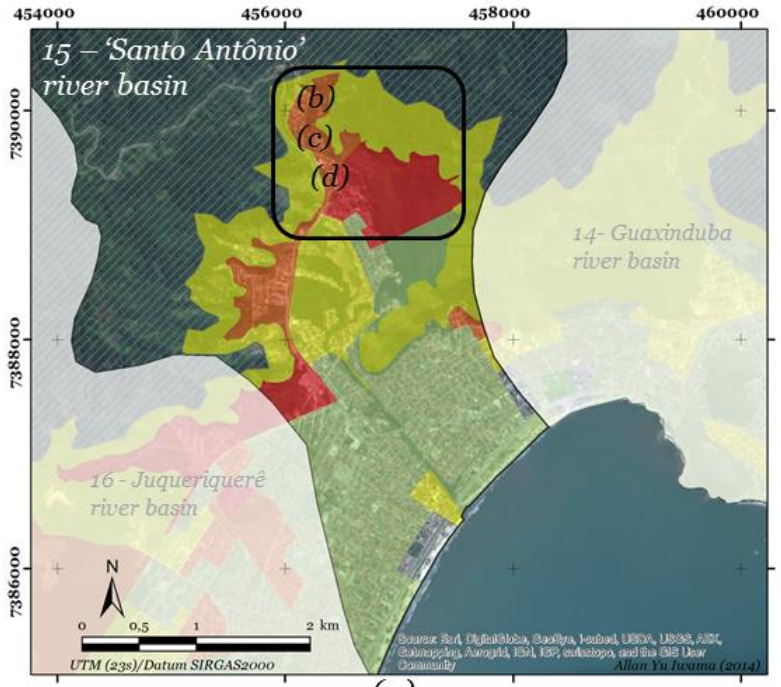
A - The most affected area in 1967, now with some occupation

B - The most affected area nowadays;

C - Similarly affected in 1967 and today, with highest populated density

(Fonte: Sakai 2014)

LAND USE/COVER PATTERNS - URBANIZATION



(a)

Legend

SoVI (2010)	Vulnerability
1	Extremely low
2	Low
3	Medium
4 -7	High (urban areas - by census)
5 - 6	Very high (rural areas or slums areas)
0	No classified

(b)

(c)

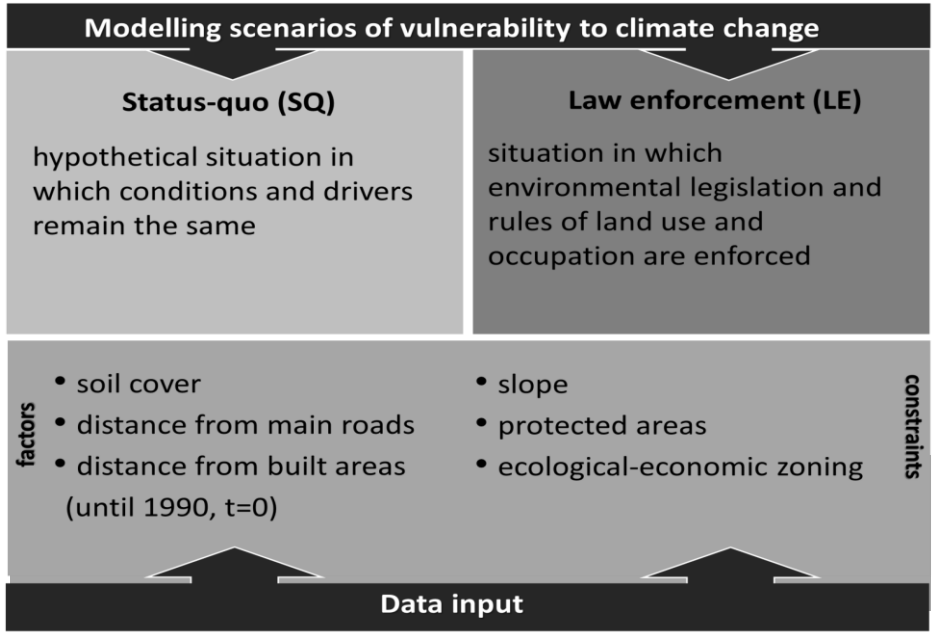
(d)

HIGH SOCIAL VULNERABILITY (SoVI) IN AREAS OF FLOODING AND LANDSLIDES

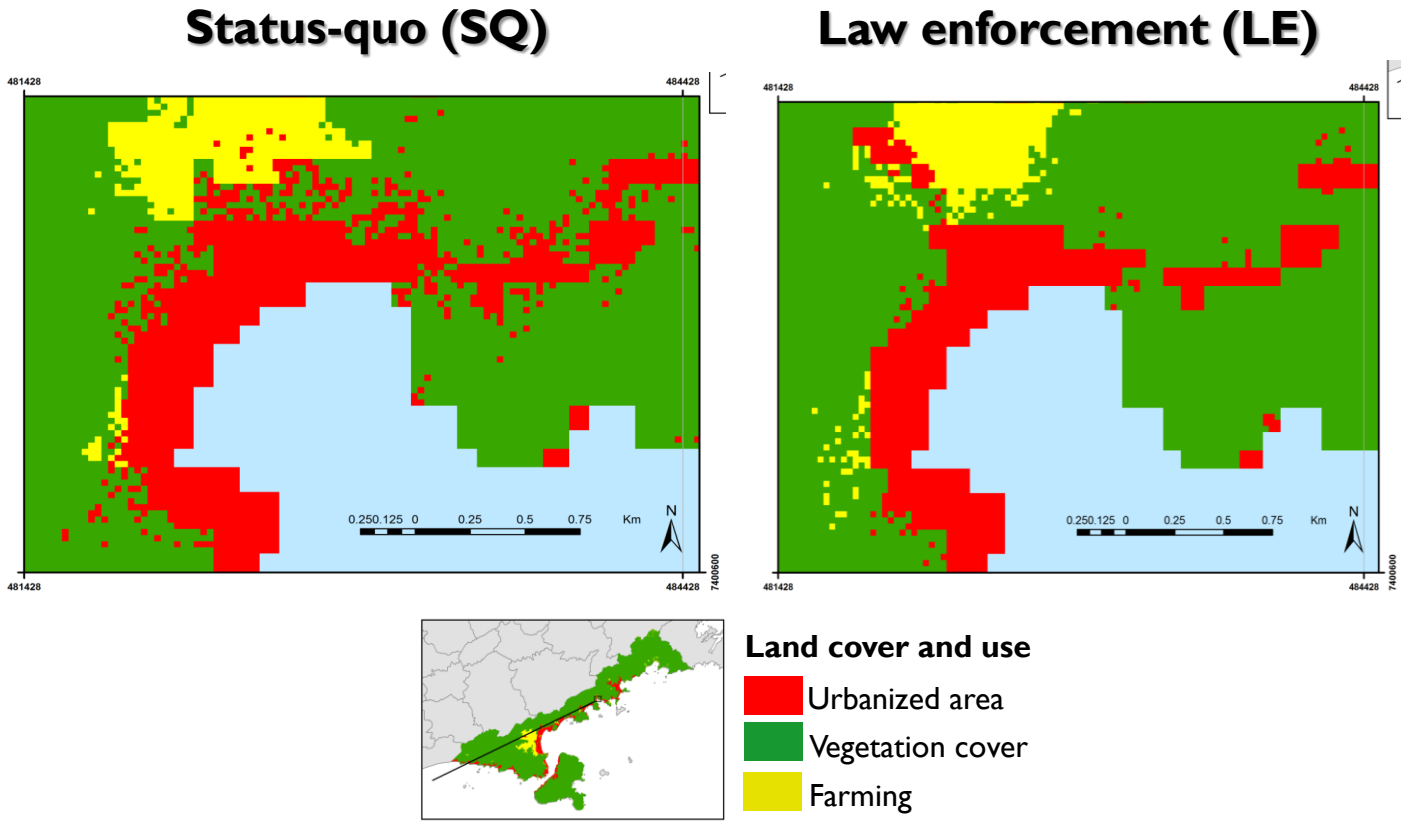
INADEQUATE OCCUPATION

Disaster management instruments

MODELLING THE SPATIAL DYNAMICS OF URBAN GROWTH AND LAND USE CHANGES

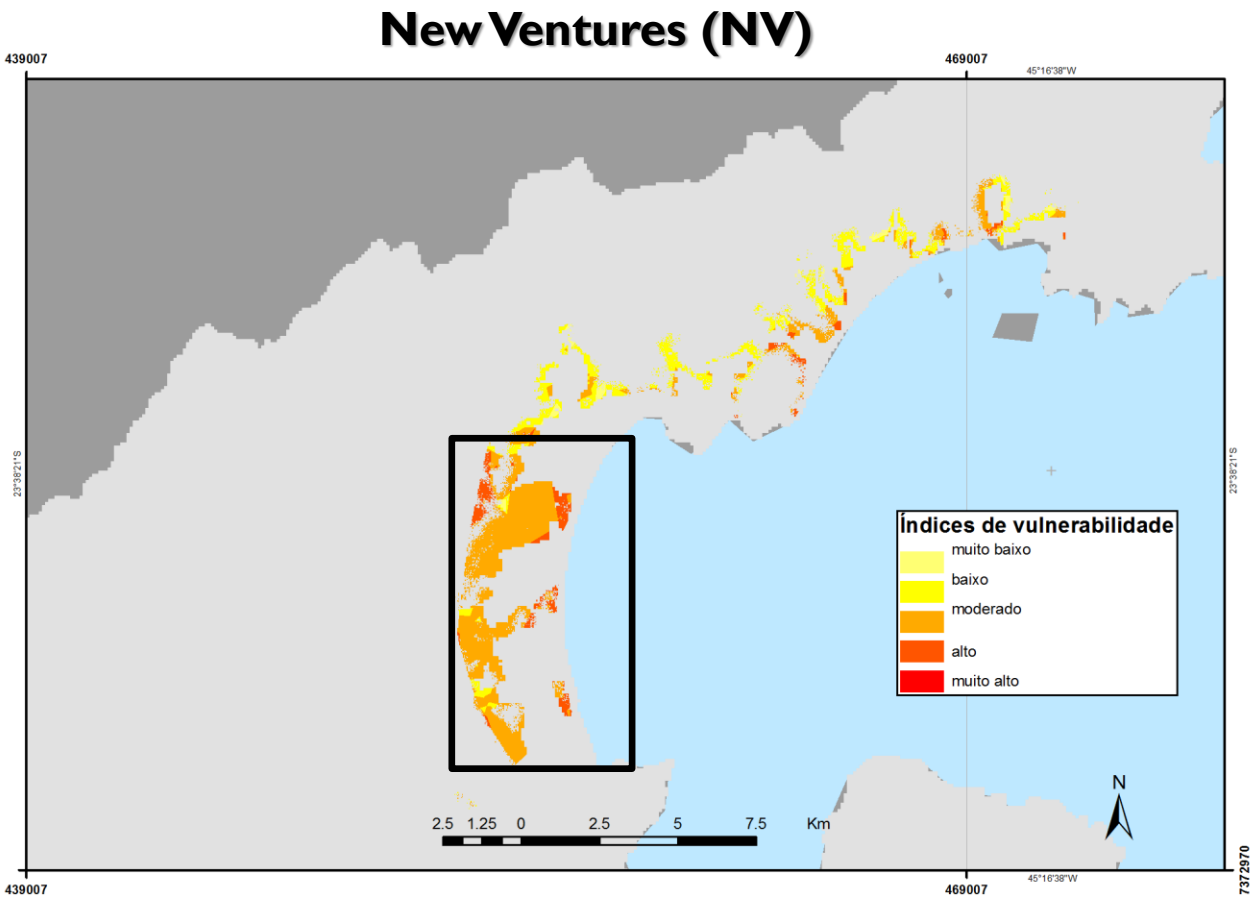


Maps for 1990, 1999, 2010 and a 2030 forecast were produced using the DINAMICA EGO software. – FUZZY approach

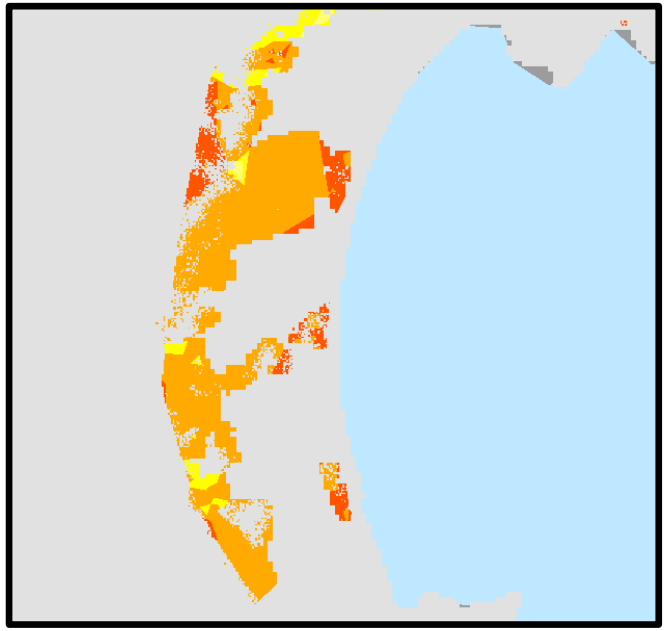


Forest 1st ones to suffer!

MODELLING THE SPATIAL DYNAMICS OF URBAN GROWTH AND LAND USE CHANGES

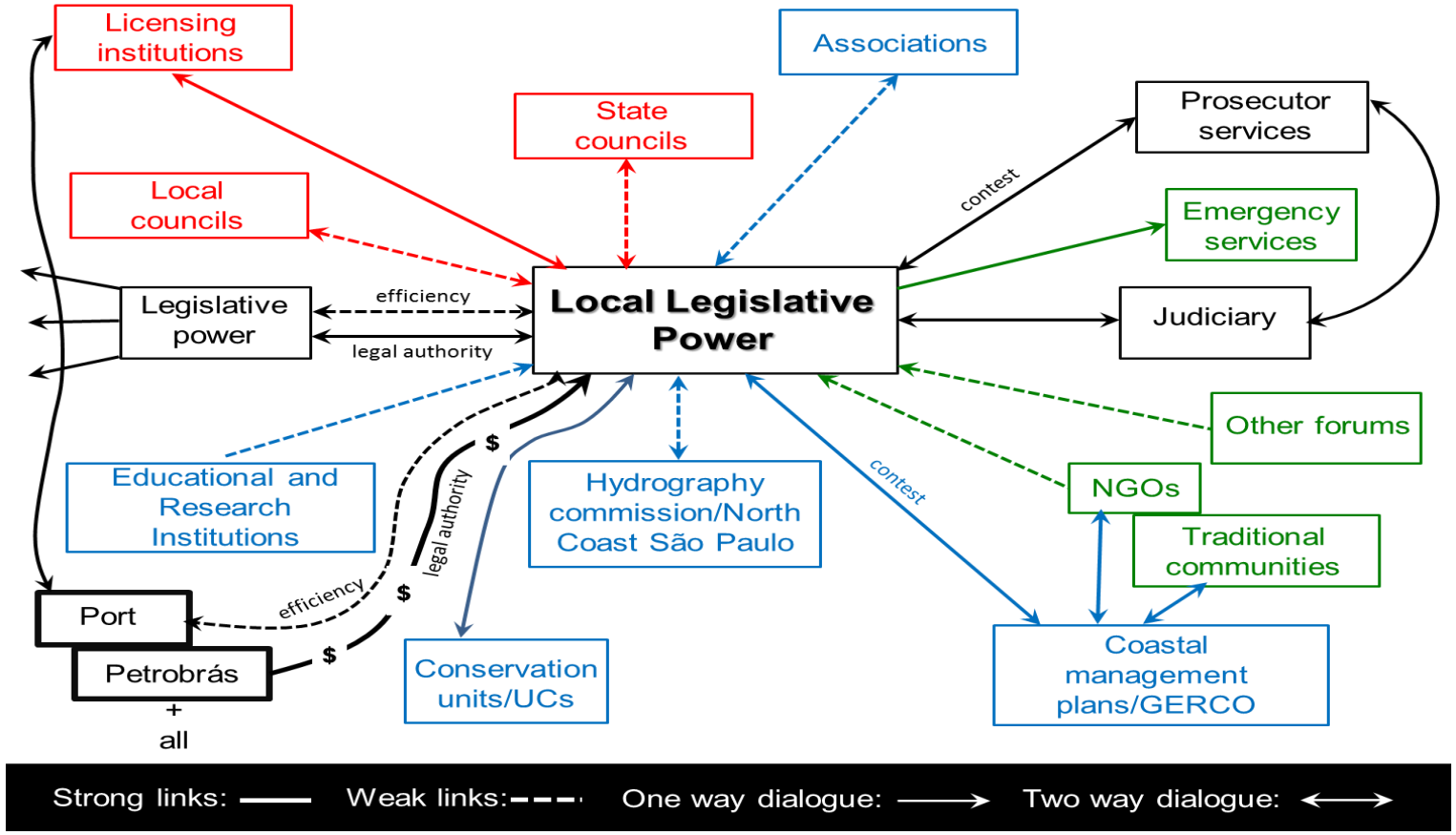


After 2010, 65% of urban areas projected in NV scenario were classified as having moderate, high or very high vulnerability index.



THE SOCIO-INSTITUTIONAL CONTEXT

Cross-scale institutional linkages mapping



Climate change and adaptation issues not in the local political agendas

Discussion group - (IFSP - Caraguatatuba, 03/04/2014)

Face-to-face interviews (50) finalising by end of March

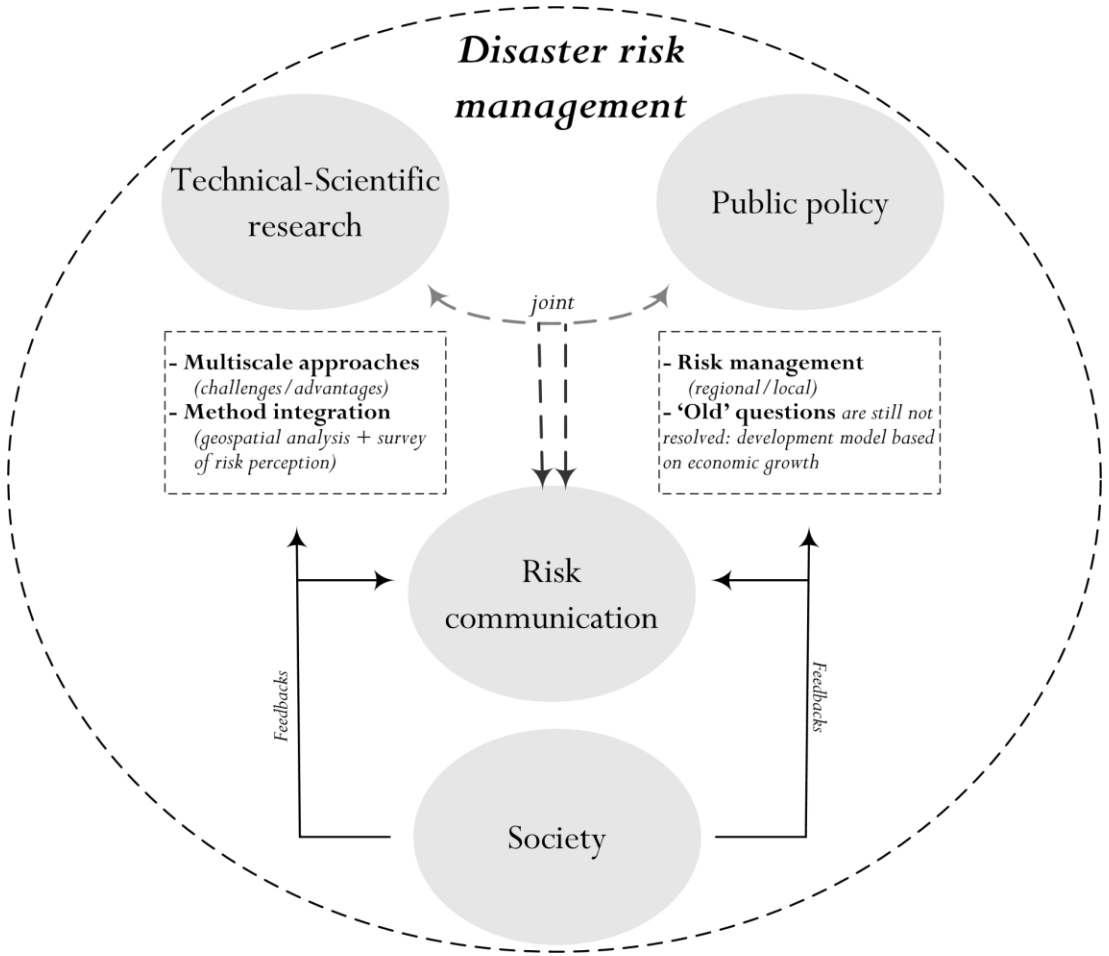
FINAL REMARKS

- The North Coast of São Paulo is **highly vulnerable to expansion of irregular occupations** when regulations are not enforced.
  - Coastal areas have become residence of the poorest communities who usually experiences the worst effects of natural hazards including flooding, landslides, erosion and loss of coastal lands.
  - Forest areas are the first ones to be suppressed by an unsystematic urban development.
- Future scenarios of land use change shows a **substantial increase in urbanized areas** in both scenarios with a steep increase for the scenario status-quo where conditions are maintained.
  - Consequence of expansion of the Port of São Sebastião and the Tamoios highway

FINAL REMARKS

- Unprecedented rates of urbanization and population growth, led mainly by the recent exploitation of pre-salt oil reserves, is occurring **without adequate planning** of land use, population dynamics and infrastructure needs.
- Current **adaptation efforts are still incipient**. At the national level, policy instruments are being developed, however it is still slow the translation into practical measures to protect coastal settlements, infrastructure and communities of the risks associated with climate.
- Data shows there is an increasing **need to use risk management tools** such as scenario modelling to guide public policies in terms of urban and environmental planning. This can lead to faster response to structural problems (e.g.: and social inequalities, irregular occupations).

PERSPECTIVES – FRONTS FOR ACTION



(Source: Iwama et al. 2015 (in prep.) – IJ of Disaster Risk Reduction)

Challenges

- Technical-scientific research and application (integrated methods and multiscale approaches)
- Linkage research results with risk management in different levels

Opportunities

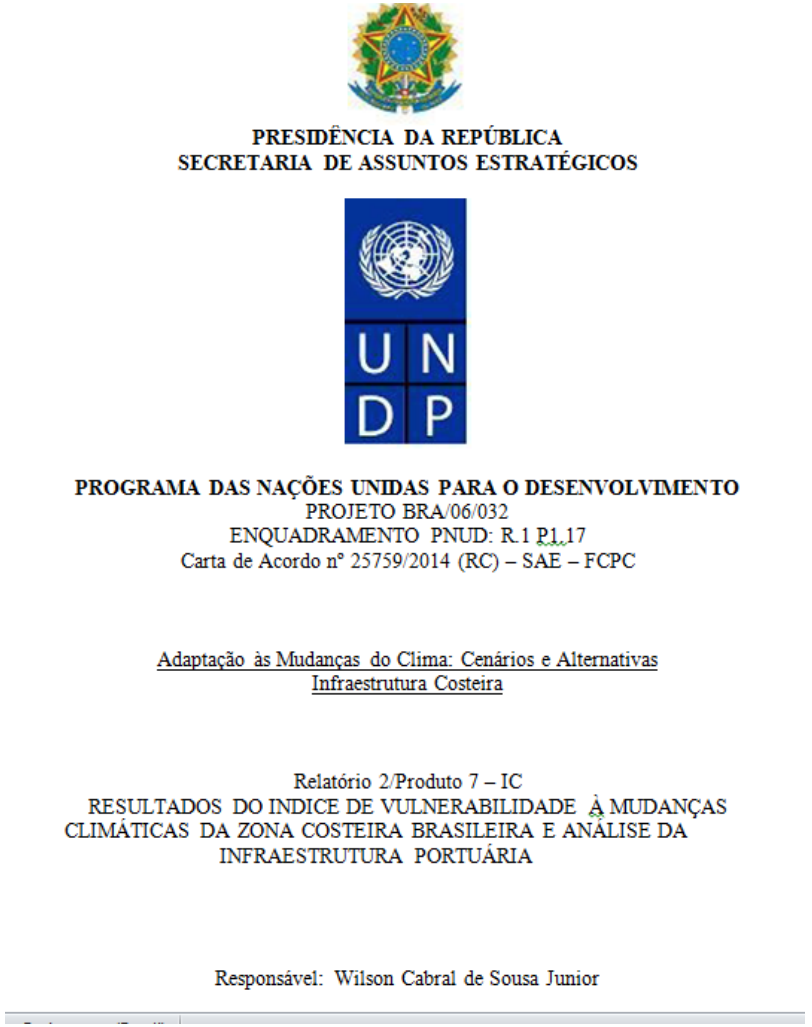
National Policy on Protection and Civil Defense (PNPDC)-2012- Actions for prevention, mitigation, preparedness, response and recovery for civil protecting, integrating public policies for land-use planning.

POLICY IMPLICATIONS

- RESULTS OF RedeLitoral Project – subsidise government programs

Development of vulnerability indicators

- **land use typology**
- **tides and waves exposure**
- **flooding**
- **debris flow**
- **coastal erosion**
- **social level**
- **population density**



PRESIDÊNCIA DA REPÚBLICA
SECRETARIA DE ASSUNTOS ESTRATÉGICOS

PROGRAMA DAS NAÇÕES UNIDAS PARA O DESENVOLVIMENTO
PROJETO BRA/06/032
ENQUADRAMENTO PNUD: R.1 P1.17
Carta de Acordo nº 25759/2014 (RC) – SAE – FCPC

Adaptação às Mudanças do Clima: Cenários e Alternativas
Infraestrutura Costeira

Relatório 2/Produto 7 – IC
RESULTADOS DO INDICE DE VULNERABILIDADE À MUDANÇAS CLIMÁTICAS DA ZONA COSTEIRA BRASILEIRA E ANÁLISE DA INFRAESTRUTURA PORTUÁRIA

Responsável: Wilson Cabral de Sousa Junior

THANK YOU! OBRIGADO!

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Mudanças climáticas globais e impactos na zona costeira: modelos, indicadores, obras civis e fatores de mitigação/adaptação - REDELITORAL NORTE SP

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