Adaptive Capacity Index: 
Part II. Santos, Brazil

Corresponding authors

Fabiano de Araujo Moreira
PhD. Student. Department of Geography
UNICAMP - Universidade Estadual de Campinas
Campinas, São Paulo, Brazil
CEP: 13083-970
São Paulo Research Foundation (FAPESP). Proc. n. 14/14598-8

Lucí Hidalgo Nunes
Department of Geography
UNICAMP - Universidade Estadual de Campinas
Campinas, São Paulo, Brazil
CEP: 13083-970

Shona Paterson, Future Earth Coasts and University College Cork
shona.paterson@ucc.ie

Professor Mark Pelling, King’s College London
mark.pelling@kcl.ac.uk
Acknowledgments

The authors of this report would like to acknowledge and thank all the participants who contributed to this research. Your insight was invaluable and your passion infectious. Individuals at the following organisations contributed:

- Baixada Santista Metropolitan Agency (AGEM)
- Secretariat of Tourism (SETUR)
- Civil Defense of Santos
- Santos Novos Tempos Program Management Unit (UGP)
- Secretariat of Environment (SEMAM)
- Secretariat of Urban Development (SEDURB)
- Secretariat of Health (SMS)
- Department of Health Surveillance
- Secretariat of Culture
- Fire Brigade of Santos
- Santos Traffic Engineering Company (CET Santos)
- Fishery Institute
- Company of Sao Paulo State Docks (CODESP)
- Piratininga Power and Light Company (CPFL)
- Group Mendes
- Industry Social Service (SESI)
- Trade Social Service (SESC)
- Sinergética
- Order of Attorneys of Brazil (OAB)
- Mar Azul Institute
- Ecofaxina Institute
- Maramar Institute
- Fórum da Cidadania (Citizenship Forum)
- Association of Construction Entrepreneurs of Baixada Santista (ASSECOB)
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1. Introduction

1.1 Study Objectives

As climate change intensifies and accelerates the capacity to cope with impacts and the ability to adapt to opportunities will become critical attributes, to not only recognise but also augment where possible, across multiple sectors and organisations. Therefore, defining and understanding the mechanisms through which these attributes can be measured and potentially enhanced is a key ongoing discussion. Adaptive capacity has been investigated through a range of systematic frameworks that differ by field, practice, scale and focus (Engle, 2011). For this particular framework the focus remains actor-centric and incorporates the influence of structure and agency as defining characteristics in an attempt to move the discussion away from simply measurement into a more practical niche where the study of adaptive capacity can be used as a stepping stone for action at a range of scales. Through the empowerment of actors, and using the Adaptive Capacity Index (Pelling and Zaidi, 2013) as a foundational basis for investigation, the conceptual framework of adaptation utilised here creates an actor-identified solutions mechanism through social learning upon which to create pro-active change in how climate change issues are addressed.

This framework therefore has three specific objectives: i) the establishment of an honest dialogue around adaptive capacity driven by actor reflection and vision ii) an investigation into organisational arrangements and learning networks that are best suited to enhancing adaptive capacity across and within a range of sectors iii) the identification of barriers to successful implementation of adaptation actions and the trade-offs necessary to create successful initiatives for effective adaptive management at a local scale. Developing adaptive capacity in order to be able to actually implement adaptation actions is a process of on-going adjustment in response to a range of drivers therefore it is important to be realistic in terms of expectations when considering the potential any framework to inspire behaviour change, especially in the short-term. However, providing the space for discourse and evaluation remains one of the most essential pathways for success and a key aim of this tool.

1.2 Adaptive Capacity

Adaptive capacity sits alongside resilience and vulnerability as a triplet of concepts that are often used interchangeably in analysis and policy, and at times overlap also with the objectives of sustainable development. This is not in itself a problem, and it is appropriate to highlight relevant concepts for
specific policy needs. So, for example, adaptive capacity sits alongside coping capacity and exposure in determining vulnerability within UNU’s World Risk Index framework (Birkmann et al., 2011). This is useful when seeking to measure vulnerability to future hazards but adaptive capacity can also be measured as an independent variable (Welle et al., 2013, Engle, 2011). Adaptive capacity, therefore, indicates the potential for adjustment and is often indicated through past behaviour but should not be equated with power or capacity for self-determination. For instance, poorer sectors of society are often said to exhibit both high degrees of vulnerability (high exposure and susceptibility to harm) tempered through high adaptive capacity (Spires et al., 2014). Here, adaptation is not indicative of power to enhance life conditions through responding to risk but through the necessity for change to enable survival – those who cannot adapt and reach the limits of adaptation face even great risks either through loss and damage or through household collapse and migration or similar forced transformations (Dow et al., 2013). Similarly, low levels of vulnerability often associated with contemporary economic success do not always align with high levels of adaptive capacity (Magnan, 2010), but instead may result in industrial, technological, organisational/cultural and economic lock-in, such as those associated with land-use inhibit flexibility (Sovacool, 2011, Spires et al., 2014).

Often such actions and initiatives can be chosen and justified so that a rush for economic gain is seen as providing for longer-run flexibility even if contemporary capacity is limited by a narrow economic base, for example in the tourism based economies of the Caribbean (Agrawal, 2003). Attempting to define a clear linkage between economic or technological status and adaptive capacity can therefore be limiting in its utility.

An alternative approach to measuring adaptive capacity sees it not so much as an outcome of resources (economic, technological) but as a characteristic of social institutions that empower a range of social actors to prepare and respond to impacts and change (Gupta et al., 2010, Zaidi and Pelling, 2013). Adaptive capacity conceived as a property of existing institutions can be cultivated either through planned measures or through spontaneous experiments from within society or organisations, both before and after specific impacting events. Focus upon the development of adaptive capacity at all scales can also be anticipatory and driven by Therefore, adaptive capacity encompasses the characteristics of existing social institutions, both formal and informal, that enable sectoral and organisational responses, as well as the inherent flexibility within those institutions that allow coping strategies to evolve and be deployed (Berman et al., 2012, Engle, 2011).

While, adaptive capacity influences the ultimate potential to implement successful adaptations and varies between different contexts and systems, it is not equally distributed (Adger, 2010, Adger et al., 2009). This means that adaptive capacity is contested with different actors holding contrasting viewpoints on the nature of loss and risk, the objects at risk and the underlying values that determine what is privileged in society – what is to be lost or enhanced through acts of adaptation and their
desired outcomes. It also introduces the concept of barriers and limitations of adaptive capacity that
can impede both planning and implementation efforts as well as provide opportunities for innovation
and experimentation (Eisenack et al., 2014, Moser and Ekstrom, 2010, Berkhout et al., 2006) and,
more precisely, the trade-offs across all sectors needed to achieve relative success with adaptation
efforts (Dow et al., 2013, Moser and Ekstrom, 2010).

Adaptation efforts must be recognised more than just a function of coping with climate impacts
threatening the fundamentals that society values. Adaptation must also be viewed in terms of
responsibility and capacity for action as well as power differentials within the actor landscape guiding
decisions and dictating trade-off acceptability. By expanding the ongoing discourse beyond ‘the how
do we cope’ mentality and including questions like who is responsible for meeting the costs of
adaptation, who is entitled to adaptation aid, financially and technologically, and how to does society
maximise adaptation effectiveness at a range of scales as elements of the discussion we provide a
more realistic avenue towards the necessary social change needed to adequately address climate
change challenges.

Adaptation action is inherently driven by the prevailing values and priorities of society and expressed
as functions of the existing social, political, and economic systems through codification in laws and
enabling legislation, established governance practices and anchored in social norms and cultural
traditions. The process of adaptation must therefore be legitimized by these norms and values, along
with the institutions and actors involved in carrying out said actions. However, the legal, political and
social basis for the advancement of management alternatives and adaptation options are not always
clear, especially due to the fact that the sheer scale of the threats and the potential cross-sectional
impacts. This lack of clarity is also compounded by the fact that multiple agencies and organizations
with various, and sometimes conflicting mandates, share responsibility for decision-making in the
management process. This increases the need to understand the organisational architecture that exists
with an adaptation space, where responsibilities lie in terms of critical planning and response
decisions and what influences may affect that space.

2. Methodological Approach to Adaptive Capacity Assessment

2.1 Sample

The aim of the methodology and sampling protocol is to provide (1) a quantitative expression of the
adaptive capacity for a community of practice for Santos, Brazil; (2) some quantitative expression of
adaptive capacity for sub-systems e.g. local government, private sector or local government,
county/central government; and (3) qualitative analysis of experiments, blockages, strategies used that explain the shape and value stakeholders award themselves for adaptive capacity.

2.2 Community of Practice

Since the focus of this study is on organisations with planning and practice responsibilities, including private sector utilities/land-owners, civil society (e.g. nature reserves) and Federal, State and Local government agencies active in Santos, the initial starting point towards the identification of relevant actors was to find an existing ‘community of practice’. With the acknowledgement that most effort would likely be centred on local government, logic suggested that an existing list of statutory or voluntary stakeholders in the development of a land-use plan or comprehensive master plan would provide a reasonable first potential sample with the recognition that that sample could be augmented by other organisations in relevant sectors as necessary. For the purposes of the Santos study the decision to use the Preventive Plan of Civil Defense of Santos developed in 1988-1999 along with organisations involved in the Hyogo Framework for Action developed in Santos in 2013-2014 was a straightforward one. The combination of the two communities broadened the scope beyond the town itself while maintaining a definable and defensible sample.

2.3 Nested Analytical Frame

It is possible for opportunities for adaptive capacity along with barriers to adaptation option adoption to occur at both the political and sectoral scale. The landscape is often very complex and busy with multiple partnerships, initiatives and agencies that all have a stake in the issue of resilience and adaptation to environmental risk. To include every organisation in an adaptive capacity analysis would be unrealistic and virtually impossible. Therefore it is important to consider the best analytical frames at which to employ the ACI.

These analytical frames can be vertical in nature, i.e. the analysis looks adaptive capacity of organisations that make up a natural hierarchy such as levels of government from town to county to state to country. This allows the flows of responsibility and power to be more fully comprehended while identifying potential barriers or levels of governance where blockages to implementation may have formed. The analytical frames can also be horizontal, i.e. the analysis looks across sectors of society including public enterprises, private-public partnerships and civil society. This helps to elucidate the public-private dynamic and allows organisations with high adaptive capacity to be recognised along with areas of low adaptive capacity that may require potential increases in resources.
or additional assistance. In order to ensure the ACI is relevant across both of the analytical frames the identification of organisations within each frame is key to the potential success of the analysis. To this end, ensuring there is a mixture of organisations that are both theoretically and practically influential in the adaptation landscape as well as organisations that have responsibility for key infrastructure, environmental risk management or flood management policy is also critical for guaranteeing an effective analytical frame for adaptive capacity research.

For the purposes of the Santos component of the Metropole study an initial sample was developed for discussion within the project team and with project partners (Table1). This involved identifying actors within both the vertical and horizontal frames who have a responsibility for environmental risk management. Within each identifiable section of the sample there is a progression in either expected scale of influence or natural hierarchy from local organisations to county-wide, regional bodies such as the Baixada Santista Metropolitan Agency (AGEM), through state agencies to national level actors such as the Company of Sao Paulo State Docks (CODESP) and Order of Attorneys of Brazil (OAB).

2.4 Sample Strategy

In order to maximise the potential for interviewee response, the Secretariat of Environment (SEMAM) and the Civil Defense of Santos were used as a communication broker. This allowed existing partnerships and relationships to be used as leverage when establishing initial contact with potential respondents. Interviews were preceded where possible by examination of organisational and strategy documentation to become familiar with core functions and capacity of the respondent’s organisation. This allowed the interview to focus on the individual respondent’s view of the organisation’s ability to adapt – access information, challenge existing policy and practice, experiment, access new resources to then mainstream; and the organisation’s interaction with other organisations and the legislative environment in achieving this.
<table>
<thead>
<tr>
<th>ACTORS</th>
<th>Santos City Organisational Matrix</th>
<th>Land Use/ Planning/ Management</th>
<th>Environment</th>
<th>Emergency and Risk Management</th>
<th>Transport</th>
<th>Energy and Water</th>
<th>Economy</th>
<th>Social Structure</th>
<th>Health</th>
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<tbody>
<tr>
<td>Civil society</td>
<td></td>
<td>i. Ecofaxina Institute ii. Mar Azul Institute</td>
<td>i. NUDEC</td>
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<td>Private sector</td>
<td>i. PRODESAN</td>
<td>i. CETESB ii. IBAMA</td>
<td>i. ECOVIAS</td>
<td>i. SABESP ii. CPFL</td>
<td>i. Group Mendes</td>
<td>i. SESI</td>
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2.5 Interview Methodology

The ACI is derived from a series of semi-structured, face-to-face interviews conducted with key stakeholders. Interviews typically last about an hour during which respondents are asked to assign a value of performance on a 5-point scale (Box 1) to each index indicator, and to discuss the conditions that shaped their capacity and that of their organisation to adapt to climate change. This combination of both qualitative and quantitative methods provides a greater amount of context and clarity and acts both to validate through example and to highlight potential policy recommendations.

To maximise the potential insight into adaptation practices, respondents are asked to comment on contemporary organisational capacities, along with two previously selected time points, ideally linked to recurrent threats or risks or events, in order to generate a trajectory of capacity over time. In this way the methodology provides scope for both direct and indirect elements of climate change and adaptation to emerge from the interview without directing as well as providing a longitudinal insight into adaptation. Respondents are encouraged to provide examples of inputs and outputs while assessing capacity for each of the identified sub-components of adaptive capacity (critical self-reflection, organisational structure, improving insight, resources to enable adjustments, and support for experiments). Multiple views are sought from each organisational unity – department, household, agency etc. to control for respondent bias in the interview process and provide greater insight. The model can be deployed to compare capacity between any social units - between departments within an organisation, between local and national organisations and across sectors or administrative-political regimes.

The 5-point scale (Box 1) employs five qualitative performance levels (Very limited, Basic, Appreciable, Outstanding, and Optimal), each is also assigned a numerical value of 1 (Very limited) to 5 (Optimal) to enable aggregation. The use of a progressive numerical scale to assess performance

<table>
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<tr>
<th>Box 1. ACI 5-point assessment scale</th>
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<tbody>
<tr>
<td><strong>Very limited:</strong></td>
</tr>
<tr>
<td>No formalised capacity. Activity is ad hoc, very infrequent and not planned or captured by strategy.</td>
</tr>
<tr>
<td><strong>Basic:</strong></td>
</tr>
<tr>
<td>A low level of formal capacity. Activity is planned. Action is infrequent and superficial, below the levels or intensity required to make a concrete difference to outcomes.</td>
</tr>
<tr>
<td><strong>Appreciable:</strong></td>
</tr>
<tr>
<td>A modest level of formal capacity. Activity is planned and strategic. Action is regular and outcomes can be identified but are limited in the depth of impact.</td>
</tr>
<tr>
<td><strong>Outstanding:</strong></td>
</tr>
<tr>
<td>Strong formal capacity. Activity is planned, strategic and integrated into all major sectors. Action is frequent, outcomes have made a clear difference to risk and its management.</td>
</tr>
<tr>
<td><strong>Optimal:</strong></td>
</tr>
<tr>
<td>Very strong formal capacity. Activity is planned, strategic, integrated and a part of everyday practice. Action is constant, outcomes have reshaped risk and its management and continue to do so in continuous cycles of activity.</td>
</tr>
</tbody>
</table>
does not indicate the presence of a universal standard for each level; neither is it to imply that the
distance between each increment is quantifiable or equal. In practice, the degree of adaptive capacity
identified by each respondent is subjective to individual experience and assessment of performance
targets for risk management. The establishment of this kind of scale of achievement levels provides
the opportunity to determine the ‘distance’ between current conditions and an objective threshold or
optimal condition at a selected scale. Asking respondents to place a numerical value forces
comparative analysis and tightens results. The strategy of asking respondents to exemplify decisions
allows some analytical triangulation between respondents and prevents wholesale strategic respondent
bias.

2.6 Survey Instrument Sections

There are nine subcomponents in the ACI model that form the underlying conceptual framework for
the survey instrument (Figure 1). This model can be used in multiple ways to elucidate a variety of
interactions and dialogues within an overarching resilience/transformation narrative. The central pillar
of the conceptual framework is a critical self-reflection component. This represents the ability of
policy and implementing agencies to reflect on practice outcomes. Including critical self-reflection
indicators in the ACI model increases the transparency and accountability of actors and institutions
being assessed since they provide a gauge of the effects of an organizational capacity development
intervention, not simply a record of activities undertaken. Critical self-reflection can be demonstrated
through examples of how an organisation changed strategic direction or the tools or mechanisms used
to meet an existing goal. A prerequisite of this indicator of adaptive capacity includes ensuring space
for reflection that goes beyond questions of efficiency to include a testing of existing practices
(Pelling and Zaidi, 2013, Brooks et al., 2005).

One investigative area of particular note is the role that social learning spaces within and between
organisations are being utilised at different scales. Spaces for learning can either be cultivated in the
formal or canonical system, or when this is closed off then within the more hidden shadow or
informal systems of relationships, networks and spaces (Pelling et al., 2008). The interaction between
the shadow and canonical and especially how far the canonical can tolerate the shadow without losing
key performance goals such as transparency and efficiency is a key dilemma and threshold point for
adaptive capacity.
The nine subcomponents of the conceptual model were mapped on to four main overarching survey sections in order to allow easy interpretation and relevance for interviewees. The survey sections were:

- **Risk Identification**
  - The availability of risk identification mechanisms and early warning systems in the overall system for risk impacts. These mechanisms can be the outcome of national or local initiatives that manifest at the city or county level.

- **Risk Reduction**
  - Refers to pre-event management activities designed to either directly enforce or empower actors to contain human vulnerability and hazard, and enhance adaptive capacity and actions in the long and short term.

- **Learning**
  - Willingness to incorporate lessons and reassess organisational goals

- **Adaptive Governance**
  - The degree to which the existing system has inbuilt mechanisms for flexibility (change within existing limits of practice) and reform (a timely changing of the limits of regimes, technical ability or underlying values and goals).
2.7 Analysis

Two analytical tasks are performed on the data collected from the interview process. Initially, a quantitative analysis produces a description of capacity from the viewpoint of respondents. This can be presented for each respondent, and in aggregate form. Weighting is kept neutral to enhance the transparency of the analysis and avoid data transformation issues. This task focused primarily on the right hand side of the conceptual model which primarily deals with agency.

Secondly, interview data is analysed and coded qualitatively to draw out processes, gaps and opportunities for to help draw out analytical clarity and focus policy recommendations. The four subcomponents on the left of the conceptual model, supplemented by additional questions, represent the structure of the organisation under investigation and were the main focus of these analyses.

The semi-structured nature of the ACI approach allows multiple perspectives and outlooks to be examined within individual interviews as well as across sectors. The examples of inputs and outputs provided by respondents supply crucial context which can elucidate strategies, approaches and mechanisms which organisations employ to increase adaptive capacity as well as underlying values that drive the how, what and where questions of actual implementation. Understanding the normative standards and base values of organisations playing a key role in climate change adaptation provides insight into how priorities are being set and what shifts in approach may be possible.

2.8 Analytical Themes

A foundational analytical approach provides the opportunity to map analytical efforts on to three main themes: i) trade-offs, ii) knowledge and technology transfer, and iii) responsibilities, decentralization and participation. All of these themes must incorporate both internal organisational decisions and character along with external drivers such as justice implications and adaptive limitations and will be viewed within the three organisational approaches, utility-maximising, behavioural, and institutionalist, as defined by Berkhout (2012).

i) Looking at trade-offs between investment in adaptation efforts with other internal capacities and imperatives provides a key frame to discern the different capabilities of similar organisations in different sectors, landscape locations or geographical regions. The building blocks of organisational character, the processes of decision-making, experimentation and resource configuration, along with the level of investment in future planning (horizon scanning) all require trade-offs that play a defining role in not only how
an organisation might adapt to change but also which barriers to adaptation may be the most likely to be encountered. It also offers the opportunity to understand how constraints imposed upon organisations, for example through the reduction of financial and human capital in state agencies, influence the ability to invest in capacity development and what trade-offs are necessary to either formally or informally tackle these constraints, such as knowledge sharing.

ii) Knowledge and technology transfer sharing includes the development and use of social networks, partnerships and social learning. This provides the opportunity to analyse the importance of shadow and conical spaces to organisations with the adaptive landscape as well as attempt to categorise opportunities that might be exploitable by other similar organisations in a different situation. The transfer of lessons-learned and the potential opportunity to co-produce and co-design solutions to overcome barriers is easy to justify in theory but often more difficult to apply in practice due to issues such as data sharing, patent restrictions, and costs. Highlighting this as a key theme provides the opportunity to increase transparency with the adaptation landscape as well as understand why the adaptive capacity agenda may be difficult to advance in some geographical or locational situations.

iii) Changing responsibilities through efforts such as decentralization of authority or a greater demand for a wider participatory and integrated approach create both opportunities and constraints for organisations that provide extensive analytical prospects within the adaptive capacity discourse. These changes are usually more extensively felt at the state level and often impact, both positively and negatively, the state’s ability to negotiate and collaborate with other sectoral actors to achieve adaptation objectives and targets. It is therefore key to understand how responsibilities are changing and the potential impacts of those changes may be on existing adaptation efforts as well as opportunities for future initiatives.

2.10 Bias and Limitations

The project was resource bound and therefore attempted to focus on generating depth in study that could drill down from the national to local level along a vertical horizon. Additionally key actors in a variety of sectors were used as counter-balances to populate the horizontal axis and provide greater context for governmental actions. Alternative sample frames could have highlighted differences in perceived adaptive capacity by geographical region (e.g. coastal/interior) or the urban-rural axis. The
final sample does include indicative viewpoints from several productive and critical urban and rural sectors.

Respondent bias was primarily controlled for through the use of a structured questionnaire tool administered in person by same principle project researcher. If in-person interviews were not possible, Skype was used as an alternative in order to retain non-verbal interaction. It was felt that given the complexity of the information required this would be more fruitful than an internet or postal survey. This resulted in detailed and careful consideration being given to the interview questions by the respondents.

Strategic bias introduced by respondents is always a possibility. This was perhaps confounded further by the use of a communication broker to identify respondents which may have resulted in a narrow sample due to their own community of practice limitations. This highlighted the importance of building a discursive approach around the core questionnaire further which provided scope for respondents to explain their quantitative judgements of capacity and acted a control on unsupported views.

3. Study Context

The promotion of planning and business decisions and legislation that embrace avenues to cope with risk and change is becoming increasing more essential as environmental, social and economic conditions continue to change rapidly. The aim of this research is to supply organisations in Selsey in the UK, Broward County in the USA, and Santos in Brazil with better guidance on elements of internal and external capacity that can enable them to go beyond raising awareness and, instead, to undertake efforts that will lead to the implementation of practically focused adaptation actions and decisions.

A series of interviews with managers, technical professionals and thought leaders in a variety of organisations that actively play a role in the economy and viability of each of the regions will provide a quantitative and qualitative assessment of the adaptive capacity. By involving a wide range of risk managers and practitioners with a both a macro and local level of understanding, experience and influence the results will contrast existing political economy, wider institutional contexts and the organisational landscape within which decisions must be made while also providing adaptive capacity profiles to assist in this transition.
These interviews create an environment where self-critique of risk management practice, and capacity to change values, behaviour and outcomes are used as indicators of adaptive capacity alongside a review of existing practices and capacities. The tool that is being used, The Adaptive Capacity Index (Pelling and Zaidi, 2013), provides a mechanism through which existing management priorities, organizational structures and governance can be reviewed at multiple scales with a view to identifying efficient pathways for mainstreaming adaptation. The results can be used in a variety of ways including improving information flows, re-orienting disaster management to a more proactive and developmental footing, and revising institutional and legal frameworks to balance capacity and responsibility between national and local or sector specific actors. The process will enable local decision makers, policy makers, and key sector representatives to share experience and insight about adaptation efforts and initiatives, as well as the difficulties that hinder efforts.

3.1 Study Site Overview

This report focuses on the research efforts in Santos, state of São Paulo, Brazil (Figure 2). Founded in 1546, the city is one of the oldest settlements of the country. The Port of Santos - currently the most important in South America - dates back to the beginnings of the city, so that the history of Santos is indelibly associated with the emergence of the harbour. Figure 3 shows a reproduction of the old village of Santos.

Figure 2. Santos within the state of São Paulo, Brazil. Source: Eduardo K. Hosokawa
The locational advantages of Santos due to its natural resources, the fact that Santos is very close to São Paulo, the largest city in Brazil and connected with the rest of the country by an extensive network of highways – contributed to the current strategic role of Santos in Brazil’s economy. Bordered by the slopes of Serra do Mar - a mountain ridge which runs parallel to the coast - and spread over an area of 280.7 km², part of the city lies on the island of São Vicente (15%) and part on the mainland (85%) (Figure 4). However, 99.3% of the population lives in the insular part of Santos.
The municipality is also the seat of the Metropolitan Region of Baixada Santista (MRBS), regional leader on economic development, with nine municipalities and around 1,749,343 inhabitants (Figure 5).

Figure 5. The MRBS within the state of São Paulo, Brazil and a detail with the 9 municipalities. Dark colors indicate higher elevations. Source: Gabriel, Nunes and Marengo, 2012

3.2 Physical Description

3.2.1 Geology, Geomorphology and Hydrology

The natural environment of Santos and surroundings is a rich mosaic of ecosystems along with extensive climatic and topographic diversity, with plains extending from the Atlantic Ocean to the Serra do Mar Mountains, the most outstanding geomorphological feature in Eastern South America.
Originally covered by the Atlantic Rainforest biome with forest, marshes and mangroves, the region is one of the richest areas in biodiversity of the world and was declared a Biosphere Reserve and World Heritage by UNESCO (1992) and National Heritage by the Brazilian Constitution (1988). The mainland of Santos is an area under protection with sparse occupation. The forest provides shelter for numerous species, protection for the coastal zone, prevents erosion and siltation and therefore, contributes for increasing resilience against the impacts of global warming (SOS Mata Atlântica). However, the region is one of the most threatened on the planet due to the rapid urban expansion rate, as well as exogenous variables (like globalization), which together promoted a comprehensive and rapid disturb in its ecological dynamics, fact that might contribute to the increase of hazardous events and to expose more people to risk.

The region presents a complex relief with ridge areas with slopes of up to 45° and altitudes that overcome 1,000 meters as well as flood-prone plains with unconsolidated sediments. Pre-Cambrian rocks form the crystalline base of the Serra do Mar Mountains which frames the area. The structure of the Serra do Mar Mountains is marked by a formation of several tectonic blocks, with numerous rifts (Riccomini et al., 1989). These structures are characterized by structural alignments and cliffs, with the widespread occurrence of tertiary and quaternary sediments and soils (Modenesi-Gauttieri et al., 2002).

The massive is variously fractured towards the NE and NW and through erosion by water these fractures formed a number of valleys, like Valley of Cubatão, in the vicinity of Santos. Sediments were deposited on coastal plain and the variations of climate during the Quaternary, which involved dry periods with a low sea level and wet periods with a high sea level, influenced the development of the current landscape. Some areas present soils which are deeper (yellow-red latosols) while others has shallower and rocky soils (lithosols), with distinctive saturation capacity (Government of the State of São Paulo, 1990).

The urban area of Santos, concentrated in the island of São Vicente, lies in a coastal plain, with low altitudes and some isolated hills (morros), part of the Massif of São Vicente of ancient origin. Figure 6 presents an overview of the island of São Vicente, shared by Santos and São Vicente cities.
The humid tropical conditions and the forest contributed to the development of deep soils, despite the steep slopes. Soils present high hydraulic conductivity values, which allow rapid infiltration and interflow along soil cracks and roots, which contribute to landslides. Notwithstanding, consecutive days of heavy rains can saturate soils and hinder or even impede infiltration. The area presents natural low stability threshold under constant decrease due to different pressures in the area. Geological, geomorphological and hydrological characteristics associated with high temperatures and precipitation, type of vegetation (banana trees spread in the area retain water by root, increasing the weight) and gravity facilitate mass movements in the area (soils and rocks). The hills are densely occupied with houses perched on steep slopes (Figure 7) and next to rivers, and as a result the area has high recorded historical incidence of landslides triggered by intense rainfall.
In spite of its natural fragility, its strategic geographical position contributed to transform the region into an articulating centre. In the beginning of the 20th Century coffee production drained by the Port of Santos brought much prosperity to the city. Between 1940 and 1950 Santos almost doubled its population, becoming one of the ten largest cities in the country. From the 1950’s major changes modified the socioeconomic profile of the region, as a result of the gradual transition from an economy based on coffee to an industrial economy. In the middle of the 20th Century transnational corporations set up in the area with a major concentration of industries next to Santos. The phenomenon of second residence for the middle and high classes of São Paulo (only 70 km away from Santos) gained impulse and the growing of civil construction and other related economical activities attracted to the area an important population contingent of immigrants. These transformations brought in turn both benefits to the economy and deficits in the infrastructure and created a marginal population segment that occupied the unstable hillslopes of the Serra do Mar Mountains and mangrove areas. Although the occupation of hillsides dating back to the early days of city, shanty towns appeared and grew rapidly and this occupational pattern and pollution generated by industries accelerated landslides, mudslides and urban floods triggered by precipitation (Carmo and Nunes, 2008). Furthermore, the deforestation promoted by this model reduced the water retention capacity of the soil and contributed to continental runoff and biodiversity losses.

These processes contributed to the continuous growth of the society’s vulnerability to natural events in the region: several landslides have been registered in Santos and other cities, with dramatic consequences: on March 10, 1928, 80 lives were lost due to the collapse of part of the slope of Monte Serrat (Figure 8), burying several houses and affecting areas of the Santa Casa de Misericórdia de Santos, the oldest hospital in the country, which has moved to another area after the disaster. In 1956 only, several landslides, some of them associated with high tide, caused at least 64 fatalities, affected more than 150 residences and displaced many families (Secretaria da Ciência e Tecnologia and Secretaria do Meio Ambiente, 1988). Although wet mass movements are natural events in the area, climate change could exacerbate these phenomena, as well as flash floodings in the marine plain, many times associated with flood tides.

The evaluation of weathering processes dynamics in the area deserves special attention as changes in temperature and precipitation might accelerate the rate of weathering processes and produce thicker weathered profiles, exposing both people and assets to the risk of landslides and floodings. It is possible that the amount of weathered material in some sectors of Santos is much higher than expected, so that future mass movements could transport downhill a much larger volume of material, leading to unprecedented catastrophes.
In the insular part of Santos many rivers are partially or totally canalized, as River Saboó or River São Jorge, respectively. However, the natural conditions (flat area and high precipitation totals) and the high urbanization rate pose difficulties for water infiltration, causing urban floodings. Episodes are particularly dramatic when associated with high tides. In the mainland the rivers are meandered, the most important being rivers Quilombo, Jurubatuba and Cabuçu. Moreover, the Santos Estuarine System has one of the highest degradation levels in the state of São Paulo due to the presence of the petrochemical industrial plant in the neighbour city of Cubatão, the Port of Santos and the irregular use and occupation of the lands, favouring the dissemination of diffuse sources of contamination. (Gasparro et al., 2008).

Deficiencies in the sewer system in the city in the beginning of the last century originated several outbreaks of diseases and constant floods and contributed for the built of a sophisticated system of canals. Figure 9a shows the construction of canal 1. Nowadays Santos has seven canals (Figure 9b).
3.2.2 Weather and Climate

Within the humid tropics, the region is affected by tropical, subtropical and mid-latitude controls and patterns of climatic fluctuations are to some extent organized on a global scale. During summer, when convective activity is greater, the SACZ (South Atlantic Convective Zone) influences the rainfall regime, with band cloud cover and rainfall remaining semi-stationary for several days. Frontal systems are common in the area, mainly during autumn-winter. At local level, the morphology, the ocean proximity and the high urbanization (heat island and changes in the prevailing wind directions) influence climatic conditions.

Table 2. Rainfall climatology for some selected gauges

<table>
<thead>
<tr>
<th>City</th>
<th>Altitude (m)</th>
<th>Latit. (S)</th>
<th>Long. (W)</th>
<th>Avg 1960-1999 (mm)</th>
<th>Annual Maximum (mm)</th>
<th>Annual Minimum (mm)</th>
<th>Monthly Maximum (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bertioga</td>
<td>720</td>
<td>23°45'</td>
<td>46°08'</td>
<td>4657.4</td>
<td>7391.1 (1947)</td>
<td>1758.2 (2001)</td>
<td>384.7 (Jan/1975)</td>
</tr>
<tr>
<td>Cubatão</td>
<td>5</td>
<td>23°52'</td>
<td>46°23'</td>
<td>2520.5</td>
<td>4138.6 (1947)</td>
<td>1754.8 (1963)</td>
<td>258.9 (Mar/2003)</td>
</tr>
<tr>
<td>Guarujá</td>
<td>3</td>
<td>23°57'</td>
<td>46°11'</td>
<td>2306.4</td>
<td>5973.1 (1947)</td>
<td>1364.7 (1938)</td>
<td>310.5 (Jan/1973)</td>
</tr>
<tr>
<td>Guarujá</td>
<td>3</td>
<td>23°56'</td>
<td>46°17'</td>
<td>2215.1</td>
<td>3151.6 (1966)</td>
<td>1446.5 (2001)</td>
<td>219.0 (Jan/1973)</td>
</tr>
<tr>
<td>Santos</td>
<td>200</td>
<td>23°53'</td>
<td>46°13'</td>
<td>3375.6</td>
<td>5559.3 (1947)</td>
<td>1946.8 (2001)</td>
<td>252.4 (Feb/1994)</td>
</tr>
</tbody>
</table>

Source: DAEE; CTH/USP; SIGRH, 2005, adapted by Nunes
Precipitation is high but variable and concentrated during spring-summer semester, as can be seen from Table 2 and Figure 10, while temperatures vary little along the year, with annual average of 23.1°C (Figures 10 and 11).

Figure 10. Climogram of Santos (1996-2015). Data of CIIAGRO, organized by Nunes.

Figure 11. Average monthly temperature for Santos (1996-2015). Data of CIIAGRO, organized by Nunes.

Determining how changes in weather and climate events contribute to disasters, especially frequency, intensity, duration and geographical extent is of utmost importance for designing and implementing adaptation strategies, as the exposure of people and assets to extreme episodes increases their vulnerability to flooding and landslides. Further, heavy rains are associated with higher rates of
infectious diseases, such as dengue fever, zika and leptospirosis. Extreme weather events might also affect the physical stability of the coastline: for instance as water warms, it will evaporate more quickly and might bring more rain and winds; kinetic energy would be transferred to the sea in the form of waves or storm tides and would carry sediments of erosion or silt hit to the coastline and urban assets (Zee, no date).

Evaluating recent trends of heat waves in Santos by comparing two periods (1961-1990 and 1991-2007) Fante and Sant'Anna Neto (2015) concluded that Santos experienced substantial increase in heat waves, defined as at least 5 consecutive days at or above 5ºC the record highs of the area.

Heavy rainfall events in Southeastern Brazil for the period of 1960–2004 presented a positive and consistent trend for the area where Santos is located (Teixeira and Satyamurty, 2011). Nunes, Martín-Vide and Gabriel (2013) analysed the weight of the largest amounts of daily precipitation in the bulk of the series and concluded that the daily precipitation in Santos and surroundings presents high variability, which can be amplified due to climate change.

In view of determining risk areas and temporal evolution of hazardous events by type and location, Rampazo (2015) collected and analysed data of floods, landslides, wind-driven phenomena and other weather-related phenomena that affected Santos. The author found 154 events (the first in 1878), 49.0% of which in summer and 53.2% of which in the more recent decade (2005-2014). Storm surges are also common phenomena in Santos (Figure 12) and are on increase: analysing data from 1961 to 2015 Souza (2013) found 89 events, 66 of which between 2001 and 2011.

3.2.3 Demographics and Economics

According to the 2010 Census 419,388 people lived in Santos, which represented an increment of 0.03% over the 2000 Census. The population of 2015 is estimated at 423,579 inhabitants, 99.9% living in the urban area (IBGE, SEADE, data of 2015). The stabilization of the population growth reflects that the occupation of the urban space is consolidated in the absence of empty spaces, and the high population density of the city: 1,509.0 persons/ km², more concentrated in some sectors, as can be seen from Figure 13.
The 2010 census showed that around 20.0% of the residents are older than 60 years and as an average, the household density is 2.9 (Plano Municipal de Habitação de Santos, 2009). Santos has the largest
Brazilian index of verticalization (63.0%) and 70.1% of residents live in their own houses (Plano Diretor de Santos, Revised, 2013). It is important to highlight that population can increase considerably during the summer vacation, period which coincides with the concentration of rainfall (Figure 10), fact that may put more people at risk to be affected by floodings, landslides and other related phenomena.

Employment sectors in Santos, according to SEADE (data of 2014) are: i) services (74.1%); ii) commerce and vehicles repairs (17.1); iii) civil construction (4.5%); iv) industry (4.1%) and v) fisheries (0.2%). Employers by age in Santos are distributed as follow: under 24, 17.4%; between 25 and 39, 43.3%; between 40 and 59, 35.1%; and over 60, 4.2% (SEADE, data of 2014).

Santos’s GDP is around R$ 38 billion (£6.5 billion) (SEADE, data of 2012) and large-scale economic interests include the Port of Santos, the largest and more important of Latin America and the main logistic center of the country, as around a quarter of the value of products traded by Brazil in the international market passes by this harbour. The activities of the Port of Santos account for more than a quarter of all goods entering and leaving the country and constitute the main source of the municipal income. The cargo handling at the Port has doubled in only 10 years (2001-2010) and it is expected to double again in 2019, reaching 170 million tonnes / year. However, the impact of this activity in the city is enormous (like air quality and ocean and river pollution) and must be re-evaluated (CODESP).

The income per capita in Santos is R$89,589.87 (£15,535.00 GBP) (SEADE, 2014) and its Municipal Human Development Index (MHDI) is 0.840 (Atlas Brasil, 2013). But although the city is the fifth best in Brazil in life quality, it presents high sociospatial inequalities: 8.2% of the population lives in subnormal and/or precarious sectors (Secretaria de Desenvolvimento Metropolitano, 2011). By Figure 14 one can identify subnormal, precarious and the other uses for each municipality of the MRBS.

3.2.4 Environmental Risk Overview

The understanding of how both natural and social contributors operate within this complex region, in which agents, causes and effects are nested within a dynamic coupled system, is crucial to minimize environmental impacts in Santos. A recent study (Harari et al. unpublished, Metople) showed that sea levels have risen 0.36 ± 0.18 cm from 2004-2013 in Santos and is expected to rise further (Figure 15). Together with the rise trend of heavy precipitation, the potential impacts to flooding in Santos also continue to growth.
Fig. 14. Housing according to their characteristics in the MRBS: rural, subnormal, precarious, common, no information. Source: Secretaria de Desenvolvimento Metropolitano, 2011.

Figure 15. Three scenarios of sea level rise in Santos (Baseline: 2000).
Santos is a portrait of the social asymmetry of the country, presenting a clear sociospatial pattern, with high income neighbourhoods closer to the sea (Figure 16) and poor sites in special at the Northwestern Zone of the São Vicente Island (Figure 17) and in some hillslope sectors (Figure 7). Reflecting the social imbalance of the region, the risk index for the MRBS based on the ISDR proposal (International Strategy for Disaster Reduction, 2002, adapted to the region) showed that the city as a whole has at the same time high Municipal Human Development Index (MHDI) and high values of poverty index and risk and thus, high vulnerability (Table 3). This fact highlights that the economic development of the region is based on unsustainable practices.

Figure 16. Overview of a high income neighbourhood in Santos

Figure 17. Overview of low income neighbourhood in Santos (Zone Northwest)
Table 3: Class values for each parameter of the risk index for the cities of the MRBS

<table>
<thead>
<tr>
<th>Municipalities</th>
<th>DD</th>
<th>MHDI</th>
<th>PI</th>
<th>Hazard</th>
<th>PI</th>
<th>R</th>
<th>Vulnerability</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bertioga</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1.29</td>
</tr>
<tr>
<td>Cubatão</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>2.71</td>
<td></td>
</tr>
<tr>
<td>Guarujá</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>3.14</td>
<td></td>
</tr>
<tr>
<td>Itanhaém</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2.29</td>
<td></td>
</tr>
<tr>
<td>Mongaguá</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2.14</td>
<td></td>
</tr>
<tr>
<td>Peruíbe</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2.00</td>
<td></td>
</tr>
<tr>
<td>Praia Grande</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3.00</td>
<td></td>
</tr>
<tr>
<td><strong>Santos</strong></td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3.86</td>
<td></td>
</tr>
<tr>
<td>São Vicente</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>3.57</td>
<td></td>
</tr>
</tbody>
</table>

Where R is risk; H is the number of hazards registered from 1961-2007; DD is the demographic density; PI is the poverty intensity; AP is the number of aged population (i.e., over 65 years old) and MHDI is the municipal human development index.

Source: Trescenti and Nunes, 2010

Figure 18 shows the map of the Social Vulnerability Index for Santos (IPEA, 2015). The index is based on urban infrastructure, human capital, income and work, demography and municipal human development index, and varies between 0 and 1, the closer to 1, the higher the vulnerability. Results enhance the clear sociospatial pattern of Santos neighbourhoods, with higher values (e.g. high social vulnerability) in the mainland and the so-called Northwest Zone (Figure 17).

Figure 19 shows the map of inundation vulnerability to Brazil, red color representing the most vulnerable locales. Coastal areas, including the shore of the state of São Paulo, are amongst the more vulnerable of the country.

Figure 20a and 20b present respectively different threats to landslides and inundation in the state of São Paulo: for both hazardous events one can see that Santos is under very high threat (Ferreira, 2014).

The recent oil finds in the Pre-salt layer of Santos Basin has been creating new demands for infrastructure, transport and communication and has been exerting strong pressure in the region.

To address poverty, the municipality has undertaken numerous initiatives in housing and urban services financed by the Brazilian Growth Acceleration Programme and the World Bank which, however, are insufficient to solve the problem.

Fig19. Vulnerability to inundation, Brazil Source: SNIRH, 2015.
The aspects exposed show that in Santos the welfare of the ecosystems and of the population in the coming years depends upon how the region can be prepared for this growth, as well as the degree of the environmental changes the area can face due to the global environmental change. Situation might be aggravated as urbanization and land use changes are also important components to this phenomenon due to their effects on heat retention, runoff and pollution. Changes in climate and weather patterns associated with sea level rise would influence wet mass movements, floodings, storm surges and other wind-related episodes compromising the ecological services and posing a threat to combat and reduce poverty in Santos. The rich and dynamics interactions between natural and social components in a fragile space with enormous potentialities, pose both unprecedented challenges and opportunities for the sustainability of the area, within the cultural and political context of the region.

### 3.3 Policy and Planning Landscape

#### 3.3.1 National Planning Efforts

The national policy that addresses the issue of adaptation to climate change or risk management in Brazil is complex, with the highlights of the National Policy on Climate Change, which created the Work Group on Adaptation (WG Adaptation) for the establishment of the National Plan on Adaptation to Climate Change; the National Plan for Risk Management and Disaster Response; and the National Policy on Protection and Civil Defence. These actions play an important role in planning
and implementing measures in line with the state and local governments, intensifying the work on risk management with research, actions on infrastructure, monitoring of risks, creation of funds to carry out projects around the country, and so on.

Although prior to this efforts there were actions in the country to the risk management, actions specifically related to the issue of climate change has emerged in the 2000s with the creation of the National Policy on Climate Change, and laws for the management of risk have been defined mainly from 2012 due to the efforts of the federal government facing the numerous climate-related disasters in several states at the end of the last decade and beginning of the current one, which represented thousands of deaths and caused national uproar.

**National Policy on Climate Change (PNMC)**

The Brazilian government established, through Decree No. 6263 of 2007, the Interministerial Committee on Climate Change (CIM) and its Executive Group (GEx), in order to guide and develop the National Plan on Climate Change, in addition to proposing the objectives, principles and guidelines of this National Policy. The plan was published in December 2008 with the aims of encouraging the development and improvement of actions to mitigate emissions of greenhouse gases and create internal conditions to deal with the impacts of global climate change (adaptation). In 2009, the PNMC was established by means of Law No. 12.187. This policy formalized the voluntary commitment of Brazil to the United Nations Framework Convention on Climate Change and the Kyoto Protocol to reduce greenhouse gas emissions between 36.1% and 38.9% of projected emissions by 2020.

The Plan is structured into four areas:

1) Mitigation opportunities;
2) Impacts, vulnerability and adaptation;
3) Research and development; and
4) Education, training and communication.

The PNMC was regulated by the 2010 Decree No. 7.390 which foresee the development of Sectorial Plans with the inclusion of actions, indicators and specific goals to reduce emissions, with mechanisms for verification of compliance. In agreement with the decree the Sectorial Plans were launched in the year 2012: besides mitigation strategies it also includes adaptation actions. Until now there were prepared sectorial plans for eight major thematic areas:
• Action Plan for the Prevention and Control of Deforestation in the Legal Amazon;
• Action Plan for the Prevention and Control of Deforestation in the Cerrado (Brazilian savannah)
• Ten Year Energy Plan;
• Low Carbon Agriculture Plan;
• Sector Plan for Mitigation of Climate Change for the Consolidation of Low Carbon Emission Economy in the Manufacturing Industry;
• Low Carbon Mining Plan;
• Sector Plan for Transport and Urban Mobility for Mitigation of Climate Change;
• Health Sector Plan for Mitigation and Adaptation to Climate Change.

Although the PNMC does not set guidelines for adaptation actions it mentions the need to address this issue. Article 4 dealing with the policy goals points to the need for "implementation of measures to promote adaptation to climate change by the three levels of the Federation, with the participation and collaboration of economic agents and social stakeholders or beneficiaries, particularly those especially vulnerable to its adverse effects". The Article 5 states as one of its guidelines the preparation of "adaptation measures to reduce the adverse effects of climate change and the vulnerability of environmental, social and economic systems" (article 5 - paragraph iii.); and "the development of integrated strategies to mitigate and adapt to climate change at the local, regional and national levels (art. 5 - paragraph iv)".

**Brazilian Forum on Climate Change (FBMC)**

The aim of the Brazilian Forum on Climate Change function is to permanently enable the participation of civil society in government forums on climate change. The Forum was established by Decree No. 3.515 of 2000, and regulated by Decree No. 6.263 of 2007.

**National Plan on Climate Change Adaptation (PNA)**

In order to improve the performance in adaptation of the WG Adaptation, the GEx of the Interministerial Committee on Climate Change was created in 2012, with coordination of the Ministry of Environment (MMA) and the Ministry of Science, Technology and Innovation (MCTI). All agencies represented in GEx and other participants are part of the WG, which act directly or indirectly on the agenda of adaptation to climate change in the Federal Government. The WG also includes the participation of civil society through the Brazilian Forum on Climate Change (FBMC).
The main purpose of the WG was to establish and structure a set of government measures to adapt to climate change, observed the period of preparation of the plan by 2015, as defined in the Multi-Year Plan (Plano Plurianual, PPA: 2012-2015), culminating in an agreement for the creation the National Adaptation Plan. The WG worked based on the support and engagement of thematic networks, with the contribution of experts whose role is to prepare technical documents with sectorial and, where possible, a territorial approach. Representatives from government, research institutions and universities, civil society and economic sectors were invited to join these networks. To support the activities of the WG and subsidize the development of an adaptation strategy, the Ministry of Environment signed an agreement with the Getúlio Vargas Foundation (FGV – a traditional institution on economics and administration business). In addition, the MMA and the MCTI are making efforts to establish projects and partnerships along with the state governments, the scientific community and the organized civil society.

To collaborate on the creation of this Plan, the Climate Network (Rede Clima), for example, coordinated by the Ministry of Science, Technology and Information, through the National Institute for Space Research (INPE), has produced data, information and knowledge on the topic that are essential for policy makers to monitor the measures taken and to formulate other actions that may be necessary. In addition, it was considered the first report of the National Brazilian Panel on Climate Change Assessment (PBMC, 2013); the recommendations of the Third National Environmental Conference, in which climate change was the central subject, with the participation of over 115,000 people; and the report ‘Subsidies for preparation of the National Plan for Adaptation to Human Impacts of Climate Change’, prepared by the Brazilian Forum on Climate Change. Still, concerning the assessment of the impacts of climate change specifically, there is a provision in the current Multi-Year Plan to develop a system for observing the impacts of climate change on natural systems and economic activities in Brazil, an initiative under the responsibility of MCTI.

Several sectors were identified by the WG activities of the National Adaptation Plan: Agriculture, Biodiversity and Ecosystems, Cities, Natural Disasters, Industry and Mining, Infrastructure (Energy, Transport and Urban Mobility), People and Vulnerable Communities, Water Resources, Health, Food and Nutrition Security and Coastal Areas. Having delimited this context, the WG has defined as basic purposes for the national level:

1. To guide the expansion and dissemination of scientific, technical and traditional knowledge supporting the production, management and dissemination of information on climate risk, and the development of training measures for government entities and society in general;
2. Promote coordination and cooperation between public agencies to climate risk management through participatory processes with the society, for continuous improvement of actions for climate risk management;
3. Identify and propose priority adaptation measures to reduce the climate risk.

The PNA must be added to the initiatives and achievements of the mitigation of climate change impacts made to date in order to guide the implementation of recommended adaptive measures. The synergy between initiatives on adaptation to climate change under this Plan and the national framework for risk management and alert to natural disasters, especially the National Policy on Protection and Civil Defence instituted by Law No. 12.608 of 2012is of noteworthy. This relationship is most evident in a scenario of increased occurrence of extreme events according to climate models.

For federal coordination, a permanent sub-group for consultation with state governments should be established. This will have the role of preparing and submitting the guidelines and technical recommendations for the federal cooperation on adaptation so that state, municipal and federal government promote resilience in a coordinated and cooperative manner. There are also responsibilities of federal articulation instance on the methodological harmonization to identify impacts, climate risk management, vulnerability analysis, adaptation options and providing inputs to the preparation, implementation, monitoring and review of the PNA.

**Funds to the PNA**

To give support to the PNA's actions, the highlights are primarily the funds related to the National Policy on Climate Change, such as: the Amazon Fund, the Low Carbon Agriculture Program and the National Fund on Climate Change (FNMC). It is expected that other international sources of funding can be obtained to implement the goals and guidelines of this Plan, such as the Green Fund and the Fund of the United Nations Framework Convention on Climate Change Adaptation, among others. The Climate Fund (*Fundo Clima*) is linked to the Ministry of Environment and offers two types of resources: refundable and non-refundable. The refundable funds are administered by the National Bank for Economic and Social Development (BNDES), while the non-refundable funds are operated by MMA.

Regarding the support to the projects, the FNMC has applied most of the non-refundable funds under management to support measures and actions to minimize the negative impacts of climate change. More than R$60 million have been applied since 2011. Some specific measures are included; for example, support project for the implementation of the National Centre for Natural Disasters Monitoring and Alerts (CEMADEN), through the acquisition of information technology equipment and technical assistance contracts. This Fund was created by Law No. 12.114 of 2009 and aims to fund projects, studies and actions related to climate change mitigation and adaptation to its effects.
Collaborating Institutions

Several institutions were identified as official sources of relevant information to their demands, among them: the National Institute for Space Research, the National Centre for Natural Disasters Monitoring and Alerts, the National Centre for Risk and Disaster Management (CENAD), the Ministry of Science, Technology and Innovation, Climate Network, the Brazilian Panel on Climate Change, the National Institute of Meteorology (INMET), the National Water Agency (ANA), the Secretariat of Strategic Affairs of the Presidency (SAE) the Brazilian Agricultural Research Corporation (EMBRAPA), the Institute of Applied Economic Research (IPEA), the Brazilian Institute of Geography and Statistics (IBGE).

The CENAD, created by Decree No. 5.376 of 2005, has the role of consolidating the information about risks in the country, such as landslides and floods risk areas together with the collection of registers of natural and technological disasters and its associated damage. The management of this information enables the Centre to support states and municipalities in the actions for preparation to disasters along with the most vulnerable communities.

The Brazilian Panel on Climate Change is responsible for preparing the National Assessment Report, which consists of important systematic scientific evidence to governments and society. The first report, released in 2013, presents the analysis of the national vulnerability. It is planned to be updated every four years.

The National System for Monitoring and Alerts Natural Disasters, established by MCTI/CEMADEN, was created in 2011 to respond to the increase of natural disasters in the country in recent years and thus, seeks to increase the capacity of society to reduce the effects of these disasters, reducing the number of victims and damages arising from the provision of information on imminent risks. Its actions consist in receiving information containing data on the occurrence of natural and technological disasters and associated damage from various Federal Government agencies. These are then evaluated and processed by experts and submitted to the Civil Defence and Protection of states and municipalities, and the alert occurs according to the intensity of the adverse event, in view of facilitating recovery actions on disaster scenarios. In this sense, recovery actions can become prevention, considering the knowledge of the areas and their vulnerabilities.

Furthermore, international initiatives can assist the management of climate knowledge in Brazil. Recently the country joined the Earth System Grid Federation (ESGF) through INPE: it is a worldwide system of archiving and distributing data, whose mission is to provide access to these data and information at world level. This will allow access to information simulations of important climate
modelling scenarios, observation satellite observation and reanalysis in addition to other information dissemination strategies to be established.

**National Policy on Civil Defence and Protection (PNPDEC)**

The National Policy on Protection and Civil Defence, Law No. 12608 of April 11, 2012, guiding the management of risks and disasters focus on prevention, mitigation, preparedness, response and recovery and other sectorial policies, with the purpose of ensuring the promotion of sustainable development. The PNPDEC brought some innovations such as:

- Integration of land-use policies, urban development, health, environment, climate change, water management, geology, infrastructure, education, science and technology and other sectorial policies with a view to promoting sustainable development;
- Development and implementation of the Protection and Civil Defence Plans in the three levels of government, establishing short, medium and long term goals;
- National Information and Monitoring Disaster System;
- Professionalization and qualification, on a permanent basis, of the protection and defence agents;
- National Register of municipalities with susceptible areas to the occurrence of high-impact landslides, flash floods or geological or hydrological processes; and
- Inclusion in the curriculum for primary and secondary education of the principles of protection and Civil Defence and environmental education, among others.

The PNPDEC also foresees the implementation of preventive and mitigation measures of risk situations and, therefore, is aligned with adaptation strategies to climate change with a focus on expanding the adaptive capacity and reducing vulnerability, aimed at climate risk management.

**Secretariat Programs of Civil Defence and Protection (SEDEC)**

In the Multi-Year Plan (2012 - 2015), called More Brazil Plan (*Plano Mais Brasil*), the Secretariat of Civil Defence and Protection runs the program 2040 - Risk Management and Disaster Response, with the following goals:

- Induce networking performance of organisations that integrate the National System of Civil Defence in support of Civil Defence actions at the national and international levels aiming at disaster prevention;
- To promote prompt response actions and reconstruction in order to restore public order and public safety in disaster situations at national and international level;
To expand the mapping of risk areas focusing on municipalities recurrently affected by flooding, sea and river erosion, floods and landslides, to guide Civil Defence actions;

To promote disaster prevention with a focus on more susceptible municipalities to flooding, mudslides, landslides and drought, through instruments of urban and environmental planning, monitoring of urban occupation and implementation of structural and emergency interventions.

**National Plan for Risk Management and Disaster Response**

Created in 2012, it foresees investments of R$18.8 billion in joint actions to prevent and reduce the response time to disasters. Its goal is to ensure safety for those who live in areas susceptible to natural disasters, and its preventive actions also aim to preserve the environment, covering 821 municipalities that account for 94% of deaths and 88% of the total displacements around the country.

The new investments are added to the R$27.6 billion and were contracted between 2007 and June 2012, with a total investment of R$46 billion in 2014. The funds were invested in debt action in four areas: prevention (R$15.6 billion); mapping (R$162 million); monitoring and alerting (R$362 million); and response (R$2.6 billion). Among a number of specific actions of the Plan, it can be highlighted:

- Purchase of health care equipment, rescue, air support, engineering and communications for the military;
- Simplifying the process of buying food, meals, bottled water, cleaning and personal hygiene, mattresses and bedding;
- Implementation of Civil Defence Payment Card for transfer of funds to municipalities and states;
- Forecast of financial resources for rescue, relief and reconstruction;
- Technical support and delivery of equipment to the Municipal Civil Defences;
- Training on Civil Defence and risk management;
- Construction of housing units of the “My House, My Life 2” Program (*Minha Casa, Minha Vida 2*).
3.3.2 Recent Framing Initiatives

**Resilient Cities (Cidades Resilientes)**

In 2011, during the 7th National Week for Disaster Reduction, the National Secretariat of Civil Defence and Protection launched in Brazil the campaign "Building Resilient Cities: My City is Getting Ready", in order to increase the level of awareness and commitment around sustainable development practices, reducing vulnerabilities and providing welfare and security to citizens, and is part of the International Strategy for Disaster Reduction (ISDR), coordinated by the United Nations (UN).

Building a resilient city involves 10 essential steps to be implemented by mayors and local public officials. Five of them have as origin the priorities set in 2005 by the Hyogo Framework for Action (Japan), when 168 countries pledged to take steps to reduce the risk of disasters by 2015. Measures include: the creation of educational and training programs in schools and local communities, compliance with standards on construction and principles for planning and land use, investments in implementation and maintenance of infrastructure to prevent flooding and to establish mechanisms of organization and coordination of actions based on the participation of communities and organized civil society.

**Mapping Project (Projeto Mapeamento)**

The Mapping Project is focused on data collection and analysis of vulnerability to natural disasters for the elaboration of risk maps and on presentation of proposals to disaster prevention interventions, and is being developed by the National Secretariat of Civil Defence and Protection in 275 mapped municipalities by the Geological Service of Brazil (CPRM) through the "Emergency Action for Risk Areas Sectorization".

**Integrated Disaster Information - S2ID**

The Integrated Disaster Information aims to computerize the transfer of funds process in a disaster situation. The aim is to qualify and give transparency to the management of risks and disasters in Brazil, in addition to speed up the process and to guarantee access to information on disaster on many levels.
3.3.3 **State of São Paulo Planning Efforts**

**State Program for Prevention of Natural Disasters and Geological Hazard Mitigation**

Created by State Decree No. 57.512 of 2011, mainly aims at the coordination and optimization of the several actions related to the theme and the search for innovations in this area of knowledge, indicating ways to prevent, reduce, manage and mitigate risk situations in the state of São Paulo.

Coordinated by the Secretariat of the Military House, through the State Coordination of Civil Defence, the Deliberative Committee of the State Program on Natural Disaster Prevention and Geological Hazard Mitigation, consisting of Secretaries of State, considered and approved on 25 October of 2012 the proposal presented by Executive Action Coordination Group the Short and Medium Term Work Plan (2012-2020), which presents a diagnosis and proposes ways to articulate the actions. It also has the participation of the Geological Institute (IG) with the Preliminary Proposal of the State Program for Prevention of Natural Disasters and Geological Hazard Mitigation of 2010.

**Mappings Landslides, Flooding and Erosion Risk Areas**

Since 2004 the development of landslides, flooding and erosion risk area mappings began, in order to better understand the condition linked to this phenomena and location, enabling the implementation of structural and non-structural measures (as training, monitoring and preventive plans of Civil Defence) required to reduce, mitigate or eliminate the risk, in addition to supporting the work of the Municipal Civil Defence in the care of emergency situations.

These studies have been prepared by State Coordination of Civil Defence (Military House), by the Ministry of the Cities, or by the initiative of municipal governments, adopting the recommended methodology in “Brasil - Ministério das Cidades & Instituto de Pesquisas Tecnológicas” (2007). The mappings focus on risk areas generally indicated by the municipal experts of Civil Defence, which undergo technical evaluation, defining risk sectors, indicating the risk level degrees ranging from low to very high. Until July 2012, 78 municipalities were mapped in the state of São Paulo.

**State Policy on Climate Change (PEMC)**

The PEMC, created by Law No. 13.798 of 2009, has the goal to establish the commitment of the State to the challenge of global climate change, to dispose the conditions for the necessary adjustments to impacts of climate change as well as to help reducing or stabilizing the concentration of greenhouse gases in the atmosphere.
Although it doesn’t establish direct actions for adaptation measures, giving clear emphasis on mitigation measures in accordance with the National Policy, the law contemplates the issue at times, as noted below in Box 2.

**Box 2. Articles of the State Policy on Climate Change of São Paulo that address adaptation.**

**Article 5** - V. Implement prevention and adaptation actions to the changes produced by the impacts of climate change in order to primarily protect the most vulnerable layer of the population;

**Article 6** - V. Cooperate in the preparations for the prevention and adaptation to climate change impacts, develop and elaborate appropriate and integrated plans for coastal zone management, metropolitan areas, water resources and agriculture as well as for the protection and recovery regions particularly affected by droughts and floods;

**Article 7** - I. Map with vulnerability assessment and prevention and adaptation needs to face the impacts of climate change, integrated with the actions of Civil Defense;

**Article 10** - IX. Identify and map existing vulnerabilities in municipal territories as a basis for local adaptation policies to the impacts of climate change;

**Article 25** - Under Article 17 of this law, the application of funds from the State Fund of Water Resources (FEHIDRO) should include climate change, defining the areas of greatest vulnerability and the prevention, mitigation and adaptation;

**Article 27** - I. Develop climate change adaptation and extreme weather events programs that prioritize the most vulnerable populations in order to facilitate interaction between civil society and the São Paulo State Government to promote the internalization of the issue in the spheres of activity of relevant social actors, such as State Departments, local authorities and state and local Foundations, Municipalities, business and academic sectors, civil society and media;

**Article 28** - The Climate Change Program of the State of São Paulo (PROCLIMA) will coordinate the state systematic inventory actions and will follow the monitoring of vulnerabilities, implementation of adaptation measures and the systematization of information on greenhouse gas emissions; and

**Article 33** - IX. Develop a participatory plan for adapting to the effects of climate change, contemplating disasters of climatic origin, within 2 (two) years.

The Plan also foresees the creation of the Participatory Plan for Adaptation to Climate Change and the State Communication on Vulnerability to Natural Disaster and Strategic Plan for Emergency Actions and Risk Areas Mapping.

*Preventive Plan of Civil Defence (PPDC)*

This plan was implemented on the summer of 1988/1989, aiming to minimize the consequences arising from mass movement phenomena, especially hillside landslides and barrier falls. The PPDC encompasses technical actions (Geological Institute and Institute for Technological Research), weather monitoring (Environmental Company of the State of São Paulo - CETESB) and state and
municipal Civil Defences, as well as representatives of the civilian population. PPDC includes the follow municipalities: Cubatão, Santos, São Vicente, Guarujá, Ilha Bela, São Sebastião, Caraguatatuba and Ubatuba (Cerri et al., 1990).

Since its implementation, the PPDC operates between November and March, period that can be extended to April. During this period, the plan provides permanent observation status and according to weather and geotechnical conditions, permanently monitored, it can change the risk level, which are attention, critical or emergency, each one with different actions which aim ultimately to minimize consequences of economic and social natures (Nunes; Modesto, 1992). The Plan proved to be efficient, as the number of casualties has decreased dramatically in the last decades. Currently the Preventive Plan of Civil Defence and Contingency Plans are in place in 129 municipalities, and Santos currently has: Contingency Plan; Risk mapping; and Municipal Plan for Risk Reduction.

**Municipal Risk Reduction Plans (PMRR).**

The work of PMRR involves: a) training of municipal teams for preparation of diagnosis, prevention and management of risk, including the mapping of risk areas with illegal occupation on the municipality; b) financial support for the preparation, by the municipality, of the risk reduction plan, planning tool which includes the diagnosis of risk, the necessary safety measures, the estimate of resources required, establishing priorities and compatibility with upgrading programs of shanty towns and regularization; c) financial support for the preparation of slope retention projects in risk areas identified as priorities in the Municipal Plans of Risk Reduction. Until July 2012, 19 municipalities in the state of São Paulo had PMRRs.

**Civil Defence Municipal Plans**

They are municipal instruments of risk management, in order to establish a set of guidelines and information for the adoption of logical, theoretical and administrative procedures, structured to be triggered quickly in emergency situations, thus allowing the coordinated action of public agencies, local and regional, and other private institutions collaborators, efficiently and effectively, minimizing damage to health consequences, community safety, public and private equity and the environment. At the end of 2011, 98 municipalities declared to have Municipal Plans of Civil Defence. Santos has organized its Municipal System of Civil Defence in 1980, by Decree No. 5.877.
Economic Ecological Zoning

It is a basic instrument of organization of the territory, aiming to organize, in bound form, decisions of public and private operators in respect of plans, programs, projects and activities that directly or indirectly use natural resources, ensuring full maintenance of capital and environmental services ecosystem.

Geotechnical mapping for land use and occupation planning and management

Geotechnical charts are cartographic documents that bring details of the physical environment and its geodynamic processes, showing the limitations and potentials of the land, thus guiding their use. They are essential especially for cities with susceptible to landslides, floods and other natural disasters areas, understanding expressed in the Federal Law 12.608 of 2012, which established the National Policy on Civil Defence and Protection. In addition, according to the law it is necessary the charts must observe the Strategic Master Plan. In its Article 22, defines the construction of "geotechnical charts of eligibility to urbanization, urban setting guidelines focused on the safety of new soil instalment and the utilization of aggregates for the construction industry." The Institute for Technological Research (IPT) is responsible for precursor charts of urban areas in the country, the first being the area of the hills of the cities of Santos and São Vicente, dated 1980. This was an unprecedented work in the country, consolidating this tool as a reference for territorial and urban planning work and implementing a new working method in the field: geotechnical mapping. Dozens of other documents were prepared then and helped consolidate the methodology over the years.

The susceptibility charts are cartographic documents drawn up in compliance with the National Plan for Risk Management and Disaster Response, launched in August 2012 by the Federal Government to assist in the prevention of natural disasters. Prepared by the Geological Service of Brazil in partnership with the IPT, the susceptibility charts serve as an auxiliary instrument in the preparation of territorial, environmental and urban planning actions of municipal administrations. Santos was one of the 40 municipalities in the state benefit with the document in 2014.

Serra do Mar Strategic Program

Joint action between the Secretariat of Environment and Housing and Urban Development Company (CDHU) that aims to: recover the occupied areas on the slopes of the State Park of Serra do Mar (where Santos is located), eliminating risks to substandard housing; protect biodiversity and water supplies; and promote the restoration of degraded areas.
Seminars for training municipal civil defense agents.

There are some preparatory courses for coping with risk situations (Contemporary Cultural Studies Centre - CEDEC, Ministry of Cities), particularly aimed at monitoring risk areas and the operation of preventive plans of Civil Defence. In 2011 the CEDEC organized 25 trainings, the Civil Defence Preparatory Seminars and workshops for Operation Summer, covering all regions of the state, reaching an approximate audience of 2,536 people and distribute educational materials and practical activities.

Pluviometric and Fluviometric Monitoring

The Department of Water and Power (DAEE), together with the Technology Centre of Hydraulics Foundation and Agricultural Research Support Foundation (FUNDAG) maintains a telemetric network of over 250 fluviometric and pluviometric stations around the state of São Paulo, providing real-time data, based on four situation rooms located in São Paulo, Registro, Taubaté and Piracicaba. Data are online and can be universally accessed.

Secretariat of Housing Programs for hazardous areas.

To meet the population groups that present difficulties of solving their housing needs in the housing market, the Housing and Urban Development Company, linked to the Ministry of Housing (SH) is a public company that promotes residential care, and Paulista Social Housing Agency (Casa Paulista), created in order to promote and implement programs, partnerships and actions that multiply the supply of housing of social interest in the state. Among its responsibilities, there is the Agent Operator responsible for directing and implementing the financial resources of the Paulista Fund for Social Housing (FPHIS) and the Guarantee Housing Fund (FGH), created to support the production of social housing. The main duties of the Secretariat of Housing of the State is the promotion and supply of public housing quality, legalized, integrated with public transport, education, health, leisure and other benefits of urbanization. Therefore, the SH also promotes redevelopment actions of shanty towns, areas and property settlement, environmental and urban renewal and removal of families on risk areas.

3.3.4 Local Planning Efforts

Even though the city of Santos follow a number of national and state laws, it does not have specific guidelines for the issue of adaptation to climate change, although this scenario can be changed soon
with the creation of the Municipal Commission for Adaptation to Climate Change in 2015 that should establish the Municipal Plan for Adaptation to Climate Change in the coming years. However, it is important to point out that the municipality has a strong presence in the matter of risk management, especially regarding the geotechnical risks, aligning with various laws and guidelines of other levels of government, as can be seen in Figure 21.

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>Municipal System of Civil Defence of Santos established</td>
</tr>
<tr>
<td>1988/99</td>
<td>Preventive Plan of Civil Defence published</td>
</tr>
<tr>
<td>2000</td>
<td>Brazilian Forum on Climate Change established</td>
</tr>
<tr>
<td>2007</td>
<td>Interministerial Committee on Climate Change established</td>
</tr>
<tr>
<td>2009</td>
<td>National Policy on Climate Change published</td>
</tr>
<tr>
<td></td>
<td>State of São Paulo Policy on Climate Change published</td>
</tr>
<tr>
<td>2011</td>
<td>State of São Paulo Program for Prevention of Natural Disasters and Geological Hazard Mitigation established</td>
</tr>
<tr>
<td>2012</td>
<td>Work Group on Adaptation for the implementation of the National Plan on Adaptation to Climate Change established</td>
</tr>
<tr>
<td></td>
<td>National Policy on Protection and Civil Defence published</td>
</tr>
<tr>
<td></td>
<td>National Plan for Risk Management and Disaster Response published</td>
</tr>
<tr>
<td>2015</td>
<td>Municipal Commission for Adaptation to Climate Change of Santos established</td>
</tr>
</tbody>
</table>

*Figure 21. Legislative and Policy Review Timeline for Santos, Brazil*
Municipal Commission for Adaptation to Climate Change

This Commission, created through Decree No. 7.293 of 2015, is responsible for the preparation and monitoring of the Municipal Plan for Adaptation to Climate Change of Santos, in accordance with the National Plan on Climate Change Adaptation and Complementary Law No. 821 of 2013, establishing the Director Plan for Development and Urban Expansion of the city of Santos. The Municipal Plan for Adaptation to Climate Change must be drawn up within one (1) year from the date of the publication of the decree.

3.3.5 Recent Local Framing Initiatives

Hyogo Framework for Action

Reports that measure the progress of nations and communities to meet the goals of the Hyogo Framework for Action (Japan), which is a universally accepted reference for reducing disaster risk. Santos drew up its report measuring its progress and challenges in implementing disaster risk reduction actions in the city. As a result, it increases the understanding of risk between the parties and establishes a baseline for future interventions.

3.3.6 Recent Local Action Initiatives

Santos Novos Tempos Program

It is an extensive set of urban interventions in various parts of the city created in 2010 funded by the World Bank. Investments are directed to promote the solution of institutional needs and the city’s infrastructure, including actions that will permanently eliminate flooding in the Northwest Zone; slope retention of hills, reducing risks of landslides; and construction and renovation of social housing and environmental recovery, integrated into a large training program and professional qualification of the low income population (Figure 22). The improvements will benefit about 120 thousand people, attracting investments that generate new jobs.
The set of actions will have a total cost of US$88 million (R$166 million), with funding approved in November 2009 by the World Bank that guarantees the release of US$44 million over five years. The other US$44 million will be the counterpart of the Santos Prefecture to enable housing projects in partnership with the state and federal governments. Investments of the federal government will come through the Growth Acceleration Program (PAC). The participation of the State Government will be in various stages of the program: construction of housing in Vila Alemao, Sao Manoel and Saboó, and transfer of Cruzeiro do Sul aggregation in Morro da Nova Cintra, under the responsibility of the Santos government. Currently the program is undergoing review and seeking new partnerships to restart the work.

*Community Centres of Civil Defence (NUDECs)*

This project provides information by means of courses on Civil Defence concepts, with geologists of the municipal staff which aims to form their own community groups with the preventive role of educating the public and communicating the organisation in emergency situations. The Civil Defence activities are permanent and are not limited to the emergency situations, in view of preventing accidents throughout the city, especially in the hillslopes. The agency created the NUDECs, which have trained about 500 residents of risk areas. The groups are made up of community members and the council currently has 11 active ones.
4. Adaptive Capacity Index

While it is easy to point to a range of risk management, climate and resiliency policy initiatives and actions that are on-going in the State of Sao Paulo as well as across the nation policy landscape of Brazil, understanding the adaptive capacity of the actors within this crowded landscape is key to generating a picture of the potential success of regional adaptation. The ability of local governments to implement these policies, and for public and private organisations to create opportunities for adaptation, is directly tied to the adaptive capacity of that actor. Therefore understanding potential limitations and barriers at the organisational and agency scale is also critical especially as it has been argued that this is the scale that societal responses to climate related impacts will be driven and implemented (Berkhout, 2012, Eisenack et al., 2014).

The ACI results presented here have been obtained from detailed semi-structured interviews conducted with a sample of 24 experts and representatives of different institutions and organisations that currently populate the environmental risk/climate change management arena in Santos (Table 4). This index therefore reflects the performance of climate risk reduction and adaptation based on the evaluations of academic, professional and official actors in the region.

Results for 2005, 2010, and 2015 are shown initially in aggregate by framework subcomponent (Table 5) and have been disaggregated by location and sector in further analyses where appropriate. The overall ACI results for Santos shows a continuing and persistent trend of progression over the last ten years. Respondents associated these increases, especially for the last period 2010-2015, with the largest operation of federal, state and local levels in risk management and climate change issues, which was intensified after the major disasters that occurred in the country between the years 2008 and 2011, causing thousands of deaths and financial losses in several states. Some laws have been prepared and adopted in the following years of the disasters: at the national level, 2012 was a decisive year establishing two important new laws to reduce disasters in the country: the National Policy on Protection and Civil Defence and the National Plan for Risk Management and Disaster Response; at the state level, in 2011 it was established the State of São Paulo Program for Prevention of Natural Disasters and Geological Hazard Mitigation.
<table>
<thead>
<tr>
<th>Santos City Organisational Matrix</th>
<th>Land Use/Planning/Management</th>
<th>Environment</th>
<th>Emergency and Risk Management</th>
<th>Transport</th>
<th>Energy and Water</th>
<th>Economy</th>
<th>Social Structure</th>
<th>Health</th>
</tr>
</thead>
</table>
| Government (local, regional, state and federal agencies) | i. AGEM
ii. UGP
iii. Secretariat of Urban Development | i. Secretariat of Environment
ii. Fishery Institute | i. Civil Defence of Santos
ii. Fire Department | i. CET- Santos
ii. CODESP | | | | |
| Civil society | | i. Ecofaxina Institute
ii. Mar Azul Institute
iii. Maramar Institute | | | | | | |
| Private sector | | | | | | | | |

ACTORS

Preventive Plan of Civil Defence

FUNCTION

i. Secretariat of Tourism
ii. Secretariat of Culture
i. Secretariat of Health
ii. Department of Health Surveillance

i. ASSECOB
i. Fórum da Cidadania
ii. OAB

i. CPFL
i. Group Mendes
i. SESI
ii. SESC
4.1 Overall ACI results for Santos

Table 5. Overall Adaptive Capacity Sub-Components Scores

<table>
<thead>
<tr>
<th>Sub-Component</th>
<th>2005</th>
<th>2010</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical self-reflection</td>
<td>3.03</td>
<td>3.14</td>
<td>3.41</td>
</tr>
<tr>
<td>Ability to experiment</td>
<td>2.69</td>
<td>2.69</td>
<td>2.94</td>
</tr>
<tr>
<td>Ability to learn</td>
<td>2.91</td>
<td>3.12</td>
<td>3.41</td>
</tr>
<tr>
<td>Ability to plan for the future</td>
<td>2.99</td>
<td>3.17</td>
<td>3.43</td>
</tr>
<tr>
<td>Command over available resources</td>
<td>2.37</td>
<td>2.59</td>
<td>3.01</td>
</tr>
<tr>
<td>Organisational responsibility</td>
<td>3.11</td>
<td>3.33</td>
<td>3.61</td>
</tr>
<tr>
<td>Organisational architecture</td>
<td>2.77</td>
<td>2.91</td>
<td>3.18</td>
</tr>
<tr>
<td>Levels of capital</td>
<td>2.99</td>
<td>3.19</td>
<td>3.40</td>
</tr>
</tbody>
</table>

In addition, outstanding performance on the national scenario of the Municipal Civil Defence of Santos was also directly related to the good performance of the municipality in these matters, a fact that has been occurring since the late 1980s, when the civil defence started to act more strongly on risk management in the city after many disasters with casualties. The Preventive Plan of Civil Defence (PPDC), created in the summer of 1988/1989, came in order to "minimize the consequences resulting from mass movement phenomena, especially landslides and barrier falls" (Nunes and Modesto, 1992), and was largely responsible for the strong performance of the municipality of Santos, one of the first to implement this action plan greatly reducing the number of disaster victims in the city ever since.
It is also important to note that the role of the municipality is primarily related to risk management, especially when it comes to landslides, with the specific issue of adaptation to climate change still very incipient in the municipality, which must be linked to the already active risk management carried out by the Civil Defence and other institutions and which is under discussion by the Commission for the creation of the Municipal Plan for Adaptation to Climate Change created in 2015.

4.2 Cross-Cutting Factors

Most of the respondents noted the access to financial resources as a limiting factor to implementing adaptation actions throughout the region over the decade under investigation, however, other resources - human and technical - are seen as suitable for the city's needs, both by the presence of several public and private universities as well as institutions such as the Civil Defence which has advanced technical resources for risk management. To the issue of financial resources, although the lack of this resource may be a barrier, it was observed that other ways to get funds beyond the usual funding made by the local, state or federal government, may be used as alternatives that local organisations are already seeking, strengthening its ability to conduct experiments and putting in place risk reduction actions. The creation of specific funds for departments or government areas and search for financing by domestic and foreign private organisations appear as a strong component to alleviate the barrier of access to financial resources for better performance in risk management and adaptation.

One issue worth mentioning is how actions in the municipality still have a much more striking feature to remedy the disasters that occur and not to prevent and plan so others do not occur. Although there are shares currently in order to prevent and plan for the future, mainly due to the establishment of the new laws of national and state civil defences, there is still difficulty in integrating information and actions of the various organisations to ensure improved performance accordingly.

“In landslide issues, floods, there is support that is curative, it comes after the incident: the retaining walls are built after the illegal occupation, so why making a retaining wall if you have an irregular occupation? Don’t let it be occupied, if you do not let it you do not need the retaining wall.”

Respondent from the CET of Santos, personal communication, January 2016

The two categories that are slightly below the others are the command over available resources and the ability to experiment, both tied to the issue of existing support in the system for better performance on the issue of management risk and adaptation, and that was driven by the civil and private sectors that directly feel this lack of support from the government. The other
categories have higher rates mainly because the city has a strong performance in risk management since the 1980s, having an active Civil Defence and a number of other organisations that contribute to the work of the Civil Defence in the municipality.

4.3 Sectoral ACI Indices

For public organisations there are high rates in all categories, especially in the last year, 2015, reflecting the perception that respondents have on the intensification of the activities of this sector at federal, state and local levels in the issue of risk management (table 6). However, some categories differ from those presented in the overall result for the city: in this sector the organisations find some difficulty in accessing financial resources, which also weakens the capacity of institutions to support new experiments for the municipality, and also have some difficulty to make self-reflection, mainly due to the fact that the structure of public sector organisations are more rigid, hindering greater flexibility in their jobs so that they can integrate new issues such as adaptation to climate change.

Table 6. ACI Results for Each Sector
Some difficulties in the operation of local public organisations on risk management were observed (especially in organisations that doesn’t work directly with disasters, i.e., emergency and risk management), and that was identified in interviews as a problem of assigning these issues within the organisational structures, which tend to be rigid and bureaucratic in this sector. The risk and adaptation issues are not yet established in the structures of the organisations as key issues to be discussed and subject to direct actions, which ultimately leave these issues in the background and affect the experiments in the city, unless any specific event requires immediate action, like the strong undertow of 2005 when there was a need to rebuild the waterfront avenue in the area of Ponta da Praia and barrier construction to fortify the border.

Within the session of the government agencies the most active sector in the relevant issues to this study is the emergency and risk management: this sector showed high levels in several categories, precisely because of its importance for the city and outstanding performance, even on the national scene, facing the risk issues (table 7). Among all categories, only one is a bit below the others, the support for new experiments, with the financial resources as possible limiter for these actions, as highlighted by the respondent of the Municipal Civil Defence Santos:

“Everything that has costs restricts the actions. It is not an impediment, but it takes a little longer. When there are no costs involved, we have complete freedom to all sorts of the experiments, everything that can potentially contribute to the improvement of our work.”

Respondent from the Civil Defence of Santos, personal communication, October 2015

In general, compared with other sectors of government agencies the transport sector has presented easiness to support the achievement of these experiments, since the importance of such experiments are presented to higher level organisations; while on the other hand, organisations of land use, management and planning sector have some difficulty in supporting the realization of these experiments, because although there is availability of these organisations to support experiments, bureaucratization and the search for resources can be prohibitive: in this sense, creation of specific funds to different secretariats and departments can help to provide a financial contribution for direct action of these departments in new experiments without the need to seek funding at the Prefecture, such as the creation of the Urban Development Fund (Fundurb), quoted by the respondent of the Secretariat of Urban Development, which can hold this resource and thus work more efficiently on existing demands. With new federal, state and local laws, this sector observed strong increase in the last ten years in all other categories, showing a great performance of this sector on risk issues in the municipality.
### Table 6. ACI Results by Sector

<table>
<thead>
<tr>
<th>Municipal Plan for Civil Defence</th>
<th>FUNCTION</th>
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<tr>
<td><strong>Santos City Organisational Matrix</strong></td>
<td><strong>Land Use/Planning/Management</strong></td>
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<tr>
<td><strong>ACTORS</strong></td>
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<td>Government (local, regional, state and federal agencies)</td>
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<td>Civil society</td>
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<td>Private sector</td>
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The civil society organisations are willing to evaluate their measures, are aware of the problems that must be addressed, and have high levels of resources in general, however, they have a low level of support to conduct experiments and low capacity to act with existing resources (low support for new projects and low capacity in staff training to work in the area). The main barrier to greater performance of the civil sector in the risk reduction or adaptation is the lack of support from other sectors, because although this sector has high levels of available resources to act and access to cutting-edge knowledge, the lack of support, especially from the public sector, prevents a greater role by this sector on these issues. Because there is no support and therefore they cannot act strongly on this issue (although there is a will), the civil sector end up presenting a difficulty to plan actions in this direction for the future, which should be essential in a system that needs to prepare for the effects of climate change.

It was possible to generate graphs in just two sectors of the civil society agencies due to some difficulty in finding organisations that relates to the relevant issues of this study. In the environmental sector some Non-Governmental Organisations (NGOs) were interviewed and it was observed that there is great interest on the part of these organisations to act more effectively in these risk issues and adaptation, as evidenced by the numerous very optimistic respondents answers. It was observed that NGOs believe that their performance is very strong within what they propose, however, the respondents gave great prominence to the problem of lack of support to act more effectively in the risk issues and adaptation in the city, and that as a result of a lack integration of the public sector with other sectors, making it difficult to establish partnerships, information exchange, etc. In the sector of social structure, one can observe a difficulty in planning for the future and effectiveness in improving the performance of these organisations to act on risk issues and this is primarily because there are changes in administrations in less than five years and, therefore, they have goals in a medium or even short term only, which limits the power to confront these issues by those organisations in the long term.

One big difference is observed in the support for conducting experiments between environmental sectors and social structure of the civil agencies: the first has a low level while the second has a high level and this is caused by the fact that the social structure can promote events, seminars, courses to improve the diffusion of knowledge, more in the educational sense, while NGOs in the environmental sector can experiment with more direct actions to solve problems, which are different types of actions that relates to the support for carrying out new experiments in risk issues. Moreover, in the command over available resources category, while the environmental sector organisations, as stated earlier, showed that there is a low support for risk reduction issues and do not have strong ability in training staff to better performance in these issues, the sector of the social structure observed an increase in
that support, especially after the accidents in recent years related to the Port of Santos, which initiated new partnerships to confront accidents and other events, as the respondent of the Forum da Cidadania says:

“The concern on environmental risks in terms of accidents at the port have increased, especially after this last accident, so you have a concern now with the area management, have to rethink legislation, rethink how licensing has been done, rethink plans for emergency actions, so there is that, the city saw that it must be more careful, but I do not see that the city has this as one of the priorities for the allocation of more funds, then in terms of the concern is one thing, in terms of political action to make changes is better than it was, but is still far”

Respondent from the Fórum da Cidadania, personal communication, October 2015

Private organisations, as the civil society ones, also identified some difficulty in acting with the available resources, highlighting the lack of political and financial support for acting in risk reduction, and do not have great capacity in staff training to act in these matters (with the exception of the organisations in the social structure sector for this last item); moreover, have low level on the issue of organisational structure, which also highlights the lack of support in the system to act in this area, besides having rigid structures with defined actions that prevents a certain flexibility to act on these issues. Despite the lack of support and the rigid structures, the other categories presented high levels because this sector has great resources to work on new fronts if there is demand, can make a critical self-reflection and plan for the future, however, is must be highlighted that its performance in this area will be more active only if there is this demand, which is not observed by private agencies until now (again: with the exception of the organisations in the social structure sector).

In only one sector of private agencies, the social structure, it was possible to generate the graph for the analysis because more than one organisation in this sector responded to the questionnaire. In the other sectors of the private agencies only one organisation replied to the questionnaire in each sector, making it impossible to generate graphs for these sectors.

For the sector of the social structure of private agencies is worth noting that there is great desire for improving the performance on risk management and climate issues and this is due to the fact that they work directly with educational issues, i.e., organisations want to promote more educational activities, lectures, courses, exhibitions, and so on, which can promote greater awareness among the population and greater engagement of other sectors, however, the respondents of this sector observe, as well as the ones of civil society agencies, the lack of support from the public sector, which prevents greater actions in this field, highlighting the lack of integration between organisations of different sectors as one of the main problems to face the risks in the municipality.
5. Key Findings and Discussion Points

The lack of progression across the components of the adaptive capacity index from the perspective of local actors was accounted for through: i) a lack of organisational integration across the risk management regime, and ii) the dominance of the adaptation agenda by Civil Defence. This supressed incentive for leadership and innovation, especially across multiple agencies. Global economic pressures were also felt by Santos. While the global economic downturn of 2008 had a limited effect on the Brazilian economy at the time, greater impacts were noted post 2014 with more constrained resources and funding opportunities reported across all sectors and agencies. Together these pressures served to stabilise Santos’ adaptive capacity.

Some key findings were listed to join all the information gathered in the interviews for this study: i) limited financial resources and the heavy administrative systems that hinder the approval of new projects and, therefore, the acquisition of resources in different sources of funds, ii) definition of assignment of the risk management issue within organisations, lack of recognition of the issue, iii) lack of support from the public sector to the other sectors, and iv) the need for integration of organisations for better planning and action in the area, which is also affected by the lack of continuity of different administrations.

i) The lack of financial resources was identified in most of the interviews, often being detached from other resources available on the same question (human and technical resources), since other resources are perceived as adequate for municipal needs in organisations. It has been highlighted as a barrier to better performance in risk management issues in Santos, especially because of the lack of flexibility and slow disbursement of these resources in the city, and current political and economic crisis have been quoted several times by respondents as an aggravating factor to this issue, not only for the public sector but also for the private sector and non-governmental organisations.

However, it was perceived in the interviews that the difficulty in accessing financial resources, hampered by the heavy administrative system and aggravated in the current crisis scenario, makes organisations start to pursue new alternatives for performing actions on environmental issues and risk management, allowing greater flexibility for getting funds. Among them, one can quote: i) the Municipal Urban Development Fund (Fundurb), the Municipal Environment Fund, the State Water Resources Fund (Fehidro), the Federal Climate Fund (Fundo Clima), ii) independent funding agencies, either national or international, depending on existing edits aligned with the real necessities of the municipality, iii) funding lines provided by the federal government to finance projects that are aligned with their support lines, since they are already developed and are accepted in the edicts;
among others. In addition, some respondents indicated actions being carried out in the municipality to prioritize projects and approve more efficiently the resources, such as:

We are building, searching for support ourselves, we have very few available resources, but we are creating possibilities within our legal rights; the Municipal Commission for Neighbourhood Impact Analysis (COMAIV) and the suspended runway law themselves are good examples of what we can do to bring these resources to the Secretary. 

[...]

There is a legal department together with the mayor’s own office doing this job, it has become all Secretaries’ concern for all the actions involving them, and it does not stop me from doing my job here; but there is a section today who manages the resources and think of strategic projects; so, they have been a very efficient department together with the government’s Secretary, it is called Secretary of Chief Government. 

Respondent from the SEDURB, personal communication, November 2015

The bureaucracy has been identified as a key point for reducing the adaptive capacity of the municipality of Santos, especially when it relates to the preparation of studies and projects for obtaining funds and execution of works in the municipality. Several respondents recognize that there are alternative ways of fundings, however, because of the lack of financial resources for developing the project and the general bureaucracy, they fail to draw up such projects. These aspects constrains experimentation in the city, as the traditional forms of finance take too long and are very bureaucratic.

We got a support from the World Bank, I was in office in 2001, we started working for getting funding from the World Bank in 2001 and the funding came out in 2007. Then I left. So, depending on the support, this support… even because of bureaucratic procedures, it is not the bureaucracy, but there are a number of procedures and the bank takes a year to evaluate them and so on. Depending on where you will get resources it takes a long time. [...] Great plans, to seek resources… we have to have a solid foundation to get, because the federal government gives access but you have "x" days to present the proposal. If you don't present the proposal you're out. Usually when the federal government opens resources, it knows that municipalities would want it and already have the proposals ready. 

Respondent from the SEMAM, personal communication, October 2015

In the history of brazilian public administration there is a repeated struggle between two forces: on one side the chain of bureaucracy that is formalistic, ritualistic, centralized, inefficient and adverse to periodic attempts to modernize the state apparatus, which attempts to perpetuate their social control and its privileges through bureaucratic centralization; on the other side the modernizing currents of the bureaucracy and their political and business allies (Castor and José, 1998).

In mid-1990, Brazil started the process of breaking with the traditional State bureaucracy by implementing the model of managerial administration through the Master Plan of the State Apparatus Reform (Brasil, 1995), which was a breakthrough for the country (Marcelino, 1998). One aspect in which the plan was based on was the cultural dimension, in which there should be a transition from a bureaucratic culture that had prevailed until then, to a managerial culture: the bureaucratic manager was seen as inefficient, uncompromising and with little attention to the needs of users of public
services, while in the management model the manager would be seen as enterprising, creative and attentive to the population (Junquinho, 2002). Although it started in 1995 as an attempt to reduce the traditional inefficiency of the public sector due to the bureaucracy of the system, until today this problem is perceived, including with several respondents highlighting the issue of a cultural problem as central which limits experimentation.

ii) The lack of assignment of the environmental risks and adaptation to climate change in the organisations in Santos is latent and has been identified in a series of interviews in this study. The Municipal Civil Defence is the reference organisation with regard to risk management for the city and has been active on these issues in recent decades, becoming the focal point in the city on risk management. Meanwhile, there is a lack of recognition of risk issues in the structure of other organisations, so that there is little integration between the civil defence and other sectors of public organisations. The non-assignment of these issues in the structure of organisations constrains a greater adaptive capacity in the city, causing organisations to remain static in the face of the risks. According to the respondents, there is an excessive compartmentalization of the issue in the city, with very strict and tight organisational structures, hindering the further integration of the different departments of the public sector.

iii) In addition, the public sector in general does not provide support and/or create facilities to integrate the private sector and the civil society (like NGO’s, for instance) in the discussion of environmental risks and adaptation to climate change, fact which appeared with great prominence in interviews with civil society and private organisations. For the respondents of these sectors, most of the time this support simply does not exist, and is recognized as a major impediment for these organisations to cope effectively with risk issues and municipal adaptation.

It is not a problem of Santos, it is a cultural problem we face. I see this disarticulation in our culture as a very negative thing overall. For example, here in Santos, I was there when the committees were created, in the 1990s, and I was a member of the children and teenagers committee, because at the time I believed that was the right path, the articulation, the movement of the society was the path to a solution. But only then you will be aware and you see that what happens in politics happens in our everyday life, and it is an absence of participation, generosity, then you bump into several problems, personal interests.

Respondent from the SESC, personal communication, December 2015

During the workshop held in Santos in December 2015, the participants reinforced this view and took this issue as one of the most important to improve the organisational capacity of the city of Santos in environmental change. For them the public sector gets to create spaces for a contact between the various municipal organisations, as is the case of several existing committees, but they question the effectiveness and scope of these spaces. Again, the issue is seen as a brazilian symptomatic aspect of the relationship between society and state, in which the government takes on the responsibilities and
sets aside the effective participation of other sectors, and that is attenuated in the adaptation to climate change issue since it is still incipient, with the establishment of a commission to create a municipal adaptation plan only in 2015, with the detail that only departments of the public sector were summoned for this effort, demonstrating the lack of contact with other sectors.

The Public Policy Councils were created in the country by the 1988’ Federal Constitution to break with the remnants of the centrality of the power coming since the dictatorship times, operationalising participatory ideals, “allowing the population greater access to spaces for formulating, implementation and social control of public policies” (Ciconello, 2008). However, it is observed that the role of organized civil society in these councils in view of a greater share in the country's decision faces difficulties due to the fragility of these organisations and the lack of stimulus from the government.

If the balance of powers within the Councils is very unfavorable, it can be taken to isolation, becoming a merely formal existence, as it is mandatory. When this happens, instead of working towards institutional reinvention, the management councils can establish itself as parallel institutions, with little or no democratizing effect on state institutions. This is one of the problems often pointed out in the case studies: weakened councils that cannot legitimize as instances of participation, which end up being renegades to legitimizing function of the executive bodies decisions (Tatagiba, 2004).

In this sense, it is observed that the federal government has acted more strongly towards social governance and consultation, not advancing in a perspective of building spaces of participation with deliberately assignments in public policy (Ciconello, 2008), which was identified by respondents of the social and private sectors.

Added to this are two factors that relate to organized civil society and reinforce the difficulty of acting in this sector and the lack of support by the government: i) difficulties in securing financial and political sustainability, with resources increasingly scarce and delimited by agencies and national and international companies, as well as lack of a culture of donations in the brazilian society and a preference of the State in fund civil society organisations that perform basic social services; and ii) the legal framework that directs the relationship between organized civil society and the public sector that was "historically constructed from an instrumental perspective of provision of services (and of collaboration with the State)” (Ciconello, 2008).

iv) Besides the lack of support from the public sector to other organisations in the city, the integration of all organisations for a better planning in the area was identified during the interviews and reiterated in the workshop in Santos as a major issue: the city has long-term planning of risk reduction and adaptation, with studies and scenarios that indicate new evaluations needed and actions to be taken and this aspect was recognized by the respondents, however, as discussed in the workshop, the
problem is not the planning itself, but the integration among the various municipal actors to unite all visions and actions to achieve a common goal that benefits the entire municipality.

"In relation to the planning we have this work also prepared, but we have difficulties in processing, making decisions involving interests in many areas and able to minimize risk, reduce risk, that is, begin to make deeper changes, beyond the question for the diagnosis and coexistence, this is in my view, if it is possible to define in one sentence, the biggest challenge is to go beyond a good relationship, to start taking some actions, as the project here advocate, more effective, actual adaptation measures by reducing the risk, by minimizing these impacts, this is the difficulty and not just the difficulty of planning, that is because there is an excessive compartmentalization of problems, a difficulty of working, like this room here in a collaborative way, cooperative, we have some practice working with specific views in various areas of knowledge and a more recent view of work in a shared manner, common, with several complementary views on the same subject, this is a more cultural difficulty [...] more recently this has been changing, but this difficulty in my view leads us to delay some decisions”.

Member of the Civil Defence of Santos, workshop in Santos, December 2015

As previously explained, the organisational culture of the Brazilian public sector has sought a more progressive vision for greater participation in the civil and private society in decision-making, however, it has followed a much more consultative way than to provide other sectors deliberation assignments in public policy. The low commitment of government departments to ensure the effective participation and performance of other sectors in decision-making contributes to a lower integration and coordination among organisations in participatory processes. In addition, "Brazil is still a country run by a political and economic elite that is structured around privileges", resulting in partial compliance with laws and rights in the country: the establishment of participatory spaces for integration between the different actors has built an extremely progressive legal framework and formally broke with this question, however, is not effected due to the persistence of unequal power relations and the fragility of the Brazilian State (Ciconello, 2008).

Furthermore, changes in administration in the organisations for different reasons (elections or others) pose discontinuities which pervades all aspects above mentioned as key findings. The discontinuity in the management traditionally prevents a better planning for long-term issues, such as adaptation to face the effects caused by climate change.

The administrative discontinuity is a key point to planning and public administration in which each government favours short-term projects that can be completed in its mandate; project duplication, as the government carries out projects similar to the previous governments, claiming for itself the authorship of such projects; conflict of objectives between career employees and those non-permanents that acts in accordance with each management; and an amateur administration held "by individuals with little knowledge of the history and culture of the organisation and often without the necessary technical preparation", prevailing political interests instead of the knowledge of the
technicians and career officials (Schall, 1997). These aspects can be applied to the brazilian reality with a large gap between public and private organisations (Pires and Macedo, 2006).

To address these long-term issues it becomes increasingly necessary to have measures that go beyond the efforts of local, state and federal governments, e.g., with contributions from various sectors and organisations, so that the projects are much more discussed and analysed, becoming essential for the city. To include different sectors and organisations causes a major concern and recognition of the problems by these institutions, which could press future governments to continue the current plans, so that the discontinuity would no longer be an impediment to greater adaptive capacity of the municipality. It is important to emphasise that the national and the state laws established in the years 2011 and 2012 referred earlier are aimed to break with the bad tradition of discontinuity, establishing guidelines and allocating funds to the actions of civil defences, as highlighted by the respondent of the Civil Defence of Santos:

“As policymaking in 2012 structured very clearly the management roles of the federal, state and municipal levels, the actions, even the successful ones as in 2005 and the volunteered ones, had discontinuity problems, then what has changed since 2012 is that now there is a clear picture from the viewpoint of duties and powers. Then, the discontinuity is now essentially ruled out. So we're on another level, waiting for investment and with a very clear focus”.

Respondent from the Civil Defence of Santos, personal communication, October 2015

Although there is specific legislation for many different areas there is some difficulty in effecting such laws due to several issues, including unequal power relations and fragility of the brazilian State. Thus, beyond the laws established in 2011 and 2012, other actions must be taken to break with the problems arising from the administrative discontinuity. The city of Santos has been more prominent in recent years in this issue by hiring consultants for a long-term planning, just as an attempt to reduce the problems from the changes of administrations.

I think the government changes can affect this planning because our administration is political, so depending on the politician entering and the features that he wants to bring to his management people will walk according to this administration, then that's one thing that makes the people quite concerned. I believe that this long-term planning done in the city can help reduce this problem because it was made very seriously, we had an institution that helped us (Vansolini Foundation, it makes goals, indicators, long-term planning...) which came and was hired by the Prefecture, the mayor invested on it to make planning in all secretariats in all sort of things.

Respondent from the DEVIG, personal communication, February 2016

Furthermore, it was also observed that interpersonal relationships between technicians and career employees of public organisations contribute to reducing the effects caused by administrative changes, since they form informal partnerships to work in the same line of action and to have a greater contact between the different sectors and departments, and this was identified by respondents as
something that strengthens the integration between these different departments, which in turn, contributes to a better organisational capacity in the city of Santos.

Data Access

Responses varied greatly across the range of actors interviewed with regards to data availability, access and awareness. The presence of numerous research institutions active in the region, as well as several public and private universities result in a perception of relative facility in accessing cutting-edge knowledge in the city, with partnerships been indicated in the interviews. Research institutions and universities partnerships from various fields were identified, including: Institute for Technological Research (IPT), National Institute for Space Research (INPE), the Fire Brigade Foundation (FUNDABOM), Strategic Metropolitan Development Plan of Santos, Polis Institute, Sustainable Coastline Observatory, University of Campinas (UNICAMP), University of São Paulo (USP), Pontifical Catholic University (PUC-Campinas), as well as universities located in the city: Federal University of São Paulo (UNIFESP), State University Julio de Mesquita Filho (UNESP), Santa Cecilia University (UNISANTA), Catholic University of Santos (UNISANTOS) and Monte Serrat University (UNIMONTE). However, it was observed according to some respondents that the pursuit of cutting-edge knowledge also occurs through individual actions, and this access comes from the initiative of the individuals within organisations in obtaining this knowledge to improve practices and efficiency of organisations.

Moreover, it was also identified that there are several partnerships with organisations for staff training, courses and lectures, as well as organisations that have the capacity to organize events for the diffusion of knowledge for different social groups and organisations in the municipality. Among them one can quote: Oswaldo Cruz Foundation (Fiocruz), the Environmental Sanitation Technology Company (CETESB), USP, Oceanographic Institute, Navy, Federal University of Rio de Janeiro (UFRJ), SESC, SESI, National Industrial Apprenticeship Service (SENAI), Forum da Cidadania, syndicates, Command and Emergency Operations System (SICOE), Corporate University and E-Learning of CPFL, Fishery Institute, IPT, Technology College of São Paulo (Fatec) and ASSECOB. Although several organisations perform these actions for staff training and dissemination of knowledge, it was also observed that in several organisations such training occur more by encouragement for the pursuit of such knowledge by higher level actors, which is based on the individuals themselves rather than formal partnerships between institutions.

Thus, it is observed that there is a complex network of organisations and research institutions working in the region, so that there is a great number of researches in the city of Santos, which is perceived by individuals within local organisations, but it is also noted that there are still difficulties on the part of
some organisations to access cutting-edge knowledge, and personal initiative is decisive so this access occurs. The lack of integration between the institutions of the public sector with other sectors is related to the difficulty, making the city lose dissemination of learning opportunities and access to cutting-edge knowledge when sets aside a number of institutions of civil society and private organisations capable of promoting courses, lectures, events and so on.

**Formal and informal networks**

As mentioned before, the municipality of Santos has since the 1980s a strong performance with risk management, standing out on the national scene as one of the cities with more experience in the area. Therefore, the existence of several research institutions and organisations working on these issues and the identification of several partnerships that these organisations perform, either to project achievements, and for access to cutting-edge knowledge and staff training, are not a surprise.

However, it was also identified by respondents that interpersonal relationships of individuals within organisations Santos also exist, providing support to established formal partnerships. In addition, partnerships between the various career employees and technicians of public organisations reduces the effects resulting from periodic changes in administrations, since establish relationships between individuals who possess technical and historical knowledge of the organisations and, thus, can build converging lines of action that can last, increasing the organisational capacity in the city.

### 6. Challenges and Limitations of the Santos Study

The contacts previously established with the City Hall members for the other areas of Metropole (COAST) were crucial to identifying potential respondents and gain access to various secretaries and public organisations; on the other hand, there was difficulty in contacting private companies, which can be correlated with a backdrop of great economic, environmental and water crisis in the state of São Paulo and in the country in the years of 2014 and 2015: indeed, some federal and state public organisations also showed some resistance. The easiest sector to contact was the civil sector, as they were very opened to establish new partnerships and to participate of new projects, like Metropole.

Often the interviewees were incited to split their answers in inputs and outputs, but ended up answering all at once focusing the inputs, not providing examples for the outputs. This happened probably because the actions in Santos regarding adaptation efforts are very recent in the country.
7. Recommendations and Conclusions

The ACI analysis of organisations involved in environmental risk management in Santos, and its surrounding key influencers at higher scales, indicates some areas where positive movement can be enhanced so that gains that have been demonstrated over the last decade take advantage of incorporating the lessons from such as adaptive capacity assessment. From this basis many of the options for enhanced adaptive capacity that are concerned with learning, information, responsibility devolution and networks can be approached. Summarising the analysis of the ACI five key recommendations can be made:

1. Increased connectivity between, and understanding of, local efforts and activities driven by sector and local specific concerns and the city risk management and planning and development architecture
2. Increased transparency of decision making processes at higher scales to enhance local knowledge levels and understanding
3. Improved formal relationships/organisational architecture to provide a mechanism for collaboration
4. Issue ownership and leadership beyond the Civil Defence
5. Development of a voluntary and cooperative partnership among local governing bodies as a mechanism to ease the impacts of responsibility devolution without resources conundrum that often impacts adaptation efforts, which can be used as a potential template for the newly formed Municipal Commission for Adaptation to Climate Change.

The considerable challenge of dealing with future climate impacts, impacts that often have not yet been experienced, is compounded by levels of risk coupled with uncertainty that countries, governments, organisations, communities and individuals must cope with and attempt to take advantage of. As climate change intensifies and accelerates, the capacity to cope with impacts and the ability to adapt to opportunities will become critical attributes, to not only recognise but also augment where possible, across multiple sectors and organisations. This means that anyone in a role that requires making long-lasting potentially climate-impacted decisions, the majority of whom will not be adaptation specialists or climate experts, would ideally have knowledge of the levels of existing adaptive capacity within their organisation as well as areas of potential improvement.

Adaptation involves the manipulation and fine-tuning of socio-technical systems (people and assets) so that the coupled systems can be better prepared for the climatic changes such as sea level rise and the frequency and intensity of flooding and storm events. This means that changes to both social behaviour in conjunction with infrastructure change are needed. However, modifications to
Infrastructures are normally difficult to achieve, with opportunities to do so in a cost-effective way occurring only rarely. In the case of the 50-plus year design-life of a seawall, while much can be changed during the design and construction process, once it has been built many of its design features become very hard and sometimes impossible to change [e.g. its physical location, materials used, drainage structures and toe embeddedness]. This shows why change is such a challenge: the opportunities occur rarely and when they do, the expense is usually highly restrictive. It is generally much easier, and cheaper, to adapt when decisions are first being taken rather than to correct them later. This implies that if capacity is low, but important decisions are expected, then focusing efforts on improving outcomes for maximum return on investment is critical. On the other hand, a high level of adaptive capacity enables decision-makers across and within sectors to design and implement climate change adaptation strategies at source within their own sphere of influence as well as contribute to broaden efforts across the risk governance landscape. In addition, where capacity is high but no decisions are expected, this provides a source of learning or skilled people that can potentially be used to support others to develop their own capacity.

The ACI is designed to allow actor-identified solutions to be generated resulting in a more pro-active approach to how climate change issues are addressed. Through the inclusion of social learning mechanisms and the empowerment of actors, the ACI builds upon existing efforts to measure adaptive capacity by combining quantitative and qualitative data. Developing adaptive capacity in order to be able to actually implement adaptation actions is a process of on-going adjustment in response to a range of drivers therefore it is important to be realistic in terms of expectations when considering the potential any framework to inspire behaviour change, especially in the short-term. However, providing the space for discourse and evaluation remains one of the most essential pathways for success and a key aim of this tool. Each additional case study can demonstrate the usefulness of not only measuring adaptive capacity but how using that analysis can empower adaptation driven decision making and provide the opportunity to re-orient management to a more proactive and developmental footing as well as learning opportunities for actors.

The Santos case study generates a series of recommendations and insights with regards to adaptive capacity at an aggregated level of vertical and horizontal analytical frames. However, the capacity of local actors is, in many respects, shaped by their relationships and interdependencies with the wider governance landscape: primarily the political and economic context in which they must operate (High et al., 2004). Much of the interplay between local actors and landscape as a system happens within the shadow system of informal and personal relationships that embody public and private life, rather than canonical organisational pathways (Pelling et al., 2008). This becomes even more important for Santos due to changes of governments that hinder the continuity of local policies, and should be encouraged to maintain and enhance the adaptive capacity of the municipality.
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