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Barriers and opportunities for adapting to climate change on the North Coast of São Paulo, Brazil --Manuscript Draft--

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Corresponding Author:	Eliane Simões, Ph.D. Instituto Tecnológico de Aeronáutica São José dos Campos, SP BRAZIL	
Corresponding Author Secondary Information:		
Corresponding Author's Institution:	Instituto Tecnológico de Aeronáutica	
Corresponding Author's Secondary Institution:		
First Author:	Eliane Simões	
First Author Secondary Information:		
Order of Authors:	Eliane Simões	
	Wilson Cabral de Sousa Junior	
	Debora M. de Freitas	
	Morena Mills	
	Allan Y. Iwama	
	Isabel Gonçalves	
	Debora Olivato	
	Pedro Fidelman	
Order of Authors Secondary Information:		
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Abstract:	<p>This paper examines barriers and opportunities for climate change adaptation in an urban coastal setting where adaptation is in its infancy. It draws on a diagnostic framework as a foundation for identifying and organising barriers and opportunities in terms of three broad phases of the adaptation process, i.e., (1) understanding the problem, (2) planning adaptation options, and (3) managing implementation of such options. Data comes from the analysis of documents (e.g., policy, plans and reports) and a survey of 49 representatives from 42 organisations (e.g., government, environmental non-governmental organisations, businesses and local industry and professional associations). Nineteen barriers and/or opportunities pertaining to the different phases of the adaptation process were identified. Three of those barriers (i.e., competing priorities, existing management context and existing ecological context) are our additions to the initial list of common barriers proposed in the diagnostic framework. Barriers pertaining to the understanding phase were the most frequently noted by respondents. The understanding phase was also one which most of the barriers were nevertheless considered as opportunities. Emerging critical barriers and/or opportunities for climate change adaptation included perception of signal, availability and accessibility of information, existing management context, and leadership. We propose that addressing these barriers and opportunities would involve improving perception about climate change and availability and accessibility of</p>	

	information, fostering anticipatory planned adaptation through the existing management context, and developing leadership for adaptation. Findings from this study may prove useful to other jurisdictions, particularly those where climate adaptation is at its early stages of development.
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Author Comments:	<p>07 September 2016.</p> <p>W. Cramer; J.D. Ford Editor-in-Chief Regional Environmental Change Re: Revisions Manuscript REEC-D-16-00037</p> <p>Dear Editor,</p> <p>We revised manuscript REEC-D-16-00037 "Barriers and opportunities for adapting to climate change on the North Coast of São Paulo, Brazil". Also attached is the detailed response to reviewers.</p> <p>The manuscript has been substantially revised to address the reviewers' concerns. We feel that this has resulted in a much improved manuscript; without fundamentally altering the scope and purpose of our study.</p> <p>Attention please: we changed the legend figures 3 and 4 (not the figures).</p> <p>Yours sincerely,</p> <p>Eliane Simões</p> <p>Dra. Eliane Simões, the first author, is now the corresponding author.</p> <p>Débora M. de Freitas was the corresponding author in the first submission.</p> <p>Please, use my contact information: Eliane Simões, Technological Institute of Aeronautics, São Paulo State Rua Peixe Galo, 115. Ubatuba/SP - Brazil. P.O. Box 11680000 *simoeslica@gmail.com</p>

Barriers and opportunities for adapting to climate change on the North Coast of São Paulo, Brazil

SIMÕES, E. ¹; SOUSA JUNIOR, W. ¹; de FREITAS, D. M. ^{1,2,*}; MILLS, M. ³; IWAMA, A. Y. ¹; GONÇALVES, I. ¹; OLIVATO, D. ¹; FIDELMAN, P. ⁴

¹Technological Institute of Aeronautics, Engineering Division of Infrastructure, Department of Water and Environmental Sanitation, Pça. Mal. Eduardo Gomes, 50 CTA/IEI, São José dos Campos, SP CEP 12228-900, Brazil.

²Biosciences Institute, São Paulo State University-UNESP, Coastal Campus. Praça Infante Dom Henrique s/n - São Vicente/SP - Brazil. P.O. Box 73601. * freitas.debora@gmail.com

³ School of Biological Sciences, The University of Queensland, Brisbane, Queensland 4072, Australia.

⁴ Sustainability Research Centre, University of the Sunshine Coast, Sippy Downs, Queensland 4556, Australia.

ABSTRACT

This paper examines barriers and opportunities for climate change adaptation in an urban coastal setting where adaptation is in its infancy. It draws on a diagnostic framework as a foundation for identifying and organising barriers and opportunities in terms of three broad phases of the adaptation process, i.e., (1) *understanding* the problem, (2) *planning* adaptation options, and (3) *managing* implementation of such options. Data comes from the analysis of documents (e.g., policy, plans and reports) and a survey of 49 representatives from 42 organisations (e.g., government, environmental non-governmental organisations, businesses and local industry and professional associations). Nineteen barriers and/or opportunities pertaining to the different phases of the adaptation process were identified. Three of those barriers (i.e., competing priorities, existing management context and existing ecological context) are our additions to the initial list of common barriers proposed in the diagnostic framework. Barriers pertaining to the understanding phase were the most frequently noted by respondents. The understanding phase was also one which most of the barriers were nevertheless considered as opportunities. Emerging critical barriers and/or opportunities for climate change adaptation included perception of signal, availability and accessibility of information, existing management context, and leadership. We propose that addressing these barriers and opportunities would involve improving perception about climate change and availability and accessibility of information, fostering anticipatory planned

1 adaptation through the existing management context, and developing leadership for
2 adaptation. Findings from this study may prove useful to other jurisdictions, particularly
3 those where climate adaptation is at its early stages of development.
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7 Key words: adaptation; barriers and opportunities; climate change; Brazil
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10 11 **HIGHLIGHTS** 12

- 13
14 • Stakeholders perceive various barriers to adaptation but also emerging
15 opportunities.
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- 17 • We propose additional barriers and/or opportunities to a diagnostic framework
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- 19 • Improved perception, leadership and planned adaptation are critical emerging
20 issues
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1. Introduction

Challenges facing the future of the world's urban areas, particularly those located on the coast, are enormous, diverse and complex. Home to the majority of the world's population, the coastal zone is the focus of development, competing interests and growing concern due to climate change impacts (Dutra *et al.*, 2015; Gibbs, 2015; Sales Jr., 2009; Small and Nicholls, 2003). Rising sea levels (Burrows *et al.*, 2011; Cooper and Pile 2014; Gibbs, 2015; Measham *et al.*, 2011), changes in rainfall patterns, flooding and coastal erosion pose major climate-related threats to environmental processes and private and public assets located in vulnerable areas (Adger, 2003; Bradley *et al.*, 2015; Gibbs, 2015). The poorest and marginalized populations are the ones most harshly affected by such threats (Taylor *et al.*, 2012; Sales Jr., 2009). Cities and their citizens need to be strategic to better prepare for climate-related events that will affect them. In this context, adaptation emerges as an important societal response to the risks and impacts of climate change.

Adaptation encompasses numerous actions addressing impacts directly (e.g. loss of biodiversity (Adger, 2003) and/or indirectly (e.g. by increasing social-ecological resilience). These include, for example, using scarce water more efficiently, adapting existing building codes to stand future climate conditions and extreme weather events, and developing spatial plans and corridors to help species migration (European Commission, 2007). Central to the concept of adaptation is the reduction of harm and/or realisation of benefits to humans (Cooper and Pile, 2014) and human adjustments to resource availability and risk at different spatial and societal scales (Adger *et al.*, 2005). For the purposes of this paper, we use a generic but inclusive conceptualisation of adaptation, as proposed by Moser and Ekstrom (2010, p. 22026); i.e., adaptation “involves changes in social-ecological systems in response to actual and expected impacts of climate change in the context of interacting nonclimatic changes.”

While there is growing awareness that many adaptation actions are local and build on experience of managing past climatic risks (Füssel, 2007), there can be barriers and limitations to it (Baker *et al.*, 2012; Biesbroek *et al.*, 2014; Moser and Ekstrom, 2010; Taylor *et al.*, 2012). General definition of barriers to adaptation includes challenges, obstacles, constraints or hurdles that impede adaptation. These can come from several sources including lack of information or expertise, constraining resources, limited political support and leadership (Measham *et al.*, 2011; Tribbia and Moser, 2008; Baker *et al.*, 2012; De Freitas *et al.*, 2013; Runharr *et al.*, 2016), and a focus on short-term adaptation measures (Fidelman *et al.*, 2013). In this paper, we define barriers as “obstacles that can be overcome with concerted

1 effort, creative management, change of thinking, prioritization, and related shifts in resources,
2 land uses, institutions, etc.” (Moser and Ekstrom, 2010, p. 22027). Simply put, barriers are
3 the impediments that can compromise the adaptation process. It is, therefore, critically
4 important to reduce the ‘adaptation deficit’ between the implementation of adaptation with
5 the ever-increasing need for it. The identification and analysis of barriers to adaptation and
6 possible opportunities to overcome them contributes towards reducing such deficit (Eisenack
7 *et al.*, 2014). Further, climate change poses a wide range of risks but also emerging
8 opportunities for enhancing adaptive capacity to climate impacts (Baker *et al.*, 2012;
9 Measham *et al.*, 2011; Sales Jr., 2009). A range of enablers of adaptation have been provided
10 in the literature including, but not limited to, production of new, or integration and synthesis
11 of existing information; policies, plans and programs; planning and natural resource
12 management legislation; enabling new organisations and defining climate change mandate for
13 existing ones; tools and guidelines to cope with climate impacts; and establishment of
14 networks (Fidelman *et al.*, 2013). In this context, this paper seeks to understand how key
15 stakeholder groups perceive and respond to actual and potential climate-related changes. It
16 uses the case of the North Coast of São Paulo, Brazil to underscore barriers and opportunities
17 for adaptation in a coastal urban setting.
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31 **2. Diagnosing Barriers to Adaptation**

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34 20 This study draws on the framework of Moser and Ekstrom (2010) to diagnose barriers
35 and opportunities for climate change adaptation. We focus particularly on the *process*
36 component of the diagnostic framework as a foundation for identifying and organising
37 barriers and opportunities. This component describes adaptation as a rational decision-
38 making process consisting of three broad phases, i.e., (1) *understanding* the problem, (2)
39 *planning* adaptation options, and (3) *managing* implementation of such options. Each of these
40 phases includes a series of stages: understanding involves problem detection, information
41 gathering, and problem definition; planning involves development of adaptation options,
42 assessment and selection of options; and, management involves implementation of selected
43 options, monitoring outcomes from these options, and evaluation (Fig 1). Each of these
44 stages, in turn, identifies common barriers based on the adaptation literature (Moser and
45 Ekstrom, 2010) (Table 1). Competing priorities (P1.7), existing management context (M1.8)
46 and existing ecological context (M1.9) are our additions to the list of common barriers
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identified by Moser and Ekstrom (2010). They emerged as important barriers identified over the course of this study.

Importantly, barriers may also be conceptualised as opportunities when pre-conditions to overcome these barriers are identified, and which when implemented, can generate other positive externalities (e.g. lack in technical qualification can be perceived as an opportunity if there is local/regional capacity to produce relevant knowledge). Further, focusing on opportunities is critical to moving forward and finding solutions to barriers (Evans *et al.*, 2011; Keller and Dow, 2014). Therefore, the list of barriers were also used to identify and organise opportunities for climate adaptation.

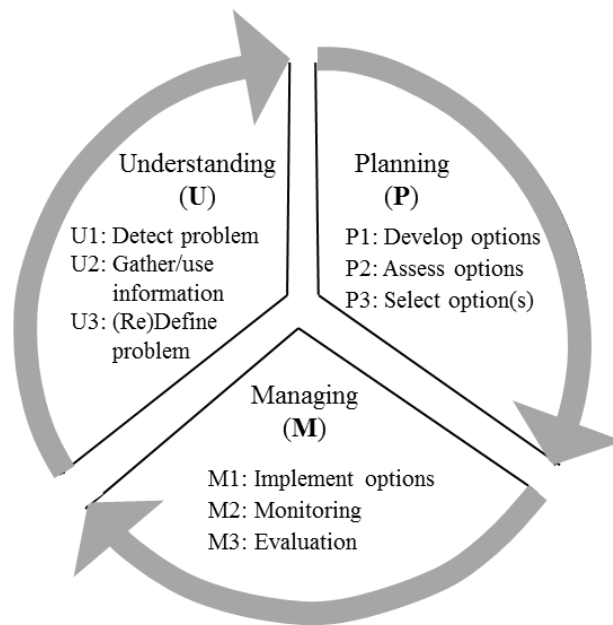


Fig.1. Phases and stages of the adaptation process. (After Moser and Ekstrom, 2010).

Table 1. Barriers and opportunities in the different phases and stages of the adaptation process (after Moser and Ekstrom, 2010).

Understanding (U)	Planning (P)	Managing (M)
<i>U1 Detect problem</i>	<i>P1 Develop options</i>	<i>M1 Implement option(s)</i>
U1.1. Existence of signal	P1.1. Leadership (authority and skill) in leading the process	M1.1. Threshold of intent
U1.2. Detection (and perception) of signal	P1.2. Ability to identify and agree on goals	M1.2. Authorisation
U1.3. Threshold of concern	P1.3. Ability to identify and agree on a range of criteria	M1.3. Sufficient resources
U1.4. Threshold of response need and feasibility	P1.4. Ability to develop and agree on a range of options that meet goals and criteria	M1.4. Accountability
<i>U2 Gather/use information</i>	P1.5. Control over process	M1.5. Clarity/specificity of option
U2.1. Interest and focus	P1.6. Control over options	M1.6. Legality and procedural feasibility
U2.2. Availability	P1.7. Competing priorities*	M1.7. Sufficient momentum to overcome institutional stickiness, path dependency and behavioural obstacles
U2.3. Accessibility	<i>P2 Assess options</i>	M1.8. Existing management context*
U2.4. Salience/relevance	P2.1. Availability of data/information to assess options	M1.9. Existing ecological context*
U2.5. Credibility and trust	P2.2. Accessibility/usability of data	<i>M2 Monitor outcomes and environment</i>
U2.6. Legitimacy	P2.3. Availability of methods to assess and compare options	M2.1. Existence of monitoring plan
U2.7. Receptivity to information	P2.4. Perceived credibility, salience and legitimacy of information and methods for assessment	M2.2. Agreement and clarity on monitoring targets and goals
U2.8. Willingness and ability to use	P2.5. Agreement on assessment approach	M2.3. Availability and accessibility of established methods and variables
<i>U3 (Re)define problem</i>	P2.6. Level of agreement on goals, criteria, options	M2.4. Availability of technology
U3.1. Threshold of concern	<i>P3 Select options</i>	M2.5. Availability and sustainability of economic resources
U3.2. Threshold of response need	P3.1. Agreement on selecting options	M2.6. Availability and sustainability of human capital
U3.3. Threshold of response feasibility	P3.2. Sphere of responsibility/influence/control over option	M2.7. Ability to store, organise, analyse and retrieve data
U3.4. Level of agreement or consensus, if needed	P3.3. Threshold of concern over potential negative consequences	<i>M3 Evaluate effectiveness of option(s)</i>
	P3.4. Threshold of perceived option feasibility	M3.1. Threshold of need and feasibility of evaluation
	P3.5. Clarity of authority and responsibility over selected option	M3.2. Availability of expertise, data and evaluation methodology
		M3.3. Willingness to learn
		M3.4. Willingness to revisit previous decisions
		M3.5. Legal limitations on reopening prior decisions
		M3.6. Social or political feasibility of revisiting previous decisions

*P1.7, M1.8 and M1.9 are new additions to the original list of barriers proposed by Moser and Ekstrom (2010).

3. Contextualizing the Brazilian coastal zone and the study region

Geographical and socio-economic context

The Brazilian coastal zone covers 324.000 km² and has a population density of 121 people/km², six times the national average (BRASIL, 2008). The North Coast of Sao Paulo state has an area of 1,944 km² and an estimated population of 281.778 inhabitants across four municipalities: São Sebastião, Ilhabela, Caraguatatuba and Ubatuba (IBGE, 2011). It is geographically positioned within the axis of greatest economic development of the country, between the metropolitan cities of Rio de Janeiro and São Paulo (Figure 2). The North Coast of Sao Paulo is bounded by the Serra do Mar, a long system of mountain ridges and escarpments parallel to the Atlantic coast. Large part of its area lies close to hillside conservation areas and are unsuitable for human settlement (Iwama *et al.*, 2014). Similar to other coastal areas in Brazil, the North Coast faces multiple environmental and socio-economic pressures. The region has a history of major landslides and flooding, which are predicted to become more frequent and intense as a result of a changing climate (Iwama *et al.*, 2014, Sakai *et al.*, 2013).

The environmental and socio-economic characteristics of the North Coast municipalities can make them susceptible to the impacts of climate vulnerability and change (Martins and Ferreira, 2010). Such characteristics also have important implications for the ability of these municipalities to respond and adapt to climate change. For example, the proximity of Serra do Mar makes these municipalities especially susceptible to orographic precipitation, and consequently intense runoff processes, river discharges, mass movements and landslides (Sakai *et al.*, 2013). Urban sprawl has extended into such susceptible areas making the North Coast's municipalities particularly vulnerable to environmental and climatic events (Inouye *et al.*, 2015). Further, São Sebastião and Caraguatatuba feature expansion of the oil and gas industry and associated infrastructure, such risk impacts of the collision between ships and incidents involving oil spills, besides the removals of settlements caused by the implantation of the road project (Teixeira, 2013). Ilhabela and Ubatuba feature an important tourism, that can be include the tourism based on community and nautical tourism.

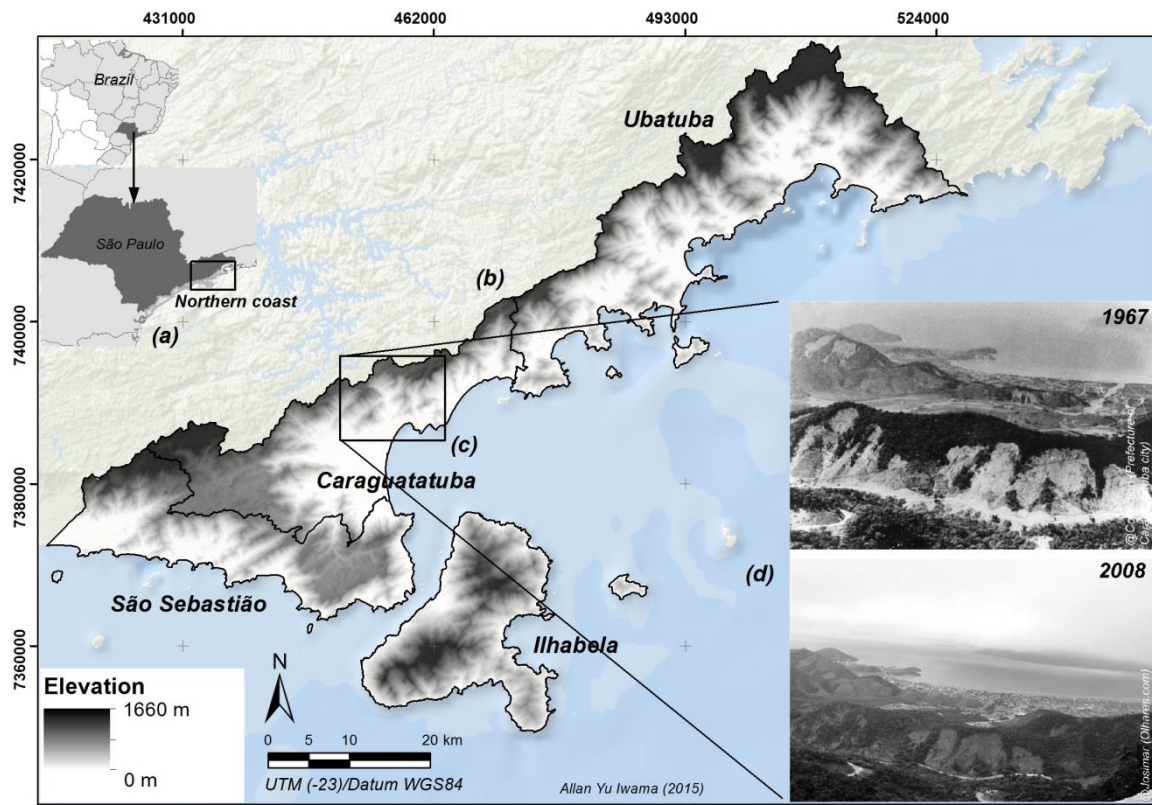


Fig. 2 North Coast of São Paulo comprising the municipalities of São Sebastião, Ilhabela, Caraguatatuba and Ubatuba. The pictures show areas affected by heavy rainfall in 1967. (Source: Iwama *et al.*, 2014).

Policy context for adaptation

Adaptation efforts are still developing in Brazil at both national and sub-national levels. Nationally, there are three main policies relating to climate change adaptation: (1) the National Policy on Climate Change (PNMC), established in 2009, includes cross-sector actions to reduce population vulnerability; (2) National Adaptation Plan, a central component of the PNMC, covers several sectors (e.g. coastal zones, natural hazards) requiring mitigation and adaptation plans; and, (3) National Policy on Protection and Civil Defense (PNPDC), launched in 2012, covers in an integrated manner prevention, mitigation, preparedness, response and recovery issues pertaining to civil defense. In addition, the National Coastal Management Plan (PNGC, 1988), despite not addressing climate adaptation directly, provides an overarching set of guidelines for implementing sustainable development related policies, plans and programs. The plan mandates that coastal states develop coastal

management plans and ecological-economic zoning (EEZ-LN). Those were developed for the North Coast of São Paulo in 1998 and 2004, respectively.

São Paulo, the largest Brazilian state in terms of population and economic development, is the most advanced state regarding climate adaptation strategies. These include a State Policy on Climate Change (PEMC, 2009), which underlines the EEZ as a fundamental instrument for environmental planning and a framework for sustainable development. Additionally, in 2011 the State of São Paulo established the State Program for Prevention of Natural Disasters and Geological Hazard Mitigation (PDN).

Despite initial progress on establishing climate change response strategies, the translation of such strategies into action has been limited, in particular to protect coastal populations and infrastructure in vulnerable areas (Barbi and Ferreira, 2013; Iwama *et al.*, 2014; Inouye *et al.*, 2015).

4. Methods

This study was framed by the diagnostic framework conceptualised above and used a mixed method approach. Online and face-to-face survey was undertaken in 2015 (both containing the same questions) to explore barriers and opportunities for climate change adaptation. The survey also explored stakeholder perceptions of climate and non-climate risks, and existing efforts that may contribute to climate change adaptation (questionnaire in appendix 2).

The questionnaire consisted of thirty-six questions exploring stakeholder's perception of climate and non-climate risks and impacts; their organisation involvement in adaptation; and resources, information and knowledge and policy influence underpinning their organisations capacity to engage in adaptation. It was administered to 49 individuals, representatives from 42 different organisations including high level government decision- and policy-makers, environmental non-governmental organisations, businesses and local industry and professional associations (Figure 2; see also Table in appendix 1). These respondents were selected based on their participation in the existing coastal management initiatives on the North Coast of São Paulo (e.g., members of the Watershed Committee, Coastal Management Review Group, and Protected Areas Advisory Committees), workshops organised by the RedeLitoral Project (which this study was part), and other events focused on coastal management in the region during 2013 and 2014.

This study involved two stages. First, common barriers to the different phases and stages of the adaptation process (Table 1) were used as a heuristic to systematically identify and categorize barriers and opportunities to adaptation on the North Coast of São Paulo. We then identified the main barriers (i.e., detection and perception of signal [U1.2] and threshold of concern [U1.3], leadership [P1.1], and existing management context [M1.8]) and analysed them in further detail. At this second stage, our study of leadership (P1.1) focussed on perceptions of organisations engaged in coastal management and climate change adaptation. We categorised organisations based on the frequency in which they were identified by stakeholders (Table 2).

Table 2. Categories of organisations according to the frequency of mentions.

Category	No. of mention
Most influential	>15
Influential	10-15
Somewhat influential	5-10
Least influential	<5?

We then linked the organisation to existing national, state and municipal coastal management and climate change efforts (M1.8) and classified whether their engagement in such efforts was direct, indirect, and optional or unrelated (Table 3). Existing coastal management and climate change adaptation initiatives (M1.8) were examined in terms of how they addressed the main climate change threats identified in IPCC for Central and South America (IPCC, 2014) and Brazil’s National Adaptation Plan (currently in development). Data analysis was performed with the software NVivo.

Table 3. Classes of organisations according to their role in climate-related efforts.

Class	Category	Description
3	Direct	The role of the organisation in climate change and civil defense efforts is explicitly stated in the PNM C, PNDEC, and PEMC.
2	Indirect	The role of the organisation in climate change and civil defense efforts is not explicitly stated in the PNM C, PNDEC, and PEMC; but, can be understood through associations.
1	Optional	The role of the organisation in climate change and civil defense efforts is not explicitly stated in the PNM C, PNDEC, and PEMC; but, there is a potential for the organisation to play a role.
0	Unrelated	The role of the organisation in climate change and civil defense efforts is not stated in the PNM C, PNDEC, and PEMC; and cannot be implied.

5. Results

5.1 Common barriers and opportunities for adaptation

Nineteen barriers and/or opportunities pertaining to the different phases of the adaptation process were identified for the North Coast of São Paulo (Table 4). Barriers pertaining to the understanding (U) phase were the most frequently noted by respondents (43%). These barriers were associated particularly with detection (and perception) of signal (U1.2) (12 mentions), availability and accessibility of information (U2.2) (17 mentions) and level of agreement or consensus (U3.4) (13 mentions). Respondents perceived threats related to the region's socioeconomic development as certain, while threats relating to climate change were mostly seen as possible, but not current and thus not urgent or difficult to manage. The following quote is illustrative:

“Climate change isn't certain, but there is urban growth on the whole coast, thus it would be possible to adapt constructions to withstand sea level rise.”

The understanding phase was also one which most of the barriers were nevertheless considered as opportunities, particularly detection (and perception) of a climate change signal (U1.2) (12 mentions as ‘barrier’ and 13 as ‘opportunity’), and availability and accessibility (U2.2) of information (17 mentions as ‘barrier’ and 20 mentions as ‘opportunity’). For example, participants were able to detect climate-related changes in the region (e.g., precipitation) although they did not necessarily link these changes to climate change. Further, respondents suggested that existing channels for the distribution of information could be used to distribute local scale information about climate risks and impacts.

Table 4. Stakeholder perception of barriers and opportunities for climate change adaptation on the North Coast of São Paulo.

Barrier/opportunity	Description	Barrier	Opportunity
U1.1 Existence of a signal	Visible and measurable risks to people and/or the environment	06	05
U1.2 Detection (and perception) of	Recognition that risks identified are linked to climate change	12	13

1	signal			
2	U1.3 Threshold of concern	Engagement of various or some sectors of society and organisations with efforts to address climate and non-climate risks	00	03
3				
4	U1.4 Threshold of response need and feasibility	Situations that require immediate action and viable response	00	04
5				
6				
7	U2.2 Availability and accessibility of information	Access to interpretable knowledge on relevant climate impacts; availability of relevant education and capacity building opportunities	17	20
8				
9				
10				
11	U2.5 Credibility and trust (in the information and its sources)	Trust of the information and its sources resulting in not being well received and not being discussed/addressed	03	03
12				
13				
14	U2.6 Legitimacy	Role of professional-informal organisations	02	00
15				
16				
17				
18	U3.4 Level of agreement or consensus	Understanding relevance of climate change, adaptation needs, and trade-offs to other priorities. Once incorporated into political agenda, policies are taken and dismissed promptly	13	07
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25	P1.1 Leadership, including authority and skill in driving the process	Ability to define priorities, and adapt existing programs to incorporate new priorities. The absence of political will to engage in climate adaptation issues	20	12
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28	P1.2 Ability to identify and agree on goals	Progress in efforts contributing to climate adaptation (both climate and non-climate driven).	00	01
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30				
31	P1.7 Competing priorities	Existence of focal areas considered to be more important or urgent than climate adaptation	16	00
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38	P3.2 Sphere of responsibility/influence/control over options	Autonomy to choose the areas of engagement and ability to plan and execute chosen actions	08	05
39				
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42	M1.2 Authorisation	Lack of autonomy and support from own organisation	02	00
43				
44	M1.3 Sufficient resources	Human, technical and financial resources and time	23	14
45				
46				
47				
48	M1.6 Legality and procedural feasibility	Structures and processes exist for enforcement of environmental regulations and land-use planning	00	03
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50				
51				
52	M1.7 Sufficient momentum to overcome institutional	Ability to change constraining attitudes to climate adaptation towards those supporting climate adaptation	01	00
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	stickiness, path dependency, and attitudinal obstacles			
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2				
3	M1.8 Existing management context	A range of climate and non-climate strategies supportive of adaptation are in place	00	26
4				
5				
6	M1.9 Existing ecological context	Ecosystem health, level of biodiversity conservation.	00	01
7				
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9				
10	TOTAL		123	117
11				
12				

In the planning phase, leadership (P1.1) (lack of) was considered a significant barrier (20 mentions); and, yet an opportunity (12 mentions). Many respondents stated they would require a mobilising agent to encourage adaptation. They suggested that organisations that focus on conservation or coastal planning are undertaking actions, which contribute to climate adaptation may be able to play such leadership role. Further, leadership has important implications for other barriers/opportunities, such as authorisation (M1.2), resources (M1.3) and momentum (M1.7). The main opportunities for this phase included the existence of local organisations (e.g., watershed committees, protected area advisory boards and NGOs) that could incorporate adaptation actions into their activities. This could be achieved, for instance, through the implementation of regional sustainable agendas.

Lack of resources (M1.3) was the most mentioned barrier (23 mentions) in the management phase. This included insufficient equipment, lack of technical capacity, limited funds and insufficient time. Nevertheless, 14 responses noted some existing resources could potentially be tapped into adaptation. These included the regional financing funds and ongoing projects such as state water resources funds, royalties and environmental compensation funds associated with the expanding oil and gas industry.

5.2 Emerging critical barriers and/or opportunities for adaptation

5.2.1 Detection (and perception) of signal and availability and accessibility of information

Eighty-four percent of respondents perceived environmental change signals on the North Coast of São Paulo (Table 5). Respondents frequently mentioned changes to the pattern of rainfall and higher frequency of landslides and flooding associated with extreme precipitation and unregulated land occupation. Sixty-seven percent of the interviewees identified an increase in natural disasters, including landslides and floods. Other perceived

environmental changes included change in temperature, sea level rise, coastal erosion, increase in storms (waves), change in wind conditions, proliferation of diseases, irregular land occupation and siltation of rivers (2%).

5 **Table 5.** Main perceived environmental change on the North Coast of São Paulo (n=41).

Environmental change	No. of mention
Pattern of rainfall	14 (34%)
Landslides	9 (22%)
Flooding	7 (18%)
Change in temperature	5 (12%)
Sea level rise	5 (12%)
Coastal erosion	4 (10%)
Increase in storms (waves)	2 (6%)
Change in wind conditions	2 (6%)
Proliferation of diseases (dengue fever)	2 (6%)
Irregular land occupation	1 (2%)
Siltation of rivers	1 (2%)

Further, representatives from the small-scale fishery were concerned about potential impacts of climate change on fishing stock (in terms of quantity, distribution and seasonality). Likewise, representatives from agriculture were concerned about the impact of changed rainfall patterns and spread of invasive species. The perceived environmental changes were usually attributed to rapid development and perhaps exacerbated by climate change. For example, respondents frequently noted that the proliferation of dengue fever was related to the increase in temperature. However, respondents were not certain that the perceived environmental changes resulted from climate change. In addition, they did not perceive climate change risks as urgent or difficult to manage. As a result, only a few organisations incorporated climate change into their portfolios. For example, the North Coast Watershed Committee includes climate change impacts in its management plans. Similarly, the state agency Fundação Florestal requires that protected area management plans include potential impacts from climate change. Most respondents identified a lack of information on local scale impacts

5.2.1 Existing management context (M1.8)

As noted previously, the existing management context refers to climate and non-climate efforts supportive of adaptation. Respondents reported a wide range of activities

undertaken by their organisations, which address key climate change risks and impacts (Table 6). These activities focused, in particular, on minimising the risk of disasters from extreme events, such as flooding, erosion and landslides. This includes activities to reduce the impacts from urban expansion, such as the construction of dikes and breakwaters, use of sustainable construction techniques, improved drainage systems, river dredging, and sewage treatment system. Similarly, various planning instruments contribute to adaptation, for example, by limiting urban expansion in vulnerable areas. Further, legislation relating to coastal management and civil defense has provided for monitoring and enforcement that support adaptive capacity. This includes monitoring rainfall and establishing thresholds for evacuation of vulnerable areas. Other activities reported by respondents have focused on learning, and therefore, building adaptive capacity. Such activities include, for example, a social learning process developed by the revision of the Ecological-Economic Zoning (EEZ) working group.

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Table 6. Activities addressing key climate change risks on the North Coast of São Paulo (IPCC, 2014; PNA, 2015).

Activity	Risk							
	Extreme precipitations causing flooding and landslides	Decreased food production and food quality	Spread of vector-borne diseases	Erosion/Sea Level Rise	Saltwater intrusion by the sea level rise	Natural resources and biodiversity loss	Increase of extratropical cyclones' frequency	Acidification
Alternative energy systems	•	•√	•	•	•	•	•	•
Strategic integrated environmental assessment in licensing process (cumulative effects analysis)	•√	√	√	√	√	•√	√	√
Low impact construction techniques	√	√	√	√	√	√		
Biodiversity conservation	•√		•√		•√	•√		
Territorial planning	√	•√	√	√	√	•√		
Urban planning	√	√	√	√	√	√		
Environmental monitoring and control	√	√	√	√	√	√	√	
Restoration of vegetation	•√		•√			•√		
Local and sustainable food production	√	√	√			√		
Food security in public schools based on local production	√	√	√			√		

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Pollution reduction		√	√			√		
Pollution control		√	√			√		
Improved drainage	√		√	√				
Solid waste management		√	√			√		
Sea walls	√			√				
Sanitation systems		√	√			√		
Land use risk management	√		√	√	√	√		
Monitoring and warn those living in risk areas	√	√	√	√	√	√	√	√
Environmental education and capacitation processes	√	√	√	√	√	√	√	√
Research	•√	•√	•√	•√	•√	•√	•√	•√
Capacity building events (workshops, seminars)	√	√	√	√		√		
Water storage		√			√	√		
Resilient infrastructure	√	√	√	√		√		

Note: √ = local and regional or micro level activities; • = global level activities

5.2.2 Leadership (P1.1)

Thirty two respondents (Figure 3) identified 108 organisations and groups they see as relevant or influential in climate change adaptation in different levels of public policy (e.g. Municipal Plan of Risk Reduction (PMRR) at local level and National Plan of Climate Change (PNMC) at the federal level. A large diversity of the institutions considered act at different governance scales (federal, state, regional and municipal) (Figure 3). However, while cross-scale action leads to opportunities for integration, actions are not currently integrated, especially in relation to climate change adaptation. For example, the state climate change policy influences the actions of the State Department for Environmental Planning, but is not considered by the municipal governments.

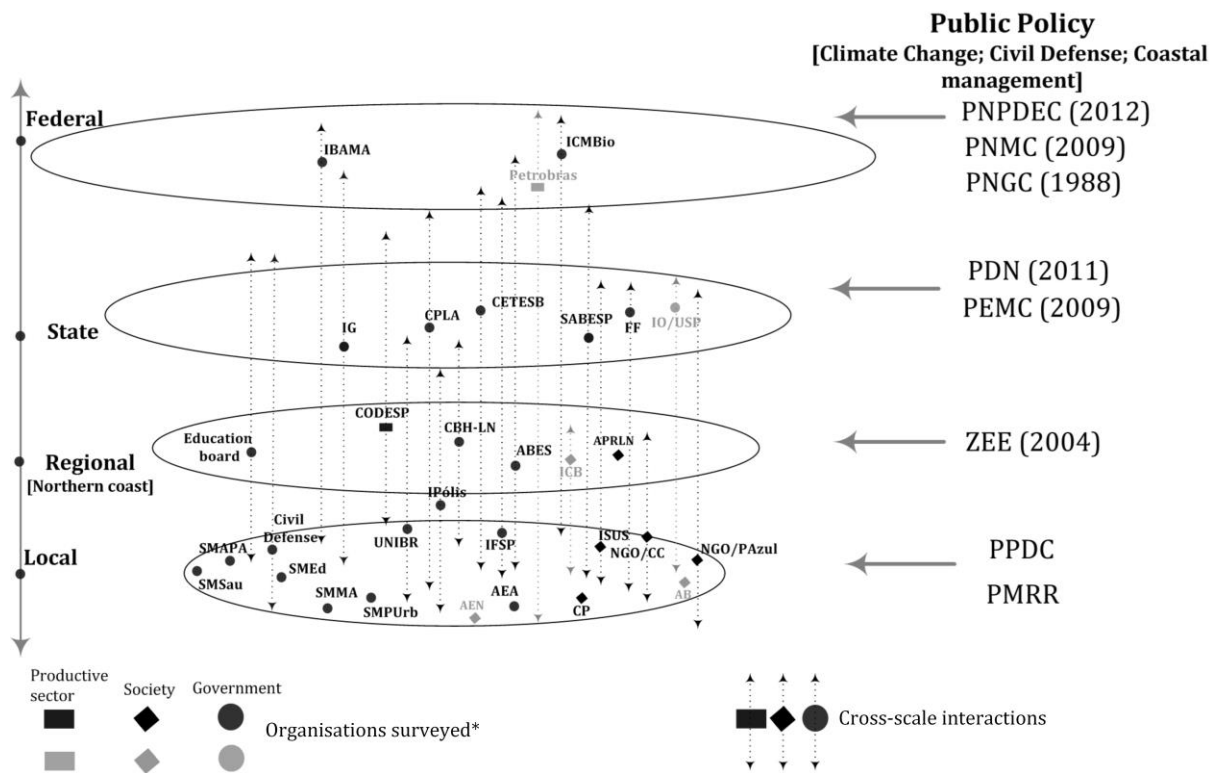


Fig.3. Organisations surveyed and public policies. Lighter grey symbols indicate organisations that completed the online survey. See Appendix A for abbreviations.

Perception about the relevance of different organisations in responding to climate change varied among respondents. However, there was an overall consensus about the level of influence of those organizations on climate change adaptation. Organisations ranked as more influential were local councils and protected area management entities (e.g., Fundação Florestal was mentioned 15 times), local council environmental departments (SMMA), civil

defense, universities, state environmental agency (SMA), non-governmental organisations (NGOs), watershed committee (CBH-LN) and Public Prosecutor (mentioned between 10 and 15 times). The least cited organisations (scoring between 5 and 10 mentions) included: the Ministry of Environment (MMA), National Centre for Monitoring and Natural Disasters Warning (CEMADEN), State Civil Defense, Ministry of Environment, and Regional Directorate of Education (Education Board) – Figure 4.

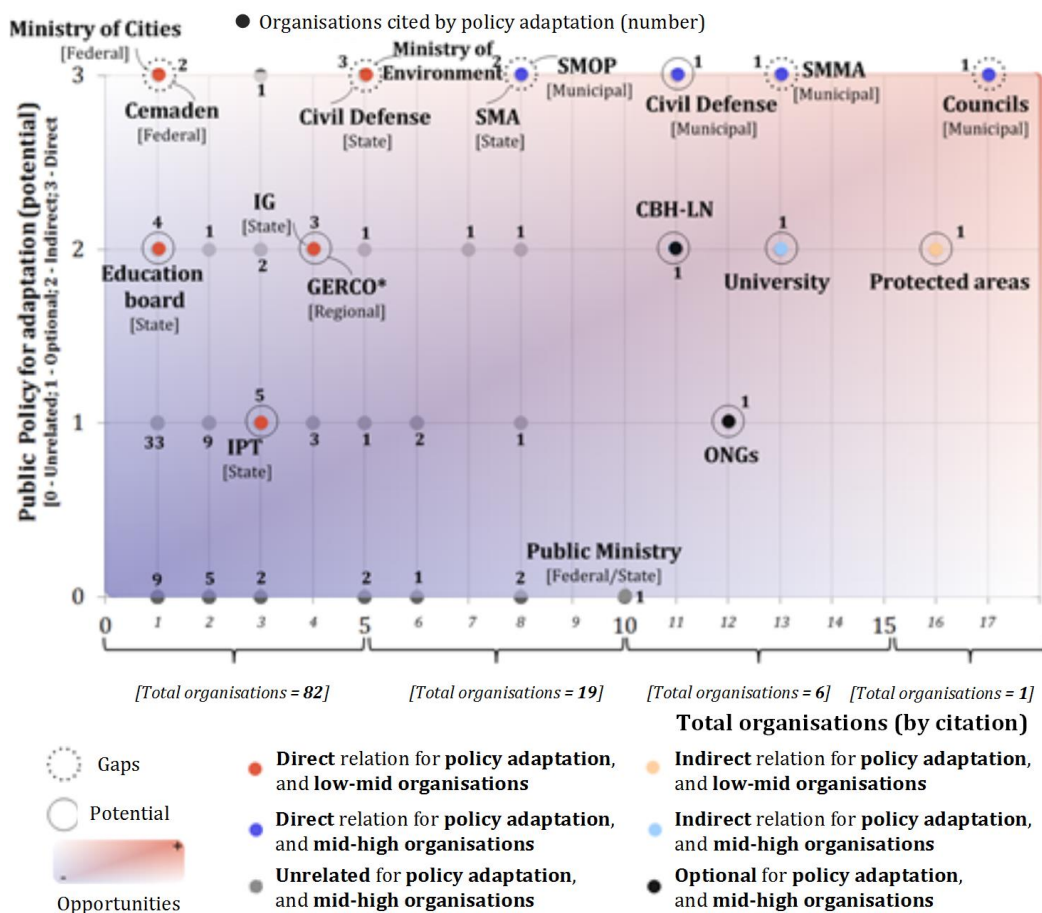


Fig 41. Perception of stakeholders about the relevance/influence of the most cited organisations in responding to climate-related and adaptation issues. See Appendix A for abbreviations.

Interestingly, some of the organisations with legal responsibility over climate-related actions were perceived as not being relevant or influential in adaptation. These include the National Centre for Natural Disaster Monitoring and Warning (CEMADEN), Geological Institute (IG), Institute of Technological Research (IPT), Ministry of Environment (MMA),

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State Environmental Department (SMA), and State Civil Defense. On the other hand, the large number of organisations perceived as relevant or influential (35 from the 108 mentioned), which, however, do not have a formal role in the public policies analysed (e.g. protected area management entities, universities, watershed committee and NGOs) suggests they could play a role in climate adaptation (Figure 3).

6. Discussion

This study examined challenges and opportunities for climate adaptation in the context of coastal management on the North Coast of São Paulo. Among the several barriers and opportunities identified, detection and perception of signal, existing management context and leadership emerged as the most critical ones. Addressing barriers and capitalising on opportunities would require improving perception about climate change and availability and accessibility of information, fostering anticipatory planned adaptation through the existing management context, and developing leadership for adaptation. These are discussed below.

6.1 Improving perception about climate change and availability and accessibility of information

Several factors may explain the failure of many respondents – including those who experience climate-related events first-hand – to link environmental change signals to climate change. For instance, while climate change studies are available for the region, there is limited engagement between scientists and decision-makers. Further, such studies are not readily available and accessible to decision-makers. This is illustrative of knowledge being shared among peers, or by means of academic publications not reaching a large portion of society (e.g. Tribbia and Moser, 2008; Biesbroek *et al.*, 2013). Further, current understanding on the nature of barriers to adaptation is suggested to be *"limited and highly fragmented across the academic community"* (Biesbroek *et al.*, 2013, p. 1119).

It is, therefore, imperative to make available and accessible information on climate risks and impacts if response strategies (e.g., adaptation) are to be developed (Lindell and Hwang, 2008). This includes disseminating information about the links between climate changes and local weather events, when they exist (Spence *et al.*, 2011). In this context, respondents indicated the need for actions evidencing potential effects, scenarios and forecasts to raise awareness and identify appropriate response strategies (e.g. monitoring of

1 extreme weather events). The use of scenario models is another way to produce and
2 disseminate relevant information (Di Giulio *et al.*, 2014). Such models comprise a strategic
3 decision-making tool for addressing climate change through participatory diagnostics and,
4 ultimately, adaptive measures (PROVIA, 2013).
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7 Furthermore, because adaptation requires learning, both public and private sector
8 organisations need to build capacity to process and interpret information on climate change
9 risks and impacts (Barnett *et al.*, 2014; Kettle and Dow, 2014). It is, therefore, imperative to
10 improve our understanding of how different groups interpret and assign meaning to social-
11 environmental phenomena differently (and sometimes conflicting), which in turn influence
12 ideas about the significance and prioritization of barriers to adaptation (Biesbroek *et al.*,
13 2013).
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21 *6.2 Fostering anticipatory planned adaptation through the existing management context*

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24 The response strategies to climate and non-climate threats analysed consist mostly of
25 coping strategies *ex post*) (M1.8). described above They result in part from public policies
26 that are reactive (Iwama *et al.*, 2014), and have been compounded by inadequate resources
27 (M1.3) and, particularly, competing priorities (P1.7), Similar to other nations, these are
28 common barriers to adaptation associated with political imperatives that emphasise reducing
29 short-term risks rather than long-term strategic planning (see e.g., Ford *et al.*, 2011).
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35 Given the long-term nature of climate change, adaptation strategies should have a
36 long-term focus allowing for adjustments in anticipation to climate change impacts.
37 Ultimately, these strategies should entail actions that promote more fundamental shift in the
38 system in light of undesirable conditions (Nelson *et al.*, 2007). Fostering such anticipatory
39 planned approach (Luers and Moser, 2006) would benefit from the existing management
40 context (M1.8) described above. This would involve mainstreaming adaptation into existing
41 planning processes, which would also provide opportunities for building and mobilising
42 adaptive capacity (McSweeney, 2010). Further, some of the existing management context
43 includes collaborative decision-making involving multiple stakeholders, such as the North
44 Coast Watershed Committee (Iwama *et al.*, 2014). They would serve as adequate platforms
45 for a range of stakeholders to provide input into the design and implementation of adaptation-
46 related policies (Kettle and Dow, 2014; Shaw *et al.*, 2013). Last, current management efforts
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1 involve multiple sectors, governance levels (Figure 2) and interconnected issues (Table 6).
2 Anticipatory planned adaptation should be strategic, taking into account interdependencies
3 across those sectors, governance and issues (Fidelman *et al.*, 2013).
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6 *6.3 Developing leadership for adaptation*

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9 Leadership is critical for adaptation when it points to (a) direction(s) and motivates
10 others to follow (Gupta *et al.*, 2010). Respondents perceived as influential many local and
11 regional organisations without a climate change mandate. Developing leadership for
12 adaptation of these organisations would benefit from mainstreaming climate change into their
13 activities, as discussed above. As well pointed by Eisenack *et al.* (2014), regardless of the
14 position or authority role, leadership (particularly in the early stages of adaptation) with clear
15 responsibilities can entail new governance mechanisms and changed context for decision-
16 making. In this context, the concept of boundary organisations may prove relevant if leaders
17 were responsible for effective brokering of information, e.g., between knowledge (technical
18 and local) and governance systems (Vogel *et al.* 2007). Ultimately, they would perform
19 intermediary functions between knowledge and practice (Lynch *et al.*, 2008; Shaw *et al.*,
20 2013). Another important leadership role would be capacity building, particularly, decision-
21 making capacity. On the North Coast of Sao Paulo this would require overcoming the
22 perceived limited financial and technical resources noted above. In any case, the role of
23 leading organisations needs to be considered with caution. In many instances, it has resulted
24 in abuse of power, stalled social learning and dominance of particular interests, undermined
25 ownership among stakeholders and challenged the coordination of adaptation activities
26 (Eisenack *et al.*, 2014).
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45 **7. Concluding remarks**

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47 This study used the framework of Moser and Ekstrom (2010) to diagnose barriers to
48 climate change adaptation in a coastal urban context where adaptation is in its infancy. In
49 such context, we identified additional barriers to those proposed in diagnostic framework;
50 therefore, expanding their diagnostic capability. These barriers include competing priorities
51 pertaining to the planning phase of the adaptation process, and the existing ecological and
52 management contexts pertaining to the management phase of the adaptation process.
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2 Interestingly, this study conceptualised barriers to climate change adaptation in terms of
3 opportunities to highlight some of the pre-conditions to overcome barriers. In this context,
4 detection and perception of signal, availability and accessibility of information, existing
5 management context, and leadership emerged as critical barriers to climate change
6 adaptation. We propose that addressing these barriers will involve improving perception
7 about climate change and availability and accessibility of information, fostering anticipatory
8 planned adaptation through the existing management context, and developing leadership for
9 adaptation. Findings from this study may prove useful to other jurisdictions, particularly
10 those where climate adaptation is in its early stages of development.
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Appendix 1. List of organisations surveyed.

Organisations	Level
Councils	Local
Protected areas – UC	State/Regional
Forestry Foundation – FF	State
Local council environmental departments – SMMA	Local
University (Research institutions)	Regional
Non-governmental organisations– ONG	Regional/ Local
Municipal Civil Defense – COMDEC	Local
Watershed Committee of Northern Coast – CBH LN	Regional
Public Ministry - MPE/MPF	State/Federal
State council environmental departments – SMA	State
Local council fishery and agriculture departments – SMAPA	Local
Brazilian Institute of Non-Renewable Natural Resources – IBAMA	Federal
Environmental Agency – CETESB	State
Engineers and Architects Agronomists association – AEA	Local
Water and sewage company – SABESP	State/Regional
Fishing community – CP	Regional/ Local
Ministry of Environment – MMA	Federal
Ports Security Control – CODESP	Regional/ Local
Sectorial Group of Coastal Management – GS GERCO	Regional
Chico Mendes Institute for Biodiversity Conservation – ICMBio	Federal
Geological Institute – IG	State
Local council of education – SME	Local
Tecnological Institute for Research – IPT	State
Local council of health - SMS	Local
State Department for Environmental Planning – CPLA	State
Federal Institute of São Paulo - Caraguatatuba – IFSP	Federal/Regional
Forestry Institute – IF	State
Pólis Institute	Regional
National Centre of Monitoring and Alerts for Natural Disasters - CEMADEN	Federal
Ministry of Cities – MC	Federal
Education board	State
National Institute for Space Research – INPE	Federal
Brazilian Association of Environmental and Sanitary Engineering – ABES	Federal
Rural Producers Association – APRLN	Local
Coastal Institute for conservation – ICC	Regional/ Local
Oceanographic Institute of the University of São Paulo – IO/USP	State/ Local
‘Ponto Azul’ Institute	Local
University of São Sebastião - UNIBR	Local
Environmental vigilance	Local

Appendix 2. survey questionnaire

QUESTIONS

PART I - INSTITUTIONAL DETAILS AND PERCEPTION OF THREATS AND RISK

1. Name	Occupation
2. Institution	3. Performance scale
4. Areas of action and main activities of your institution: a) management of natural resources (); b) environmental conservation (); c) Building (); d) Health (); e) Education (); f) Urban Planning (); g) Territorial Planning (); h) Other _____	
5. Taking into account the concept of hazard of the National Policy of Civil Defense (Law No. 12.608 / 2012), and Landslides phenomena and elevation of the sea level in the North Coast (LN) SP, you consider your the institution related to climate change? How this is expressed in actions taken or in institutional guidelines?	
6. Now, taking into account the concept of risk (PNPDEC Law No. 12,608 / 2012), and phenomena mentioned above and incidents LN, do you think the risk may be accentuated to the threat of climate change? As it is expressed in your institution?	
7. You evaluate your institution identifies evidence indicating the need to adapt to Climate Change in the North Coast? Which are?	
8. What evidence you consider that move (or convince) the policy makers of their institution to develop adaptation actions?	
9. You think that your institution promotes and encourages actions related to Climate Change? Describe some action already undertaken or underway.	

PART II - BUILDING ADAPTATION

10. In its opinion, the activities that your institution develops promote adaptation to climate change? () Remote () Small () Medium () Intense
11. These activities have effectively incorporated actions for adaptation to climate change? Cite some examples and explain your answer.
12. Do you consider that there are effective institutional opening for insertion of the climate change adaptation actions on the work agenda of your institution? () Remote () Small () Medium () Intense. Justify:
13. What do you consider that it is necessary for this integration happen more intensely?
14. How would you describe the role of your institution regarding the implementation of adaptation actions to climate change?
15. What are the opportunities (potential or otherwise) that the institution has to develop adaptation actions?
16. What are the barriers to enter adaptation actions on the work agenda of your institution?

III - LEARNING ABILITY / ACTIVITY INVOLVING THAT LEARNING: INFLUENCING PUBLIC POLICY

17. In your opinion, how the various forums and boards of the North Coast can contribute to the development of actions to adapt to climate change? Exemplifying
18. Which institutions in your opinion, should develop actions to adapt to climate change? What are the specific actions that should be carried out?
19. Do you consider that the issue of climate change has influenced public policy and decision making? Please provide example (s)
20. In your opinion, what needs to happen for adaptation actions to climate change can be incorporated into the agenda of your institution?

IV- RESOURCES

21. In general, as the theme Adapting the LN can mobilize resources (financial, human, information / knowledge)? Please provide example (s).
22. What is the level of importance that your institution gives resources to incorporate climate change adaptation actions in developing such activities? why?

Resources	Very important	Important	Some importance	Not important	Why? Give examples
financing funds					
staff paid					
volunteers					
Other types of resources. specify:					

23. How would you describe the ability of your organization to access and mobilize these resources to meet the needs mentioned above? () Highly suitable, () Adequate; () Somewhat inadequate; () Highly inadequate; () Do not know.
24. What are the types of resources that your institution is receiving, and what you consider important so that it can fulfill its mission? () Financing / financial resources, () Personal / paid workers; () Volunteers; () Other species resources specify: _____ () Other.
25. Which agencies, organizations and groups can provide these features?

Organizations	resource type
Org 1, 2,3,4,5	

V - INFORMATION, KNOWLEDGE, LEARNING

26. How important is access to information for your institution fulfill its functions or to develop activities related to adaptation to climate change for the region? why?

Resources	Very important	Important	Some importance	Not important	Why? Give examples
scientific data and technical information					
Knowledge about experiences and practices of other organizations					
Others. To specify:					

27. How would you describe the ability of your organization to access and mobilize information and knowledge for the performance of its functions or theme of integration of adaptation? Justify your answer. () Highly suitable to mobilize and access, but not to manage; () good, () a little inadequate, () Highly inadequate; () Do not know.

28. What organizations, agencies and groups are the main sources of information / knowledge for your institution fulfill its functions or answer the question of climate change?

Organization	Type of information or knowledge
Org 1, 2,3,4,5	

29. What types of information / knowledge your institution NOT RECEIVE and you consider important?

30. What types of information your institution available to others?

Organization	Type of information or knowledge
Org 1, 2,3,4,5	

VI – INFLUENCE

31. Evaluate the degree of importance of the actions mentioned in the table below for your institution influence other institutions in support of adaptation to climate change in the region?

actions	Very important	Important	Some importance	Not important	Why? Give examples
Collaboration (influencing others to collaborate)					
Participation (influencing others to work together)					
Integration					
Others. To specify:					

32. How would you describe the ability of your organization to influence other institutions with postures / activities in order to put the issue of adaptation in their agendas? Justify () Highly suitable if the issue of adaptation was inserted in politics (not yet arrived, is ethereal); () Good, () a little inadequate, () Highly inadequate; () Do not know.

33. Exemplifying institutions which are capable of influencing attitudes and activities:

Organization	Type of influence
Org 1, 2,3,4,5	

34. Do you consider that there are institutions / entities or groups that negatively influence the issue of adaptation to climate change in the region? What and how?

35. Is there any aspect that has not been discussed in this interview that considers it important? Please specify.

36. Calls up their cooperation to mount the network of influences that your institution is involved: registering the largest targetas those considered most important / influential (positively or negatively) on the issue of adaptation to climate change; and the smaller targetas for less important / influential; and the means for those in which the influence / importance is considered medium.

REVISIONS MANUSCRIPT No. REEC-D-16-00037 'Barriers and opportunities for adapting to climate change on the North Coast of São Paulo, Brazil'

EDITORS' comments	AUTHORS' Response
EDITOR-IN-CHIEF	
The paper is interesting and well-written but a key shortcoming is the lack of information on the questionnaire which needs to be addressed.	The survey questionnaire has been included as an appendix.
Also ensure all journal refs have DOI numbers.	All journal references have their DOI numbers now. In case of reports and other documents, the last accessed weblink has been provided.
HANDLING EDITOR	
I agree with reviewer 1 that you should more clearly highlight the novel insights from your study.	Novel insights have been clearly highlighted in the manuscript. These include additions to the diagnostic framework, and moving beyond the usual analysis of barriers to adaptation to incorporate opportunities (and, therefore, providing insights into the pre-conditions to overcome barriers). In addition, the manuscript offers a critical regional (Brazil, South America) case study that contributes to understanding of emerging barriers and opportunities for climate change in coastal areas. The setting analysed is one where climate adaptation is still in its infancy; therefore it provides insights that might prove useful for other jurisdictions where adaptation is at early stages of development.

REVIEWER #1 comments	AUTHORS' Response
General comment:	

<p>This is an interesting manuscript, however I do not detect any new evidence from analyses of empirical data nor a more theoretical investigation that helps to further enhance current knowledge or understanding of the process of societal adaptation. Perhaps, further explanation and discussion can improve this manuscript (see below). Therefore, I advise to reject and encourage to resubmit. Also, an urban planning or policy related journal such as Journal of Environmental Planning and Management, Cities, or a national or regional journal will perhaps be more receptive to this manuscript.</p>	<p>As noted above, novel insights have been highlighted in the manuscript. These include:</p> <ol style="list-style-type: none"> (1) additions to the diagnostic framework, i.e., we identified three critical additional barriers to the list proposed by Moser and Ekstrom (2010); We propose these barriers be added to the framework; therefore, expanding their diagnostic capability; (2) moving beyond the dominant analysis of barriers to adaptation to incorporate opportunities, and, therefore, providing insights into the pre-conditions to overcome barriers; (3) providing a critical regional (Brazil, South America) case study that contributes to understanding of emerging barriers and opportunities for climate change in coastal areas. The setting analysed is one where climate adaptation is still in its infancy; therefore it provides insights that might prove useful for other jurisdictions where adaptation is at early stages of development.
<p>Specific suggestions:</p>	
<p>Page 3: I recommend to specify the differences between the municipalities under study. These municipalities have different socioeconomic conditions and therefore, different enabling condition for adaptation.</p>	<p>Further explanation has been added to differentiate the socioeconomic characteristics and different condition for adaptation of the municipalities</p>
<p>Page 3: Further describe the current or recent past condition of adaptation of the municipalities under study. It would be useful if you identified literature that describes these conditions, for example (Marandola et al, 2013).</p>	<p>Further explanation and associated literature have been added</p>
<p>Page 11/Lines 42-46: An example of what U1.2 and U2.2 mean as an opportunity and barrier (similar to page 13/lines 27-38) would be useful.</p>	<p>Further explanation has been added.</p>
<p>Page 14/Lines 1-5: It seems that there is a mistake in the identification of the critical barriers/opportunities: U2.2 and M1.3 were not included here. In addition U1.3 was identified as a mayor barrier and in table 4 appeared as 0% assigned to this point. This error is extended to page 14 and 15 (see point 5.2. Emerging critical barriers to adaptation). According to table 4 here must be included U1.1, U2.2, P1.1, P1.7, and M1.3. Further explanation of why your selection (i.e. U1.1, U1.3, P1.1 and M1.8) is defined as a most critical barriers is required.</p>	<p>Apologies this had been an error in the original submission, which we have now rectified. Results and discussion have been revised accordingly.</p>
<p>Page 20: I recommend to use the same structure described in table 1 to analyze the results. This would allow the reader to identify and understand each of the points in the survey in your discussion. For example 6.1</p>	<p>The codes associated to the barriers (as in Table1) have been added to the results.</p>

Understanding, improving perception about climate, 6.3 Planning, developing leadership for adaptation, and so on.	
Page 20: I recommend that the following papers are included in your discussion (Runhaar et al, 2012; Biesbroek et al 2013).	The suggested literature has been included in the discussion (subsection 6.1).
Page 20: Considering appendix A, more discussion would be useful regarding the scale of problems among institutions.	Further explanation has been added in light of Appendix A
Page 20: Even though the responsibilities in the adaptation process have been identified as an important barrier (e.g. Carter 2011), I do not see discussion about it. Here related with table 1 Planning (p)/p3.	Discussion about responsibilities in the adaptation process has been included.
Page 20: Considering table 4, further discussion of the points mentioned as opportunities (U2.2 M1.3, M1.8) would be beneficial.	The points mentioned have been further elaborated
Page 21/Lines 11-22: I do not understand the example here presented. How are the conservation efforts in North Coast São Paulo considered a limiting factor and then an opportunity?.	We have clarified that government officials perceive conservation efforts as limiting their ability to implement adaptation measures based on engineering structures.

REVIEWER #2 comments	AUTHORS' Response
General comment:	
This is an interesting and relevant paper on a contemporary issue. The paper is conceptually sound and is framed nicely in the context of contemporary challenges in implementing climate change adaptation strategies and actions. It provides a useful regional case study that contributes to understanding of the subject. A number of quite minor editorial-type changes are needed, but the key shortcoming is the lack of information on the questionnaire. One cannot tell how the questions were framed, whether answers were free or from a list, etc. Without this, it is impossible to properly evaluate the results. It is readily addressed by inclusion of the questionnaire as an Appendix and some discussion of the nature of appropriate questions in the text. The other major shortcoming is the conclusion- as presently written it does not contain the main conclusions of the study.	The survey questionnaire has been included as an appendix and referenced in the text. The concluding remarks have been rewritten to highlight the main conclusion and contribution of the paper.
Specific comments:	
Abstract- ..." incorporated into policies is variable". (not unknown)	Corrected.
Abstract- ... "...framing is around coastal governance" (delete 'the')	Corrected.

16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65	Abstract- "... contribute to climate change adaptation,..." (not coastal zone management) p2 line 1- particularly p2 line 8- change "increases" to "changes" p2 line 9- change "possess" to "pose" p2 line 13- "better prepare for..." P3 line 4- McDonald P3 line 13- "... need for it." ... "identification and analysis.." p 3 line 23- "... by seeking to understand the perceptions... p3 line 27. "What are the threats associated with climate change and how are they perceived..." p3 line 28 "barrier sand opportunities to climate change adaptation" p4 line17. "barriers can also be conceptualised as opportunities when pre-conditions are identified that enable these barriers to be overcome, and which when implemented, can generate other positive externalities.(e.g. lack of technical capacity can be perceived as a an opportunity to produce knowledge)." p 7- explain "irregular". It is ambiguous. Reword the first paragraph. p 7 line 10- delete "the" P7 line 11. How is the Brazilian coastal "region" defined? "the Brazilian coastal zone covers 324,0000 km2 and has a population density of" p 7 line 20- With an area of 1,944... p8. the first paragraph should be reworded- it is clumsy English. p8 line 14 "Adaptation efforts are still being developed..." p9 lines 17-20 reword this sentence. p 9 line 26- change "organise" to "categorize" P 10 Table 2- influential - correct spelling four times p 11. Results. One needs to know the questions asked and whether the respondents selected from a list, or were given a free choice, in order to interpret these results- need to provide the questionnaire as an appendix and also include relevant descriptions of the questions in the text. p 11 line 23- how did respondents make the link between barriers and opportunities- were they guided by the questions? or were these connections made by the authors.	Changed as suggested. Corrected. Changed as suggested. Corrected. Corrected. Corrected. Corrected. Changed as recommended. Changed as recommended. Corrected. Corrected. Replaced by ´unauthorized land occupation on hillside areas´. Corrected. Rewritten as advised. Corrected. This paragraph has been revised and rewritten. Rewritten as advised. This sentence has been rewritten. Changed. Corrected. The survey questionnaire has been included as an appendix and referenced in the text. Connections between barriers and opportunities were identified based on the narrative of respondents. This has been clarified in the text
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p13 line 3- How can lack of leadership be seen as an opportunity? this needs more explicit explanation.	While, there is no single organisation providing adaptation leadership (barrier), respondents identified several local and regional organisations perceived as potential leaders in developing and leading adaptation strategies (opportunity). This has been clarified in the text.
p 13, line 15- were these potential funders identified by the correspondents or the authors?	Potential funders were identified by respondents; this has been clarified in the text.
p 14- how can there be anything other than whole numbers in the number of mentions column? Surely a person is an individual who either mentions something or doesn't?	Apologies this had been an error in the original submission, which we have now rectified.
p 14, lines 18-21- does this imply that the others were selected from a list and these factors were identified in addition by respondents from these sectors?	The list was identified by respondents. This has been clarified in the text.
p 15-line 22- add "for" example. Define ZEE in the text	Correted. ZEE was replaced by Ecological-Economic Coastal Zoning (EEZ).
p 18, Fig 2- what does horizontal scale represent?. What does position within vertical scale categories imply?	Horizontal scale represents sphere of operation (local, regional, state and federal) of the organization; position within the vertical scale is ramdom, arrows denote interaction across spheres of operation.
p 18- second paragraph requires revision for clarity of English.	This paragraph has been rewritten.
p 19, Fig 3. Is this diagram based on the organisations' perceptions of their own role, or the perception of all the organisations of their role?	Diagram was based on the information provided by respondents about their own organisations.
p 21 para 2, The relationship between barriers and opportunities needs to be explained more clearly here- you have not made this point clearly in the paper, and yet it is an important finding.	The relationship between barriers and opportunities have been clarified in the text.
p 23- conclusions need to be rewritten	Conclusions has been rewritten.

