RISK, VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE: AN INTERDISCIPLINARY APPROACH[1]

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Introduction

Issues related to risk, vulnerability and adaptation have been extensively addressed in the literature, at least since the 1940s, to follow the development of a multidisciplinary research field devoted to human occupation in risk areas/zones (WHITE, 1945; WHITE and HASS, 1975). The term vulnerability started to be more often used in the 1980s in studies about risks and hazards (WISNER, 2009).

These issues have become more relevant and most often cited in the context of climate change and of exposure and adaptation to extreme weather events. The complexity of social and environmental risk conditions tend to rise and become more difficult to be predicted, assessed and reported (IPCC, 2012) within a scenario of increasing extreme weather events (IPCC, 2007; 2012; WMO, 2013) and inadequate human interventions in the physical space (e.g., unplanned occupations in steep slopes, contaminated areas or wetlands), followed by potentially serious negative effects on the population.

Despite a certain degree of uncertainty, which, in turn, influence the actions and the coping with these risks (BECK, 2010; GIDDENS, 2010; WISNER, 2009), climate change increases existing inequalities between the poor and the rich, or between different

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portions of human settlements (BECK, 2010). On the other hand, such inequalities tend to be reduced to the extent that global-scale risks increase, a condition to which even the most powerful and wealthy are exposed to. According to this perspective, risks - environmental pollution, technological hazards and climate change risks - affect everyone and have no boundaries (BECK, 1992; 2009; 2010).

Given this myriad of concepts related to complex social relations that change over time according to individual events and experiences, the aim of the current study is to analyze the vulnerability and adaptation issue. The analysis meant to review important references on the issue in order to improve the debate about a case study in the Northern coast of São Paulo. This case study was based on an approach focused on results understood as either **outcome vulnerability** or **contextual vulnerability**. The study proposes an analytical reading from three main axes based on the result of a survey about the risk perception of climate change (n = 914 interviewees): physical environment risk, social vulnerability and protagonism.

Through the adopted approach, we intend to reflect on risks and on vulnerability not only as physically conditioned, but also considering daily experienced conditions, thus resulting from historical processes of spatial occupation. These processes show signs of segregation and socio-spatial stratification that, on the one hand, affect the access to goods and infrastructure in areas suitable for housing and, on the other hand, assign 'marginalized' groups to areas of higher risk of landslides, floods and other events.

Thus, if the exposure to risks and vulnerabilities caused by the occupation process may not depend on climate change effects, the frequency of more extreme events (heavy rains or prolonged droughts) may increase the risk and the number of people at risk (HUQ *et al.*, 2007, UN-HABITAT, 2011) and, therefore, affects the response conditions to such events.

Risk, vulnerability and adaptation: a multiscale and interdisciplinary approach to the analysis of vulnerability to climate change

The hazards, the risks and the risk perceptions

Risk is understood as the probability of an event and its negative consequences, according to the UN Office for Disaster Risk Reduction (UNISDR, 2009).

Hazard, in its most comprehensive concept, may be understood as an event or phenomenon that may cause loss of lives or injury to people, property damage, social disruption or environmental degradation. Thus, risk is understood as a calculable hazard (VEYRET, 2007; TOMINAGA *et al.*, 2009), to the extent that damages [or benefits] are accepted as consequence of one's decision (see also BRÜSEKE, 2007).

According to the UNISDR (2009), the term 'risk' has two distinct connotations: the one in which the emphasis lies on the concept of chance or possibility (e.g., the 'risk of an accident'); and that formulated in technical environments, in which the emphasis lies on the consequences or damages (e.g., the 'potential losses') in a given place and time.

In practice, individuals do not always share the same perception about the meaning

and the underlying causes of different risks. Thus, understanding how the risk perception affects risk-coping and adaptation strategies is increasingly important to risk, vulnerability and adaptation issues.

The perception of risk by individuals may be taken into consideration according to the following perspective: it tends to be stronger to the extent that there is also a greater experience or familiarity with the problem, such as living in areas at high risk of flooding or of sea level rising, wherein extreme rainfall effects are felt in a negative way (BRODY *et al*., 2008).

However, several studies focused on risk perception have shown that these perceptions are strongly influenced by *(a)* psychological, symbolic and sociocultural factors (ADGER *et al*., 2009; ALEXANDER, 2011; BRODY *et al*., 2008; DOUGLAS, 1994; LEISEROWITZ, 2006; SLOVIC *et al*., 2010;); (b) elements related to the place and proximity to hazards/risks (VEYRET, 2007; BRODY *et al*., 2008; SANTOS e MARANDOLA Jr., 2012); and (c) the access to information and the way they are disseminated by the experts and the media (DI GIULIO *et al*., 2013; GARDNER, 2008; MOSER and LUGANDA, 2006; MOSER, 2010; RENN, 2008).

These factors, once combined with different beliefs, attitudes and experiences, affect individual and collective behaviors (VALENCIO *et al*., 2004; 2005; VEYRET, 2007; RENN, 2008; WEBER, 2010) as well as actions related to the mitigation of and adaptation to climate change (BRODY *et al*., 2008; HOGAN, 2009; VIGNOLA *et al*., 2013).

Understanding how risk perceptions are influenced by the aforementioned factors is critical to identify how risks are perceived and how these perceptions (individuals/social groups) have influenced the extent of risks (ADGER *et al*., 2013; CUTTER *et al*., 2003; DI GIULIO *et al*., 2013; VALENCIO *et al*., 2004; 2005; VARGAS, 2009; VEYRET, 2007; SLOVIC *et al*., 2010), since they influence the vulnerability and adaptation to hazards or disasters associated with extreme weather events.

Vulnerability and adaptation

The term vulnerability emerged as an important theoretical and analytical concept related to the risks/hazards and to the context of climate change.

Vulnerability has different meanings or concepts (ADGER, 2006; O'BRIEN *et al*., 2004; 2013), but it may have at least two different interpretations with implications in treating and solving the problem. The first interpretation usually focuses on the biophysical aspects of the vulnerability analysis. Studies in this field tend to consider that people living in precarious physical environments or in environments subjected to the most dramatic physical effects (of climate change) are the most vulnerable ones (LIVERMAN, 2001; TOMINAGA *et al*., 2009). Accordingly, the responsiveness (of an individual or social group) to climate changes determines or influences the vulnerability of such individual or social group. This analysis considers vulnerability as an outcome of the analysis on the physical features of the environment (outcome vulnerability – O'BRIEN *et al*., 2013).

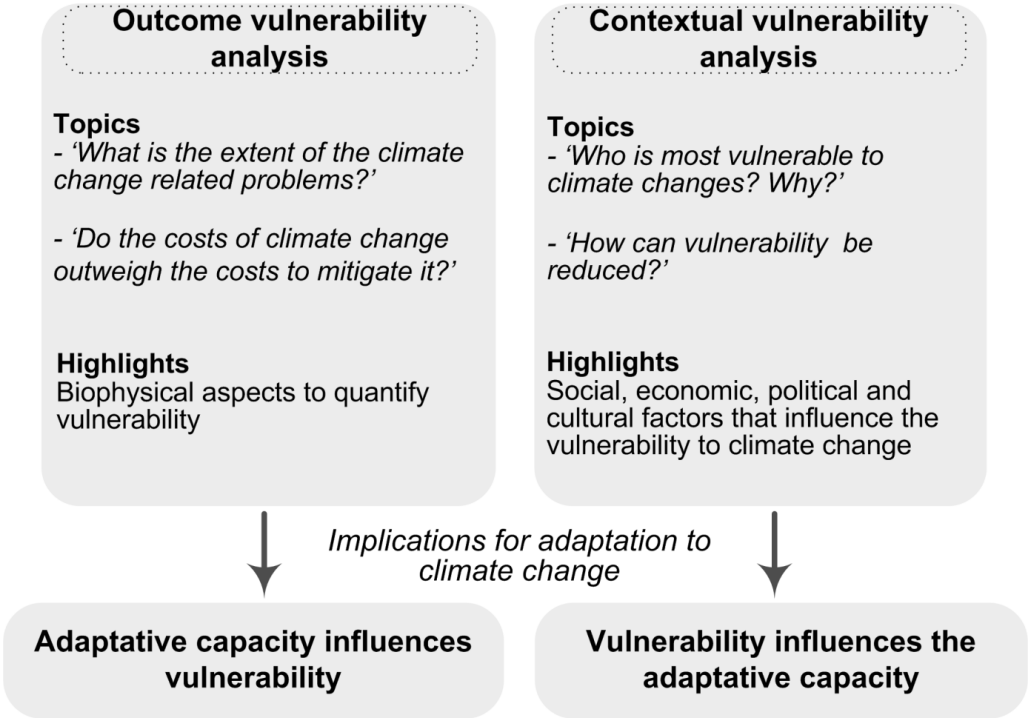
On the other hand, there are multiple factors and environmental, social, economic, political and cultural processes that influence the vulnerability of individuals and their

responsiveness to the effects of climate change (BLAIKIE *et al.*, 1994; CUTTER, 1996; CUTTER *et al.*, 2003; O'BRIEN *et al.*, 2004; 2013; WISNER *et al.*, 2004; ALEXANDER, 2011; ADGER *et al.*, 2009; 2013). Understanding these processes is a prerequisite to reduce their effects (O'BRIEN *et al.*, 2004; 2013).

Vulnerability is contextually analyzed (contextual vulnerability – O'BRIEN *et al.*, 2013) according to this perspective and it determines or influences the responsiveness to climate change. According to Adger et al. (2009), there are four assumptions that limit the responsiveness and/or adaptation to climate change: *(i) the ethical issue* - what society considers "critical" or "acceptable" as adaptation measures depends on different values and priorities, *(ii) the lack of knowledge* or *uncertainties* about climate change are often cited as one of the reasons for the delay in the adaptation, *(iii) the risk perception*, when society does not believe that the risk is sufficient for immediate or urgent action, and *(iv) the devaluation of cultural aspects* in times of crisis, in relation to the interpretations, choices and action strategies to reduce the risks (EISER *et al.*, 2012).

Figure 1 is a diagram of the term vulnerability and of its different interpretations and implications for adaptation.

Figure 1. Outcome and contextual vulnerability: analysis, interpretations and implications for the adaptation to climate changes.



Source: Prepared by the Iwama and authors, based on O'Brien et al. (2004; 2013).

The two interpretations of vulnerability - outcome and contextual - are complementary, although they show differences according to their scientific approach and referral of political responses to climate change (O'BRIEN *et al.*, 2013). In addition, the integrated analysis of these concepts/interpretations may favor a new approach to risk, vulnerability and adaptation to climate change. Miller *et al.* (2010) showed that many researchers, in their respective fields, are actively involved in co-producing new knowledge, allowing promising complementary research fields for the integration of concepts and methods related to the vulnerability issues.

The (multi)scales: quantification and relational aspects

As it was observed in the literature and in empirical cases, the issues of risk, vulnerability and adaptation require studies at multiple scales. Multiscale studies have been essential to such issues due to the assessment of relational, situational and spatial dimensions that affect society and individuals exposed to the same hazards, but on a different extent depending on the scale (HARDOY and PANDIELLA, 2009).

Gibson et al. (2000) define the spatial, temporal, quantitative or analytical scales as those that measure a certain phenomenon, as well as levels, or units of analysis, wherein the phenomena are located in different positions in a scale. Based on this concept, the current study analyzes that the change of scale is also followed by changes in ecosystem patterns and processes (WIENS, 1989). The interactions of a given phenomenon usually occur at different scales and it results in increased complexity (WIENS, 1989; CASH *et al.*, 2006).

Several authors have shown the need for a multiscale approach to explain the variations and interactions of phenomena/processes that occur at multiple scales and in a mosaic of spatial situations. Both the social and the ecological processes may operate at different spatial extents and periods of time (TURNER II *et al.*, 1990; 2003; YOUNG, 1994; WILBANKS and KATES, 1999; CASH and MOSER, 2000; ROTMANS and ROTHMAN, 2003; CASH *et al.*, 2006; MEA, 2006; VANWEY *et al.*, 2009). Therefore, the multiscale analysis shows potential use as analytical approach in studies about climate change and, in some occasions, it is essential.

The representation of the processes occurring in the social dimension and in the environment is not trivial (EVANS *et al.*, 2009). Thus, it is important to understand how the changes associated with spatial data representation may affect the analysis of phenomena or situations.

Finding measures that take into consideration the several dimensions and the multiplicity of causes that are at the origins of environmental, social or technological risks is a challenge. Many studies have pinpointed the importance of addressing the scope of meanings given to terms such as risk, vulnerability and adaptation by thinking about the multidimensionality of different action scales in time and space as a way to understand the hazards/risks based on a relational perspective between society and the environment (ADGER, 2006; BIRKMANN, 2007; BLAIKIE *et al.,* 1994; MARANDOLA Jr. and HOGAN, 2006; TURNER II *et al.*, 2003; WISNER, 2009).

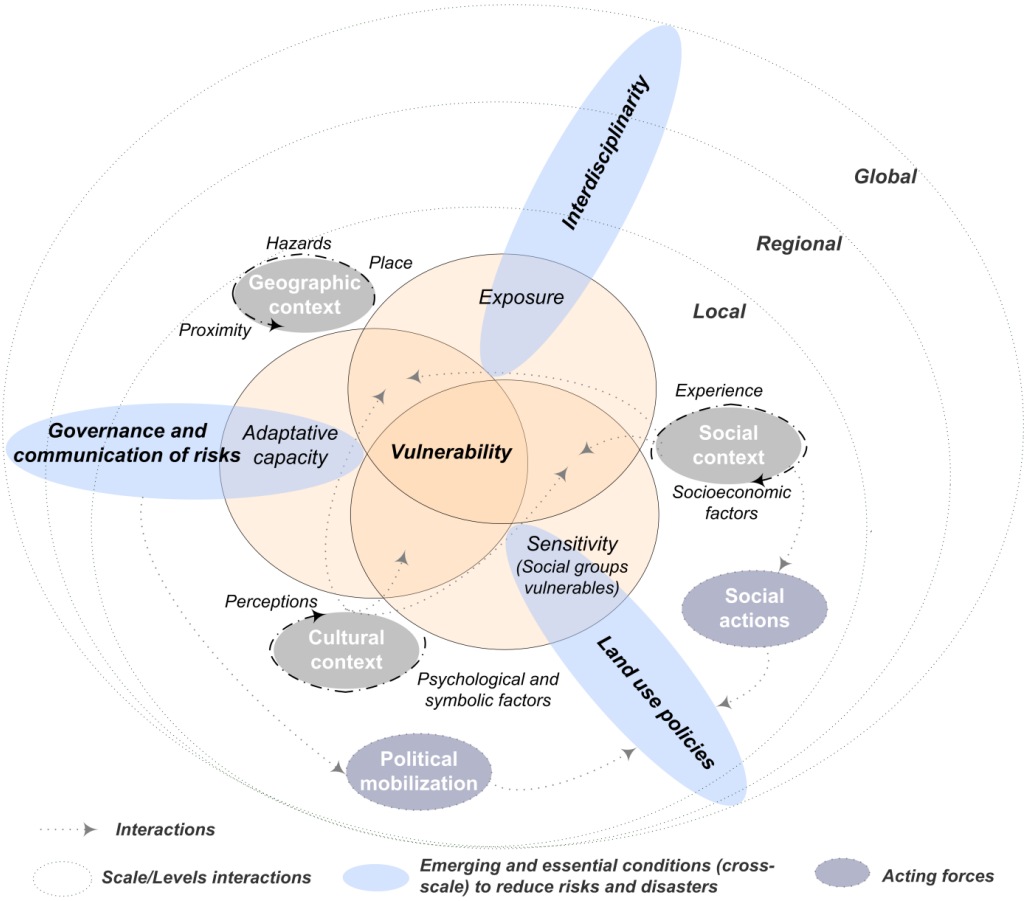
Brazil has a large production of researches focused on identifying susceptibility to hazards and risks from the geological and geomorphological point of view (AUGUSTO FILHO, 1995; TOMINAGA *et al*., 2004; 2009; OLIVEIRA *et al*., 2007; FERREIRA *et al*., 2008; BITAR, 2009). There are also some studies focused on quantifying or outlining vulnerabilities (ROSSINI-PENTEADO *et al*., 2007; ALVES, 2009; FERREIRA and ROSSINI-PENTEADO, 2011; MELLO *et al*., 2012a; NICOLODI and PETERMANN, 2010; ALVES *et al*., 2010; ANAZAWA *et al*., 2013). Although some studies have analyzed the risks and vulnerabilities according to a relational perspective, they still require approaches that take multiple scales and levels into consideration.

Integrating multiple scales: interdisciplinarity in the vulnerability concept

The literature reports an increasingly urgent need for developing interdisciplinary approaches (FERREIRA, 2000; 2004; BRAGA *et al*., 2006; EVANS *et al*., 2009; MORAN, 2009; 2011; BUARQUE *et al*., 2014), which consider multiscale analysis to understand and offer methods to integrate, analyze and monitor the changing processes in ecological and social systems (CLARK, 1985; TURNER II *et al*., 1990; ROTMANS and ROTHMAN, 2003; MEA, 2003; 2006; VANWEY *et al*., 2009; MORAN, 2011) and to incorporate appropriate concepts and methods to understand and measure the vulnerability and adaptability of populations facing situations caused by climate change (ALVES, 2009; MORAN, 2009; MARANDOLA Jr. and D'ANTONA, 2014).

This section proposes a conceptual diagram for the multiscale and interdisciplinary analysis of these topics in order to synthesize the key concepts of vulnerability and adaptation in the climate change context. Figure 2 shows three components of the vulnerability analysis (exposure, sensitivity and adaptive capacity of vulnerable social groups) and their possible causes or the forcing elements that have simultaneously and often operated in interconnection: on the one hand, the inadequate land use and, on the other hand, the weak governance associated with a development model based on economic growth (business as usual). Such situation has increased environmental degradation and, at the same time, has generated social inequalities or precarious conditions for the development of communities and of society as a whole. Somehow, this intricate process has intensified the exposure to risk and amplified the vulnerability of social groups or individuals - influenced by geographical, socio-cultural, psychological and symbolic contexts. Such situations tend to be intensified and become of great magnitude in the scenario of extreme weather events.

Figure 2. Conceptual diagram of vulnerability proposed according to a multiscale and interdisciplinary approach.



Source: Prepared by the Iwama and authors

Several studies have focused on a conceptual proposal of risk, vulnerability and adaptation (CUTTER *et al.*, 2003; TURNER II *et al.*, 2003; WISNER *et al.*, 2004; LUERS, 2005; BIRKMANN, 2006; 2007; UNISDR, 2009; 2011; IPCC, 2012) by emphasizing the social perspective of the problem or disaster.

Thus, the present paper emphasizes three important and challenging aspects for the implementation of the vulnerability and adaptation analysis in the climate change context: (I) interdisciplinarity, (II) integration of land use planning policies, and (III) risk governance and communication.

***(I)* Interdisciplinarity** (PHILIPPI Jr. *et al.*, 2000; FLORIANI, 2000; FERREIRA, 2000; 2004; BARRY *et al.*, 2008; BROTO *et al.*, 2009; ALVES, 2014). Floriani (2000) argues that '*the modern scientific knowledge is forced to deal with an increasing complexity*'. Thus, interdisciplinarity must be a basic and fundamental premise in studies about environment

and society and must take viewpoints and complementary analyses into consideration in order to deal with this complexity. The topic requires taking some specific elements into consideration, namely: (i) the use of spatial indicators, followed by contextual analyses to qualify the investigation results (MARANDOLA Jr. and D'ANTONA, 2014); (ii) the multiscale analysis to capture the phenomenon at different scales or levels of analysis; (iii) the use of different methodologies and approaches, or mixed methods (MARANDOLA Jr. and D'ANTONA, 2014), notwithstanding the methods and epistemological approaches specific of each of the sciences - natural and social (FLORIANI, 2000; ALVES, 2012; 2014); (iv) researches or collaborative and participatory technical studies as a strategy to articulate research/society and management (WINOWIECKI *et al.*, 2011).

***(II)* Integration of land use planning policies** (UNISDR, 2004; 2009; 2011; FERREIRA, 2012; BRASIL, 2012) to articulate guidelines and actions to reduce vulnerability to risks and disasters - one of the premises of the National Protection and Civil Defense Policy (BRASIL, 2012) is '... incorporating the reduction of disaster risk (...) between the land management elements... '. Therefore, it is worth highlighting two necessary elements - *stronger social action* and *political mobilization* - that must work together to drive forces towards formalizing institutions to deal with the problems (ALVES, 2012; 2014).

(III) A **risk governance** associated with **risk communication**, which is open to adaptations and reflections according to each risk context and, above all, which is in line with the aforementioned topic (II).

Renn (2008) points out that at least four dimensions affect and structure the risk governance, namely: the *organizational capacity* that considers the risks at different levels (local, state or national) or at combined levels (DI GIULIO and FERREIRA, 2013); the *risk policy and regulation based on cultural aspects*, as an important factor to support a global estimate of how the same risks may differently affect political decisions about a certain risk element (BECK, 1992, 2010; BRÜSEKE, 2007); *the network of actors or individuals* involving the participation of civil society, NGOs, and local governments in the construction and assessment of risks to take appropriate risk management decisions - in this case, risk communication is an essential (DI GIULIO *et al.*, 2013; MOSER and LUGANDA, 2006; MOSER, 2010) strategy to guide and empower society so it can cope with the risks it is subjected to.

Renn (2008) highlights the better understanding of the *social dimensions of climate change and of the risk culture* as an important factor to help developing strategies to reduce or mitigate risks.

Although these three aspects - interdisciplinarity, integration of land use planning policies, and governance associated with risk communication - still have to overcome many challenges, they have advanced in recent years by bringing positive perspectives to risk and disaster reduction actions and to environmental studies. Obviously, the solution to the issue is not trivial and it should not be limited to the three aforementioned aspects. However, they may be considered as key points to studies on such topic.

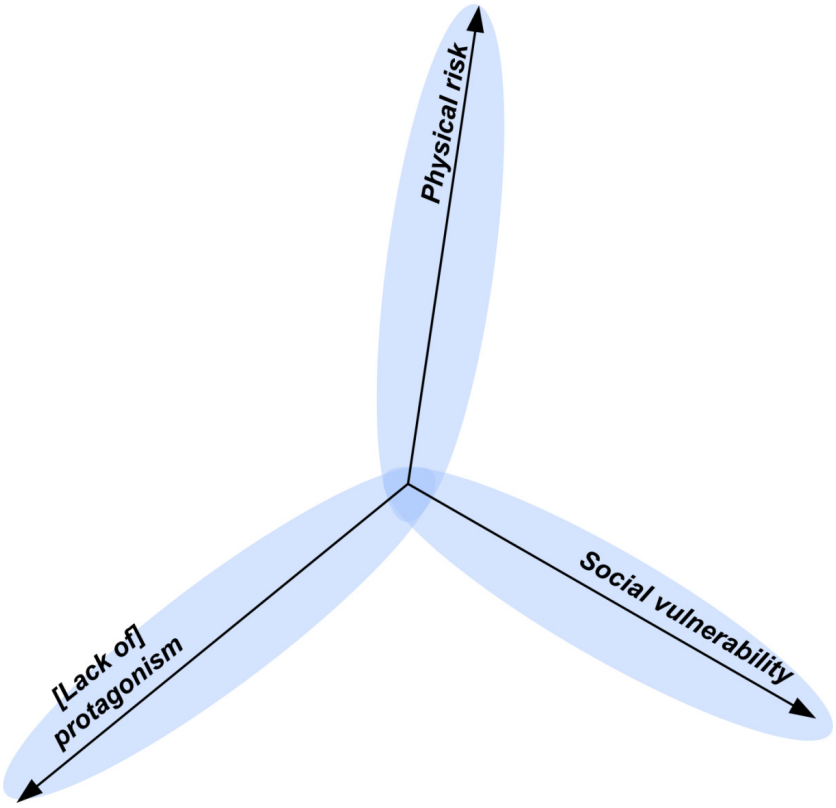
Therefore, the survey allowed structuring the research strategy used to analyze vulnerability and adaptation in the coastal region of São Paulo. Next section presents methodological elements in the light of concepts presented in the previous sections, which subsidize the results and discussion in the current study.

Analytical approach to the study of vulnerability and adaptation

Vulnerability in three axes: physical risk, social vulnerability and protagonism.

Based on the empirical results of the Northern coast of São Paulo (IWAMA, 2014; IWAMA *et al.*, 2014), it is possible to analyze vulnerability from the perspective of three axes: the 'physical' risk, i.e., the probability of a hydrological or geological hazard to happen; the social vulnerability, in terms of the socio-spatial segregation, in which marginalized people are placed in areas at high risk of landslide or flood; and the protagonism (or lack of it), which depends on a number of factors (experiences, culture, proactivity - EISER *et al.*, 2012; AGDER *et al.*, 2013). Together, they provide the multiple dimensions of vulnerability - see the conceptual model in **Figure 3**.

Figure 3. Conceptual vulnerability analysis model in three axes: physical risk, social vulnerability and protagonism.



Source: Prepared by the Iwama and authors

Three different, although interrelated, contexts were taken as an example in this analysis, namely: (1) **reduced vulnerability** - a condition of low physical risk and low social vulnerability associated with high degree of protagonism; (2) **intermediate vulnerability** – a condition of moderate physical risk also associated with moderate social vulnerability, and people or social group with some degree of protagonism to solve the problems presented to them; (3) **increased vulnerability** - concerns a condition of increased vulnerability: when there is high physical risk associated with high social vulnerability and with no or very little protagonism.

Outcome and contextual vulnerability approach: study case in the Northern coast of São Paulo (Brazil)

Several studies have characterized the Northern coast of São Paulo by focusing on the major changes caused by infrastructure projects related to oil exploration activities in the region (FERREIRA *et al.,* 2011; IWAMA *et al.*, 2014; TEIXEIRA, 2013) and on their implications for the population (CARMO *et al.,* 2012) with respect to social conflicts and physical environment risks.

It is possible to say that the development model in the Northern coast region is in conflict with the perspective of protecting the natural resources - the area is covered by the Serra do Mar landscape and it has several protected area categories. It is a development model that still offers poor sanitation infrastructure, inadequate housing, and limited access to health services.

In addition, the region has already faced large landslides (Caraguatatuba disaster in 1967), and these events may occur with greater frequency and intensity in the region.

Thus, vulnerability was analyzed in the practical example on the Northern coast of São Paulo in the light of the proposal by O'Brien *et al.* (2013), i.e., by considering the resulting vulnerability. Thus, it was possible to analyze the spatial distribution of areas susceptible to landslides, flooding or soil subsidence (soil kneeling) along with social vulnerability areas, and it resulted in the cartography of potential risk and vulnerability (IWAMA *et al.*, 2014).

The analysis was based on the multiple scale analysis and took into consideration the Water Resources Management Unit[i] (UGRHI-3), with a more detailed scale analyses of the thirty-four sub-basins that form the UGRHI-3 (IWAMA *et al.*, 2014).

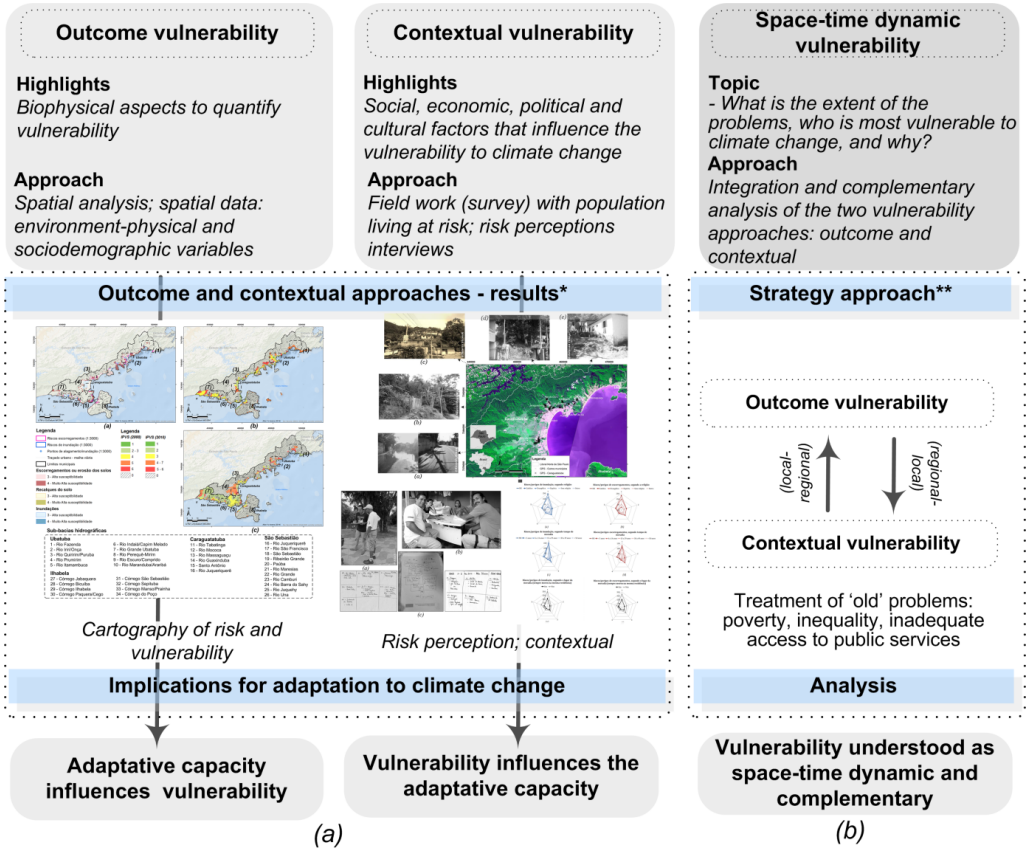
Cartography, as an analytical representation of vulnerability, presents a static of reality, which does not allow analyzing the nuances that influence attitudes towards the adaptation to risks. Thus, understanding contextual vulnerability, by looking at the geographical place from the viewpoint of the affected population, or from their memory and inherent places, brings another aspect that cannot be analyzed as resulting vulnerability.

Therefore, after mapping the areas that are mostly susceptible to landslide and flooding hazards, a risk perception survey was prepared to identify how people perceive the effects of climate change, risks, and how they cope with the risks they are exposed to.

Figure 4 presents a sketch of the methodological framework of both outcome and contextual vulnerability applied to the Northern coast of São Paulo in the light of the

concepts presented in the previous sections, which resulted in the analysis of vulnerability as a space-time process.

Figure 4. Methodological approach of outcome and contextual vulnerability applied to the Northern coast of São Paulo.



* *Based on Iwama (2014) and Iwama et al. (2014)*
** Methodological proposal to analyze a multidisciplinary and multiscale problem

Source: Adapted from Iwama (2014); Iwama et al. (2014); O'Brien et al. (2004; 2013).

Four groups of semi-structured questions were applied for 914 people who live near or inside risk areas: (i) interviewees' profile; (ii) climate change; (iii) risks and adaptation; (iv) governance and communication - Mello *et al.* (2012b) performed a preliminary analysis using this set of questions. The questions related to risks and adaptation were selected to present the results and discussion of the survey.

Results and discussion

Overall, the results indicate that the sense of risk is based on the causal interpretations of events. There was ambivalence in the responses of adaptation to climate

changes. For example, it was observed that 48.9% of the interviewees (447 people) remain in their homes under hazardous conditions because they like living in the that place (due to emotional bond or proximity to the day-to-day activities) or simply because they trust their lives to a deity, in this case, they leave it in 'God's hands' (54.5% of the respondents or 498 people). On the other hand, responses such as: '[...] the risk is low [...] but the neighbors are at risk [...]' were recurrent.

Part of the interviewees somehow denied the risk they are exposed to and the reasons for such behavior are multifactorial: religious, economic, cultural and even the uncertainty about the weather phenomena and the mapping of risky areas. They question the technical mapping or climate prediction models – as first considered by Beck (1992) in the context of nuclear accidents and diffuse risks, and subsequently related to climate change in his work (BECK, 2010).

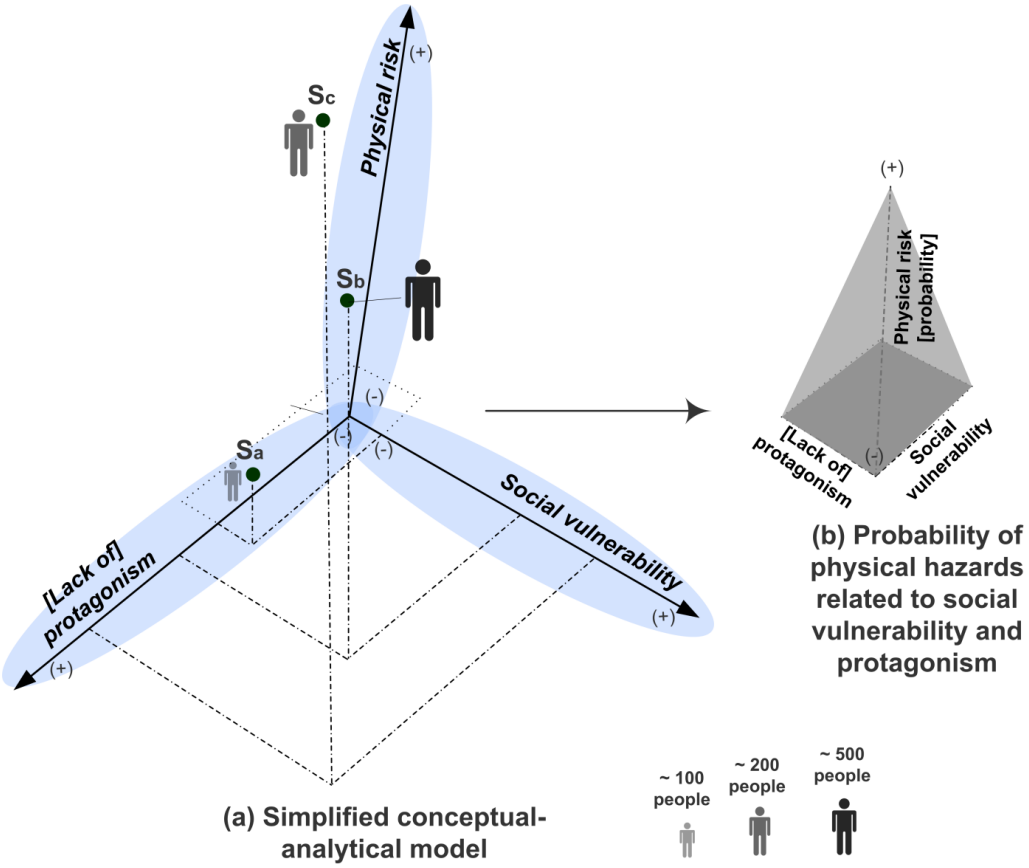
Figure 5 (a) shows that 100 out of the 914 interviewees would have some degree of proactivity to look for solutions to reduce risks other than 'leaving it in God's hands'. It was observed in the risk perception survey that their answers about taking the responsibility to reduce or avoid the problems suggest that there is some involvement of the population to act on the risks it is exposed to. However, some reports suggested that the respondents would not know what to do to avoid or reduce these risks.

Therefore, the conceptual model considered an analysis at several levels: given a social group or an individual safeguarded from the problems already experienced in the everyday life (lack of basic infrastructure, limited access to public facilities, housing at risk) and with high degree of protagonism, they will probably be better prepared or adapted to reduce the risks they are exposed to, even if the likelihood of physical risk increases - **Figure 5 (b)** - called **reduced vulnerability or situation A (S_a)**. This sense or perspective must also be understood in a context of **intermediate vulnerability or situation B (S_b)**. This situation, at least in the light of the results of the current study, indicates that approximately 500 people would have some degree of protagonism.

The third context - **the increased vulnerability or situation C (S_c)** - points out to approximately 200 people who responded that if they were at risk, they would leave it in God's hands.

According to the results of the risk perception survey applied to the contextual vulnerability approach, 48.9% of the interviewees (447 people) said they like living in the place, despite the risks, and choose to stay due to their affective bond to it, or because [people] do not consider it as such a serious risk. Thus, they 'accept' living in the place and are willing to face the danger when someone warns them about it. Whether they perceive or not the risk, or even regardless of their income, almost 60% of the interviewees (approximately 500 people) would leave imminent risk situations in God's hands, whether they are associated with landslides or flooding. The risk is denied or simply not perceived by those subjected to it. However, they perceive the risk for their neighbors. In the light of examples also observed in countries other than Brazil [mostly in developing countries], the results suggest that there is still an incipient preparation to act in emergency situations, because these countries have not yet consolidated a 'culture of risk prevention'.

Figure 5. (a) Simplified conceptual-analytical vulnerability model analyzed in three axes; (B) analysis in perspective - same social vulnerability and protagonism according to different risk probabilities of the physical environment.



Source:Prepared by the Iwama and authors

Somehow, the protagonism (or lack of it) reflects the actions or attitudes of people towards the adaptation to problems they experience every year, especially in rainy summers. Thus, it is worth reflecting about whether it is more appropriate to wait for another disaster with magnitude equal to or greater than that of 1967 (Caraguatatuba) – due to climate change or not - or to take precautionary measures to better socially and spatially distribute the population in the territory, by taking into consideration the social specificities as well as the environmental and geological conditions, besides the articulation of different land use planning instruments.

By considering the development model used in the study area (and in other Brazilian cities) as a possible background cause to the current problems, it is necessary to think about the issues that may not be internalized in people's perceptions, since they influence their protagonism to face the problems that already exist and those that may come to exist due to the effects of climate change. Rather than discussing the causes of

these changes, we address the problem that is already experienced in the region in order to face the following situations: the recurring problems that have historical consequences (as it was previously mentioned, see also **Figure 4 (b)**), and the future problems, which, although uncertain, may worsen the existing ones.

Thus, we go back to the discussion in **Figure 2** with respect to actions focused on promoting an attentive and active political mobilization in order to perform effective social actions to solve the old problems and, thus, to reduce the risks. Obviously, these actions (political and social) must happen together and collectively.

Final considerations

The paper intended to summarize the main concepts about risk, vulnerability and adaptation to climate change by following an interdisciplinary approach. Far from providing an answer to such issues, the study sought to reflect on an approach that, somehow, should permeate the aspects of a multiscale analysis opened to mixed and/or integrated methods evaluate risk, vulnerability and adaptation - as in the case of vulnerability, which is understood as both the outcome and the contextual vulnerability.

In addition, the study reflected on the analysis of vulnerability according to three interconnected axes (physical risk, social vulnerability and protagonism) for a population often facing physical environment risk situations. The protagonism axis may offer an opportunity to identify actions and encourage attitudes that promote a better understanding about how to respond to the problems.

Although the present reflection was based on results of a study case conducted in the coast of São Paulo, it contributed to explore new approaches for vulnerability analysis with implications for adaptation in a broader context.

Guiding integrated and participatory work efforts may promote the involvement of the population in coping with and reducing risks arising from historically recurrent issues - poverty, socio-spatial segregation, and limited access of some social groups to basic urban infrastructure - or with those that are to come, such as climate change.

Note

i The UGRHIs are land use units 'with dimensions and characteristics that allow and justify the decentralized management of water resources' (State Water Resources Policy - State Law 7663/1991 - SAO PAULO, 1991).

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RISK, VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE: AN INTERDISCIPLINARY APPROACH

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***Resumo*:** Este artigo trata sobre risco, vulnerabilidade e suas implicações sobre a adaptação da população aos problemas já enfrentados em seu cotidiano e os advindos das mudanças climáticas. Com base na literatura sobre o tema e no estudo de caso no litoral norte de São Paulo – Brasil, o trabalho buscou sintetizar os temas que convergem na análise da vulnerabilidade e adaptação às mudanças climáticas, resumidos em três componentes: (i) a interdisciplinaridade para estudos em ambiente e sociedade, exigindo análise multiescalar, (ii) a integração de políticas de ordenamento territorial e (iii) a governança e comunicação de riscos. Com base em resultados de um levantamento de percepção de riscos (914 entrevistados), é apresentada uma reflexão para a análise da vulnerabilidade sob três eixos interconectados (risco físico, vulnerabilidade social e protagonismo), valorizando o grau de protagonismo da população que enfrenta as situações de riscos do meio físico, de maneira que sejam orientados esforços de trabalhos integrados e participativos que propiciem o envolvimento da população para enfrentar e reduzir os riscos advindos dos problemas recorrentes e históricos – pobreza, segregação social e espacial – ou daqueles que estão porvir, como os das mudanças climáticas.

Palavras-chave: Vulnerabilidade; Multiescalar; Interdisciplinaridade; Mudanças Climáticas; Litoral norte de São Paulo.

***Abstract*:** This study addresses risk, vulnerability, and their implications for the adaptation of communities to the problems they face in the everyday life and to those derived from climate change. Based on the literature about risk, vulnerability and adaptation to disasters and on a case study conducted in the Northern coast of São Paulo - Brazil, we summarize the converging themes in the analysis of vulnerability and adaptation to climate change, which are divided in three components: (i) interdisciplinarity for studies about environment and society, requiring multiscale analysis, (ii) the integration of land use management instruments, and (iii) risk governance and communication. Based on the results of a risk

perception survey (914 interviewees), we analyze vulnerability according to three interconnected axes (physical risk, social vulnerability and protagonism) by emphasizing the role played by the population in face of physical risk situations, as a way to guide integrated and participatory work efforts to encourage the engagement of the population to cope with and reduce the risks derived from historical and recurrent problems – such as poverty, social and spatial segregation - or with those that are about to come, such as climate changes.

Keywords: Vulnerability; Multiscale; Interdisciplinarity; Climate Change; Northern coast of São Paulo