ADAPTATION AND PUBLIC POLICIES IN THE SÃO PAULO MACRO METROPOLIS: **A SCIENCE-POLICY APPROACH**

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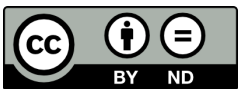

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SUMMARY

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FOREWORD

CARLOS A. NOBRE[1]

Bringing science and politics together to make a decision on climate change adaptation

Globally, climate change already has a significant impact, such as rising sea levels, shrinking Arctic ice areas, exacerbation of climate extremes leading to natural disasters and crop losses among many others. In many megacities, this effect is multiplied by local climate change, especially the impact of the "urban heat island", increased waterproofing for runoff, urban pollution and particulate emissions, vegetation removal etc.

All of these urban impacts are strongly present in the São Paulo Macrometropolis (SPMM). The climate change observed in the SPMM due to the rapid urbanization process - almost always chaotic and far from adequate planning - is felt daily in the life of the city and its suffering population: in the last 80 years, the average temperature has risen by about 3 ° C and the temperature differential between the city and vegetated areas around SPMM reaches 7 ° C on sunny days; episodes of destructive rainfall (eg, over 100 mm in 24 hours) already occur once a year on average, compared to one occurring per decade up to the 1940s. In short, climate change has actually reached SPMM, long and forcefully and strikingly.

In the various scenarios outlined by the Intergovernmental Panel on Climate Change (IPCC) only at the end of this century, and if the Paris Agreement is unsuccessful, global temperatures will have risen by 3 ° C over the period pre-industrial, values already reached in the most urbanized points of SPMM. Given this picture of climate change already exacerbated and already felt in the SPMM, one may wonder what public adaptation policies have been taken in recent decades, as these changes were already clearly discernible even before the topic of climate change global issues become relevant. In fact, they were almost always reactive and low-effectiveness adaptation measures, such as swimming pools. As with global climate change, it is the poor and vulnerable SPMM populations that are most affected by the observed climate change. And projected future climate change may pose

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more obstacles to poverty reduction.

It is interesting to note that only at a time when the theme of adaptation policies and increased resilience to global climate change has gained international adherence, coupled with global sustainability frameworks, such as the increasingly important milestone of the Sustainable Development Goals that puts With a huge emphasis on building sustainable and resilient cities, an effort is underway to seek adaptation solutions for SPMM.

Deep within the Brazilian tradition, we respond mainly to external pressures - which are urgent and mandatory in any case on climate change adaptation - rather than having our own policies that address the many national sustainability challenges. Adaptation is always seen as complex, involving actions at the local level that are not dissociated from priority development actions such as poverty reduction, health, jobs, quality of life, but also depend on the support of policies and institutions, including their funding, which are usually national. In the 21st century, it is also essential to seek solutions in the field of technological innovations.

The book **Adaptation and public policies in the São Paulo MacroMetropolis: a science-policy approach** brings together leading national and international researchers in a remarkable and pioneering interdisciplinary academic effort that covers in depth in its 21 chapters all the relevant aspects of the theme of adaptation to change. For the Paulista Macrometropolis of more than 25 million inhabitants, reflecting a diversity of perspectives. It describes in detail the ongoing climate change, its impacts and the future risks to SPMM in terms of human health, natural disasters, mobility and economic development. At the same time, it addresses the various dimensions of public adaptation policies and suggests paths for their implementation, including bringing examples from other metropolises around the world towards human well being, poverty reduction and environmental preservation for a sustainable and resilient macrometropolis.

It is a book aimed at a wide range of readers, from college students and researchers interested in its multiple topics, to virtually all policy-makers by the centrality of the topic on sustainable development, to the public at large who wants quality information on climate change and the São Paulo Macrometropolis. This book will increase the visibility of adaptation and the need to seek creative and innovative solutions for a more sustainable SPMM.

INTRODUCTION

PEDRO HENRIQUE CAMPELLO TORRES [1]
PEDRO ROBERTO JACOBI [1]
FABIANA BARBI [2]
LEANDRA REGINA GONÇALVES [1]

Cities or metropolises should plan to face climate change impacts

Between March and July 2018, the Institute of Energy and Environment (IEE) of the University of São Paulo (USP) and the FGV-CES - Center for Sustainability Studies, carried out an international survey with a network of partners under the LatinoAdapta Project, with the objective of analyzing knowledge gaps for the area of climate change adaptation related to managers, technicians and decision makers at municipal, state and national levels.

Questionnaires were conducted with public managers and interviews with climate change adaptation experts who have held or hold positions in the public administration. One of the preliminary findings of the study indicates that there are currently no gaps regarding the production of scientific information on adaptation to climate change, on the contrary, it has been the focus of considerable research and countless recent publications. What still demand more analysis, from the point of view of environmental governance, is the production of material and the training of managers who act at the end of the decision-making process, in the most diverse circumstances.

The initiative of this book is, therefore, a propositional answer to the diagnosis found in this research. Seeking also, in an innovative way, a scientific production that is presented in a language easily understood and which reaches the largest number of interested parties, as well as one that is still applicable, reproducible, and inspires other similar initiatives within the most diverse areas of knowledge. To this end, we have assembled an extremely qualified team of experts from Brazil and other countries, showing that from the point of view of science there is a need for solid production, and to take on the challenge of writing a book useful to the general public and society as a whole.

[1] University of São Paulo.
[2] UniSantos/NEPAM/UNICAMP.

We believe that these initiatives, in an academic environment marked by an excess of productivism, are fundamental for the construction of the new epistemological paradigm we face in the 21st century, especially from the perspective of the Global South's relationship to the production of public policies for cities, management of common resources, as well as justice and urban environmental governance.

Cities, especially metropolises - and their extensions such as the São Paulo Macrometropolis - have been mentioned, each time more frequently, as components of the problem, as well as solutions to the effects of climate change. The United Nations Intergovernmental Panel on Climate Change (IPCC), the leading intergovernmental panel on climate change research, held a meeting in March 2018 for the first time with the Cities & Climate Change Science Conference, endorsing the importance of discussing cities as the center of the climate debate, as was already recommended to the 43 IPCC session in Nairobi (2016). This session recommended that a Special Report on Climate Change and Cities be included in the seventh evaluation cycle (AR7), taking into consideration working with academics, urban professionals, agencies and scientific agencies to stimulate scientific reports and peer-reviewed publications on the subject.

But why are cities and the metropolises important for the debate? They represent more than 70% of global carbon dioxide (CO_2) emissions from fossil fuels (SETO et al., 2014) and are in areas that are vulnerable to the impacts of climate change (REVI et al., 2014). In addition, the process of urbanization on a planetary scale continues to accelerate, especially in regions of the Global South, such as Latin America - the most urbanized region in the world - China, India and Africa.

Although almost a consensus in forums for international debates, the actions or leadership of cities as active actors in relation to the effects of climate change on a subnational scale remains fragile in Brazil. In the State of São Paulo, the country's largest GDP, there is no specific legislation addressing climate change, adaptation or mitigation plans. When they do exist, as in the case of the city of São Paulo, compliance is at the mercy of inconstant political conjuncture as documented in the amendment of Law 14.933 of 2009, which stipulated that in 2018, no bus in the capital would be operated with fossil fuels, to Law 16,802, dated January 17, 2018, which extends that deadline for yet another 20 years.

We are confronted, as in the above case, and it is not new, in the fragile governance of our natural resources and common goods, in the absence of strategic, just and feasible environmental planning. In this sense, it is imperative to reinforce the pedagogical and knowledge-building character in relation to the theme, imploding and exploding the walls of the academy and international forums. One of the key governance challenges is undoubtedly intergovernmental integration, the improvement of municipal management - with qualified managers and decision-makers - backed by long-term management, management based more on prevention rather than emergency and curative action (JACOBI and NASCIMENTO, 2016).

In the case of adaptation to climate change, the central objective of this book is a question of how to plan and govern for the uncertainties and complexities, as we do not know when, and in what proportion, the impacts will be. But this should not be an excuse for inaction. On the contrary, the governance of risks and natural disasters, such as seeking to construct more resilient urban environments, is an issue to be addressed, espe-

cially since the municipality is primarily responsible for the environmental, territorial and risk management of the disaster, just as it is the first space of the citizen and his democratic duties and rights (JACOBI and NASCIMENTO, 2016).

In this way, the chapters address issues related to climate change governance in cities and in the São Paulo Macrometropolis, as well as other related issues such as water resources, territorial planning and management, extreme climatic events, coastal zones, biodiversity, gender issues, environmental justice and education. The book is also a product of the reflections made on the theme within the scope of the FAPESP Thematic Project "Environmental governance of the micrometeorologist paulista in face of climatic variability (2015/03084-9)" that produces and disseminates knowledge, extrapolating the barriers of the disciplines, presenting an interdisciplinary approach for the purpose of building dialogue between science and politics.

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CHAPTER 1

LUÍSA SCHMIDT [1]
CARLA GOMES [1]
PEDRO ROBERTO JACOBI [2]

Interdisciplinary learning and knowledge for adaptation: communities, academia and the environment

There is an increasing body of evidence demonstrating how climate change above all stems from the patterns of economic growth and consumption that today prevail on a planetary scale. The IPCC – the Intergovernmental Panel on Climate Change was unambiguous in its special October 2018 report, that keeping global warming below 1.5ºC will be crucial to avoiding profound and irreversible impacts on ecosystems and the wellbeing and security of entire populations. However, the report adds that such will require deep and accelerated transitions in the management systems for the soil, energy, industry and transportation, as well as for cities, in order to attain carbon neutrality by 2050, which would be extremely difficult to obtain with the technology available today (IPCC, 2018).

Climate change thus serves to encapsulate, more than any other environmental dilemma, the contradictions inherent to the very concept of sustainable development, in the form it has been incorporated into the predominant political discourse (REDCLIFT, 2005). While efforts have thus far sought to resolve environmental problems with resort to technical solutions that do not compromise the prevailing institutional structures, the scale of environmental change has now reached a point of rupture, as the exhaustion of the planet's resources has already become evident on various levels (ROCKSTRÖM et al., 2009, STEFFEN et al., 2015).

In this context, the challenge of adapting to climate change as taken on a central role within the reflections around the various dimensions of development, as well as on the potentially emerging alternatives. The rising levels of extreme climate conditions have

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[2] University of São Paulo.

triggered an increased socio-environmental vulnerability, while simultaneously raising public awareness on the incidence and intensity of such extreme events and the resulting economic losses.

Nevertheless, as Karen O'Brien (2012) maintains, in terms of adaptation policies and actions, there remains a tension between accommodation to the inevitable and forecast changes – with a preponderance of technical solutions – and a transformative approach that opens the way to deliberately creating alternatives for social organisation. The climate challenge does bring us the opportunity to explore alternative models of economic and social development that reach further in terms of attaining values around human well-being and social justice, questioning the social and economic roots of current vulnerabilities (PELLING, 2011).

Climate change, as a complex problem, characterised by uncertainties and a plurality of perspectives, also requires a transversal response from the perspective of the production of new knowledge; an approach able to reach beyond both the disciplinary compartmentalisation characteristic of the scientific system and the rigid boundaries between the natural and social worlds (BERKES & TURNER, 2006). Still furthermore, this demands an expansion in the conventional roles of scientists, decision-makers and citizens, in favour of co-producing knowledge among diverse actors and social groups (AGRAWAL, 2009).

Throughout the last decade, we have witnessed the gradual emergence of a new, integrated approach to climate science that involves the deconstruction of traditional structures of knowledge across various levels:

1. Overcoming the gulf between the natural and social sciences through the emergence of multiple integrated projects that seek to better understand the socio-environmental phenomena surrounding climate change and pre-empting future scenarios of risk;
2. Transversal disciplinary approaches across the natural, social and human sciences (for example, closer collaboration among social scientists such as sociologists, historians, economists and anthropologists) and the emergence of new frontiers in these disciplinary fields;
3. Integration of diverse types and sources of knowledge, including greater recognition of that knowledge labelled as 'lay', traditional or local.

ADAPTATION OF THE EDUCATION SYSTEM: INTERDISCIPLINARITY AND DIVERSITY

In a context shaped by global planetary degradation, it is striking how the cognitive-instrumental rationality that underlies its origins still prevails. This poses the challenge of rupturing the compartmentalisation of knowledge, which requires the involvement of a set of actors from across every level of the education universe. This opens the path to enabling other forms of rationality for engaging in diverse systems of knowledge, the training and professionalization of teachers but also professionals in general and across the university community, strengthening contents and knowledge that are based on sustainable values and practices, essential to stimulate interest, engagement and social responsibility.

Without ever rejecting the specialist disciplinary fields currently in effect, but most certainly contributing to their reformulation and development, the environment and sustainability as notions return the human to the centre of concern of scientific programs.

The emergence of the environmental problem, and particularly of climate change, leads to the more complex processes of knowledge and wisdom necessary to learning about the material processes that configure contemporary society-nature relationships (MORIN, 2007). The ongoing social transformations increasingly demand interdisciplinary conceptions able to orient research strategies and the formulation of environmental and sustainable development policies. We ought to recognize the effects of the prevailing economic policies on the dynamics of ecosystems and the living standards of societies (FUNTOWICZ, 2000). To consolidate the focuses of knowledge, study reference frameworks need focusing on the effects of environmental problems as regards methodological transformations alongside the interdisciplinary dialogues that open new horizons for the diagnosis of socio-environmental changes and nurture the formulation of different approaches to environmental sustainability (JACOBI, 2012).

Furthermore, the multiplication of environmental problems, and especially those resulting from climate change, have imposed themes on the different scientific fields for which they were not previously prepared, requiring the reformulation of teaching and research parameters in order to meet the challenges arising.

The emphasis on practices able to stimulate interdisciplinarity and transversal approaches demonstrates a great potential for working with themes capable of eliciting changes in behaviours, in socio-environmental responsibility and environmental ethics which inspires a new perspective. This incorporates understanding the complexity involved in these processes and the challenge of adopting more reflective and pro-active attitudes and, consequently, citizens becoming more responsible, careful and engaged in collaborative environment focused efforts (WALS, 2007). This furthermore identifies the need to stimulate a more active participation of society in debating its own destinies as a means of establishing a socially identifiable set of problems, objectives and solutions (JACOBI, 2012).

The path to be designed therefore necessarily embraces a change in our access to knowledge and information, transformations in institutions and the logics of corporate governance, as well as the formation of leaderships focused on the premises underpinning the construction of a sustainable society based on the exercise of active citizenship and changes to individual and collective values.

Hence, educational processes require restructuring to prepare current generations not only to accept uncertainty and the future, but also to generate complex and open thinking about the uncertainties, the changes, the diversity, the scope for constructing and reconstructing in a continuous process of new readings and interpretations of that already thought, and configuring opportunities for action in which has yet to be thought.

Correspondingly, there are now emerging human resource training programs based on interdisciplinary perspectives, contemplating a new articulation between the natural, social and exact sciences. This represents a concrete example of establishing collaboration structured around the different subjects that constitute the field of science – to integrate teaching and research oriented towards reflection, analysis and the formulation

of proposals for action.

ADAPTATION AS A MOTOR FOR SOCIAL TRANSFORMATION

The need to adapt to climate change has driven an approximation among decision making spheres, based on the assumption that such efforts to adapt shall require closer levels of collaboration among political decision-makers – across the global, national and local scales –, scientists and citizens, understood as stakeholders that jointly share the risks of climate change even while holding different needs, perceptions and interests.

Public institutions, as well as academia, are increasingly challenged to reach beyond the conventional 'top-down' approach and deploy mutual learning philosophies (ADGER et al., 2005). Out of this context arise participative models of research, such as action-research, as well as concepts such as the co-production of knowledge and knowledge brokers for transmitting and conveying learning and information (DILLING & LEMOS, 2011).

The empowerment and capacity building of public officers, for example, is one crucial component of adaptation processes. Recent experiences in the co-production of adaptation strategies at the municipal level have already demonstrated how capacity building strengthens the response capacities of local institutions and simultaneously fosters a greater sense of political commitment among local decision-makers and a virtuous interrelationship between science and politics. On the one hand, the focus on the local level enables proximate responses that duly take into consideration the specific features of each territory across the biophysical, social and economic levels. On the other hand, these decision-makers begin to take on a key role as the points of connection with other municipalities, thereby enabling the creation of networks for disseminating the best practices, adaptable and replicable in other geographic zones (SCHMIDT et al., 2018).

Given the sheer urgency of climate adaptation and the evidence demonstrating how this shall not be possible without institutional and behavioural changes, these participative approaches thereby foster shared responsibilities among institutions and social actors, as well as a greater transparency and legitimacy in their decision-making and the effective supervision of public policy implementation.

The vulnerabilities and perceptions of the different stakeholders, across diverse spatial and temporal scales, have to be taken into account in any adaptation focused options. These respectively undergo constant negotiation as the criteria determining them, social and environmental in character, are susceptible to change over the course of time (ADGER et al., 2005). In this process of social learning, knowledge brokers play crucial roles as members of communities – local decision-makers or other stakeholders – who act to facilitate the dissemination of adaptive ideas, practices and knowledge. The co-production of knowledge thereby helps ensure the building of relationships of trust among the stakeholders, crucial for implementing adaptation actions on the ground, but also generally raising awareness about climatic risks (MCNIE, 2013).

Another dimension that has gained visibility in the context of climate adaptation is the scope for integrating more effectively the knowledge and practices of disadvanta-

ged social groups that have been overlooked in the production of scientific knowledge, for example, the learning held by traditional fishermen or smallholder farmers. While this 'lay', traditional or local knowledge was broadly neglected up until recently, the concept has now become omnipresent; not only in the international political discourse, but also within the context of adaptation research. However, full integration nevertheless requires rethinking the traditional role attributed to each knowledge matrix (KLENK et al., 2017).

In any case, in order to break with the hiatus existing between recognition of the climate emergency and the real construction of practices capable of structuring the foundations for a sustainable and adapted society, there is the need to strengthen what have traditionally been known as 'communities of practice' (WENGER, 1998)[3] and social learning (GLASSER, 2007)[4], as well as implementing processes able to boost the numbers of people exercising this knowledge and fostering their mutual communications, in order to enable interactions capable of driving substantial advances in the production of new repertoires and social practices for sustainability.

The greatest challenge stems from creating opportunities for active social learning able to ensure the real involvement of participants in dialogues and relationships that favour: the perception of diversity in opinions and views of the world; the mediation of individual and collective interests; and the scope for expanding repertoires that deepen the capacity for contextualisation and reflection.

Hence, this calls for the strengthening of the collaborative methodologies under development across multiple scales, which bring about processes of functional, integrative and transparent governance. This implies, beyond mere participation, other facets such as the openness to information and dialogue, shared responsibility, effectiveness and coherence. Climate adaptation consisting, after all, in a process of social learning, building commitments with a broad social support improves policy legitimacy and strengthens their priorities for action. The participation of stakeholders thus becomes fundamental to maximising the synergies and ensuring good coordination, leveraging responses and resources, as well as fostering quality and acceptance of the adopted policy options, all the while enabling the success of their respective implementation.

The last IPCC report points to the need for profound changes in the prevailing economic, political and socio-cultural systems, which shall only be possible through the structural transformation of the logics underlying the production and dissemination of knowledge about climate change. At this level, any integrated approach crucially needs to overcome the barriers between natural and social sciences, implying transversal disciplinary approaches and the inclusion of new forms of knowledge. This also makes it necessary to adopt new practices for adaptation that inherently involve the participation of different actors, alongside transformative methodologies capable of favouring mobilisation for change.

[3]According to Wenger (1998): "Communities of practice are groups of persons who share a concern or a passion for something that they do and learn how to do better to the extent that they regularly interact".
[4] Social learning is hereby understood as a process of cultural change oriented towards dealing with the currently prevailing socio-environmental problems.

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CHAPTER 2

KLAUS FREY [1]
JUTTA GUTBERLET [1]

Climate governance and democracy: a South-North perspective

In this article, we reflect on the role of democracy and governance in relation to the possibilities and dilemmas related to effectively addressing climate change risks. Although the emphasis of this collection is the São Paulo Macrometropolis, in this chapter our intention is to put the subject in a broader perspective. At the outset, it is crucial to point out that any climate policy, whether local or regional, strongly depends on corresponding international policy that is part of an international climate regime that is capable of providing appropriate guidelines for consistent policies at different territorial scales. For this reason, our reflection recognizes the importance of adopting a perspective of scales: from global to local. As conflicts arising from climate change intensify, the Macrometropolis[3] will increasingly become the subject of mitigation and adaptation policies, as well as the political arena for regional cooperation and democratic negotiation toward effective climate governance.

We want to explore the idea that in the future the Macrometropolis will play a growing role in climate governance and that this governance must be multilevel, polycentric, participatory and politicized in order to achieve technically effective, environmentally sustainable, socially responsive and politically democratic answers. To advance in this reflection, the chapter is divided into three parts, in addition to the introduction. In the first part, we briefly analyze global climate governance from the South-North perspective; in the second part, we address some democratic dilemmas related to climate change, in order to, in the final part, elicit some challenges for cities and large cities, with emphasis on the possibilities for democratic climate governance of the São Paulo Macrometropolis.

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[3] The term Macrometropolis refers to the conurbated, densely populated, expanded metropolitan region of Greater São Paulo, with more than 30 million inhabitants, or 64 % of the population of the state of São Paulo. The Macrometropolis covers an area of 53,000 km2 and 174 municipalities distributed about 200 km around the state capital city São Paulo.

GLOBAL CLIMATE GOVERNANCE FROM THE PERSPECTIVE OF A SOUTH-NORTH DIALOGUE

Compared with most other public policies for specific sectors, environmental policies have some particular characteristics. These include: the need to adopt intersectoral and interdisciplinary approaches, the close interdependence of environmental and economic activities, both in terms of production and consumption, and thus the inherent high potential for conflict, and finally, the technical and scientific complexity of spatial and temporal impacts that requires resorting to the technical and scientific knowledge of experts. These particularities of environmental policy are even more serious in the case of climate policy, making climate change, according to Fiorino (2018, 27), "the biggest problem of collective action in history." As long as such problems do not cause concrete disasters, they tend to accumulate gradually, depending on scientific progress to make ecological threats visible and, consequently, possible to be addressed by the political system. One of the dilemmas of climate change is that there is often a decoupling between the places where these problems are primarily generated and the places where they mainly cause environmental, economic and social damage (usually located in the Global South); effective and socially just solutions to global problems depend on a "cosmopolitan vision" (BECK, 2007, 315) and with that the abandonment of the selfish and short-term impulses that still dominate the current lack of global climate governance (FRANCHINI et al., 2017), highlighting the centrality of 'climate justice' as a challenge to global climate governance.

The principles of environmental and climate justice recognize the huge gulf in resource availability that separates the poor from the rich and that calls into question the "right to development" (MRF, 2015) of the poorest countries and of the poorest people in both Southern and Northern countries. Lack of access to resources makes it impossible for large parts of the world's human population to lead decent lives, something that is absolutely essential to reverse. The scale and complexity of the issues related to climate change highlight the true interdependence of all life forms and between the various worlds (the global South and the Global North). It is recognized that these relationships must "lead to a new and respectful paradigm of sustainable development, based on the urgent need to expand and transfer green technologies and support resilient low carbon strategies for the poor so that they become part of the combined effort toward mitigation and adaptation" (MRF, 2015).

Furthermore, Bulkeley et al. (2014) draw attention to the gradients of resource wealth and poverty that exist among populations in the Global South, where the wealthy and influential are generally not identified as privileged people who should, due to their greater resources, therefore bear greater responsibility in the discussion of climate justice. These differentiations need to be made and the large socioeconomic disparities that sometimes exist within the same community or the same city or region need to be included in the discussion of climate justice.

However, there is widespread skepticism in the literature regarding the ability of the current global governance system to promote the planetary balance necessary for humanity to remain within the "safe space of human development"; that is, within the "boundaries of the "planetary playing field" for humanity if we want to be sure of avoiding major

human-induced environmental change on a global scale" (ROCKSTRÖM et al., 2009, 1), demanding "levels of cooperation never before reached by international society in global governance" (FRANCHINI, VIOLA & BARROS-PLATIAU, 2017, 178).

The expectation that science - represented in climate policy by the Intergovernmental Panel on Climate Change - simply investigates and then makes policymakers and political decision makers aware of the problem of global climate change, thus allowing appropriate solutions to be developed, seems unrealistic and has come up against the structures and power relations of capitalist society. In this capitalist society, the pursuit of profit, the accumulation of capital, and the exploitation of nature predominate so that the advances achieved are merely mechanisms of ecological modernization that ultimately avoid the necessary structural societal and economic changes that the present period of the Anthropocene demands (FRANCHINI, VIOLA & BARROS-PLATIAU, 2017). How then to achieve the collective policies and decisions necessary to accomplish collective actions for a true structural socio-ecological transformation capable of enabling climate change mitigation and adaptation strategies? This question puts politics - and democracy itself - at the center of attention and will be investigated below.

DEMOCRACY IN THE CONTEXT OF CLIMATE CHANGE

The principles of climate justice underscore the importance of ensuring that decisions made about climate change are participatory, inclusive, and transparent and that decision makers are accountable for their actions to society. It also means that those most vulnerable to climate change are heard and that mitigation and adaptation practices focus primarily on these groups. At the regional and Macrometropolis level of São Paulo, this means identifying inequalities, vulnerabilities and scarcity of resources within this territory, giving priority to preventive work that benefits these populations.

Governance that aims at sustainability, mitigation, and adaptation to climate change and, at the same time, seeks to be democratic, inclusive, and fair, must necessarily involve various stakeholders in the practices of governance. In this way, interactive governance (FREY, 2004; KOOIMAN, 2008) represents an adaptation of the political-administrative system to the diversity, complexity and dynamics of contemporary society.

It is not easy to meet the expectation of reconciling the interests of multiple public and private stakeholders that intervene in a territory, in order to achieve a result that is beneficial, or at least acceptable, to all. The participatory process requires a high level of organization and mobilization of society to solve common problems, building collective solutions. In the context of the global South, numerous other difficulties arise as a result of the fiscal crisis, lack of public investment or high levels of corruption in the public and private sectors. In discussions and deliberations, conflicts and disagreements arise. We understand conflict as the force of transformation within democratic processes for sustainability, as expressed in the theory of agonistic democracy, which considers conflict as the essence of politics and democracy (RANDOLPH & FREY, 2019). According to Mouffe (2013), there is a need to transform antagonisms into agonisms and enemies into adversaries, through arenas where conflicts can surface. It also emphasizes that a counter-hege-

monic project based on the principles of social and environmental justice is indispensable, given the unsustainability of the capitalist system that is focused primarily on the pursuit of profit.

From this perspective, one should neither aspire to the elimination of conflict nor give up dialogue and continuous negotiation. Both conflict and the search for consensus are essential elements of politics and democracy. Democratic politics never happens without conflict, while governability depends on compromises and reaching consensuses that are possible, temporary, and never permanent (MOUFFE, 2013; RANDOLPH & FREY, 2019). In climate governance, opposing approaches clash - those who demand immediate action to mitigate and reverse the framework imposed by forces driving climate change, and the hegemonic power that continues to advocate growth-based development, productivism, and consumerism (ESCOBAR, 2015). An agonistic perception of democracy opens spaces where different actors are present and where conflicts can manifest and be openly discussed and resolved to promote the necessary social, environmental and political transformations. How difficult this constructive negotiation is in practice can be seen through examples of cities that have implemented participatory budgeting, watershed-level planning, or participatory deliberation through public policy councils.

DEMOCRATIC CLIMATE GOVERNANCE FOR CITIES AND METROPOLISES?

Rising temperatures and extreme weather events leading to floods, landslides, infrastructure destruction, and prolonged droughts are already among the major challenges in densely populated urban centers. In the context of the Global South, there is also the issue of inequality, such as unequal exposure to thermal stress. Little attention has been paid to the combined impact of local heat island effects and global climate change that together greatly affect low-income residents on the outskirts of cities. Population growth and housing shortages that mainly affect low-income inhabitants of cities are aggravating factors in the context of the Global South. Disparities in green space access between high- and low-income neighborhoods have already been proven in cities around the world, but are particularly obvious in the Global South (WOLCH et al., 2014). The lack of basic infrastructure and services results in spatially unequal impacts that disproportionately harm marginalized and vulnerable populations. These aspects related to climate (in) justice need to be on the international agenda and part of global climate negotiations.

The perspective of South-North relations runs through all negotiations for the international climate regime and requires the world's major metropolises to play an increasing and a leading role in mitigating the impacts of climate change (BARBER, 2017). We defend the concept of a "glocal" polycentric, multilevel environmental governance that is based on a model of agonistic democracy. However, as Purcell (2009) warns, this form of democracy can also be co-opted by hegemonic powers, without actually challenging the foundations of the neoliberal project. It further points to the need to pursue a democratic practice that is "unambiguously hostile to neoliberalization" (PURCELL, 2009, 147). This transformation of the political agenda, in response to climate governance, requires a focus on forces and movements that often operate outside the state through insurgent practices

whose driving force is located within civil society and in people's daily lives. Hence, the need to pay more attention to the potential role of the various popular movements, called "insurgents" due to their contestation and resistance against the hegemonic planning and intervention practices of neoliberal local governments (e.g. the Waste Pickers Movement, the Homeless Movement and other popular collectives and grassroots movements). While "invited spaces" controlled by government actors primarily aim to legitimize unsustainable policies, often only in the interests of dominant sectors, authors such as Miraftab (2018) bet on the ability of these popular movements to occupy new territories, the "invented spaces" of which, it is hoped, truly counter-hegemonic movements and projects may emerge. On the other hand, it is evident that effective transformations towards local and regional climate policy depend as much on active and strong environmental movements, popular movements demanding social and climate justice, and attentive and critical media as on a scientific community that is interdisciplinary and politically conscious, as well as governments that are able to broker conflicts and exercise leadership in the search for sustainable development paths.

We can still reverse many of the major predicted impacts if we act responsibly and commit to sustainability. Cities and especially large urban agglomerations are ideal spaces to mitigate the effects of climate change through changes in production, consumption, construction, transportation, energy generation and use, and everyday lifestyles and habits, as well as participatory policies that involve actively working on real existing conflicts rather than avoiding or silencing them. Cities and metropolises with their large agglomerations of people and their high social capital, seeking to develop and implement innovative and transformative policies based on social and environmental justice, have the potential to make the necessary transformations to address the risks to which we are increasingly exposed in the context of the Anthropocene.

We underscore the urgency of climate governance that is decolonial, challenging Western knowledge and placing value on other knowledges built through everyday experiences that is translated into theories and practices that aim to explain urban phenomena and processes in the specific context of the Global South. Finally, our reflection points to the need to deeply examine the impact of the struggles of urban social movements and their insurgent practices on interaction with governments and other dominant sectors to ascertain their potential for shifting political agendas towards climate justice.

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CHAPTER 3

JEROEN VAN DER HEIJDEN [1]

Innovative urban climate governance: A brief overview of global trends

It is often stressed that cities are point-sources of activities and behaviour that contribute to climate change. It is also often stressed that it would be in cities where the consequences of climate change will be felt most severely. At the same time, cities are widely considered as the places where behavioural, economic, and technological interventions for climate change adaptation and mitigation have the best potential to be implemented and scaled up (IPCC, 2018; UN, 2018). Seeking to utilize their climate mitigation and adaptation potential, cities around the globe have rapidly developed as sites of innovative and experimental governance to spur climate action (ROSENZWEIG et al., 2018).

Since the 1990s, scholars have been mapping, exploring and interrogating these urban climate governance interventions seeking to understand if they help to accelerate the transition to low-carbon and resilient cities. Initially, this literature presented hopeful narratives of promising local practices and sometimes presented cities as saviours of the planet in the face of climate change (BARBER, 2013; BRESCIA & MARSHALL, 2016; C40 & ARUP, 2017; MEYER, 2013; NEWMAN, BEATLEY, & BOYER, 2009). More recently, however, scholars have been using a more critical tone, indicating that our knowledge of what constitutes effective urban climate governance is fragmented and dispersed and that many cities around the globe are not taking action required to mitigate and adapt to climate change effectively (e.g., BAI et al., 2018; JOHNSON, 2018; LUQUE-AYALA, MARVIN, & BULKELEY, 2018; RECKIEN et al., 2018; ROMERO-LANKAO, BURCH, & HUGHES, 2018; SENNET, BURDETT, & SASSEN, 2018).

In what follows, four global trends in urban climate governance are lifted from this extensive literature. They are introduced to give the reader a glimpse of how cities across the world are responding to climate change. By no means is this review exhaustive, but it

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should provide interested readers enough pointers to follow up on.

CITY NETWORKS: BUILDING JOINT CAPACITY

When overviewing the literature on urban climate governance, the first global trend that stands out is the rapid development of city networks (ACUTO & RAYNER, 2016). City networks are essential but often informal bodies at translocal and international levels, comprising formal bodies at the local level (JORDAN & TURNPENNY, 2015). City networks help cities to learn from each other, share ideas and best practices, and work together towards a joint goal. Three well-known city networks are ICLEI – Local Governments for Sustainability, the C40 Cities Climate Leadership Group and the Covenant of Mayors for Climate and Energy. The first is an international network of more than 1,500 cities, towns and regions founded in 1990; the second is a network of over 80 of the world largest cities founded in 2005; and the third is a network of over 7,000 local and regional authorities (mostly from European countries) founded in 2008 (VAN DER HEIJDEN, 2018). There is some evidence that city networks help overcome regional and national barriers to climate governance, including the difficulty of developing and implementing mandatory regulation and the lack of institutional capital in, particularly, smaller municipalities. For example, progressive cities in less progressive nations may find like-minded cities in more progressive nations. Also, by combining resources (funds, staff and so on), these networks are, in theory, capable of carrying out more rigorous experiments (these are discussed below) than cities can achieve on their own (ACUTO & RAYNER, 2016; BANSARD, PATTBERG, & WIDERBERG, 2017).

A typical example of cities working towards a joint goal in a city network is a subgroup of the C40s cities that have organised themselves as the Connecting Delta Cities Network. This is a network of delta cities that actively pursue urban climate adaptation and climate-proof their cities. Unique about the network is that it links member cities at the policy level through a bilateral Memorandum of Understanding. This binds the cities to share policies and practices, help each other to develop and implement climate actions, and generate lessons for the broader community of member cities (FRANCESCH-HUIDOBRO, DABROWSKI, TAIB, CHANC, & STEAD, 2017). The Network's website (www.deltacities.com) now provides a wealth of information and knowledge developed by these cities, and accessible to other cities that are facing similar challenges.

COLLABORATION: WORKING WITH CITIZEN AND BUSINESSES

A second global trend in urban climate governance is a collaboration between (local) government, citizens and businesses. It has long been argued that governments cannot solve complex societal, environmental and economic problems (such as urban climate adaptation and mitigation) by themselves and need to collaborate with individuals and organisations outside of government (ANSELL & GASH, 2008, 2017; GOLLAGHER & HARTZ-KARP, 2013). In broad brushstrokes, the argument then is that collaboration allows for using resources and knowledge outside of government in policymaking, as well as create a mu-

tual interdependence for the policy programs and governance interventions implemented. Collaboration is expected to result in context-appropriate solutions, and yield higher levels of acceptance of (and, ultimately, compliance with) the governance interventions developed than those solely developed by governments (GÓMEZ-ÁLVAREZ, RAJACK, LÓPEZ-MORENO, & LANFRANCHI, 2017; SIDIKI, CARBONI, KOSKI, & SADIQ, 2015).

Illustrative examples collaborative urban climate governance processes are the development of the One Less Nuclear Powerplant Policy (OLNPP) and the 2030 Seoul Plan in Seoul, South Korea. Both policies and the governance interventions following from it were developed in close consultation with citizens and allowed for citizen involvement in the implementation of urban climate actions. The OLNPP is the result of a staged development process, involving sixteen discussions between the Seoul Metropolitan Government and civil society representatives over four months in its drafting stage. The draft plan was then presented at a large-scale town hall meeting, attended by more than 400 citizens. They were part of a review process involving 22 group discussions, that resulted in over 100 ideas for climate change mitigation actions. Many of these ideas have been reflected in the OLNPP (SMG, 2012). In the development of the 2030 Seoul Plan, 220 citizen representatives and experts were involved in five plan-development stages. The plan was further reviewed at a public hearing and in local planning sessions (WON-SOON, 2014; YI & JUNG, 2017). This, for Seoul, novel approach to collaborative urban planning has won the city the 2018 Lee Kuan Yew World City Prize for good urban governance and the 2016 Gothenburg Award for Sustainable Development.

EXPERIMENTATION: STRUCTURED TRIAL AND ERROR

A third global trend in urban climate governance is experimentation as a mode of governance. Though experiments, city governments and others seek to find promising governance interventions, processes, and instruments to accelerate local climate action (BULKELEY, CASTAN BROTO, & EDWARDS, 2015; JOHNSON, TOLY, & SCHROEDER, 2015). Experiments are not to be mistaken for ad hoc ventures of implementing novel governance interventions. They are purposeful attempts of the trialling of alternative governance interventions within deliberately constructed sites, with processes or instruments in place for knowledge production. Experimentation is a process of structured trial and error to ultimately come to urban climate governance interventions that are effective in a specific setting. Essential to experimentation is the measuring of change and adjustment of interventions to lessons learnt (EVANS, KARVONEN, & RAVEN, 2016; JOHNSON ET AL., 2015; KARVONEN & VAN HEUR, 2014).

An illustration of an urban climate governance experiment is the oft-lauded Cap and Trade Program in Tokyo, initially introduced in 2010 (CASTAN BROTO & BULKELEY, 2013). The Program targets approximately 1,300 large commercial buildings or properties comprised of several buildings (such as university campuses). It combines mandatory emission reductions with voluntary credit trading and covers 20 per cent of carbon emission of Tokyo. In sum, property owners of targeted buildings can achieve required emission reductions by retrofitting their buildings or by buying credits to offset the emissions of their buildings.

If they achieve higher levels of reductions than what is required, they obtain credits that they can trade with those property owners who are not able to achieve the required reductions. The Program follows up from a now discontinued mandatory carbon disclosure program for large commercial and industrial facilities that was in force from 2002-2009. Lessons learnt from that program were essential in developing the Cap and Trade Program. Of particular interest is that the Program increases the level of required reductions every five years to achieve ever higher overall reductions, and allow property owners to plan the retrofitting of their property portfolios over time and learn to work with this novel approach to emission reductions (TRENCHER et al., 2016).

VOLUNTARY PROGRAMMES: MOVING FORWARD WITHOUT FORCE

A fourth and final global trend worth mentioning is a wide variety of voluntary programs and governance interventions in place in cities around the world that seek to spur climate action of individuals and organisations, but without the force of law (VAN DER HEIJDEN, 2017). Joining such programs comes with exclusive rewards to those that commit to them, including information and knowledge, financial support, and access to peer and client networks (POTOSKI & PRAKASH, 2009). Voluntary programs often resemble the structure of traditional governance interventions. They consist of a set of rules, monitoring and enforcement processes, and penalties for non-compliance or rewards for compliance (COGLIANESE & NASH, 2014). It is generally expected that they are easier to develop and implement because they do not have to go through the checks and balances required for mandatory interventions, and they can target specific groups of firms or citizens rather than proposing a 'one size fits all' solution as mandatory interventions often do (SIK & KRIZNIK, 2017).

A typical example is the Better Buildings Partnership in Sydney, Australia, launched in 2011. The program brings together the City Council and the city's 14 major property owners. It aims to reduce carbon emissions, waste, energy, and water consumption in buildings belonging to these major property owners. Together, these property owners account for over 50 per cent of all commercial property in Sydney's central business district. The program requires its participants to reduce their existing buildings' carbon emissions in 2030 by 70 per cent as of 2006 emissions (BETTER BUILDINGS PARTNERSHIP, 2013). Participating property owners sign a letter to the Mayor of Sydney pledging that they will make improvements to their buildings to achieve this goal. In return, the City keeps them involved in prospective policy deliberations so that they can plan their property portfolios accordingly. It further seeks to reduce regulatory barriers the property owners face in retrofitting their property. Besides, the City promotes the performance and leadership of the participants in the program in various media outlets, including a website that is dedicated to the program.

CONCLUSION

In sum, there is no shortage of innovations in urban climate governance. The four trends and illustrations discussed here only scratch the surface of the wide variety of urban climate governance interventions cities are now involved in. However, does all this innovation ad up to a set of responses that is sufficient to curb climate change, or at the very least prepare cities for the consequences of a changing climate? Unfortunately, the answer seems to be: they provide a good starting point, but a rapid increase in the speed and scale of urban climate action is required.

Where scholars have for long been hopeful of cities as saviours of the planet in the face of climate change pointing at governance innovations of the kind presented here, that narrative has changed rapidly since the 2015 Paris Agreement was signed. More and more, scholars point out that cities cannot curb climate change and adequately respond to its consequences just by themselves. They argue for a rapid upscaling of successful innovations to regional and national scales, for linkages between different governance levels to allow for a flow of knowledge and finance, for a move beyond technical solutions towards those that change behaviour, and for more stringent (precautionary) mandatory requirements at national level (FUHR, HICKMANN, & KERN, 2018; SMEDS & ACUTO, 2018; VAN DER HEIJDEN, 2017).

To put it simply, we have a wealth of information available of how, where and with what outcomes cities around the globe have been trialling innovative climate governance interventions. Rather than trialling even more innovative approaches, it now seems time for cities to look at each other, learn from each other, and replicate each other's most promising solutions.

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CHAPTER 4

MICAELA TRIMBLE [1]
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Water governance for adaptation and resilience in the Anthropocene

Water is essential for life; it is the bloodstream of the biosphere (a 20-km layer where all living organisms are embedded). It connects people and places, playing a key role for human livelihoods and for ecosystem functions and services in terrestrial and aquatic ecosystem (ROCKSTRÖM, et al. 2014). Aquatic systems and watersheds are social-ecological systems, which means that they involve complex interactions between social and ecological components (the former involving economic and political elements as well). These interactions are influenced by drivers and internal factors at multiple levels, which make them unpredictable (BERKES et. al. 2003).

The provision of water ecosystem services is influenced by climatic changes through the effects of rainfall and temperature on river flows, on water storage and water quality, among others. Changes in land-use patterns (for instance due to increased agricultural areas) and infrastructures for water storage and distribution, are some of the human actions influencing water systems. The twenty-first century is facing a global water crisis. In numerous places worldwide, there are crises involving water scarcity, disasters related to water, problems regarding drinking water and sanitation, degradation of ecosystems, among many others.

These crises are part of the Anthropocene, the era where humans are the predominant force influencing ecosystems and global environmental changes on planet Earth (STEFFEN, et al. 2018). Global trends in population growth, energy consumption, arable land, deforestation, carbon dioxide concentrations, and other stressors, correspond with trends in water quantity and quality, that is, increased water use and decreased water quality.

In a context of rapid global environmental change and multiple water crises, at-

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tention to governance is critical since it can lead to the implementation of strategies for solving the problems. Governance systems involve the setting of rules for decision-making and the patterns of interaction between the different actors or stakeholders (such as government agencies, non-government organizations, farmers, citizens, etc.). In this chapter we address the need for a transformation in water governance regimes. In particular, we focus on adaptive governance as a suitable approach for the dynamic and changing times we live in, in which resilience needs to be a desired target.

TRANSITION TIMES: TOWARDS ADAPTIVE WATER GOVERNANCE

Water has been historically managed following a technocratic approach based on the prediction and control paradigm, trying to control single variables (such as river flow). However, this approach (still existent and prevalent to some extent) has led to numerous negative implications, giving rise to alternative paradigms, such as integrated water resource management (IWRM). Some of the pillars of IWRM are the integration across sectors, different uses and users; the incorporation of economic, social and environmental dimensions of sustainability; and the participation of multiple actors. Even though many countries worldwide have made changes in their legislation to include IWRM principles, their implementation remains slow and thus IWRM has not led to profound changes yet (PAHL-WOSTL, 2015).

Another approach that has been increasingly advocated is adaptive governance. Through the interaction of actors, networks and multiple organizations, it is particularly suitable for dealing with the uncertainty and complexity of social-ecological systems. Adaptive governance is characterized by at least four dimensions (FOLKE et al. 2005): (1) building knowledge - combining different knowledge systems (local, traditional, scientific); (2) adaptive management practices – via iterative cycles of learning by doing; (3) flexible institutions (rules in use) and multilevel governance systems (for instance, comprising municipal, state and federal actors); and (4) dealing with external perturbations, uncertainty and surprise. Some strategies proposed for meeting the requirements of adaptive governance are: analytic deliberation, involving interested parties in informed discussion of rules; nesting, allocating authority at multiple levels from local to global; and institutional variety, employing mixtures of institutional types (DIETZ et al. 2003).

Adaptive governance should comprise polycentric institutional arrangements (with multiple centers of decision making, each operating with some degree of autonomy), since the interaction across organizational levels can foster learning and increase the diversity of response options, and thus, the system could be better prepared to deal with uncertainty and change. There is empirical evidence that polycentric governance regimes, with distribution of power but effective coordination structures, have a higher performance in achieving water-related goals, and they are also associated with a higher ability to respond to challenges from climate change (PAHL-WOST, 2012).

In Brazil and other South American countries, there are signs showing that water governance has been gradually moving from the traditional mode towards a decentralized, participatory and potentially adaptive approach. National Water Policies (passed ten

to twenty years ago - depending on the country) represent an enhancing legislation for this transition. Multi-stakeholder forums (such as water basin commissions or committees) composed of government and non-government actors have been implemented, and they show some elements of adaptive governance, although with numerous limitations to overcome.

SEIZING WINDOWS OF OPPORTUNITY FOR GOVERNANCE TRANSFORMATIONS

Factors that trigger shifts in management and governance approaches are usually related to management problems, including real or imagined resource crises, conflicts between uses or users, or conflicts between users and management agencies. Significant changes are most likely to occur when (i) recognized problems, (ii) available solutions, and (iii) politics, come together at critical times, providing a window of opportunity. Often, unexpected internal or external changes creating a window of opportunity are a pre-requisite for social-ecological transformations. These windows of opportunity for improved governance lay in between the preparation phase and the transition phase of a social-ecological transformation (OLSSON et al., 2006, FOLKE et al., 2010).

Perceived or real crises (e.g. caused by external markets, natural resource condition, government policies) often trigger transformations, since they promote learning, knowledge generation and self-organization, thus opening up space for new management trajectories. Solutions are the second element of windows of opportunity; disagreement among stakeholder groups on the actions that should be taken may occur even when there is some agreement on the driving forces behind the crisis. Transformative changes occurring as a result of ecological crises, shifts in the social components of the system, or political-economic change, define and create novel system configurations by introducing new components and ways of governing social-ecological systems. In some cases around the world, it has been possible to transform governance in response to crisis (such as in the Northern Highlands Lake District - USA). However, many social-ecological systems transform too late, when significant degradation and loss of utility from the system have already occurred, or they fail to seize windows of opportunity when they arise (the opportunity for change is often limited to a very short period of time)(OLSSON et al., 2006).

GOVERNANCE FOR RESILIENT SOCIAL-ECOLOGICAL SYSTEMS

The term "water resilience" was coined recently to refer, not to the resilience of water, but to the role that water plays in the resilience of ecosystems and societies, in an era of rapid global change1. Resilience has numerous definitions, but it refers to a system's ability to living with change and the unknown, as well as responding to it. Thus, anticipation, innovation and learning are also facets of resilience. Its three main dimensions are: persistence, adaptability and transformability (FOLKE et al., 2010). Resilience as persistence is about having the capacity to continually change and adapt, while continuing on the same pathway (this could be a trap if a system is in an undesirable state; in other words, resilience can be a

bad thing, and in such a context, it needs to be reduced). Resilience as adaptability is about the capacity to continue to develop on the path the system is undertaking but innovating and changing, in order to live with change. Lastly, resilience as transformability is about shifting pathways (or having the capacity to do it) and cross thresholds for sustainable development, something crucial in the Anthropocene.

Seven important principles for resilience thinking, which also apply for water resilience, are: 1) maintain diversity and redundancy, 2) manage connectivity, 3) manage slow variables and feedbacks, 4) foster complex adaptive systems thinking, 5) encourage learning, 6) broaden participation, and 7) promote polycentric governance systems. Recent research analyzing the relationships between governance and resilience has shown that some of the governance attributes which confer resilience to social-ecological systems, are polycentricity, diverse and inclusive participation, transparency, leadership, adaptability and flexibility (PLUMMER et al. 2014). Adaptive water governance includes these dimensions, and thus, it can contribute to building resilient watersheds.

FINAL REMARKS

Transformations in governance systems imply important cultural changes, among others. Education plays a key role in this process; in particular, tertiary education in Latin America needs to leave behind the fragmented and reductionist paradigms, which limit the exchange between disciplinary domains and the interaction between knowledge systems. Also, uncertainty must be understood as an intrinsic property of any complex and adaptive system, and therefore, it has to be incorporated as such into decision-making processes.

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CHAPTER 5

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GUARANY IPÊ DO SOL OSÓRIO [1]

Economics, strategies and public policies for climate change adaptation

Regardless of the ambition of future greenhouse gas (GHG) mitigation efforts, some amount of climate change (CC) adaptation is inevitable due to the consequences of past emissions. Adaptive capacity is a natural characteristic of humans; nevertheless, uncertainty concerning CC impacts requires adjustments in the ways individuals, companies, and governments anticipate future events and make their decisions. Here we introduce relevant concepts and tools in order to understand, suggest, and prioritize alternatives to deal with such a complex issue as CC adaptation. Thereby, we expect that the reader can access other documents and works about this subject with propriety.

BASIC CONCEPTS AND RATIONALE FOR PUBLIC ACTION CONCERNING ADAPTATION

As a starting point, discussions over adaptation can benefit from the classification of economic goods (those that offer utility for individuals, but are scarce) according to their degrees of rivalry (when the consumption by one individual reduces the consumption of others) and excludability (when one individual who has not payed to use the good cannot be prevented from doing it), as shown in Table 1.

This way, it is possible to see that some adaptation measures, such as disaster warning systems and the provision of information on climate conditions, have clear characteristics of public goods. Others, such as the acquisition of air-conditioning equipment, should be characterized as private goods. This classification suggests how to best provide and manage adaptation goods: goods and services with high degrees of rivalry and excludability, usually, require less attention from public officials.

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TABLE 1: Classification of economic goods.

		(Degree of) Rivalry	
		Low	High
(Degree of) Excludability	High	**Club/toll goods** Ex.: theaters, clubs.	**Private goods** Ex.: food, cars.
	Low	**Public goods** Ex.: national defense, weather forecasting.	**Common goods** Ex.: fish stocks, climate regulation.

Source: Adapted from Ostrom (2010).

Nonetheless, other categorizations are also important, for instance, with regards to the degree of interdependence between providers and users of a good or service:

- **One-way (unidirectional) interdependence:** when providers and beneficiaries belong to different groups of actors. Example: prevention of an increase on Earth's average temperature between different generations.
- **Two-way (bidirectional) interdependence:** when providers and beneficiaries belong to the same group. Example: management of shared water infrastructure (BISARO & HINKEL 2016).

Here, there are more reasons for public action in the first case, while self-governance alternatives may be more prevalent in the second. More specifically, in relation to public or common goods for adaptation (jointly referred as "collective goods"), Nordhaus (2006) offers a distinction between those with an additive character from those with a joint character:

- **Additive adaptation:** when any individual contribution increases the volume of adaptation goods. Example: installation of green roofs by any household reduces flood risks in its area;
- **Joint adaptation:** when there is a minimum amount of actors that must contribute simultaneously to the provision of an adaptation good so that it can be supplied. Example: all farmers in a region must reserve stretches of their properties to maintain their environmental functions, such as protection of soil and water bodies, biodiversity conservation and attenuation of local climate imbalances.

Public action may play essential and support roles in both instances, either to incentivize adaptation by private entities (managing conflicts, minimizing inequalities, ensuring contracts, producing and sharing information, guaranteeing coherence between different policies and their instruments) or to directly provide adaptation measures through public investment (HALLEGATE, LECOCQ & PERTHIUS 2011).

STRATEGIES TO PRIORITIZE ADAPTATION MEASURES

From the classifications above and the understanding that resources to promote CC adaptation are scarce, it is now possible to discuss some strategies to prioritize adaptation measures. First, it is no longer adequate to take only historic patterns and past climate data into consideration; it is necessary to make predictions about the future climate and economy.

In this sense, tools traditionally employed to support decision-making processes in the private and public sectors, such as cost-benefit (CBA), cost-effectiveness (CEA) and multicriteria analysis (MCA), compare different courses of action according to their costs (implementation, operation and maintenance) and benefits both in monetary units (for instance, the reduction of economic losses as consequence of an extreme weather event) and in non-monetary terms (for instance, the quantity of lives saved).

Under conditions of low uncertainty, these tools may suffice to back a decision, given that costs and benefits tend to be clear. Nonetheless, decision-making under high uncertainty, characteristic of CC, requires the use of tools capable of identifying those adaptation measures that are successful under a wide range of possible climate scenarios[2]. These measures are commonly divided into two groups:

- **No-regret:** those measures that are cost-beneficial even if no (additional) CC occurs;
- **Low-regret:** those measures that require small additional efforts to deal with the impacts of CC.

Ranking adaptation goods according to their costs and benefits may be sufficient for private and club goods, in which the provider is the (sole) beneficiary of the good. For collective goods, however, it is possible to identify six social dilemmas that present different incentives for individuals to engage (or not) in adaptation efforts. Table 2 offers possible solutions for these dilemmas.

In summary, instances of additive adaptation suffer from the so-called "free-rider" problem (when someone benefits from a good or service without having to pay for it), in which the adoption of economic instruments tends to internalize the costs and benefits of a decision by the individual who makes it. Joint and two-way adaptation measures may be solved by aligning the expectations among all agents. Naturally, surrounding contexts and existing institutional arrangements affect the appropriateness of each possible solution for a given dilemma.

ADAPTATION: PRIVATE DECISIONS AND PUBLIC POLICIES[3]

Economic models are commonly based on two premises: individuals maximize

[2] See FGVces & ANA for a practical application of a CBA for multiple climate scenarios in the Piancó-Piranhas-Açu water basin (in the northeast of Brazil).

TABLE 2: Social dilemmas and possible solutions for collective adaptation goods.

Adaptation	One-way	Two-way (supply)	Two-way (demand)
Additive	Contributions by any agent generate additional benefits for a third-party. **Solution**: Economic instruments (subsidies); state provision.	Contributions by any agent generate incremental benefits to all. **Solution**: Economic instruments (subsidies); construction codes.	Use reductions by any agent generate benefits to all. **Solution**: Market-based instruments (tradeable permits).
Joint	Contributions by all agents in a group generate benefits for a third-party (other groups). **Solution**: Command and control; economic instruments targeted at co-benefits.	All must contribute to generate benefits to any agents. **Solution**: Communication instruments; public consultations.	Use reductions by all generate benefits to any agents. **Solution**: Information sharing.
Type of good	Collective	Collective	Common

Source: adapted from Bisaro & Hinkel (2016).

their well-being (as they conceive of it) and have rational expectations (take predictions about the future into consideration). That is, if individuals anticipate that climate will be different in the future, which actions can they take to protect themselves? The institutions (public policies) surrounding them may enlarge or restrict their portfolio of possible adaptation measures.

At an aggregate level, the manner through which the economy adjusts itself to shocks, via changing relative prices, already symbolizes a kind of adaptation. Still, there remain gaps that may be filled by public actors seeking to diminish inequalities within a territory; ensure coherence between different policies; integrate CC into energetic, hydric, transportation plans; etc. In any case, the dissemination of data on expected climate risks emerges as a necessary condition to enable adaptation efforts; this provision of information has the characteristics of a public good.

If, for instance, CC leads to warmer summers, in urban areas there will be a higher demand for air-conditioning equipment; in rural areas, farmers may alter their mix of inputs and production methods. In both cases, technological innovations can increase the efficiency and decrease the costs of these responses. Therefore, a robust institutional environment, conducive to innovation, with developed capital markets, and effective patent laws, is key.

With regards to extreme weather events, such as flash floods, on the one hand,

[3] This section relies on the approaches and examples provided by Kahn (2016) and Fankhauser (2016).

through higher premiums, insurance providers may discourage the allocation of people and assets on high-risk areas. On the other hand, the public sector may contribute with actions that gradually reposition individuals and assets to less exposed areas, for example, by applying different tax schedules on properties and adopting policies to reduce housing deficits and increase land regularization.

Lastly, poorer individuals tend to suffer more with CC impacts. In this sense, economic and social development seems to be one of the best ways for individuals to adapt. Development reduces social vulnerabilities (creates wealth, increases incomes, improves health and education indicators etc.). When achieved in conjunction with thorough climate assessments, it also increases adaptive capacities and reduces risk exposure (so-called climate resilient development). Thus, it is important to ensure that CC and development agendas are synergistic and not adversaries (DO SOL OSÓRIO & SANTOS 2016).

FINAL REMARKS

The concepts introduced above are also applicable to the Brazilian case. It is our hope that the reader, when confronted with a problem related to CC adaptation, attempts to check her ideas with the classifications and tools presented here, identifying the most appropriate ways to provide an adaptation good. This way, adaptation strategies in Brazil may rely on sounder foundations and be better executed.

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CHAPTER 6

DANIELLE TEGA [1]
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Gender and adaptation to climate change impacts

Adaptive capacity to climate change impacts is highly heterogeneous within a society or locality. Inequalities constructed by relations of class, race/ethnicity, gender, age, among others, imply different levels of vulnerability and, consequently, adaptive capacity. The objective of this chapter is to present some considerations on gender and adaptation to climate change impacts, emphasizing: a) how the gender perspective has been incorporated into the international debate on climate change; b) how women are affected by these impacts and how they contribute to addressing the problem. The final considerations point to existing challenges for thinking and building climate policies that takes into account gender specificities.

GENDER AND CLIMATE CHANGE IN THE INTERNATIONAL AGENDA

According to the Inter-American Commission of Women (CIM - Comisión Interamericana de Mujeres) document on gender and climate change, feminist research and campaigns have challenged the invisibility of gender issues in the debate on the international agenda, promoting the importance of this perspective in policies and in climate change adaptation and mitigation plans (CIM, 2008:1).

The 1984 United Nations Environment Program (UNEP) marked the first process in which the link between gender and environmental issues was recognized. At that time, a group of UNEP advisors was created to consider the connection between women's exclusion issues and their real and potential contributions to environmental conservation in a development context.

[1] PAGU/UNICAMP.
[2] UniSantos/NEPAM/UNICAMP.

In the following year, the World Conference for the Review and Evaluation of the Achievements of the United Nations Decade for Women: Equality, Development and Peace, held in Nairobi (Kenya), opened another important space for debating the issue (IBID., p. 2).

Not only international organizations, but also international women's movements have played a key role in developing a platform for advocacy regarding the environment and sustainable development. Activists, activists from social movements or members of diverse non-governmental organizations: women from different parts of the world held the I World Congress of Women for a Healthy Planet in 1991, in the city of Miami (USA), which elaborates Agenda 21 of Women's Action. In dialogue with these initiatives, the United Nations Conference on Environment and Development, held in Rio de Janeiro (Brazil) in 1992, adopted a gender perspective in its policies and action programs. This conference represented a milestone in recognizing and strengthening the role of women in promoting development and environmental sustainability (PNUD, 2008, p. 38).

In this scenario, other international forums and agendas began to incorporate and deepen the relationship between gender and the environment, gender and sustainable development, gender and climate change. The Inter-American Commission of Women, for example, recognizes in its work program for the biennium 2006-2008 the interest of the Caribbean, Central American and Mexican States on the impact of natural disasters on women. The Committee therefore calls for the inclusion of a gender perspective in all work on this subject in the political sphere of the Organization of American States (OAS)(CIM, 2008, p.2).

More recently, at the last Conference of the Parties (COP) of the UN Framework Convention on Climate Change (UNFCCC), COP 23, held in Bonn, Germany, in 2017, a Gender Action Plan was established to implementation of gender-related decisions in the UNFCCC process. This decision seeks to promote the full, equal and meaningful participation of women and to promote gender-sensitive climate policies and gender mainstreaming in the implementation of the Convention and in the work of the Parties (UNFCCC, 2018a).

WHY ARE WOMEN AFFECTED IN A SPECIFIC WAY BY CLIMATE CHANGE?

The inclusion of a gender perspective in the international agenda of environmental debates is of dual importance. On the one hand, it points to the recognition of its own characteristics in the way women are affected by climate change. On the other hand, it allows, knowing these specificities, ways of adapting and mitigating the problem to reduce gender inequalities.

The historically built inequalities in the relations between men and women are strongly present when we think about the issue of climate change and adaptation - and, in some cases, with aggravation. Recent research by the UN Women on the 17 Sustainable Development Goals (SDGs) and its relationship with gender equality and women's rights points out, for example, that there are 122 women aged 25 to 34 living in poverty extreme for every 100 men of the same age group in the same situation (UN-WOMEN, 2018). The Report on Poverty and Human Rights in the Americas, approved by the Inter-American Com-

mission on Human Rights (IACHR) in 2017 emphasizes that Afro-descendant and indigenous women are in a special situation of vulnerability by historically experiencing triple discrimination based on gender, poverty and race/ethnicity (CIDH, 2017).

Such inequality is reflected in the climate change approach: in the developing world, in particular, women are disproportionately involved in activities dependent on natural resources, such as agriculture, as compared to salaried occupations. In this sense, they participate more strongly in activities directly affected by climate change, such as rural and forest women, for example, in their work in agriculture and forestry. The changes projected for future climates should affect women through a variety of mechanisms: directly through reduced availability of water, vegetation and firewood, as well as health issues related to vulnerable populations.

It should be emphasized, however, that the vulnerability of women in agricultural economies is fundamentally affected by the lack of access to rights, economic resources, sources of wealth and the means of production – they are often unrelated to information and capacity building, financing opportunities, and control of agricultural land. This insecurity has implications both for their vulnerability to a changing climate and for their ability to adapt to the productive livelihoods of a changing climate.

Similarly, studies point out that women are more vulnerable than men to climate--related disasters. In dealing with the South Asian scenario, for example, Fordham (2003) points out the main factors contributing to the differential vulnerability of women in the context of natural hazards: high levels of illiteracy, minimal mobility and opportunities for work outside the home, and, again, issues related to the ownership of resources such as land. Climate change, therefore, has specific gender implications in terms of vulnerability and adaptive capacity.

In addition, historical social relations have severely limited the exercise of women's civil, political, economic, and cultural rights. The sexual division of labor has placed women in a disproportionate burden on domestic tasks and family care, drastically restricting the use of their time for other activities and goals, such as more active participation in environmental decision-making in all levels.

Despite these socially constrained limitations, women call on forms of resistance and adaptation that pass through collective and community actions - but that nevertheless require an institutional force to be effective. They play a critical role in responding to climate change because of their local knowledge and leadership role in both sustainable resource management and sustainable practices at the household and community levels. The presence of women in leadership spaces has led to better results of climate projects and policies. Still experiencing difficulties, their participation in the political field results in a greater capacity to respond to the needs of their groups in a specific way, and society in a general sense: policies or projects implemented without the significant participation of women can increase existing inequalities and minimize the effectiveness of the intended actions (UNFCCC, 2018b).

Gender-sensitive adaptation programs are thus more effective in protecting lives and livelihoods. After all, policies that deal with this problem, with a focus on coping with these asymmetries suffered by women, the most vulnerable part of the issue, affect everyone in general - and contribute to the fight against gender inequality.

CONCLUSIONS AND CHALLENGES

Gender inequalities observed in vulnerability and adaptive capacity reflect broader social structures. Climate interventions that ignore these issues reinforce the asymmetrical gender dimensions of vulnerability. Adopting such a perspective is a necessary tool for assessing adaptive capacity and for developing interventions that seek to facilitate adaptation to climate change impacts. Another point to consider is the necessary shift in policy focus: more proactive training rather than just reactive disaster management contributes to reducing inequalities.

Disproportionate participation of women in decision-making processes and labor markets aggravates these inequalities and often interfere in their contributions to climate policy planning, formulation and implementation (UNFCCC, 2018b). The low representation of women in politics, a problem present in most countries, impairs the existence of a plurality of voices in this process. As a result, the recurrent socioeconomic disadvantages of women continue to be ignored and remain a critical challenge to adaptation efforts, since addressing climate change involves political decisions by governments.

To make responses to climate change more effective, it is strategic to combat socioeconomic and cultural differences in relation to women. Access to information, work and education, sharing of knowledge, listening to their experiences as leaders and greater representation of women in institutional politics are urgent points to be addressed. In this sense, public management needs to work with a gender perspective to develop public policies and strategies to cope with climate change. It is also necessary to consider the specificities existing among women themselves: in a structurally racist society, black and indigenous women find themselves in a situation of vulnerability and precariousness, demanding specific views on policies to adapt to climate change impacts.

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[3] This section relies on the approaches and examples provided by Kahn (2016) and Fankhauser (2016).

CHAPTER 7

CHRISTOVAM BARCELLOS [1]

Adaptation, vulnerabilities and health in the metropolises

The history of humanity can also be summarized as a permanent struggle against variability. Shelters were created against the elements; agriculture was invented against food insecurity; walls were built against invaders; vaccines and sanitation were established against epidemics. More recently, air conditioners, which depend on an electric power generation and distribution system, as well as water supply networks have been incorporated as goods and services that seek to ensure comfort and safety for city dwellers. These items are increasingly present in residences and are strategies of adaptation to variability and climatic changes.

These technical systems are characterized by their complexity and in some situations also by their vulnerability. For example, water supply systems components are the catchment of water from (surface or underground) water sources, the treatment and distribution of water employing networks, and the domestic facilities for reserving and internal piping. Any disruption in one of these components compromises the integrity of these systems, sometimes leading to their collapse. These systems depend on an interconnected series of technical, interdependent and hierarchical objects that complement each other and interact.

Thus, the concept of basic sanitation should be taken as a technique, or a set of techniques, perhaps the oldest of humankind, that modifies the relationship between society and nature. According to Milton Santos (1999), the unequal production of geographical space is the result of the technique, which is in continual development and incorporation by society as a "hegemonic rationality". The development of water treatment technologies, such as chlorination and filtration, allowed the use of previously improper rivers to supply large urban centers. On the other hand, the discovery of the role of microbiological agents in disease transmission, such as the results of John Snow's investigation of the 1854 cho-

[1] Fundação Oswaldo Cruz.

lera outbreak in London, legitimized the use of these techniques. According to Hochman (1998), the threat of the disease microbe generated "a sense of national community, associated with demands for increased responsibilities of the Public Power." This new concept of health required the incorporation of new sanitation actions in the cities, beyond individual solutions, as well as the consequent accountability and strengthening of the State. The need to provide adequate quantity and quality of water and, at the same time, to collect and treat human waste is a consequence of the urbanization process and leads to the strengthening and legitimization of the State. Thus, urbanization has the dual role of allowing greater access to various public services, but on the other hand, of promoting increased interactions between infectious agents and populations, increasing the health risk of population groups without access to these services or where these services are poor and vulnerable (WILLIAMS, 1990).

Some examples of the application of this hierarchical model for the analysis of complex systems allow the evaluation of possible health risks due to the failure of these systems. An emergency, such as those caused by natural disasters, can compromise the water supply of various communities. In this case, a solution to ensure the health of the population is the supply of water in industrialized bottles or from tank trucks, which symbolize the by-pass of the intermediate levels of this structure. Likewise, the inadequate operation of water supply systems affects all subordinate components such as communities and households. Contamination or reduction of water supply in springs can affect whole cities. Severe outbreaks of waterborne diseases have been reported among populations supplied by water supply systems with flaws in water treatment devices (LIGON & BARTRAM, 2016).

However, this vulnerability can also be due to problems that occur at the most basic levels of this structure. The lack of resources to ensure isolation of water and sewage circuits and the safe storage of drinking water in households compromise water quality and population health (FEWTRELL et al., 2005). In Brazil, it is still common to find households without a bathroom, but connected to the general water supply network, and vice versa, households with bathrooms, but without internal and external water piping, which exposes insecure supply systems. Also, these more basic levels of this structure can generate system disturbance pressures, for example, the abrupt increase of energy and water consumption during heatwaves (TORRENTE, 2014), which may cause the interruption of these services due to demand overload. This structure is the result of the interaction between its components and is increasingly broad and vulnerable. The trend towards the universalization of water supply services has occurred in the last decades with the increased service coverage and was not accompanied by equal measures to increase the capacity to catch, treat and store water (ANDREAZZI et al., 2007). Some other items of comfort and internal organization of cities, such as the paving of streets, intensive use of air conditioners and an increased vehicle fleet have become factors for the production of risks and aggravation of vulnerabilities to climate change (JACOBI, 2013).

UNIVERSALIZATION AND PRECARIOUS TECHNICAL SYSTEMS

In Brazil, most of the urban population is having access to water through the expansion of supply networks, without, however, there being a promotion of collection and adequate treatment of sewage and garbage. The combination of these factors brings a new challenge to public health, which should broaden its focus on sanitation beyond service coverage, and include monitoring and effective actions on water quality and security of supply systems, such as the preservation of water sources, which today are compromised by irregular occupations and the introduction of sewage (JACOBI, 2013).

The process of urbanization and population densification is increasingly producing risks that are typical of large urban centers, with vulnerable sources and water distribution networks (EZZATI et al., 2005). In the same way that urban areas not covered by sanitation systems are especially susceptible to waterborne diseases, there are, on the other hand, several reports of outbreaks of waterborne diseases transmitted by the water distribution system (LIGON & BARTRAM, 2016). The precarious expansion of these systems, in this case, can also act as a means of increasing risks and the coverage of water supply services, taken in isolation, no longer represents a health protection measure. It is worth remembering that a large proportion of the population served by water supply systems are susceptible to several infectious diseases, that is, they have never been exposed to some infectious agents such as hepatitis A virus or rotavirus, which can cause outbreaks of great magnitude among these socio-spatial groups, previously protected against these diseases.

On the other hand, we should not forget that service coverage has not yet reached its universalization, leaving excluded portions of the population more impoverished. The history of São Paulo is marked by the selective investment in the infrastructure of affluent areas and the occupation of suburbs and lands with a higher risk of landslides and floodplains by the most impoverished populations (JACOBI, 2013). The city has about 20,000 people living in the streets, dwellers of deprived housing estates, as well as favelas (about 11% of the general population of the municipality), slums and suburbs recently occupied (GAMBA & RIBEIRO, 2012).

These socio-spatial groups often seek alternatives to meet their needs outside formal supply systems and services, and their health risks are significantly increased in a metropolis. If the use of artesian wells can be considered a reasonable and safe solution in rural areas, in a city with very high population density and saturated water resources, this resource shows severe risks of disease transmission. These groups are permanently exposed to several infectious agents such as leptospirosis, hepatitis A and diarrheal diseases (SOARES et al., 2010).

These groups are often subject to overlapping risks because they live in areas at risk for floods and landslides while having unfavorable socioeconomic conditions and a small capacity for investment and adaptation to climate change (ALVES & TORRES, 2006). The coverage of sanitation systems remains unequal in the city of São Paulo, especially in housing quality items, with a lack of sewage network and garbage collection. The presence of vectors of diseases, such as rats and insects, is frequent in these households (ALVES & TORRES, 2006).

REGULARITIES AND EXCEPTIONALITIES

Most reports on climate vulnerability situations in cities are based on indicators such as coverage of sanitation systems, socioeconomic and demographic markers (VALVERDE, 2017). In Brazil, it is at least contradictory to observe an increased coverage of water supply services, which reaches 97% of the urban population (according to data from the PNAD of 2016), and at the same time, widespread Diseases Related to Inadequate Environmental Sanitation (DRSAI). One possible explanation for this apparent contradiction is the very complexity of sanitation problems, due to the diverse situations in which health-sanitation relationship is observed. Models that take into account only the coverage of these services do not respond to the new needs in the sanitation sector. Other indicators should be considered to analyze the situation of sanitation and housing within the framework of complexity found now in cities in extraordinary situations.

One of the significant challenges in this regard has been the interruption of these services in cases of insufficient sources and resources for their supply, and the occurrence of extreme climatic events. In these situations, alternative and improvised measures of supply of basic needs of the population, such as water, energy and food stand out. What do you do during a heatwave if the power distribution grid is interrupted? How do you obtain food in situations where trade is suspended due to a flood? Where do you get water when the distribution service is interrupted? In these exceptional situations, the health risks of the population tend to increase and areas that could previously be considered safe and can become extremely vulnerable.

The indicators used now to measure the level of vulnerability of population groups and territories have been constructed from normal conditions, collected through censuses and surveys (ALVES & TORRES, 2006; VALVERDE, 2017). However, the pre-existing vulnerability situation can be profoundly changed with the occurrence of natural disasters or extreme climatic events. However, how, and at what point, do residents in areas affected by hazards opt for alternatives that can reduce harm?

These alternatives are based on their perception of risks, planning capacity and decision-making (MARANDOLA & HOGAN, 2005). Thus, events such as water rationing in the metropolitan region of São Paulo in 2014 and 2015 trigger disturbing processes of the standard conditions of urban services and promote a sudden change in the conditions of communities and households. The adoption of alternatives such as the opening of wells and the supply of water through tank trucks was an option of the population with higher purchasing power. Other people have improvised water storage containers inside their homes, facilitating their contamination by pathogens and the proliferation of mosquitoes.

This exceptional situation caused an outbreak of diarrhea, with an increase of thousands of cases in the state in 2014, probably due to the consumption of contaminated water. In 2015, the number of dengue cases tripled in the city, and visits by health workers have pointed to a significant increase in the use of improvised containers for water storage[2].

[2] https://saude.estadao.com.br/noticias/geral,com-impacto-da-crise-hidrica-casos-de-dengue-triplicam-em-sp,1649623

Also, one should think about the combination of events that are triggered by disasters. The tsunami and nuclear accident in Fukushima (Japan) in 2011 is an example of the same event of geological origin that damaged a nuclear power plant and produced consequences in various sectors of the economy and society in what was known as "combined disaster" (HACHIYA et al., 2014). The profusion of adverse effects triggered by a single extreme climate event is also evident in the case of floods in Santa Catarina in 2008, which caused the death of more than 100 people and the homelessness of thousands. These floods increased the risks of spreading transmissible diseases, while at the same time hampering the population's assistance due to the collapse of health services, both due to the overload of demand and the damages caused to their facilities (XAVIER et al., 2014).

These examples reinforce the need to include fluctuations in sanitation systems and their possible collapse caused by disruptions of extrinsic (generated by natural disasters) or intrinsic (triggered by increased demand, not matched by the capacity of systems) origin as vulnerability indicators. Thus, vulnerability is a characteristic of populations and territories, and the social event precedes environmental event (MARANDOLA & HOGAN, 2005).

Thus, a system of indicators that considers current conditions and future projections, as well as the vulnerabilities of the systems, becomes a valuable tool that allows the acquisition of new knowledge, and the communication of risks, for researchers, and not only these, but also managers, as a way to disclose the results of their policies, or if need be, to adapt them so that it has the desired effects.

FINAL COMMENTS

Large Brazilian cities have reached seemingly satisfactory levels of coverage of basic sanitation systems (understood as actions of water supply, sanitary sewage, garbage collection and urban drainage). However, this progress has been more due to the individual effort of housing investment than to the public investment in the expansion of these systems. The limited water supply to households, which can no longer meet increasing demands; the contaminated and compromised water sources; and the poor sewage and waste treatment programs, which are state responsibilities, jeopardize the safety of sanitation systems. Situations of vulnerability of these systems tend to be aggravated by ongoing climate and environmental changes.

Extreme climatic events such as droughts, floods, landslides and storms tend to cause disruption or even interruption of these services. Population groups accustomed to being supplied by complex systems may suddenly be deprived of these services, forcing a temporary change in their living standards. The impacts of these events on health can be severe and extend over large areas.

Thus, an extreme climatic event cannot only be characterized by its low probability of occurrence, but also by producing unexpected events and triggering social and environmental processes to which populations and territories are not adapted.

Therefore, two main concerns stand out for the Metropolitan Region of São Paulo and other metropolises of peripheral countries. On the one hand, sanitation policies must

reach out to the excluded, who are dispersed, with little investment capacity, and who accumulate problems with income, education, and access to health services. On the other hand, it is necessary to ensure the quality and safety of sanitation systems, among other services, for those already included in these systems, which due to their complexity and vulnerability can show flaws, especially during extreme climatic events. This diagnosis and scenario projection situation can only be fully achieved with the participation of the population directly affected by real or potential risk conditions within a democratic environment that allows for intersectoral and interdisciplinary dialogue.

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CHAPTER 8

FABIANA BARBI [1]

Adaptation and local governments in the Macro Metropolis Paulista

Local governments have become key political agents in climate policy over the past twenty years. Their actions have been enhanced by transnational municipal networks (TMNs) that have acted as a driver of climate action at the local level engaging local governments in the development of effective policies and actions as responses to climate change in urban areas. Therefore, local governments together with TMNs are at the frontline of climate governance (BULKELEY & BETSILL, 2013).

The activities developed by cities within the networks have positioned cities as critical sites for climate governance and have advanced claims for the strategic importance of urban climate governance (BULKELEY et al., 2014).

The time has come when responding to climate change risks is no longer optional. The reason is that extreme weather and climate events are anticipated to generate significant risks to societies and ecosystems (IPCC, 2012).

Cities are particularly threatened by climate change due to factors including their heavy reliance on interconnected networked infrastructure, high population densities, large numbers of poor and elderly people and major concentrations of material and cultural assets. Moreover, social, economic and political processes, such as poor governance structures or inadequate urban design, can exacerbate climate change risks in urban areas (CARTER et al., 2015).

Besides, since the impacts of climate change are experienced locally, cities and their local governments are crucial stakeholders in responding to this challenge in terms of adaptation strategies. Throughout the world, TNMs have played a critical catalytic role in mitigating climate change and have the potential to also support local adaptation. This scenario includes the Brazilian cities.

[1] UniSantos/NEPAM/UNICAMP.

ADAPTATION STRATEGIES IN BRAZILIAN CITIES

Brazil has 5,570 municipalities but only eight of them have approved their climate change policies. They are: Belo Horizonte (MG), Curitiba (PR), Fortaleza (CE), Manaus (AM), Recife (PE), Rio de Janeiro (RJ), São Paulo (SP) and Sorocaba (SP). And only Rio de Janeiro and São Paulo have planned adaptation strategies.

Almost all of these cities are members of transnational municipal networks related to climate change, mainly ICLEI – Local Governments for Sustainability, World Mayors Council on Climate Change, C-40 Cities and 100 Resilient Cities (BARBI & FERREIRA, 2017). ICLEI's Cities for Climate Protection Campaign (the CCP) was the first to address climate change in Brazilian cities and the one that has engaged most of them. ICLEI has placed these cities in the climate change debate bringing the issue to their political agenda. The network has also enabled Brazilian local governments to undertake climate governance experiments - so far, focusing on mitigation (BARBI & MACEDO, 2019).

The adaptation and resilience agenda was approached very recently, in 2017, especially with the Global Covenant of Mayors, when ICLEI recruited more than 75 Brazilian cities. The Global Covenant of Mayors is an international alliance of cities to promote voluntary climate action, involving both mitigation and adaptation strategies. This shows that the adaptation agenda is still incipient at city level in Brazil.

All over the world, transnational municipal networks have played a critical catalytic role in climate change mitigation and have potential to also support local adaptation. This scenario is likely for Brazilian cities as well. So far, most of the adaptation strategies in the Brazilian cities with climate policies include the development of an adaptation plan, involving several governmental sectors and vulnerability studies. In these cities, the climate agenda is being addressed and framed within Municipal Committees of Climate Change, responsible for the policy implementation.

These Committees are still very connected to the Departments of Environment within the municipality structure but in theory should involve other governmental sectors and other stakeholders: state government, research institutes, NGOs, private sector and also legislative body. Considering climate change risks, the key sectors for adaptation responses at local level are: urban development (land use management); built environment; urban infrastructure and services; environment; health and disaster management. This shows the diversity of possible and necessary actions at local level and also the variety of government sectors involved in climate change adaptation.

BARRIERS TO CLIMATE ADAPTATION IN BRAZILIAN CITIES

By analyzing the experience of Brazilian cities with climate policies, we have found that the barriers these cities face are more related to the difficulty to involve other stakeholders in the policy implementation. And the policy implementation itself, since the Departments of Environment do not have enough financial and human resources in most cases. There is a prevailing view that adaptation strategies necessarily mean infrastructure works and therefore need high financial resources. Infrastructure investments are

certainly necessary. However, nature-based solutions, such as the conservation and expansion of green areas, do not demand the same amount of investment and also constitute key adaptation strategies.

Another barrier is the lack of interaction with other levels of governance. Many Brazilian states have passed their climate policy (14 states out of 27) and there is also the national policy, which was passed in 2009. However, these measures are completely disconnected. Climate change calls for innovative forms of multi-level governance where local governments are likely to be key players, but state and national level are essential stakeholders as well.

For instance, one of the guidelines of the Sao Paulo State Policy of Climate Change refers to the prevention and adaptation to the impacts of climate change and the development of adequate and integrated plans for the management of coastal and metropolitan areas (SECTION V, ARTICLE 6, SÃO PAULO, 2010). This is the case of the Metropolitan Regions of Baixada Santista, Campinas, Sorocaba and Vale do Paraíba and Litoral Norte, which are all part of the macrometropolis Paulista.

Finally, adaptation is more addressed as disaster management rather than climate change risks management. There is an important difference here. Adaptation plans that do not consider future climate change projections are more related to disaster management. Addressing future climate projections, whenever available, is a key condition to manage climate change risks. For instance, sea level rise is a big issue in a country with 8,000 kms of coast, with most of the country's population living in these vulnerable areas. Therefore, adaptation plans for coastal cities must consider how to deal with sea level rise projections in their strategies.

OPPORTUNITIES TO CLIMATE ADAPTATION IN BRAZILIAN CITIES

We have also found some opportunities regarding climate adaptation in Brazilian cities. At least 75 cities are planning adaptation strategies through the Global Covenant of Mayors. There are other ongoing climate adaptation initiatives involving Brazilian cities. AdaptaClima is a Brazilian platform that provides adaptation content, as part of the National Adaptation Plan, published in 2017. The network Resilient Cities has some Brazilian cities as members, and some cities are also in the United Nations Campaign "Making Cities Resilient". Finally, there are at least three cities elaborating their climate adaptation plans in 2018: Salvador (BA), São Jose dos Campos and Santos, these two are part of the macrometropolis Paulista. These growing number of initiatives show that the adaptation and resilience agenda are gradually being internalized by local governments.

In most cases, Brazilian cities are acting with the support of international initiatives. There are still few Brazilian cities adopting actions with their own resources. This is something cities can explore. Since the climate policies in Brazilian cities are isolated initiatives, and not part of the National Plan, for example, other cities in the country can learn from their experience - what to do, what not to do, how they can be replicated and so on.

Finally, it is necessary more research about the role of non-state actors in climate

governance in Brazilian cities. Although local governments together with transnational municipal networks have showed an interesting direction to respond to the climate change challenge, a specific group of agents cannot solve the climate crisis by itself, since this is a complex, multilevel and multidimensional problem. The involvement of other levels of government, non-governmental groups, civil society organizations, the private sector, universities and research institutions is critical to the production of efficient and successful responses to the problem. In this sense, the future agenda in this area point to multi--agent and multi-level climate governance in Brazil.

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CHAPTER 9

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LEANDRA REGINA GONÇALVES [1]

Science and policy: challenges and opportunities for managing São Paulo Macrometropolis

Recent surveys on the importance of biodiversity and ecosystem services have brought to light three points of broad consensus: (1) we depend on natural ecosystems, the multiple services and benefits derived from them; (2) human actions have been degrading and hampering the capacity of these ecosystems to provide multiple services; (3) new environmental governance systems are needed to ensure the sustainable management of these ecosystems (BPBES, 2018).

Among the points above, this chapter focus on the construction of new governance systems, to which climate change (CC) is one of the most critical challenges. Although CC is global in scope, its drivers and effects are unevenly distributed and manifested at the local level, where the action takes place. The main types of responses to climate change are distinguished in mitigation actions - drivers control, such as greenhouse gas emissions; and adaptation - promoting the resilience of socio-ecological systems to prevent, respond to and recover from possible impacts. While mitigation actions fall on countries and sectors with higher rates of greenhouse gas emissions, such as developing countries; adaptation actions are necessary for the most vulnerable regions and communities that already suffer impacts derived from CC.

The complexity related to CC discussions and their impacts is also present in the discussion of other modern environmental problems. These are surrounded by uncertainties and require equally complex management systems, which are multilevel, cross-sectoral and hybrid, with the participation of government and society actors and organizations (LEMOS; AGRAWAL, 2006). In these systems, quality information is essential to identify

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the most appropriate and effective practices and solutions. For example, one of the best tools for developing CC responses is the development of studies that involve risk analyzes, vulnerabilities, and impacts associated with current scenarios and projections of extreme events (PMCB, 2016). Thus, the role of science as a source of information and greater interaction between science and politics is fundamental.

SCIENCE-POLICY INTERFACE: WHERE DO WE STAND?

The general role of science is to produce a set of knowledge about a particular theme. Politics, however, can be understood, in an abstract sense, as a principle, norm or guideline for action in a specific context (for a series of definitions, see CLARK, 2002, p.6). Science and politics thus represent two universes, with distinct principles and practices. In spite of this, solving environmental problems requires an approximation between science and politics, so that the knowledge produced can be used to understand the causes, effects and mitigation of environmental problems, and to support decision making in search of more sustainable answers.

Traditionally, the interface between science and politics is seen as a linear process of "transfer" of knowledge between the two universes (VOGEL et al., 2007). Such an interpretation leads to a simplification of the relationship between the two, and evidences failures in the process, such as the difficulty of access, language differences or desynchronization between demand/production of knowledge. These are barriers that must be transposed in the science-police interaction, but even in cases where they do not exist, it is possible to observe a mismatch between scientific information and political decision. In addition to this simplification, new studies demonstrate that this is a multi-way process, a network of interactions and exchanges of knowledge between the different actors - scientists, politicians and the population (VOGEL et al., 2007). Therefore, it is a matter of improving the political decision and the research arenas so that they can interact and act in an integrated and collaborative way, which involves practices of institutional and policy design as well as for the construction of knowledge itself.

Despite the consensus on the importance of science for the formulation of public policies, there are divergent perceptions of how, when and under what conditions science influences policies and, consequently, how the interaction between science and politics should be better organized (LIDSKOG; SUNDQVIST, 2015). In this context, the establishment of "epistemic communities" may be a channel by which consensual knowledge about causal understandings is applied to policy coordination and through which governments can learn (HAAS, 1992). The concept of "epistemic communities" is applied by constructivist scholars of political science to analyze the process by which states and other political actors formulate their interests and reconcile differences of interest (HAAS, 1992).

The application of this approach considers that epistemic communities provide better scientific recommendations than other modes of political orientation since specialized opinion is likely to have a more rational basis. Unlike other organized and active interest groups in the formulation of public policies, epistemic communities have internal beliefs that make them more likely to provide information that is politically unchanged and,

therefore, it is more likely that this information will be framed and followed by authorities given their impartiality and potential for social learning (HAAS, 2015).

The epistemic community, in this way, is the basis for the "transmission belt" (HAAS, 1992) that connects science and politics. In this interaction, processes of knowledge exchange are essential for building relationships of trust and collective meanings and solutions to environmental problems. Promoting greater integration of science and policy through knowledge exchange processes implies involving scientists at different points in the decision-making process (see Figure 1) and, also, exploring several roles (see Table 1), in a combined and continuous way.

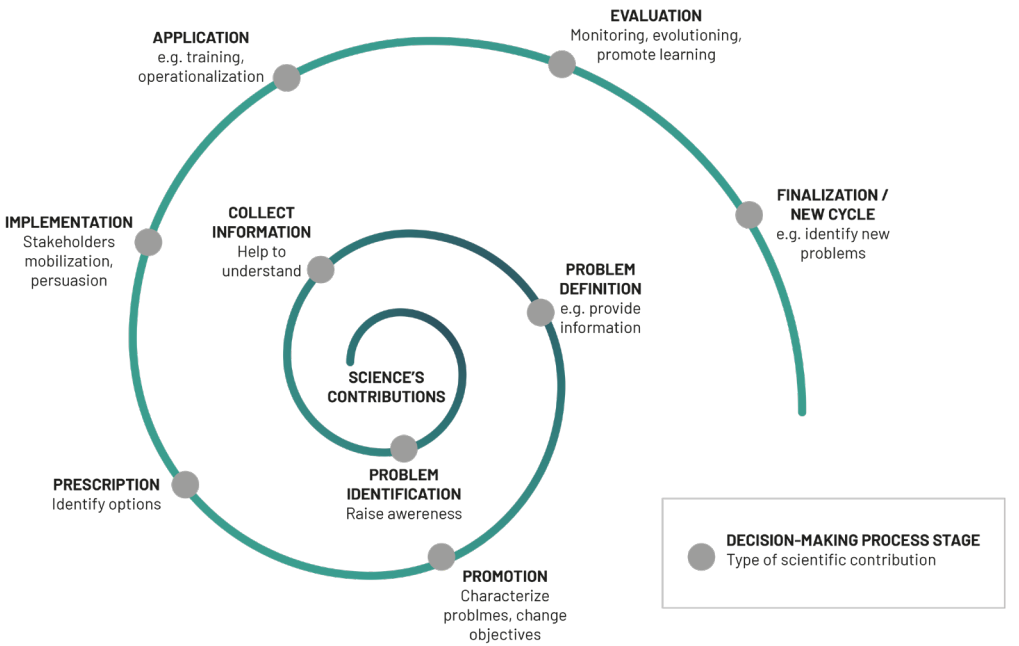

FIGURE 1: Possible contributions from science in the many stages of the decision-making process (Translated and adapted from VOGEL et al., 2007)

TABLE 1: Possible roles that scientists/researchers can play in decision-making processes on environmental issues (Adapted from XAVIER, 2017)

Role	Description
Information/ knowledge providers	Provide scientific information on request. When involved in participatory processes act as consultants that answer specific questions related to their expertise (limited engagement)
Advisers for decision making	In addition to providing information, experts advice policy-making, providing recommendation to policy outcomes, on-demand and with none or limited engagement in participatory processes

Role	Description
Knowledge brokers	Facilitate dialogue between different actors/ knowledge groups, they engage in participatory processes but not necessarily as a stakeholder in the discussion itself, but acting mostly as information translator or bridging individuals
Information translators	Individuals acting as educators contextualizing and interpreting data for nonscientists, engage in participatory processes but not necessarily as a stakeholder in the discussion
Mobilization	Identify and advertise environmental problems, driving attention to the need of discussing them
Processes facilitators	Facilitate and mediate participatory processes, they engage in the processes but not as stakeholders in the discussion
Knowledge co-producers	Engage in the participatory processes as stakeholders, with specific interests, sharing knowledge, perceptions and understating with equal value to other participants and acting in the production of new, collective knowledge

INTEGRATING KNOWLEDGE AND POLICY FOR ENVIRONMENTAL GOVERNANCE OF THE SÃO PAULO MACROMETROPOLIS

The degree of application of scientific information in policies and practices depends on the relevance, legitimacy and credibility of the information. These, in turn, depend on how knowledge is produced, shared and translated/transformed into a social context that promotes learning. That is, it depends on how the process of knowledge exchange is organized. The São Paulo Macrometropolis (MMP), in addition to the problems related to CC, brings a range of environmental challenges, such as coastal management, water management, inequality, etc., which can benefit from greater integration of science and management.

Reed et al (2014) have listed five principles (with related actions) that can improve the exchange of knowledge in a decision-making process for environmental management, which can be the guiding principles of the process within the MMP:

- **Principle 1:** Know what you want to achieve with the exchange of knowledge/information and plan the interaction process from the beginning of the research project;
  - Establish goals for the exchange of knowledge of the principle;
  - Design a strategy for information and communication exchange;
  - Base the strategy on an adaptive process that can respond to the changing needs and priorities of those involved;
  - Assign skilled staff and financial resources to knowledge exchange activities;

- **Principle 2:** Address problems and management priorities in the research project systematically;
  - Identify potential users of the survey and other relevant stakeholders in a systematic way;
  - Involve key stakeholders in research;
  - Consider the ethical implications of engagement with different stakeholders;

- **Principle 3:** Build long-term trust based on a two-way dialogue between researchers and other stakeholders and promote the co-construction of new knowledge on environmental management;
  - Engage in double-track dialogues as an equal with potential users of the research;
  - Build long-term relationships with potential users of the survey;
  - Working with intermediaries;
  - Hire a professional to facilitate workshops with users of the research;
  - Understand what can motivate search users to get involved with it;
  - Create opportunities for informal interaction and learning between researchers and stakeholders;
  - Work with stakeholders to interpret the implications of research for policy and practice and to co-produce communication material;

- **Principle 4:** Focus on disseminating results that are of stakeholder interest as early as possible;
  - Identify timely moments in which information can be presented as early as possible throughout the research process to reward and maintain the interest of research users in participating in the process;
  - Align research time with management needs;

- **Principle 5:** Monitor and evaluate the knowledge/information exchange process to improve it and ensure that the process can last beyond project funding time;
  - Periodically reflect with the research team and key stakeholders on the effectiveness of knowledge/information exchange;
  - Learn from your peers;
  - Share good practices;
  - Identify what kind of knowledge exchange should continue after the project funding time and consider how to maintain this exchange for the required period.

FINAL REMARKS

The recognition of the need for a new relationship between science and politics reinforces the need to promote different roles of scientists at different points in the decision-making process. To exercise these roles, it is necessary to create and strengthen institutional arrangements within an environmental governance system that considers the role of science, whether multilevel, cross-sectoral and hybrid, with the participation of

territory. In these arrangements, the promotion of knowledge exchange as a practice of strengthening the relationship between the project and decision-makers (at the state, macrometropolitan, regional and local levels) should be based on transparent, dialogic processes that value diverse sources of knowledge and promote social learning.

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CHAPTER 10

BEATRIZ MILZ [1]
ANA CAROLINA CAMPOS [1]

Recent extreme climate events in the São Paulo Macrometropolis

The São Paulo Macrometropolis (SPMM) is considered the largest and most important urban agglomeration in Brazil, including the Metropolitan Regions of São Paulo, Campinas, Sorocaba, Baixada Santista, Vale do Paraíba and Litoral Norte, the urban agglomerations of Jundiaí and Piracicaba, and the micro regions of Bragantina and São Roque (EMPLASA, 2017). This region has great economic importance, and according to the São Paulo Metropolitan Planning Company (EMPLASA), it includes 174 municipalities and in 2017 concentrated a population of 33.6 million inhabitants (EMPLASA, 2017).

The SPMM has a large part of the population of the State of São Paulo concentrated, so there is a high demand for resources (e.g. water and energy), as well as infrastructure (housing, supply networks, roads). The size and complexity of this agglomeration makes it more vulnerable to natural events, especially those considered extreme.

When a climate event occurs in an uninhabited area, it may cause some impact. However, when it reaches a populated area – causing disruption to the functioning of a community, involving loss of life, material, economic or environmental losses to great extent (AMARAL & GUTJAHR, 2011) – the same event can be considered a disaster. According to the geographic location and climatic characteristics of the region, the most recurrent extreme events in the SPMM are related to atmospheric activity (such as rain and wind) and topography conditions (many areas with high declivity). The main weather events in the SPMM are inundations (floods), sliding of slopes, sea elevation, tornadoes and droughts.

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There is also an increase in the number of disasters that are a consequences of climate change. Although the climate varies over several time scales, human actions since the industrial revolution have greatly increased the concentration of greenhouse gases in the atmosphere. According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) in 2014, it is estimated that the global average temperature increase is already above 0.85 °C, and this increase may still reach 1.5º C to 2º C in the next few years.

The increase in global average temperature not only raises the temperature but can make climate events more extreme – hotter summers, colder winters, more concentrated and intense drought and rain periods – as well as their consequences. Considering this scenario, it is important to know the extreme events that have occurred in the SPMM in recent years so that it is possible to be prepared in case of future events. Therefore, this chapter aims to present a brief history of the most recent extreme events that happened in the SPMM.

EXTREME EVENTS THAT OCCURRED IN THE LAST YEARS IN THE SPMM

A search was conducted in the most relevant newspapers in Brazil, selecting news related to extreme events that ocurred in the SPMM territory. From this search, a timeline was designed (Figure 1), presenting the most emblematic extreme events that occurred in the last years in the SPMM.

Among the extreme events that occurred in the last decades in the SPMM, we can highlight the occurrence of tornadoes in Itu in 1991, in Indaiatuba in 2005 and in Limeira in the year 2013. The phenomenon occurred in Itu in 1991 caused more damage, as well as destroying homes and industrial buildings, causing 15 deaths and left 176 people injured (G1, 2012). The phenomenon occurred in Indaiatuba in 2005, in addition to causing property destruction, also affected the services of energy distribution and water supply (G1, 2012).

Another extreme event that recently occurred in the SPMM was the drought between 2014 and 2016. The region's public water supply operator – the São Paulo State Basic Sanitation Company (SABESP) – pointed out that this water crisis was a consequence of the low rainfall, the result of an unprecedented climatic event (SABESP, 2015). However, researchers stated that the water crisis was a consequence of the lack of strategic planning of the public water supply system of the SPMM (CÔRTES et al., 2015).

The Cantareira System is the main water supply system in the SPMM. According to SABESP, on July 11, 2014, the system reached 0% of the operational volume, and it was necessary to use the technical reserve, also known as "dead volume" (SABESP, 2018). Many residents were affected by this water crisis, facing water shortages.

On the other hand, there were several occurrences of extreme events related to rainfall, mainly in the summer months. The main consequences related to rainfall were the occurrence of inundation, floods, landslides – causing deaths, collapsing houses, fall of trees, among others. An example of this type of extreme event was the case of the heavy rains that occurred in March 2016, affecting several municipalities that are part of the Metropolitan Region of São Paulo. Among the consequences were injured people and deaths,

as well as slow traffic, slowness and paralysis in the operation of CPTM trains, overflow of the Pinheiros and Tietê rivers and the closure of Guarulhos airport for a few hours (EL PAÍS, 2016).

In June 2016 occurred in the metropolitan region of Campinas heavy rains and the phenomenon of Microexplosions, causing injury to people, fall of trees and many damages in homes and buildings. This event caused doubts about being a tornado, due to the similarities of these phenomena and also due to the devastation caused to the affected neighborhoods.

The territory of SPMM presents several coastal cities, so it is important to consider the sea level rise and its possible adverse effects for these municipalities. An event that can happen is a storm surge, such as occurred in the municipality of Santos, in November 2016. On this occasion, the storm surge caused waves to advance in the streets and avenues of the municipality, causing inundation, flooding, falling trees and many economic losses.

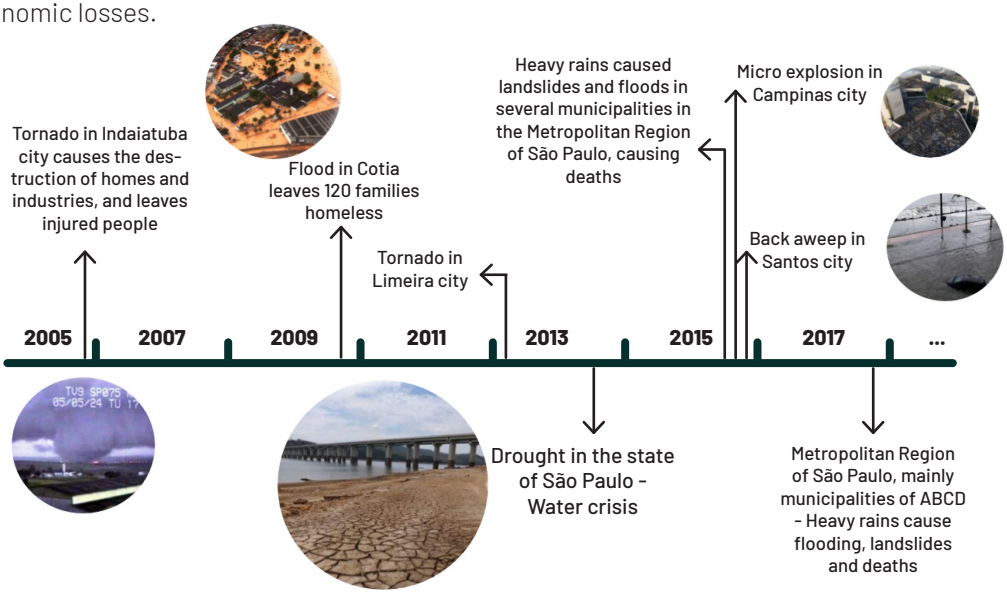

FIGURE 1: Timeline of extreme events occurred in SPMM in recent years.

CONCLUSION

Although it is not an exhaustive search, it is possible to observe through the timeline that both the quantity and the intensity of extreme events have increased in recent years. In a scenario of climate change intensification, the instruments of territorial planning are extremely important for the mitigation of the consequences. Urban planning already has rules regarding human occupation in locations with marked slope and risk of flooding, as well as margins of watercourses. However, public policies (such as access to housing, for example) are still insufficient to prevent situations where the most vulnerable part of the population is at risk.

Although climate change affects mainly the vulnerable population, they impact the cities as a whole, causing economic losses, material and collective infrastructure damages (roads, airports, ports).

Rural areas are also affected affected by the impacts of climate change. Irregular rainfall patterns, for example, impact agricultural production, which can lead to harvest losses – which affect both farmers' incomes and food supply to cities. Rural areas are also important producers of water and help regulate the climate of cities. The fragility of this space is due to the constant conflict to urban expansion.

According to National Center for Natural Disaster Monitoring and Alerts (CEMADEN, 2014), "we cannot prevent natural hazards (rain, storms and others) from happening, but we can minimize their impacts if we better understand why they occur." In the current scenario of climate change the challenges are intensified, making us evaluate our forms occupation, use of natural resources and interaction with the environment.

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CHAPTER 11

SILVANA ZIONI [1]
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The São Paulo Macrometropolis and the challenges for spatial planning and management

The contemporary space production process presents an extensive, heterogeneous and multicentric phenomenon of urbanization under the hegemony of a flexible, post-Keynesian and neoliberal model of development. At first, several concepts were used, initially to define the process of urban expansion beyond the original nuclei of the cities - metropolis, conurbation, megalopolis - that originate a new form of territorial organization – the global city-region (SASSEN, 1998, SCOTT & STORPER, 2001). More recently, responding to the changes observed, foreshadowing the process of regional urbanization, which, according to Soja (2013) would make the transition from metropolitan urbanization, arises the conception of a mega city-region, which analyzes spaces separated in institutional terms and even in terms of functional relations that are more common, but which have a great flow of people and information among themselves (HALL, PAIN, 2006, *apud* XU-YEH, 2012, p.2).[2]

In this context, the role of the region is reawakened, but requires a new regionalism, once characterized by a developmental or regional balance agenda, this regionalism is faced with a dilemma of planning and governance; on the one hand trying to institutionalize the pattern of this urbanization and on another, being co-opted by the investment and infrastructure agendas (that go together) of sectors, corporations and municipalities. Friedmann, analyzing this change in planning culture in European cities, refers to a "la carte" planning: a plan with multifaceted, flexible and localized characteristics, where

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[2] Global phenomenon, according to data from the World Urbanization Prospects (United Nations, 2018), by 2030 the world is estimated to hold 43 megacities - with more than 10 million inhabitants - with most of them in developing regions. <https://www.un.org/development/desa/publications/2018-revision-of-world-urbanization-prospects.htm>

planners would have new roles, as facilitators, mediators and even as spectators of global socioeconomic processes (FRIEDMANN, 2012).

It adds to the spatial complexity - resulting from the diversity of agents and scales in different political strategies and agendas (KLINK, 2013) -, precariousness and informality that move alongside capital flows and investment in a quest for gaps or locational holes for housing and income generation. The current and projected impacts of rapid transformations in natural systems, such as climate variability and its impacts on water-producing systems, is also added to the resulting spatial complexity.

In Brazil, the emergence of a new form of metropolitan urbanization - the São Paulo Macrometropolis (SPM) - assumes the characteristics and complexity of a city-region. Even without a scale of planning and regional governance, the SPM is a set of metropolitan regions and urban agglomerations whose institutionality has not yet been fully consolidated. Although some authors affirm that it is possible to consider it as a platform for planning and integrating public sector policies (EMPLASA, 2014, CASTRO, SANTOS-JUNIOR, 2017; TAVARES, 2018), the debate about the challenges of regional planning facing this new spatial unit persists.

THE SÃO PAULO MACROMETROPOLIS, FROM SPATIAL FACT TO THE NEW SCALE OF GOVERNANCE

The figure of an expanded metropolis had been considered for decades in the face of the demands of transport and sanitation infrastructure. The State of São Paulo's proposal to institutionalize this new scale, presented in 2011, already presented a challenge to the process of regionalization of the State, since it warned that the *"... public policies in the State, in general, disregard the spatial dimension of development, or, at most, consider it only in a lateral way"* (SÃO PAULO, 2011, p.18).

However, understanding the complexity of having the SPM's territory as a *platform for integrating government policies and actions* was already fragile and uncertain. On the one hand, the low implementation of sustainable development actions, practices and management indicates this fragility, even if normative regulation is being incorporated in the public agenda; and on the other

> "... the practice of planning and management of the development process is not centered on the idea of reducing regional imbalances, which are still part of the development context of the State of São Paulo, structurally associated to it, since the adoption of integrated public policies and implicit or explicit strategies and targets aimed specifically at reducing them constitutes a cyclothymic process within the framework of development policy". (SÃO PAULO, 2011, p. 18)

The scope of federative institutional arrangements that respond to the demands of common interest, animated by collaborative and associative spirit, do not seem to overcome the traumas of centralization, even if guaranteed the institutionalization of different regional arrangements and structures of a metropolitan character (MENCIO, ZIONI, 2017).

Moreover, even Law No. 13,683 of 2018, which amended the recently established Metropolis Statute (FEDERAL LAW 13,089 / 2015), increasing the risk of the proliferation of regional figures known as metropolitan, without having the proper characteristics and abilities to exercise public functions of common interest, believes that inter-financial governance implies the

> "... sharing of responsibilities and actions among entities of the Federation in terms of organization, planning and execution of public functions of common interest, through the execution of an integrated and articulated system of planning, projects, financial structuring, of operation and management " (Law no. 13.683, of 2018, Art. 2, IX).

Despite this, in the scope of the State of São Paulo, which already declares more than 70% of its population as metropolitan, MRs have been established without great management performance and capacity to respond to shared interest demands (GOMES, 2017) and even without being constituted as territories of political expression (LEFÈBVRE, 2009).

There are those who attribute to municipal autonomy, conquered with the Federal Constitution of 1988, the apparent (and insurmountable) obstacle to the sharing of forms of metropolitan governance, to deal with essentially multiscalar issues, as it is suggested by Brandão (2017). And there are also, as pointed out by Souza (2003, p. 148), MRs that require a spatial scale change in planning and spatial management, "which would correspond to that of the city-region. However, this city-region scale would be related to a strategic and political level of administration, corresponding to what Klink (2013) defines as related to the scenario of restructuring and rescaling to accommodate a new form of social and economic organization, but which is not necessarily represented in the SPM delimitation.

It is important, then, to note that the debate on regionalization and state rescaling is extensive and complex, and goes beyond the formation of space itself. For Brenner (2018, p.108), it is related to *"spatial construction / transformation of statepower"* in a process of articulation and disarticulation that is neither fixed nor homogeneous and results in discontinuous development processes.

Economic globalization processes in the 1970s and 1980s pressed for a diminished role of national governments in action and development regulation emphasizing the prominence of local scale, particularly of **cities**, as the integration units of global markets. At the end of the last century, the debate about the substantive qualities of these so-called global cities emerges the understanding that the spatial unity of globalization is the **region** (HAESBAERT, 2010).

This region contains a series of characteristics that conform the concept of a city-region, understood as *"the most concise metropolitan area added to its immediate surroundings, including a series of small and medium-sized centralities in the reach of the processes of metropolization"* (MAGALHÃES, 2008, p.9). In the same sense, Xu and Yeh (2010, p.1), citing the work of Hall and Pain (2006), understand that a city-region is configured as a cluster of contiguous cities and metropolitan regions, separated from the administrative point of view, intensely interconnected, but mainly nucleated by a large central city. For Negreiros et al. (2015, p. 127)

> in this space, different urban morphologies coexist, forming a network of cities with a high level of functional integration, and interact with world, national and regional metropolises, urban agglomerations and urban centers with significant roles of regional centers.

The conformation of the spatial flows will produce a territory that is at the same time very articulated and very unequal, provoking the homogenization of the identity and the heterogenization of space, what Allen et. al. (2002) call *"region with holes"*. In the factual region and the discursive matrix (HAESBAERT, 2010), actors and disputes in the region pressure the state to institutionalize a new scale of planning and governance, but not necessarily with fixed perimeters like those of the original administrative entities. In this case, unstable perimeter, established on a case-by-case basis, allows the region to be accessed and governed according to different interests (SWYNGEDOUW, 2018), interests of various economic orders, and which may reveal new territorialities, according to their regulatory frameworks.

From industrial and agricultural logistics, transportation and mobility systems, investments in innovation and access to natural resources, various "city-region" designs are being established, leading to actions, investments and demanding state regulation. Authors such as Offner & Pumain (1996), Brandão (2018) and Pires do Rio (2017) emphasize the importance of the State as an economic agent responsible for strengthening regulatory functions. This function occurs not only in the proportion of the economic dynamics of the regions, but also in the relation of the infrastructure networks and their regulatory territories, which do not necessarily conform to the territorialized institutional entities. In the same way, as the articulation of these to natural territories or to *"specific regulatory*

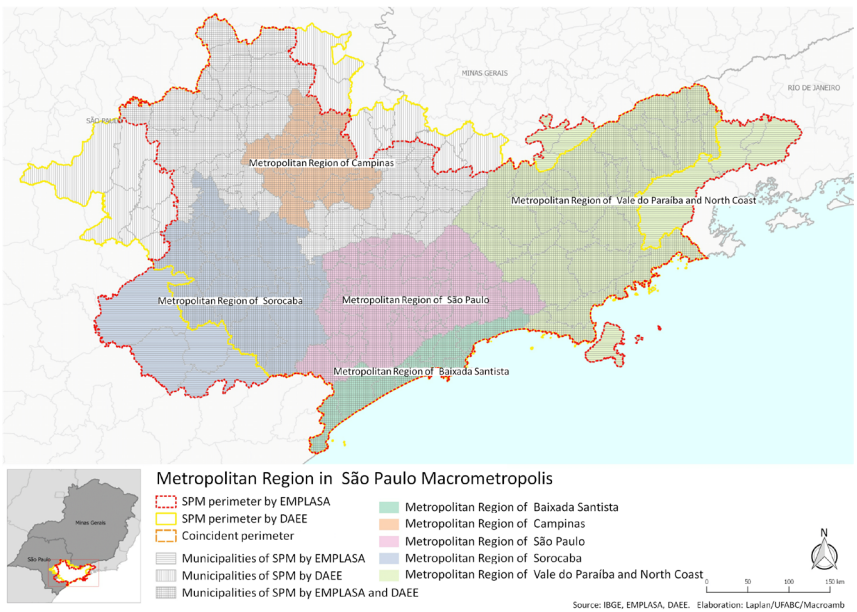

FIGURE 1: The various territories of the SPM. Source: IBGE Elaboration Ana Lia Leonel.

frameworks such as those of conservation units, circulation spaces and those demarcated to allow access to natural resources" it is not automatic or peaceful (PIRES DO RIO, 2017, p.3-4). Swyngedouw's (2001) argument in this direction is even stronger, ponting out that the intrinsic association of urbanization with availability and access to water makes the city a hybrid management object, questioning the scope of institutional structures in the configuration of particular regions.

The idea of unstable perimeter, as commented earlier, becomes convenient for various interests and agents, either in face of the challenges of institutional funding of the new regional macro-metropolitan figure, or as a response to the integration of projects and promotion of regional development, following Scott and Storper (2003) once more. The same can be assumed in the case of the SPM, whose institutionalization process, starting under the pressure of the sectoral dynamics of transportation and sanitation, has been strongly influenced by the centralization in the scope of the State of São Paulo. This state institutionalization has strong characteristics of overlapping and fragmentation of sectoral organs, without effecting an integrative proposal.

Therefore, and the reasons for discrediting the success of the governance of the metropolis - a regional instance not accepted in the Brazilian federal system - not being few, in general, what can be expected on this new scale or regional figure that is the macrometropolis? In particular, what can be expected about the SPM as a planning and governance scale? This spatial fact, which is framed in so many peculiarities, fabrics, and tensions, will certainly imply in, besides a more complex agenda of spatial planning and integration of sectoral public policies, a strategy of management and governance that embraces this new social and economic development.

In the most complete and recent study on the regionalization of the State of São Paulo, the SPM was defined as *"a complex system of cities with a network of strong functional articulations and strong expression in the space of its flows"*, and elevated to the categoryof *"Planning Unit"*, demanding new forms of management (ESTADO DE SÃO PAULO, 2011, pp. 108 and 121). This fact seemed to correspond to the immediate creation of a specific secretariat to deal with the SPM's public policies - the Metropolitan Development Secretariat (DECREE N. 56,635/2011). However, as of 2013, the course of the Metropolitan Development Secretariat had been changed, on the grounds of cost reduction, and the duties of the secretariat have been transferred to the Civil House, in a sub-secretariat of Metropolitan Affairs (FARIA, 2018).

Since then, the SPM was the object of some studies and set of guidelines consolidated in the "Plan of Action of the São Paulo Macrometropolis - 2013-2040" (PAM). In a strategic plan format, it was presented as a *"portfolio of projects"*, set in prioritized and hierarchical form, according to vectors of Spatial Intervention - corresponding to the MRs that make up the SPM; and *systemic* vectors - related to Water Resources and Sanitation; Environmental Development; Power System; Technological Innovation, Qualification of Labor and Taxation Management; and Housing Development. Such projects, according to PAM, could "support the transformation of regional differences into advantages for the consolidation of a sustainable macro-regional development process" (EMPLASA, 2014, V.2, p.226). The success of PAM can be evaluated when its guidelines are included in the document of the Plurianual Plan of investments of the State of São Paulo for the period from

2016 to 2019 (LAW N. 16,082 / 2015), allocating public resources to the SPM, even though only certain sectors were prioritized - transport and water resources, those that have historically been associated with the formation of the SMP (TAVARES, 2018).

The experience of the SPM, which is intended as a new spatial unit of planning and integration of sectoral public policies, seems to have encountered the same impasses of metropolitan management in the Brazilian federative scenario. In the same way, it can represent the limits of state action and planning, as we know it, as mediators of the current extensive action of flows and capital, especially in countries such as Brazil, considering its pattern of path dependence.

For planning, as a field of knowledge and practices, contemporaneity represents a challenge based on a scenario of reduction of the State role and its protagonism, until then, as mediator and agent in the actions of this field. For example, countercyclical actions, or activities done in order to balance out a current cycle of spatial and economic concentration, could be limited in this scenario. However, there is a "critique of the critique", so far as, as Schöenwandt (2008) points out, only discussions and structural criticism of the hegemonic model without reflections on how planners can act, in a prospective view, can induce immobilism and disbelief in future actions. For authors such as Reimer (2013), Friedmann (2005), Sanyal et al. (2012), Limonad (2016), to name a few, it is necessary to rethink the current planning, as has always been the challenge in this field.

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CHAPTER 12

SILVANA ZIONI [1]

Transport and urban mobility: Challenges of adapation to climate change in the São Paulo Macrometropolis

The first decades of this century witnessed important innovations in the brazilian transportation sector. Cities and regions began to count on operational and management systems of greater technical efficiency, implementing technological improvements and of sectorial organization, while broadening the approach of the matter of people and goods transportation and introducing in its planning the concept of urban mobility - the consideration that conditions of displacement of people and goods do not depend exclusively on systems and modes of transport but on environmental and socio-spatial conditions (GOMIDE, GALINDO, 2013).

These innovations were promoted especially from the initiative of the federal government in creating a National Secretariat of Transportation and Urban Mobility in the Ministry of Cities, and instituting new political-programmatic bases for the sector, even before the National Policy on Urban Mobility - NPUM, by Law No. 12,578 in 2012. The political orientation of urban mobility, which began to guide plans, programs and projects, replicated in Brazilian municipalities and metropolises, had guidelines compatible with the country's commitments to the environment and sustainable development confirmed in the National Policy on Climate Change - NPCC (LAW N. 12.187 / 2009).

It can be said, then, that a decade ago, good winds were blowing from the creation of legal, institutional and financial frameworks for transportation planning, but also in favor of the Brazilian strategy of mitigation and adaptation to climate change for the transportation and urban mobility sector. However, this favorable climate would change under the effects of the critical political-institutional framework that was formed in the middle of that decade, from which episodes such as the protest days in June 2013 or the reaction

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to the truckers strike in 2018, are exemplary to understand that more immediate demands would gain spotlight, compromising the accumulation and effectiveness of policies, despite the importance of incorporating the issue of climate change in transportation planning.

This text seeks to situate how, in the context of transport policies, logistics and urban mobility, the insertion of the environmental issue and climate change has taken place and, as a transversal theme, collaborated to renew the culture and the institutionalization of the planning of transport and sustainable urban mobility. The text also points out questions about the challenge of incorporating mitigation and adaptation strategies in urban transport and planning within the São Paulo Macrometropolis. From a brief contextualization of the transport, logistics and urban mobility sectors in Brasil, the text presents the formation process of two important legal frameworks of the transport sector in light of the environmental policy, in order to, in a next part, investigate which influences and repercussions of these policies are present within the scope of the SPM (São Paulo Macrometropolis), and conclude with final considerations.

PLANNING FOR TRANSPORTATION AND URBAN MOBILITY IN BRAZIL

The transport sector in Brazil is characterized by the predominance of road transport systems, despite the continental dimensions of the country. In urban areas, in spite of the size of Brazilian cities, dependent on bus mode and onthe growing fleet of cars and motorcycles. In other words, an extremely vulnerable sector due to its unbalanced modal and energy matrix[2], and to the quality of its infrastructure and systems technology. As a result of our development pattern and insufficient investments in infrastructure have left our cities with a precarious environment and urban systems vulnerable to extreme climatic events, which are increasingly frequent, due in part to this very pattern of energy consumption and emission of greenhouse gases. Similarly, climate change scenarios emphasize the vulnerability of cargo transportation infrastructure, especially the road system, subject to direct and indirect impacts such as floods and landslides.

The condition of governance to which the sector is exposed is also critical, since, from the Federal Constitution of 1988, a process of decentralization of the executive public activities occurred, making the urban transport into an attribution of the municipal administrative instances; maintaining within the scope of the regulation, of the general norms and policies, the competence of the Union and State entities, including conflictingcompetences in aspects of urban agglomerations, to the defense of the environment. Meanwhile, the regional dimension of transport, logistics and urban mobility, which is especially important for the development of territories, urban settlements and metropolises, would only be explicitly regulated by the Metropolis Statute (FEDERAL LAW 13.089) in 2015.

[2] The modal distribution of the regional freight transport matrix indicates the predominance of the road mode, accounting for about 52% of the total freight carried, followed by rail (30%), cabotage (8%), waterway and pipeline (5%) (PNLT, 2012). In the cities, the matrix is divided between modes on tires - individual transport (31%) and collective transport (28%) and active transport (41%) - foot and bicycle displacements, with less than 4% rails, included among collective systems, present only in some capitals (ANTP, 2014).

Thus, the management of urban transport systems has faced, since the turn of the century, an impasse with serious environmental damages: the increase in the rate of motorization and individual movements; in response to chronic traffic congestion and the tendency of urban areas to spread, also increased costs and travel times; which were accompanied by the increase in the cost of production of public transport, whose tariffs also increased, expelling passengers to the informal systems offered in inefficient and unsafe vehicles, collaborating to the deterioration of the systems as a whole, which had as a corollary the reduction of capacity of investment and public management (ZIONI, 1999; GOMIDE, GALINDO, 2013).

And, regarding regional transport and logistics, which also demanded investment, the fiscal adjustment of the 1990s, and market-oriented reforms, signaled the privatization of railroads and the concession of highways as the alternative for the rapid growth of infrastructure, including new agribusiness vectors, industrial re-spatialization and configuration of the metropolis and the metropolitan region of São Paulo (DINIZ, CAMPOLINA, 2007; ZIONI, 2014). The widespread privatization of the rail freight transportation sector - federal and state; the opening of ports for private users, by means of concession and exploration of ports, cargo terminals; and the concession for private initiative to maintain highways via toll collection with greater economic viability, occurred within the expectations, without however, facing the challenge of expanding and adapting the infrastructure to a more efficient and sustainable matrix. In this sense, the National Transport and Logistics Plan (NTLP), a strategic instrument resulting of the partnership between the Ministry of Transport and the Ministry of Defense, would define, as of 2007, an investment program in transport infrastructure, which in medium and long term, would change the energy matrix of transport, and guide private investments in transport and logistics infrastructure.

Potential scenarios for the mitigation of GHG emissions were considered in the selection of the NTLP (2007-2031): more than 100 priority projects due to greater economic viability, another 200 projects with less economic feasibility, but of socio-political, environmental, technological or regional development interest, in addition to 200 projects of the Growth Acceleration Program - GAP (MINISTRY OF TRANSPORT & MINISTRY OF DEFENSE, 2007). But it is only in subsequent reports (2009 and 2012), with the recommendation for diversification of the modal matrix of transport and Clean Development Mechanism (CDM) initiatives in the implementation of the projects, that there is some influence of the NPCC on the NLTP (ZIONI, FREITAS, 2015).

Meanwhile, within the Ministry of Cities, the NPUM challenge of mitigating and adapting urban transport to climate change was at least implicit. The NPUB (2012) expressed general principles of sustainable development linked to the objectives of expanding or adapting urban transport and cargo infrastructure, with the implementation of new systems and modes with greater energy efficiency. Especially for urban mobility, a strategy of adaptation was proposed, with the reversal of priority, favoring active, non-motorized modes, and the increase of the most efficient public passenger transport systems. The policy of investment and valorization of public passenger transport systems was thus, not only a response to historical urban infrastructure deficits, but also counteracted the significant and continuous increase in individual motorization rates in Brazil's large and medium-sized cities, fueled by fiscal incentives the auto industry received, especially after the economic

crisis of 2008. Therefore, we could assume that the objectives of mitigation and adaptation to climate change would be implicitly met .

The dispute over the circulation spaces in the cities, between individual and collective modes of transportation, had an impact on the progress of management strategies and more sustainable and efficient urban transport policies. As an example, we highlight the implementation of exclusive corridors and priority bus lanes, as well as tariff policies integrated through electronic ticketing, which have improved the quality of the urban transport service, without, however, combating or mitigating the effects of traffic congestion, air pollution and accidents resulting from urban transit. Other adaptation strategies, supported by initiatives sponsored by the service market and startups, help to disseminate the use of bicycles, scooters, as urban deliveries in non-motorized modes has been expanding in Brazilian cities.

THE SECTORIAL TRANSPORT AND URBAN MOBILITY PLAN FOR MITIGATION AND ADAPTATION TO CLIMATE CHANGE (STMP)

The voluntary commitment of the Brazilian Government to reduce emissions (from 36.1% to 38.9% in relation to the 2020 scenario) in 2009, through mitigation actions and adaptation to the effects of climate change, aimed mainly at strategies for Land Use Change and Forestry, and the Energy and Agriculture sectors. The National Policy on Climate Change - NPCC (LAW N. 12,187 / 2009) had defined emission inventories, financing mechanisms, and the Climate Change Mitigation and Adaptation Sector Plans as instruments for its implementation. Through the elaboration of the previously unpublished emission inventories, [4] the *Urban Public Transport systems and Modal Interstate Cargo and Passenger Transportation* systems were also considered responsible for anthropogenic emissions and, together with the health, industry and mining sectors, could contribute to further emissions reductions. Thus, it was foreseen that by 2020 a further 21.8 million tCO2eq could be reduced by less than 2% of the initial commitment[5] (MINISTRY OF TRANSPORT & MINISTRY OF CITIES, 2013, p. 17). Despite the modest contribution to reducing emissions, the Sectorial Transport and Urban Mobility Plan for Climate Change Mitigation - STMP (2013), represented a reinforcement of the sector's policy guidelines.

[3] With the reversal of federal resources in the modernization of urban transport on rails, or as from 2007, with the Growth Acceleration Program (GAP), greater resources are now earmarked for major social, urban, logistics and energy infrastructure projects, and it is when urban passenger transport systems gain greater prominence. Investments in modern and efficient bus corridors - BRT and Light Rail Vehicles - LRV have been pledged to the 12 capitals of the 2014 Football World Cup. In addition to this, two more sustainable urban transport infrastructure investment programs were launched - PAC Urban Mobility Great Cities in 2011 and Medium Cities in 2012 (GOMIDE, GALINDO, 2013).

[4] The 1st National Inventory of Atmospheric Emissions by Road Automotive Vehicles was carried out by the Ministry of the Environment in 2011 and the 1st National Inventory of Atmospheric Emissions of Rail Transport of Charges, in 2013 by the National Agency of Terrestrial Transports - NATT.

[5] The initial commitment assumed was to reduce 1.168 billion t CO2eq by 2020. CO2eq (equivalent carbon dioxide) is a conversion metric applied to greenhouse gases (MINISTRY OF TRANSPORT & MINISTRY OF CITIES, 2013, p 13).

The Sectorial Transport and Urban Mobility Plan for Climate Change Mitigation and Adaptation - STMP (2013) was prepared with the participation of representatives of the productive sectors and civil society, besides being submitted to public consultation, under the coordination of the Ministries of Transport and Cities. In fact, faced with the challenges that climate change posed to the mobility of people and goods in cities and roads, the unprecedented articulation of the sector was necessary, or at least indicated that urban transport and cargo were beginning to recognize and bet that through environmental strategies, new opportunities for implementing modal shift and infrastructure deployment policies could emerge and be realized more easily, given the difficult governance that characterizes the sector.

For the STMP, the NPUM was an important ally, and represented a possibility of positive synergies for climate policies (MINISTRY OF TRANSPORT & MINISTRY OF CITIES, 2013, page 22). But equally positive would be the unfolding of the articulation of these policies in the local instances, since the STMP allows to combine the instruments of promotion of the accessibility to the city, with the investments in more energetically efficient modes of transport. According to LINKE et al., 2016, p.2, the STMP helped *"promote the harmonization at federal level of plans, policies and financing for urban mobility with a plan that allows the incorporation of actions for adaptation and resilience."*

The deployment of the STMP has been done mainly through the support of the internationally articulated technical and scientific community on the climate, which indicades the increasing role of cities in worsening global warming, pressing public policies to incorporate mitigation and adaptation to climate change, and has been engaged in the necessary revisions of the STMP, since as affirmed by LINKE (et al., 2016), even with the advances achieved, and despite bringing the commitment of the adaptation strategy in the title, the first version of the STMP (2013) did not go far beyond measures to mitigate the impact of transport on the environment.

The 2016/2017 Monitoring Report of the National Plan for Adaptation to Climate Change (MINISTRY OF THE ENVIRONMENT, 2018) states that *"an institutional environment favorable to the implementation of the agreed policies was guaranteed in the Ministry of Cities, despite the structural changes that implied the reorganization of teams"*, presenting a set of actions already in progress, that contributed to the achievement of the Sustainable Development Objectives and to the strengthening of national plans and policies. Indeed, the Ministry of Cities has been struggling to follow the revisions to the STMP and to promote programs and projects to disseminate information and benchmarks for the practice of climate mitigation and adaptation to climate change, such as the document *Indicators for monitoring and evaluation of the effectiveness of the National Policy on Urban Mobility*[6], published in November 2018. However, the recent change in the political and institutional climate, which has resulted in the extinction of the Ministry, may frustrate expectations of widespread dissemination of these guidelines.

[3] Prepared by the National Secretariat of Urban Mobility - SUM of the Ministry of Cities, with the technical support of the Institute of Applied Economic Research - IPEA, Institute of Energy and Environment IEMA, and the Institute of Policies of Transport and Development - ITDP.

TRANSPORTATION AND URBAN MOBILITY AT THE SÃO PAULO MACROMETROPOLIS

The challenges of transport and urban mobility, as evidenced for the set of Brazilian cities and regions, are more intense and complex when focused on the São Paulo Macrometropolis, not because it is an enlarged scale of problems, but numerous scales of different strategies and political agendas that characterize this peculiar space. In any case, transport and urban mobility will add to this complexity the ambiguities of the logics of networks and systems that are imperfectly regulated by sectoral policies.

Although institutional frameworks for transport and urban mobility have advanced, they remain in a context of conflicting competencies and overlapping systems and services, despite the diversity of modes of transport suggesting and recommending multimodal integration for transporting both cargo and people. The NPUM began to consider freight transport as an integral part of the urban transport system management, which corresponds to the evidence that the spatial reorganization of production relies on the urban network, especially in the metropolis, since the logistics system also seeks the locational advantages of technological innovation and metropolitan markets (ZIONI, 2014). In spite of this, at the federal level, as well as in the State of São Paulo, the sectorial structure of transport distinguishes logistics and regional transport systems from metropolitan transport, which overlaps with municipal transport authorities. This competency competition between transport managers and urban mobility will meet its peak and its greater spatial concentration in the SPM, where also the institutionalities of the parties that define them - the metropolitan regions - are questioned as cases of fragile governance.

The State Policy on Climate Change (SPCC) was instituted by State Law No. 13,798 of 2009, in line with the UN Climate Convention and NPCC. In anticipation of the STMP, SPCC sought, among other guidelines , to elaborate the Sustainable Transport Plan to *"prioritize investments that alter the modal matrix of transport and energy, increasing the participation of rail, waterway, cycle-lane and pipeline in relation to road transport"* in the state of São Paulo (STATE LAW N. 13,798 / 2009, ARTICLE 40).

The SPCC thus established the state's commitment to the climate change challenge of the transportation and urban mobility sector , even with the assumption that the contribution of the transport and mobility sector would be modest. Perhaps that is why the environmental scenarios for the 2020 horizon were quite optimistic. The volume of cargo transported by the road modal would represent a maximum of 75% of the total transported in the State of São Paulo, and public transportation in the Metropolitan Region of São Paulo would account for more than 65% of motorized trips, against less than 35% of individual transport (SÃO PAULO, 2009). It is important to remember that, according to the most recent Destination and Origin Survey (held in 2017), in the SPMR, the share of public transport corresponds to 54.1% of motorized trips. The figure for the participation of the individual transport intended, as an environmental scenario in 2020 assumed by the Government of the State of São Paulo, would correspond to that verified in 1967, before the implantation of the subway in São Paulo.

The Sustainable Transport Plan, as foreseen in the SPCC, can be known through its two reports - *Problem Characterization, Guidelines and Guidance for Action Programs* (SÃO PAULO, 2010) and *Emissions Inventory, Guidelines and Guidance for the Program of*

Actions (SÃO PAULO, 2013). The two documents are oriented by the indication of projects and actions that aim at the modal shift, towards more energy-efficient and proportionally less CO_2 emitting modes, such as the use of ethanol. The transport sector's target volume for 2020 would be 31.8 $MtCO_2$, corresponding to 80% of the base year - 2005, in the diagnosis of 2010, and 39.8 $MtCO_2$, as estimated in 2013.

The 2010 diagnosis focused on the emissions conditions of modes on tires, which accounted for 81% of emissions in the sector. Hence, the strategies for replacing fossil fuels with renewables or with advanced technologies for improving the efficiency of vehicles and their operation were valued; (SÃO PAULO, 2013, p.7), aiming at more balanced freight and passenger matrices, favoring the most energy-efficient modes. The improvement of transport planning and management, and the implementation of metropolitan and regional transportation plans in the state of São Paulo was another intended objective, referring to the Transport Development Master Plan (TDMP) and the Integrated Urban Transportation Plan (IUTP). Such strategies were confirmed by the 2013 report, which recommended, however, that as the SPCC stated, strategies for urban transport and cargo should prioritize *"less polluting modes (ie with less relative emissions) and not directly, to the absolute reduction of the emission per vehicle within the same way"* (SÃO PAULO, 2013, p.9).

In the meantime, it was possible to adjust emissions scenarios, considering the rebates that would be made possible by advances in the policies adopted for the use of renewable fuels, improvement of cargo transportation management, and in municipal policies to replace fossil fuels in the collective bus fleets (like the one proposed by the Municipality of São Paulo) that could impact especially the Metropolitan Regions. Thus, only the possible strategies in metropolitan areas - complete renovation of the urban bus fleet of the Capital and Metropolitan Regions of Campinas and Santos, and the extension of rail network in the São Paulo Metropolitan Region (which schedules are systematically uncorrected) - would account for 36% of the additional 12.1 $MtCO_2$ reduction that the State of São Paulo intended to achieve by 2020.

This is the cut that SPCC makes for the metropolises, without any reference to the degree of vulnerability that these regions are subject to, especially since the formation of a macro metropolitan agglomeration is already in process, concentrating most of the flows of people and goods of the State of São Paulo.

At the same time that the Sector Plan for Transport and Urban Mobility for Mitigation and Adaptation to Climate Change - SPMT was published, the Government of the State of São Paulo publicized the São Paulo Macrometropolis Development Policy - MDP, as a strategy for promotion of integrated and sustainable territorial development, and presenting itself as a basic reference for the integration of public policies and investments in the SPM (SÃO PAULO, 2014). Some studies, however, have indicated that these references do not always support the actions of government or indeed guide the management of transport and urban mobility systems in the SPM (FARIA, 2018, GOMES, 2017).

Spatial cohesion and inclusive urbanization is one of the strategic axes of the MDP action plan, which among its guidelines seeks to *"contribute to achieving metropolitan projects that meet the goals of the State Policy on Climate Change (SPCC)"* (SÃO PAULO, 2014, p. .11). In a rather vague way, an incentive guideline to "adoption of environmental sustainability requirements" was added, without mentioning the Sustainable Transportation Plan

(which was anticipated until the SPMT), also proposing to define strategies for mitigation and adaptation to climate change (SÃO PAULO, 2014). Despite this, the MDP, in the strategic axis of metropolitan governance, recognizes that there is a disarticulation between sectorial policies and lack of integration of the different levels of government in relation to metropolitan projects (idem).

Finally, when it comes to Structuring Projects / Actions related to Environmental Development, the MDP points out a final guideline supporting the implementation of the actions foreseen in the Sustainable Transport Plan for the SPM territory. It replicates SPCCs goal of reducing CO_2 emissions through *"...replacement of fossil fuels with renewables; balance of freight and passenger transport matrix, with expansion of rail transportation; improvement of transport planning and management"*(SÃO PAULO, 2014, p.79), on which there is no contestation.

FINAL CONSIDERATIONS

The consensus regarding the vulnerability of cargo and people transportation systems and the precarious conditions of urban mobility in Brazil, seems to be so absolute that it is not necessary to assert them by some political instruments. In the quest for virtuous influences and articulations among the documents that aimed to reduce this vulnerability to climate change (SPCC and SPMT) and the instruments that advanced the most in transport policies and urban mobility in this century, we noticed some gaps.

Despite this, it should be noted that many advances have been made to incorporate the environmental issue in the transport sector, in an atmosphere of collaboration and participation of several social segments and a harmonious relationship between the federative entities. However, it implies adaptations in the transport sector itself, where debates about the transition perspectives of urbanization models dependent on motorization are recent, and where improvements in infrastructure and systems often lead to physical, energetic, economical and environmental obstacles.

Noting especially the context of the great Brazilian metropolis, which polarizes the SPM, we believe that the challenge of articulating infrastructure development policies and strategies for mitigation and adaptation to climate change is even greater. Not because they are incompatible: documents even show workable commitments within reasonable time frames. However, these commitments have never been accomplished, since they imply facing a model of institutionality and sustainable governance of transport and urban mobility that has never been experienced before.

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CHAPTER 13

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Notes on Urbanization, Adaptation and Vulnerabilities at the São Paulo Macrometropolis

Actions to adapt to climate change in cities in developing countries should be related to vulnerabilities resulting from the extremely unequal production of space. In these cities, in terms of state investment and infrastructure quality, the inequality is shaped by the expressive co-location of the poorest populations within areas with greater susceptibility to flooding, mass movements, as well as inferior conditions for the provision of social equipment, infrastructure networks, or are more devoid of institutional protection, as in the case of civil defense. The article makes a brief conceptual discussion about adaptation and vulnerability, related to cities and urbanization processes, and then presents some questions concerning this theme in the São Paulo Macrometropolis (SPMM).

For Bulkeley (2013, p.144) adaptation is a "deceptively simple concept" (PELLING, 2011 *apud* BULKELEY, 2013) and acquires special definitions within the lexicon of terms used to describe and analyze the phenomenon of climate change. In the Fifth Report of the Intergovernmental Panel on Climate Change (IPCC), adaptation is defined as a process of actual or expected climate adjustment and its effects and aims to moderate or prevent damage or to explore beneficial opportunities (IPCC, 2014b, p.5). Some associated concepts are defined in the glossary of the report, namely: adaptation deficit, adaptation limits (hard and soft) and adaptive capacity. The first concept is defined as a distance between the current state of a system and a state in which the adverse effects of climatic variability are minimized. The limit of adaptation is between no adaptation is tolerable to the condition that some actions are not possible. Adaptive capacity is the ability of systems, ins-

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titutions, individuals and other agencies to adjust damage potential, leverage opportunities or respond to the consequences of climate change (IPCC, 2014a).

In cities, based on the concepts of the IPCC and other authors, Bulkeley (2013, p. 146) considers capacity and adaptation deficit critical when there is a lack of basic provisional infrastructure. Infrastructure systems such as water, sewage, housing, energy and transportation, are essential attributes in access to basic services, job opportunities, health and other conditions necessary to reduce vulnerability.

In the same critical direction, Barton (2012), in his work on adaptation and planning tools in metropolitan areas in Chile, argues that it is the social inequalities that define the landscape of vulnerability. Vulnerability in this case has a broad meaning, including: access to work and income; goods and services; location; quality of housing and surroundings; aspects of personal safety and work; quality of health and education for personal development; and the vulnerability associated with impacts of climate change. This vulnerability approach is related to environmental justice or structural issues that need to be addressed by long-term planning and policies, be they developmental, territorial planning, or sectorial. Thus, for this author, adaptation would not be a sprint, but a marathon, considering the complexity in terms of understanding the phenomenon of climate change and its systemic repercussions.

Whatever the divergences on the amount, cities have large populations, currently about half of the world's population lives in urban areas. In Brazil, about 78% of the population lives in areas considered dense occupancy (IBGE, 2017). Cities are still in the foreground when it comes to mitigation policies, since they are responsible for the important part of GHG emissions, as well as adaptation. It is in the urban space that the population is more exposed to the effects of climate change, but it is also in the cities that the possibility of creating efficient policies in both dimensions is possible (ROSENZWEIG et al., 2011).

In addition, it should be emphasized that the portion of the population most exposed to the risks of climate change is also the most vulnerable part of the urban population, with the poorest, the children and the elderly being the first affected by the consequences of these processes. Thus, adapting to cities, and especially in the deeply unequal cities of developing countries, means relating to historical liabilities of space production and meeting the different demands of specific population groups in the direction of environmental justice. It also means establishing, both in action and in regulation, policies aimed at reducing risk, considered as the meeting between vulnerability and exposure to the effects of climate change. Climate change has impacts on several public services, which are already unevenly distributed, such as the provision of drinking water and electricity and public health, whose planning and action must also consider the most vulnerable.

However, as Barton (2012) states, climate change and related vulnerability have been insufficiently addressed in the planning process, much more focused on short-term projects and actions that are often rooted in their dependencies of path, rather than innovation, provoking an acceleration of the status quo (MOMM et al., 2017). Thus, in addition to the production of data and research that deals with the relationship between climate change and adaptation in cities, it is also necessary to understand the path that will lead such a debate to the planning system.

In cities, the main effects of climate change are extremes of temperature, winds

and precipitation, leading to impacts such as floods and droughts, changes to water and air quality, and the distribution of disease vectors. These determinants, together with urban characteristics - density, location, morphology, presence of urban services, infrastructure and governance system – have, as a consequence, the loss of material and life assets, as well as an increase in respiratory, cardiac and transmitted diseases by insect, among others (ROSENZWEIG et al., 2011).

The National Plan for Adapting to Climate Change (MMA, 2016) establishes some strategic points for cities, with the premise of the municipality's role in implementing adaptation actions, with the support of state and federal governments in situations of greater complexity. It emphasizes the need to integrate the various planning instruments - at their various scales -, including master plans; basin plans, housing plans and mobility, among others.

Regarding urban vulnerability, the strategies point to a need to ensure integrated urban infrastructure, household production and improvement, and environmental restoration in urbanization projects for precarious settlements and provisions for housing of social interest, taking into account exposure to the effects of climate change with a view to reducing risk. It also establishes the need to implement actions based on the Municipal Risk Reduction Plans and Sustainable Urban Drainage Plans.

It is noteworthy, then, that the actions of adaptation to climate change is embedded in the existing demands of the rehabilitation of slums; regardless of the resurgence of extreme events and the risks, there already exists a liability to be managed. There is also a demand for the elaboration of planning instruments that are not on the agenda in the majority of Brazilian municipalities.

In the SPMM, urban vulnerability is concentrated mainly in the metropolitan suburbs of São Paulo, Campinas and Santos, which concentrate 98% of the almost 2 million and 700 thousand inhabitants in subnormal sectors (IBGE, 2010), as can be seen in Figure 1. Many of them are exposed to flood risks, mass movements and tidal influences when they occupy floodplains, hillsides and canals (CEM, 2013). In these three metropolitan regions, a study by the Center for Metropolis Studies, in analyzing precariousness more comprehensively than the methodology used by IBGE, found that it is almost 30% larger (CEM, 2013).

Regarding drought-related risks, although the (almost) universalization of water supply services in urban areas could indicate that this extreme event would be more "democratic" in distributing risk more evenly among urban sectors, a closer look at detailed information about the infrastructure refutes such an assertion.

Silva (2000) and Moreira (2008) show how the implantation of water supply networks present heterogeneities, related to the logic of the implementation and extension of these systems - which in the case of RMSP produces a hybrid structure: open and closed — as well as its provisions in precarious areas, resulting in inequalities in the quality, quantity and regularity of services, even though part of the precarious settlement does not fit fully into this situation, due to its location. In this sense, it is possible to infer that in areas in which both systems and occupations are more precarious are riskier.

The effects of climate change on pre-existing water scarcity risks will make its solution even more complex and costly. In a study on the effects of drought in Brazil, the Ministry of the Environment, together with the WWF, established an indicator of

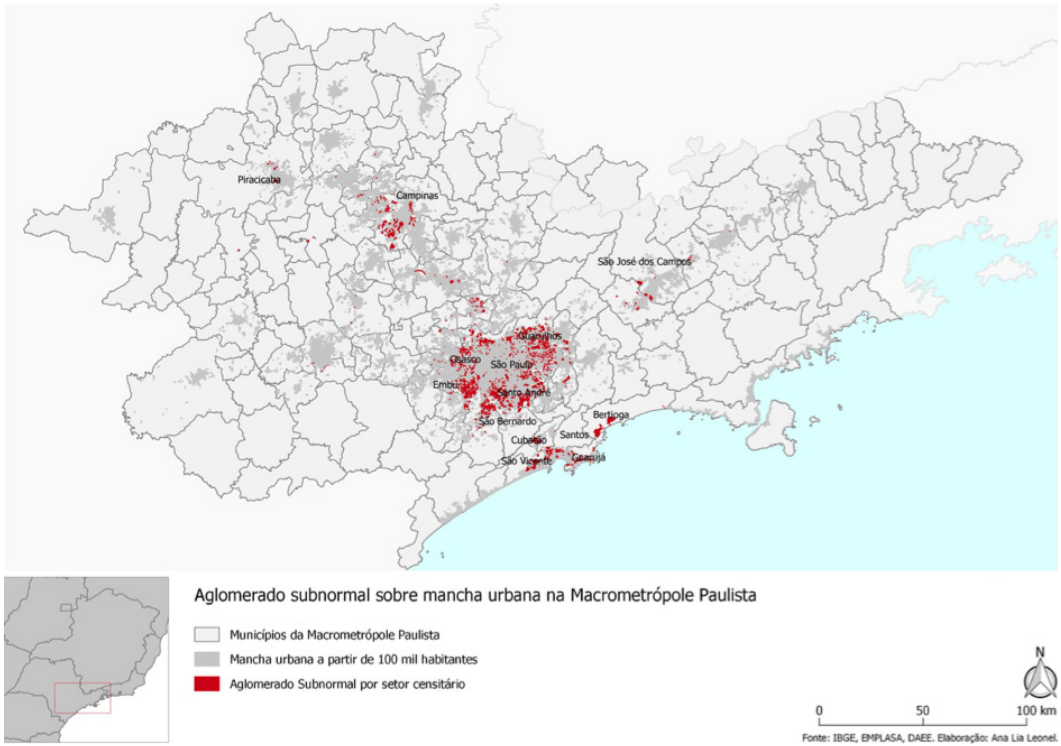

FIGURA 1. The various territories of the SPM. Source: IBGE Elaboration Ana Lia Leonel.

vulnerability (which, according to the concepts used in this article could be understood as an indicator of risk), which brings together exposure (changes in climate components) and sensitivity (biochemical effect of climate change, which includes what is here referred to as vulnerability), to determine potential impacts, and adaptive capacity (which are system responses to changes), to the scope of the Brazilian municipalities (MMA, WWF, 2017). In SPMM, the municipalities that present the greatest drought risk are those located in the Metropolitan Region of São Paulo, ranging from moderate to moderately high risk, in several scenarios studied.

Thus, if it is possible to infer that climatic changes complicate the solution of the pre-existing risks in the SPMM, it is also notable that only in directing territorial policies to solve these risks, which means prioritizing the most vulnerable communities, can respond to demands for adaptation be met. In this sense, to internalize it within the planning system, climate change can also be considered as an opportunity to break with path dependence in programs and interventions, innovating not only from the technological point of view, but also altering the location priorities of these innovations.

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CHAPTER 14

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Risk, Disaster and Adaptation at the São Paulo Macro Metropolis

The radical nature of extreme events and the disaster risk scenarios in the São Paulo Macro Metropolis (SPMM) impose the urgency of adaptation strategies to Climate Change. For this purpose, there is a need for an in-depth review of the urban structure and management focusing on governance and systemic vision on the macro metropolis flows and territorial links, while requiring a detailed look at municipal vulnerability and the impacts of human interventions on each hydrographic basin both for the water excess (floods and landslides) and the water crisis, and the increase and legitimacy of social participation in decision making.

In the current Brazilian urban scenario, the unquestionable need to implement public policies aimed at making cities socially and environmentally sustainable as a way of counteracting the scenario of growing deterioration of living conditions. The numbers of human losses in the summer of 2011 brought to light the social cost of tragedies related to natural disasters. The disorderly way cities have grown in the last 50 years has been the main cause of tragedies.

Therefore, in order to address risk, disaster adaptation in the SPMM, it is necessary to understand the historical process of socio-spatial (dis)organization and the dynamic of the SPMM, whose natural resources, infrastructure, services and problems exceed the administrative limits of a single municipality by means of an interfederal governance. There is the challenge of intergovernmental integration and the improvement of municipal governance, with qualified managers supported by an administration that develops strate-

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[2] University of São Paulo.

gic planning of municipalities, so that they can have a systemic, long-term and democratic vision.

We are progressing towards that. National political advances such as the National Policy on Protection and Civil Defense - PNPDEC (LAW N. 12,608/2012) are undeniable, the National Plan for Adaptation to Climate Change - PNAMC (2015) and the Statute of the Metropolis (LAW N. 13,089/2015), and at the regional level, the Metropolitan Climate Change Forum, the Integrated Urban Development Plan of the Metropolitan Region of São Paulo, and the contributions of the Metropolitan Thematic Chamber for Environmental Risk Management of the Metropolitan Region of São Paulo, which we will analyze hereafter.

THE URBAN CONTEXT AND THE VULNERABILITY INCREASE SURROUNDING EXTREME EVENTS

The majority of Brazilian cities, due to their history of urbanization, the characteristics of the physical environment and their modification by the land use and occupation, presents a great diversity of situations of urban environmental risks. They are "dysfunctions" or "hazards" of the urban environment with the potential to generate processes that can cause, and have caused, losses and damages to the people, property and infrastructure of the surroundings. Almost always, the causality of the risks can be explained by the process of land use and occupation and the appropriation of natural resources and, therefore, can be interpreted as a result of the unsustainable management of the urban environment.

In very big metropolitan areas, this social construction of risks is much more pronounced due to the almost absolute impermeability of the soil, the enormous demographic concentration and density of the buildings, the socio-spatial segregation that reserves the valley floors, floodplains and the steeper slopes to the poorest populations. Irregular occupations in areas of springs and slopes reflect the lack of options for the urban poor. Due to the overlapping of private interests and social demands in the distribution of land in large cities, with no resources to build or buy real estate on safe land close to the center, the poor population is forced to live in regions with difficult access, with no consolidated urban structure and often in areas of potential risk (MARICATO et al., 2010).

The Master Plans of towns foresee instruments to avoid this problem, such as the creation of Special Zones of Social Interest – ZEIS (exclusively for low-income housing) and the progressive tax on vacant or underutilized properties that do not fulfill their social role and force the needy population to look for alternative housing in the outskirts. However, the pressure of the real estate sector causes constant distortions, and governments, for the most part, give in to economic interests to maintain political support, and fail to apply the existing rules and remain the logic of continuity of a process that stimulates and reinforces the disordered occupation of the land. What can be observed is that more than a great natural catastrophe, "announced tragedies" are formed as a consequence of decades of neglect of the public power with urban planning, public regulation, master plans, laws of urban land use and occupation, building and behavior regulations, and housing policy.

There is, however, a new component to this "risk system". The technical-scientific

studies detect, more confidently every year, the trends and impacts of climate change on Brazilian cities and especially on large urban concentrations, such as the São Paulo Macrometropole. Extreme temperature and rainfall events, high concentration of pollutants due to poor air dispersion, and a higher incidence of infectious diseases would greatly affect the health and quality of life of the population. Regarding the hydro and geodynamic processes, we can already see in our cities, associated with torrential and concentrated rains, great floods and inundations, downpour with a high power to drag, landslides on slopes and ramps. In the towns of Baixada Santista, the recurrence of undertows and acceleration of coastal erosive processes is observed. In contrast, long periods of water scarcity, the water supply to the population and economic activities are affected (NOBRE et al, 2010; MARENGO, SCARANO, 2016; RIBEIRO, SANTOS, 2016).

The National Plan for Adapting to Climate Change - PNAMC (BRAZIL, 2015a) considers that the main vulnerabilities of the metropolises to such processes are related to the enormous social inequality related to housing and sanitation problems originating from poverty, besides rainwater drainage problems associated with the intense soil sealing. Among PNAMC's priority guidelines for promoting adaptation to climate change are: a) to strengthen and improve urban expansion planning processes and models, in addition to actions of Sustainable Urban Drainage and review of technical standards and regulations of building and urban parameters with the perspective of preventing the occurrence of natural disasters and the emergence of risks; and b) to consider adaptation to climate change in the rehabilitation of consolidated and degraded urban areas with installed infrastructure in the promotion of urbanization of precarious settlements and the full-scale production of social housing. And the specific guidelines for risk and disaster management (BRAZIL, 2015b) indicate: a) Regulation of Law no. 12,608/2012, fulfilment of planned actions and elaboration of the National Plan for Civil Protection and Defense; b) encouraging research focused on the understanding of the path from risk to disasters; and c) consolidation of an Early Warning System.

Objectively, we have a very clear and present identification of a threat, a danger, and some generic intentions. It's a beginning. Its continuity and materiality, however, require planning and management processes based on a long-term vision and on prevention rather than on emergency and curative action, which we did not see during the water crisis in the Metropolitan Region of São Paulo (MRSP) in the period between 2014 and 2016. The decrease in the volumes of water in the reservoirs was mainly treated as a climatic problem due to the lack of rainfall without any interaction with the population increase of the region or with the land use and occupation, excluding the complexity of a great metropolis like São Paulo and demonstrating the inaction of government representatives.

Notwithstanding the fact that large portions of the peripheral districts of the Metropolitan Region of São Paulo had problems with regular water supply, the São Paulo State government sought to create a narrative that denied the crisis in the system and the need for rationing, a narrative sustained by the great media that reported the crisis in a way that would take the responsibility away from the water governance system in the State. Thus, visibility is no longer given to impacts at different levels, from municipalities with water supply disruption, to negative impacts on the aquatic ecosystems of reservoirs and rivers. The scenario of water scarcity, reinforced by climate change, became worrisome and was

aggravated by the lack of communication and dialogue on the part of the Government of the State of São Paulo on the seriousness of the situation. The lack of proposals and information that contributed to a deep discussion among the different water users of the Cantareira System has led to the water depletion of the main reservoir of the Metropolitan Region of São Paulo.

But even though the greatest problem was the lack of rainfall, the lack of or the non-existing capacity of the State Government to articulate preventive and adaptive actions, it remains exposed that in practice decision-making does not consider the integration between the different socio-environmental public policies. With an absolutely technical and centralizing discourse, the State of São Paulo has removed any integration with the population, making it difficult to involve society in the discussion of both the cause of the crisis and the possible solutions to address the problem, increasing the water vulnerability of the population of the Metropolitan Region of São Paulo, as well as the institutional vulnerability in dealing with climate change and its associated risks.

POLICY DEVELOPMENTS IN REGIONAL GOVERNANCE FOR RISK MANAGEMENT AND ADAPTATION

Law no. 13,089/2015, which establishes the Statute of the Metropolis, provides general guidelines for the planning, management and execution of public functions of common interest in metropolitan regions and in urban agglomerations established by States, as well as general rules on the integrated urban development plan and other interfederal governance instruments (BRAZIL, 2015). With an innovative character, the Statute believes in promoting the metropolitan development of territorial units in macro scale from the recognition of the processes of metropolization of Brazilian cities for the urban planning of Metropolitan Regions and Urban Agglomerations. The purpose is to structure a national policy of metropolitan development, which in general terms, is aimed at policies in the sectors of housing, sanitation and mobility.

The metropolis results from a historical process, a socio-spatial (dis)organization with its own dynamics, characterized by its natural resources, infrastructure, services and problems that go beyond the administrative limits of a single municipality. Therefore, the proposal of an interfederal governance aims to propose actions for better use of this territory, guaranteeing its functions with quality, complying with legal requirements and attending to development based on environmental, economic, cultural and socio-political sustainability (SANTOS, 2018).

Based on these principles, the Integrated Urban Development Plan (PDUI) deals with a permanent planning process, that establishes the guidelines for the articulation of municipalities in land use planning and subdivision, which presupposes the study and mapping of the metropolitan area and the integrated vision of the territory, promoting the urban development of the metropolitan region or urban agglomeration. To this is added the task of delimiting the areas with restrictions to urbanization due to the protection of the environmental or cultural patrimony, as well as the areas subject to the special control due to the risk of natural disasters. This presupposes the articulation with existing environ-

mental and heritage bodies, and with discussion forums such as river basin committees (BRAZIL, 2015).

In the case of the process of elaboration of the PDUI of the Metropolitan Region of São Paulo, coordinated by the São Paulo Metropolitan Planning Company – Emplasa, the topic of Risk Management was considered as one of the strategies for Metropolitan Action. The works of the Metropolitan Thematic Chamber for Environmental Risk Management[3] were fundamental for this theme to be treated in an integrated manner with the other aspects addressed in the metropolitan urban development issue (EMPLASA, 2018).

Taking the experience of the Civil Defense Working Group of the Greater ABC Inter-municipal Consortium and understanding the need for a metropolitan articulation for Urban Environmental Risk Management, reinforced by the high vulnerability to risks and by the large contingent population, a mobilization was initiated among actors who work on this theme in order to create a metropolitan governance regarding the theme. A task force concluded with the finalization of the PDUI Book of Proposals approved by the Council members who participated and followed the development of the PDUI.

The main proposal is centered on a Metropolitan Plan of Urban Environmental Risk Management, which is the instrument that will give substance to the guidelines and strategies for the Urban Environmental Risk Management in the Metropolitan Region of São Paulo, and is organized in four programs: Program 1 - Knowledge production and identification of environmental risks in the Metropolitan Region of São Paulo; Program 2 – Risk Prevention and Mitigation in the Metropolitan Region of São Paulo; Program 3 - Emergency Response and Disaster Management in the Metropolitan Region of São Paulo; and Program 4 – Communication and Risk Education. All programs dialogue in some way with the PDUI's action strategies dealing with Green Area and Protected Areas Systems, and the Confrontation of urban and housing precariousness.

PROPOSALS FOR AN INTEGRATED AND PARTICIPATORY MANAGEMENT

Considering that the São Paulo Macrometropolis is one of the largest urban agglomerations in the Southern Hemisphere, working on governance issues in this territorial cut-off considering urban environmental risks is a great challenge in Environmental Governance Thematic Project of the São Paulo Macrometropolis in the face of climatic variability. Accompanying the elaboration, approval (by law) and implementation of the PDUIs of São Paulo, Campinas, Sorocaba, Piracicaba, Santos, Jundiaí with respect to actions and proposals that deal with environmental risks demonstrates the strengthening of the construction of a governance process.

However, it is also important to discuss public participation in decision-making

[3] The Thematic Chamber formed during the 8th Regular Meeting of the Development Council of the São Paulo Metropolitan Region, held on November 25, 2014, aims to articulate the actors, both of the Public Power and civil society, to promote and guarantee the articulation process for urban environment risk management (geological, hydrological, meteorological, climatological and technological), in line with the PNPDEC guidelines and strategies (Federal Law no. 12,608/12).

processes to ensure transparency and access to information so that interested parties can appropriate the problem and, then, engage and cooperate towards mitigation and/or adaptation actions. For this reason, it is fundamental to adopt a new integrated and participatory management strategy that considers society as protagonist in both decision-making and social control of the decisions that will be implemented. This requires a governance model that allows for cooperation and co-responsibility to guarantee access to common resources, such as water.

The integrated management of urban environmental risks in the face of climate change can be based on institutional management and on governance organized in three fundamental axes: (i) the production of knowledge of risk for the SPMM, focusing on water and its flows and micro basins as a unit of analysis, to deepen and consolidate a diagnosis of regional water vulnerability from an ecosystemic viewpoint of the aquifers that supply us; (II) the implementation of measures and strategies for risk reduction, including preventive or prospective interventions aimed at avoiding the installation of risk situations (Prevention), corrective measures and interventions of already existing risk situations (Mitigation), as well as the creation of mechanisms for legal support of such actions (Technical and Legal Norms) and financial instruments (Funds and Insurances) to guarantee resources for emergencies and for post-disaster recovery (Risk Transfer); and (III) disaster and emergency management (Adaptation), articulating the responsibilities of the bodies accountable for protection and civil defense, health and social protection, with the involvement of the population by means of educational actions and risk awareness management, to increase its protagonism in emergencies and its resilience to disasters.

The ongoing initiatives seek to broaden the dialogue on the water crisis, the vulnerability and uncertainties inherent in the unsustainable model of the society we are building, and bring to the discussion two points that deserve to be highlighted: the possibility of society acting by means of organized actions and the fragility of the current governance process. In this regard, Risk Reduction Platforms are needed at all levels, that is, forums for debate and decision that aggregate the main actors and public, private and community institutions in the process of discussion. Given the fragility of most part of Brazilian municipalities, it is recommended to create regional forums, in the Intermunicipal Consortia, in the Basin Committees or other structures, that are organized by each of the fundamental axes and integrated into thematic forums, such as the Housing, Climate Change, Infrastructure, Water Resources and others.

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CHAPTER 15

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Reflections on coastal climate change adaptation in the context of the São Paulo Macrometropolitan area

Climate Changes (CC) are several environmental changes affecting different social-ecological processes, at different spatial and temporal scales and with different magnitudes. The Coastal Zone (CZ) stands out for its importance in the provision of benefits for humanity, and also for its special vulnerability to CC given its synergy with the effects of anthropic activities in marine and terrestrial areas, both at the local and regional level.

The main effects of CC in CZ are related to sea level rise (SLR), changes in wind and wave regimes, increase in the frequency of rainfall and temperature extremes, and decrease in the sedimentary contribution of the river basins. These may result in risks to social welfare, mainly due to the increase in coastal erosion; loss of properties and lives; loss of biodiversity; salinization of groundwater and increased socioeconomic vulnerability.

These risks are amplified by land use and occupation patterns of the terrestrial and marine territory. They already affect coastal communities and are expected to be intensified in the coming decades (TURRA & MAIA, 2015). Thus, it is necessary to consider them for strategic planning of territorial development, promoting adaptation measures that aim to reduce social-ecological vulnerability, without compromising the sustainability and resilience of ecosystems and the multiple benefits derived from them (TURRA & MAIA, 2015).

The Ecosystem Approach, or Ecosystem-Based Management (EBM), proposes

[1] Oceanographic Institute of the University of São Paulo.

long-term planning that considers the connections and interrelationships between the ecological and social dimensions of a social-ecological system, and how these connections affect the system itself and the benefits derived (LESLIE; MCLEOD, 2007). This approach recognizes the political dimension of the planning process at multiple spatial scales, stemming from the contemporary human values and interests of different social groups, thus necessitating a dialogue with or improving the governance system in force in a given region (CHAPIN III et al. 2010).

This chapter aims to discuss the promotion of EBM in the São Paulo macrometropolitan area (MMP, from the Portuguese term Macrometrópole Paulista). To do so, we present the Coastal Zone of the MMP (MMPCZ) and how it is being impacted by the CC, as well as the existing policies and plans that address the issue. Based on this scenario, a reflection will be made to **guide the decision-making process** to develop **strategies for CC adaptation** of the MMPCZ.

THE MMPZC – CHARACTERISTICS, LIMITS AND DEFINITION

The MMPCZ comprises the Northern Coast of São Paulo (LNP, from the Portuguese: Litoral Norte Paulista) and the Metropolitan Region of the Santos Bay (RMBS, from the Portugues: Região Metropolitana da Baixada Santista)(Figure 1). Both regions are affected by the flows and pressures of the São Paulo Metropolitan Region (SPMR) and other urban agglomerations of the MMP, which introduce or induce activities that conflict with the natural vocation of the CZ of São Paulo, causing significant negative local impacts (SANTOS; TURRA, 2017).

The duality of the MMPCZ is expressed in its environmental and economic importance. This region encompasses a wide diversity of ecosystems, many of which included in nature conservation units, together with ample infrastructure focused on tourism, port, oil and industrial activities, relevant at national and international levels.

Currently, the main vectors of pressure for MMPCZ are related to the exploration and production of oil and gas in the Santos Basin, and the increased demand for coastal expansion and infrastructure for industrial and services sectors. These pressures directly influence migratory flows to the CZ, increasing the annual rate of population growth in the region, higher than the state average. This growth, coupled with a model of seasonal and degrading tourism and inefficient urban planning, results in the aggravation of recurrent problems, such as irregular occupation and precariousness in the provision of public services mainly associated with sanitation, which are managed in an uncoordinated and non-effective way by the public administration.

Considering a climate change (CC) scenario, such problems tend to be amplified and increase the vulnerability of the MMPCZ (Figure 2) (PBMC, 2016). For the RMBS, as an example, there should be an increase in the frequency and magnitude of winds and extreme storm events, the height of the waves reaching the coast, and the relative height of the sea level by an average of 1.2 mm.years-1 (PBMC, 2016). With CC, these environmental changes will intensify, affecting structures such as ports and marinas, housing, tourism facilities, and reducing/threatening the provision of social welfare provided by coastal

ecosystems to the CZ and the entire MMP.

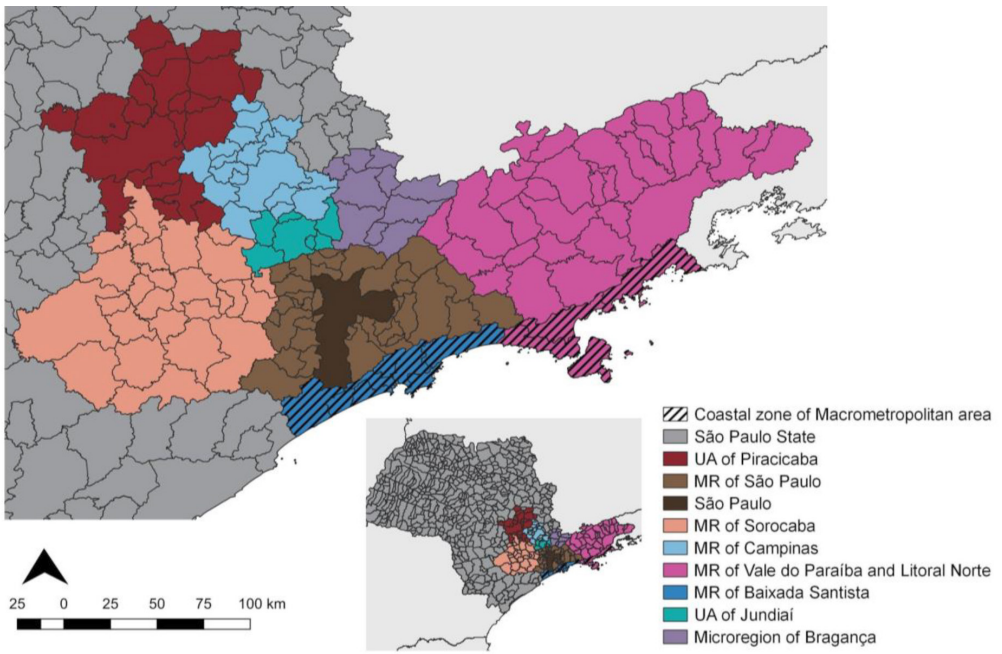

FIGURE 1: Macrometrópole Paulista (MMP) territorial approach, with emphasis on the coastal zone.

In this context, the challenge is to develop adaptation strategies aiming at the sustainability of the MMP area and not in an isolated way within its parts.

POLITICS AND PLANS FOR COASTAL CLIMATE CHANGE ADAPTATION IN BRAZIL

CC adaptation is an agenda under implementation in Brazil and a major challenge given the extension of the Brazilian coast, the number of cities in situations of high or very high vulnerability, regional inequalities and limited adaptation capacity (PBMC, 2016). All of the seventeen Brazilian coastal states suffer from natural hazards that will likely be increased with CC, but few regions have initiated effective and structuring actions to deal with them.

At the national level, discussions and actions to CC adaptation are supported by the National Adaptation Plan for Climate Change (PNA, for the Portuguese term Plano Nacional de Adaptação à Mudança do Clima[2]). The PNA (Decree no 150/2016) is an instrument developed by the federal government in collaboration with civil society, the private sector and state governments. It aims to promote the reduction of national vulnerability to climate change and to conduct associated risk management. The PNA has a chapter focused on the CZ, that identifies its current exposure to climate change, including the main impacts

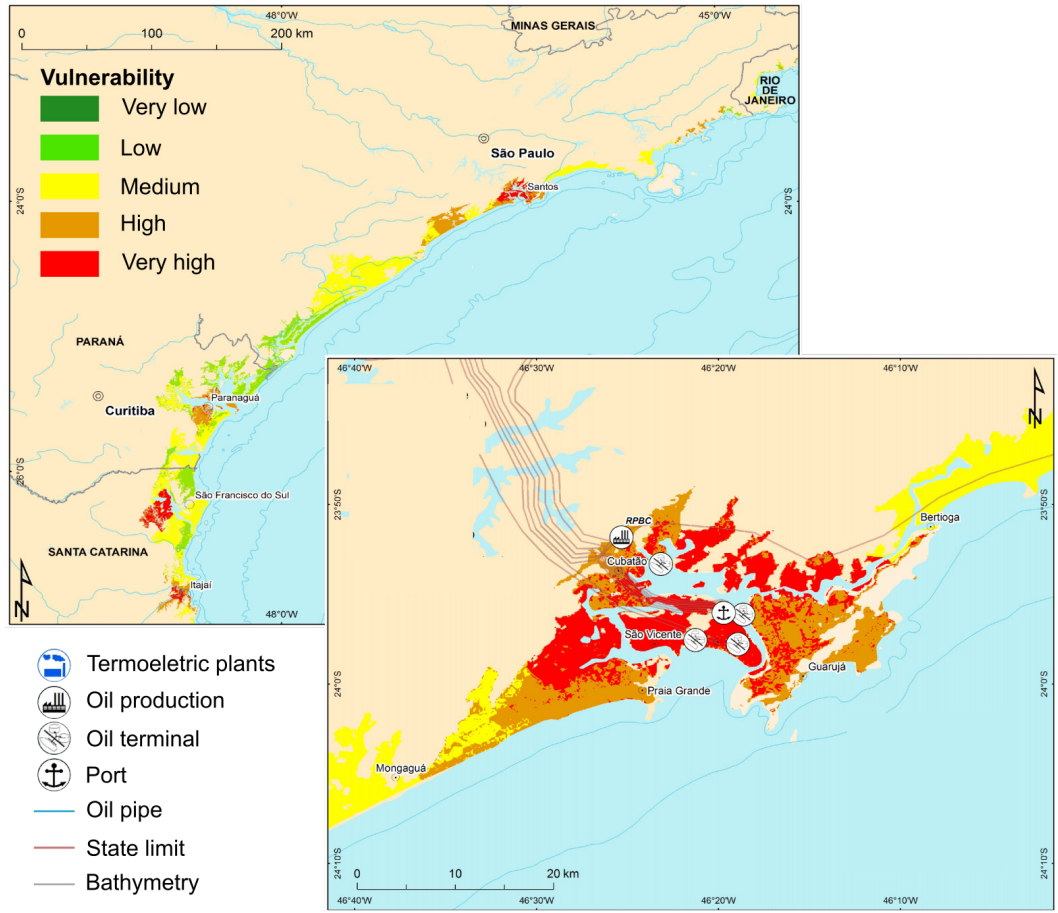

FIGURE 2: Climate change vulnerability of São Paulo's Coastal Zone, considering natural, social and technological risks. In detail, the Metropolitan Region of the Santos Bay (RMBS, from the Portugues: Região Metropolitana da Baixada Santista), in which higher risk levels are registered (Adapted from NICOLODI; PETERMANN, 2010)

and related vulnerabilities, indicating the guidelines and actions required to develop its climate resilience.

Some of the PNA guidelines for the CZ are materialized through the National Program for the Conservation of the Coast Line (Procosta), a permanent program for territorial planning and coastal zone management (Decree no 76/2018). Procosta objectives to generate data on a national scale and to understand the current situation of the CZ concerning the impacts of CC to propose possible alternatives for mitigation and adaptation

[2] http://www.mma.gov.br/clima/adaptacao/plano-nacional-de-adaptacao

to give subsidies to local strategies. Likewise, the "Guideline to Coastal Erosion Prevention and Protection" aim to assist local actions by highlighting the differences between alternatives for coastal protection, from the process of choosing best practices to the licensing and implementation rites. This guide calls attention to the need for the implementation of more sustainable coastal infrastructures, demonstrating that simple or large coastline structures should be preceded by protocols that guarantee effectiveness, longevity and environmental viability.

At the state level, the State Environmental Policy and the State Policy for Climate Change establish the Ecological-Economic Zoning (EEZ) as the main instrument for territorial planning . Based on local models for sustainable development, the EEZ disciplines the economic activities, the rational use of natural resources and the soil use and occupation pattern. Considering MMP as a new planning unit, it is necessary to detail the EEZ for the MMP, in a proposal that considers all the dynamicity of the territory, integrating its orientations to the different scales, municipal, regional and macrometropolitan. For the CZ, territory planning should also be guided by the Orla Project, which objective is to integrate the environmental, urban and property policies in the integrated management of the coastline.

It is still imperative to consider the different sectoral policies that address the additional threats/stressors to CC, such as sewage, garbage and others, for mitigation and adaptation proposals. For example, environments less impacted by additional stressors are, at first, more likely to be more successful in dealing with CC impacts. This is true even for nature conservation units so that the National Conservation Units System and the creation of effective conservation units can play an enormous role as a mitigation and adaptation CC measure.

REFLECTIONS ON ADAPTATION TO CLIMATE CHANGE IN THE MMP COASTAL ZONE

The CC adaptation in MMP demands governance innovations, such as the application of EBM to promote integrated actions for coastal management (Figure 3).

Before starting the process it is necessary to identify and engage the different types of actors related to the theme (Step 0), seeking to create the governance system within the planning will take place. Risk is a social construction, then to the need for adaptation be perceived it is necessary to awaken people to it, involving them in the planning process. In the case of the MMP, it is necessary to involve actors who are not necessarily used to think about the CZ as a whole, considering both its effect on it and its effect on its activities.

Step 1 includes an assessment of coastal vulnerability and analysis of how CC impacts will affect coastal communities, the provision of social welfare by the region's ecosystems, and the built infrastructure, considering their effects on the benefits generated by the MMP. The vulnerability assessment for CC in coastal regions generally considers three factors: the nature and magnitude of CC variability; the human resources and natural capital that will be exposed and impacted by CC; and the current adaptability of coastal communities and ecosystems. This assessment provides the baseline information for

STEP 1 *Identify and engage social actors*	**STEP 2** *Evaluate vulnerabilities in to climate change*	**STEP 3** *Select course from action to take*	**STEP 4** *Include actions in the other policies*	**STEP 5** *Implement adaptation action in MMP*	**STEP 6** *Assess progress and promote adaptive management*
Who will be impacted? Which populations? Who has knowledge about? Who has the 'power' to act?	What are the projections for the territory? What are the risks? Whats is the capacity of society to face the estimated impacts? Where will the impact be greatest? Where is the system more resilient?	It involves the identification of adaptation goals ans strategies to achieve a givem goal.	Adaptive responses should be integrated into relevant development policies, plans, programs and projects at the national, subnation and local scales. There are many entrey points fot the integration of coastal adaptation.	Assess existing administrative, institutional and personnel capacities; the availability of funding, legal structures, monitoring structures; information gaps, the cost of acting *versus* not acting; maintain scientific data and monitoring to sustain measures; political leadership and other.	The evaluation of actions must be constant, since adaptation is a continuous and iterative process that will benefit from the periodic evaluation of performance, along with an adaptive management process to adjust the implementation.
MMP actors, Mayors of the 13 coastal cities of MMP, Governor of the State of São Paulo, State and municipal secretariats of environment, urban planning, fishermen, tourists and others.	The social impact if greater where is the greater human coastal occupation. Mangrove preservation and coastal fortification actions are options to avoid relacation of communities.	The goals and objectives should be discussed with the various MMP stakeholders and may include social, economic and environmental goals.	Master Plan, National, State and Municipal Plan of Climate Change, EEZ of the North coast ans Santos shoreline. Coastal Protected Areas management plans.	Lack of continuous coastal monitoring data, short-term actions, lack of political will, little funding for adaptation actions.	Use coasta monitoring data fo assessment, as well as the perception of coastal actors on the effectiveness of measures taken.

FIGURE 3: Step-by-step to establish climate change adaptation strategies in MMP ZC. In the first line are the guidelines of the approach, in the second line a generic explanation and in the third line suggestion of application to the territory of MMP. (Adapted from USAID, 2009)

planning and should be based on the best available knowledge.

In Step 2 the selection of a course of action to deal with climate vulnerability involves the identification of adaptation and assessment goals. Coastal areas may be subject to a variety of climatic impacts and have different degrees of vulnerability, so it is imperative to prioritize actions.

The main categories for actions, which are common among different coastal adaptations programs include:

1. Maintenance of functional and healthy coastal ecosystems;
2. Reduce environmental exposure and vulnerability for CC;
3. Strengthen governance structures for coastal adaptation;
4. Maintain livelihood opportunities and diversify options;
5. Reduce human health and safety risks.

One of the main steps of this approach is to promote the integration of policies and instruments for coastal and marine zone management (Step 3). In the face of CC and with the increase of extreme climatic events in coastal cities, risks and vulnerabilities mapping must be urgently embedded in the planning, and budgeting, of the Federal, States and Municipal administration. Adaptation strategies should be understood as a key challenge for the management of the uses of coastal resources and should be 'integrated' into coastal and sectoral policies at all levels, as well as, in the case of MMP, metropolitan and state policies, to increase its effectiveness (BRAZIL, 2016). Some ways to promote this integration are to support (1) public policies at the national or regional level, (2) investments and sectoral projects, and (3) subnational initiatives. In the context of the MMP, it is imperative that the discussions on Marine Spatial Planning, the creation of protected marine areas, as well as the goals established in the Federal Plan of Action for the Coastal Zone, and the initiatives developed at the federal, state and municipal committees of coastal management and river basins, such as the Coastal EEZ, the Orla Project and the River Basin Plans, include measures to adapt to CC.

Step 4 deals with the challenges of implementing the proposed actions, which are varied and include dealing with the political-institutional weaknesses of the management system. Many of these challenges can be anticipated and addressed in the previous steps before the implementation phase, as they become evident. Recommended actions include periodic reviews at the national or local levels to ensure that agencies and communities are aware of successes and failures.

At the final step, Step 5, the evaluation of the proposed and implemented measures is carried out. It is the process of reviewing and analyzing all relevant data and information to determine if the proposed actions are meeting society's expectations and contributing to adaptation. It is at this stage that adjustments to the course of action can be proposed and that new actors can and should be involved in the process. This approach is an adaptive cycle to climatic processes in the coastal zone, which must be continuous and dynamic.

RECOMMENDATION FOR DECISION MAKING

It is imperative that CZ development is guided by scientific and technological knowledge, creating a strategic and integrated plan for CC adaptation. The theme is not new and has already been discussed in several international forums since Rio-92 with the approval of the United Nations Convention on Climate Change.

One way of promoting CC adaptation in the MMPCZ is by promoting a process for changing the actual paradigm, leading to more integrated policies, with social actors involved in decision-making, and ecosystem-based management embedded in the coastal zone. In order to propose strategies for CC adaptation in MMP, to deal with problems such as floods and erosion, it is necessary to identify and involve different governmental (municipal, state and federal) and nongovernmental institutions because the CZ problems related to CC are complex and there is an overlapping of legal competencies of the public agencies that act on planning, implementation, evaluation and monitoring CZ policies.

Therefore, new challenges in new territorial bases require innovative governance arrangements, which still need to be designed and implemented within the MMP. And yet, it is important to bring together research and management institutions.

ACKNOWLEDGMENTS

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CHAPTER 16

TIAGO S. VASCONCELOS [1]

Plans for safeguarding the MMP biodiversity under climate change

INTRODUCTION: CLIMATE CHANGE AND BIODIVERSITY

The current global climate change is generally characterized by the increase in the mean temperature of our planet's surface in approximately 0.85º C compared to 100 years ago (IPCC, 2014). Such changes, coupled to additional threats to our biological diversity (e.g., conversions of natural habitats, pollution, introduction of alien species, among others), are the main factors linked to the current biodiversity crisis, of which rates of biodiversity loss and degradation of ecosystems were faster in the last 50 years than at any other period of our evolutionary history (MILLENNIUM ECOSYSTEM ASSESSMENT, 2005). Though future projections involve the increase of 1.5 – 2º C in the global mean temperature (IPCC, 2014), even if the emissions of the greenhouse gases stopped today we would still fell the impacts in the biodiversity due to the inertia in the climatic system (PECL et al., 2017). Therefore, there is an urgent need for effective conservation actions to protect our biodiversity in a dynamic world of changing climate.

Biological organisms can respond differently to the climate change. This is true because climate regimes are the main determinants of the general patterns of species distributions. That is to say, if climate changes for different conditions, organisms will exhibit adaptive responses or, in the lack of such responses, will presumably be extinguished locally. Among the different adaptive responses, there is the recognition of three categories (BELLARD et al. 2012): a) physiological/behavioral; b) phenology, and; c) spatial. The first one involves metabolic and/or behavioral alterations that are within the range of adaptations that the organisms already have, such as dietary changes, peaks of daily activities, among others. The second case generally involves responses of phenological alte-

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ration thorough a year-basis on vital events of life cycles. Then, phenological alterations may include earlier or later flowering periods in plants, as well as seasonal migration activities of migratory animals to those periods of the year having the most suitable weather for them. Finally, the last case involves the capacity of organisms to move in the space to seek and track climatically suitable areas for their existence. Such a response is widely documented worldwide, so general tendencies involve poleward and/or upward altitudinal range shifts as a response to the current climate change (PECL et al. 2017 and references therein).

Therefore, if populations are not able to respond by any of the three above-mentioned adaptive responses to accommodate to novel climatic conditions, populations or species will become extinct locally or globally (BELLARD et al. 2012). Among the three above-mentioned adaptive responses, there is a wide range of individual and/or joint responses that help individuals to deal with the current climate change. Nonetheless, the pace and magnitude of such climatic changes are relatively faster than the capacity of response from the organisms. Additionally, there are also other threats to organisms that can act in synergism with the climate change (BELLARD et al. 2012). Thus, it is mandatory the incentive of descriptive studies and field surveys to document new species and/or new populations of species, coupled to the application of conservation biogeography approaches, in order to mitigate the potential climate change impacts on the biological diversity.

TOOLS TO MITIGATE AND MINIMIZE THE CLIMATE CHANGE EFFECTS ON THE BIODIVERSITY

Minimizing the climate change effects on the biological diversity basically involves two actions by the individuals and/or public domain: a) stimulating attitudes of sustainable practices (e.g., reuse and recycling of natural resources) that will ultimately reduce the emissions of the greenhouse gases to the atmosphere and avoid the presumed increase in the mean global temperature for the next decades; and b) understand how the biodiversity is presumed to redistribute in future climate change scenarios and establish dynamic biological conservation decisions considering these scenarios. I will basically focus on this second alternative because the first one is more related to social mitigating actions already detailed in other chapters of this book.

With the intuit to predict where organisms will be redistributed over different climate change scenarios, researchers usually make use of predictive tools called "species distribution modeling" (ARAÚJO; PETERSON, 2012). This method commonly estimates the climatic preferences (formally, the climatic niche) of a given species based on their known occurrence records. Subsequently, this climatic niche is thus projected in a given bioclimatic envelope of interest, such as future climate change scenarios. At the end, researchers will have a predictive map with the climatically suitable areas for the species occurrence in the given climate scenario (e.g., VASCONCELOS; NASCIMENTO; PRADO, 2018). The application of such a methodology for specific species with conservation concern or for entire biological groups is relevant to conservation decision-makers because they will have the information regarding where the biodiversity will be presumably distributed in

different climate scenarios. Then, regions with high or low biological diversity can be identified for different time periods. For instance, regions with current high biodiversity levels may be presumed to support lower biodiversity in the future and vice-versa (e.g., LEMES; LOYOLA, 2013), so specific conservation efforts within a given geographic space may be scheduled for a given time period according to the predictions of species distributions, which in turn increase the effectiveness of the biodiversity conservation and mitigation of the climate change effects on the biodiversity (ALAGADOR; CERDEIRA; ARAÚJO, 2014).

POTENTIAL CLIMATE-DRIVEN EFFECTS ON THE MMP BIODIVERSITY

The region encompassed by the São Paulo Macrometropolis (MMP) is within the Atlantic Forest domain (IBGE, 2012), which is predominantly made up of ombrophilous forests along the whole coastal region, the mixed ombrophilous forests at high-altitude regions (e.g., typically found in the municipality of Campos do Jordão), and the semideciduous forests mostly located northwestwards (e.g., the region of the municipality of Campinas to inlands). The bibliographical records show us consensus that ombrophilous forests (including the high-altitude mixed type) support high levels of biodiversity (e.g., plants, vertebrates and invertebrates animals). On the other hand, semideciduous forests support lower levels of biodiversity due to more seasonal temperature and precipitation regimes that are more striking at these areas (IBGE, 2012). Nonetheless, considering the whole MMP extension compared to other Atlantic Forest areas in other states, or even compared to other vegetation formations (e.g., the savannah-like vegetation of Cerrado located inlands), the MMP supports highest levels of biodiversity. This biodiversity does not solely include high number of species per se, but also high levels of phylogenetic (i.e., high number of species with different evolutionary histories) and functional diversity (i.e., high number of species with different ecological functions in the nature).

This high biological diversity considering the different ecological metrics usually leads different studies, using different taxa and biogeographic focus, to recurrently identify the coastal region of southeastern Brazil (so this encompasses the MMP area) as having high priority status for the biological conservation in the Atlantic Forest (e.g., LEMES; LOYOLA, 2013; ZWIENER et al., 2017). Although predictive studies regarding the potential species redistribution within the MMP area under different climate change scenarios are recent and performed for few biological groups, these studies basically find predictions of generalized species losses for the whole Atlantic Forest extension. This is found mainly as a consequence of the decrease in the climatically suitable areas for species under climate change scenarios (e.g., see figure 3 of VASCONCELOS; NASCIMENTO; PRADO, 2018, and references therein). However, despite these predicted species losses, the southeastern Brazil (specifically the MMP area) is still recurrently recorded as biologically important areas for conservation under different climate change scenarios. That is, considering the biogeographical context, the southeastern Brazil will still presumably support unique biodiversity with environmental relevance under future scenarios of climate change (e.g., LEMES; LOYOLA, 2013; ZWIENER et al., 2017). These areas are specifically located within the MMP areas of high altitude, such as the coastal area of Serra do Mar and Serra da Mantiqueira.

Considering this recognized biological importance, either for the present or for future predictions, increased conservation efforts for high-altitude areas within the MMP area are important actions to guarantee the historic-evolutionary legacy that is present in the biodiversity of this area. Compared to the existing Conservation Units (CUs) across the São Paulo state, the MMP region is reasonably well protected, due to the CU of Parque Estadual da Serra do Mar and some others along the Serra da Mantiqueira mountain chains. This environmental protection is relatively facilitated by the rough topography found within the MMP, which in turn makes difficult anthropogenic occupation. Nonetheless, all other remaining flatter lands, in which the human population is concentrated at urban centers, also need special attention regarding environmental planning for conservation. Then, it is important the identification and establishment of ecological corridor areas (in flat land areas) among major CUs that are mostly within rough topographic areas, so the biodiversity of the MMP will be less threatened by habitat loss and fragmentation processes (MILLENNIUM ECOSYSTEM ASSESSMENT, 2005). Therefore, we can guarantee the ecosystem functioning and biodiversity conservation of the MMP area, and ultimately, minimize the climate change impacts on a range of organisms, which in turn will support a better habitat quality for both biodiversity and the human population of this area.

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CHAPTER 17

JOSÉ A. MARENGO [1]

Brazilian Perpectives on Adapting to Climate Change in the Context of Urban Areas

CONCEPTUAL FRAMEWORK

The Fifth Assessment Report AR5 of the Intergovernmental Panel on Climate Change IPCC (IPCC, 2013, 2014) concluded that the recent warming detected during the last 50 years is due mainly to human influences. IPCC recognizes that poor people all around the globe are among the most vulnerable to the impacts of climate change consequence of global warming. In fact, among the major conclusions of the three reports of the AR5 IPCC (scientific basis, impacts-vulnerability-adaptation and mitigation) we have practices to promote sustainavel development in the present, by combining social justice, environmental health, and economical productivity, so to reduce future risks imposed by climate change, that at then end may become adaptation policies.

Adaptation means anticipating the adverse effects of climate change and taking appropriate action to prevent or minimize the damage they can cause, or taking advantage of opportunities that may arise. It has been shown that well planned, early adaptation action saves money and lives later. **Vulnerability** refers to the degree to which people or the things they value are susceptible to, or are unable to cope with, the adverse impacts of climate change. Thus, vulnerability determines how severe the impacts of climate change might be. ***Exposure*** is the degree to which people and the things they value could be exposed to climate variation or change. **Climate resilience** can be generally defined as the capacity for a socio-ecological system to: (1) absorb stresses and maintain function in the face of external stresses imposed upon it by climate change and (2) adapt, reorganize, and evolve into more desirable configurations that improve the sustainability of the system, leaving it better prepared for future climate change impacts. ***Adaptive capacity*** is the de-

[1] CEMADEN: Centro Nacional de Monitoramento e Alertas de Desastres Naturais.

gree to which they could mitigate the potential for harm by taking action to reduce exposure or sensitivity. These definitions appear in the IPCC Glossary of Terms (www.ipcc.ch) and were adopted by First National Assessment of Climate Change in Brazil, published the Brazilian Panel on Climate Change (PBMC 2013) and in the Special Report of Climate Change and Cities (PBMC 2017).

CLIMATE CHANGE ADAPTATION IN THE BRAZILIAN CONTEXT

There is growing recognition of the importance of adaptation and sustainability measures at the local level, since it is on this scale that various institutional arrangements are organized to address the dangers arising from environmental changes. Some actions include the increase and improvement of fiscal mechanisms aimed to reach adaptation, and the creation and / or improvement of structures that allow a collective and articulated management towards a common goal: more resilient cities with sustainable development.

Brazil has taken important steps in recent years to formulate and implement the National Adaptation Plan for Climate Change PNA (BRASIL 2016a). The NAP was published in 2016 and its general objective is to promote the management and reduction of climate risk in the country in the face of the adverse effects of climate change, in order to take advantage of emerging opportunities, avoid losses and damages, and to build instruments that allow the adaptation of natural, human, productive and infrastructure systems, aimed to guide initiatives for the management and reduction of climate risk in the long term. The NAP is organized into 11 adaptation strategies proposed for the sectors and topics listed as priorities for the country's sustainable development: Agriculture, Biodiversity and Ecosystems, Cities, Natural Disasters, Industry and Mining, Infrastructure (Energy, Transportation and Urban Mobility), Vulnerable People and Communities, Water Resources, Health, Food and Nutrition Security and Coastal Areas. Strategies discuss the main vulnerabilities, knowledge gaps, management of each sector and theme in the face of climate change and present the guidelines for implementing adaptive measures aimed at increasing climate resilience (Brazil 2016a).

In order to implement adaptation measures backed by NAP strategies and adapted to local needs and capacities, it is necessary to adjust the temporality of these studies to the time horizon of the Plan, 2040, and studies are currently being carried out to update this plan. The project called BRASIL 2040-Scenarios and Alternatives for Adaptation to Climate Change (BRASIL 2016b) is directed to estimation on how climate change would affect economic sectors in different horizons and suggest strategies for prevention and adaptation of different systems that could be affected. The studies were developed to support relevant processes under the NAP. One of the steps of the study was to identify some measures of adaptation to the scenario associated to the projections. Such measures involve expensive structures (e.x. dams to store water or construction of dikes in coastal areas), but also include simpler measures such as risk warning systems, changes in agricultural practices or the organization of social groups. The Adapta Clima Platform, coordinated and managed by the Ministry of the Environment (adaptaclima.mma.gov.br), was launched in December 2017 and contributes to the achievement of one of the main objectives of the NAP: Expansion and dissemination of scientific and technical knowledge and traditional:

production, management and dissemination of information on climate risk and to improve Brazil's adaptive capacity in the face of climate change. It represents a knowledge platform in adaptation to climate change, and is designed to build and make available systematized information in priority thematic areas related to adaptation to climate change and to promote communication and articulation between who produces and who uses knowledge.

EXPERIENCES WITH ADAPTATION IN BRAZIL

In general, there is a consensus that cities that present a participatory urban planning process, which guarantees democratic management, adequate housing, basic sanitation services (drinking water supply, sewage, urban cleaning, urban solid waste management, drainage and management of urban rainwater), as well as a quality road system and civil protection and defense services, are inherently more resilient to most of the impacts of climate change, according to the PNA (BRASIL, 2016)

The Climate Center / COPPE / UFRJ (2016) proposes the Adaptation Strategy for Climate Change of the City of Rio de Janeiro presenting a road map to reinforce climate risk management, combined with the generation of opportunities. This report includes a set of initiatives aimed at reducing the potential exposure and sensitivity of the city of Rio de Janeiro to climate hazards and strengthening institutional and people capacity. The Municipal Plan for Climate Change in Santos (CITY OF SANTOS 2016) is more than a set of rules, it represents a message, a clear sign of how a society can make commitments to the future, especially when this future puts us before a challenge such as climate change. There are still few experiences of local governance with greater participation of citizens, especially those focused on discussing ways of adapting to climate change. But the city of Santos, in the state of São Paulo, anticipates, recognizing this demand and places it as a priority in municipal management, ensuring the involvement of different segments of society in the formal and deliberative structure, which only exists in a society active, modern and conscious.

The Special Report on Climate Change and Cities (PBMC, 2017) discusses the adaptation of the coastal regions in Brazil. According to this study, several coastal areas of the country have high or very high vulnerability, with emphasis on the metropolitan regions of Belém, the capitals of the states of the Northeast, Rio de Janeiro and the port cities of Santos and Itajaí. High levels of vulnerability, combined with exposure to severe weather conditions and extreme weather extremes, may jeopardize the habitability of each region, as society constructs risk from its interaction with the physical world, transforming the natural event into different intensities and magnitudes. The city of Santos, located in the metropolitan region of Baixada Santista in the State of Sao Paulo and the largest port in Latin America, has seen sea level rise by 1.2 mm year-1 since the 1940s (PBMC 2017). Santos is vulnerable to rising sea level and flooding, and infrastructure vulnerability is critical. In a pioneering study on the economic impacts of adaptation, the international project on coastal vulnerability METROPOLE was developed in Santos, where coastal vulnerability to flooding due to hangovers, intense storms and elevation of the mean sea level in the northwest and Ponta da Praia (southeast) were evaluated. An impact model was used to assess

the cost of real estate losses with and without adaptation measures. The adaptation strategies were defined by the population, which participated in two workshops that were attended by civil society, scientists, commercial and tourism sectors and decision makers of the city of Santos. These were organized to discuss possible adaptation measures in various scenarios. Without adaptation, the economic loss to 2100, in the southeast region, in a scenario of low sea level rise (0-0.36m) for a 1-in-100 year storm would reach R $ 870,093,165, and for a scenario of high sea level rise (0.36-0.45m) can reach R $ 1,043,498,249 in the same southeast region of Santos.

The adaptation proposals considering these scenarios of impacts in the southeast region of Santos were more focused on the infrastructure part. For the Ponta da Praia region, 66% of the participants chose fortification as the main adaptation measure, and 30% voted for accommodation. In the northwest region of Santos, 50% decided on fortification and 43% in accommodation. Replacement was the least voted, with 4% in Ponta da Praia with 7% in the northwest of Santos. The adaptation measures proposed by the population for the northwest and southeast regions suggest dredging and recovery, and restoration of mangroves in the northwest, and beach entanglement and dune restoration, and reinforcement of dams already existing in the southeast zone, all of them fortification measures. Local and traditional communities operate in a very close relation to services provided by protected natural areas, or sustainably managed by these populations. Reducing the vulnerability of these local communities to climate change and its potential impacts requires a combination of public policy instruments related to biodiversity conservation and ecosystem services (e.x. establishment and effective management of protected areas, community management of natural areas, restoration ecological), and socioeconomic options aimed at diversifying livelihoods, increasing income generation and reducing poverty. We call this type of Ecosystem Based Adaptation (EbA)(SCARANO 2017). Natural ecosystems are more resilient and recoverable when affected by extreme weather conditions, and provide a wide range of benefits that people depend on - ecosystem services. Despite this preponderant role, studies that relate climate changes and alternatives to EbA in Brazil are still scarce (SCARANO 2017).

FINAL THOUGHTS

A review of the current NAP shows barriers to integration with adaptation in cities, among other things: that adaptation planning is scarce or short-term at most levels of government; that there is a lack of governmental structuring actions to implement the adaptation agenda in the municipalities; that there is little integration of climate policies, especially adaptation, with planning instruments at different levels and sectors, and that the adaptation agenda is not considered a priority for managers in federal, state or municipal government. Vulnerabilities stem from the fragility of human settlements in relation to dangerous climatic phenomena and are linked to circumstances such as location, area of influence and resilience - all intrinsically linked to different environmental, social, economic and political conditions. Exacerbated changes in the hydrological cycle by global warming tend to accentuate the risks of existing hazards, such as floods, landslides, heat

waves and limitations of drinking water supply. Most human activities today are concentrated in cities, and consequently urban centers play a key role in tackling climate change.

Local governments face many challenges in their efforts to mitigate and adapt to climate change. In cities, global warming is just one of several issues on the local agenda. Governments are also confronted between current priorities and long-term risks, and this situation is aggravated by the uncertainties that may involve the timing and severity of climate-related impacts in a city.

ACKNOWLEDGMENTS

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CHAPTER 18

MARIANA NICOLLETTI [1]

Paths to the climate change adaptation agenda in Brazil: from national to municipal level

ADAPTATION TO CLIMATE CHANGE: FROM THE INTERNATIONAL TO THE LOCAL LEVEL

The theme of adaptation to climate change was first proposed at the international level in the Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) in 1995. The Panel's Third Report, in its turn, pointed out, in 2001, that the changing climate was already affecting the physical systems (such as water resources) and biological systems (as ecosystems and human health), as well as the human systems (clashed by droughts or floods for instance). With the advancement of climate science and the difficulties to ratify the Kyoto Protocol, adaptation has established a political agenda around initiatives and measures to promote adjustments in natural and human systems to tackle the current and expected impacts of climate events, reducing harm and exploiting opportunities (IPCC, 2001).

This chapter is dedicated to discussing the importance of local action (at the municipal or regional level) so that socio-environmental systems can effectively become more resilient to extreme weather events (such as storms and hot waves). The focus is on the challenges and pathways for the national adaptation agenda to be translated into consistent local actions in relation to the federal plan and coordinated with other local policies (e.g. urban development ones). Both the arguments on the importance of the local agenda and the challenges and pathways explored in the following sections are anchored in empirical basis: public policies and actions, experiences and learning of adaptation efforts in Brazil. Before going forward, it is worth detaching three central characteristics of the agenda, which turn it in a new domain of public policy and make the local level the primary

[1] Fundação Getúlio Vargas/CES.

floor for acting:

- Socioenvironmental systems are affected by climate events in different intensities according to their biophysical, social and economic composition and to the extent to which they are vulnerable (exposed and sensitive) to climate events derives from well--known structural problems, such as poor housing conditions;
- Thus, the effects and impacts of climate change occur locally, in a specific way in each territory, which is understood as the conjunction of flows of resources, information, people and relationships conformed in everyday life, crossing geopolitical borders; and
- It is a multidisciplinary subject that demands knowledge from several fields, and an agenda that requires the involvement of different actors and sectors, so that viable and effective solutions - capable to reduce impacts and vulnerabilities in the short, medium and long terms - can be formulated and implemented.

Adaptation is therefore a complex, multi-level agenda (the three levels of federation are involved) and multi-scale (various sectors and social and economic actors are affected and relevant) (CASH et al, 2006). Strictly top-down approaches (from national to local), as well as purely bottom-up (from local to national), are not appropriate to think on public policies on this agenda; it is necessary to combine both. Also, due to its direct relationship with many other public policy areas, it is necessary to mainstream adaptation into an array of processes and instruments of public policies (MARGULIS, 2017), especially the territorial ones, such as master plans and integrated urban development plans.

THE ADAPTATION AGENDA IN BRAZIL

POLICY AND INSTRUMENTS AT THE FEDERAL LEVEL

The National Policy on Climate Change (PNMC, in Portuguese acronym) was established in 2009 and determined principles, objectives and guidelines for adaptation. Among the instruments of PNMC is the National Plan for Climate Change, which embraces guidelines for mitigation and adaptation. The National Adaptation Plan (NAP) was established in May 2016.

Coordinated by the Ministry of the Environment (MMA, in Portuguese acronym), the NAP is dedicated to reducing the national vulnerability to climate change and to managing the risk associated with this phenomenon. One of its specific objectives is to coordinate and promote cooperation between public bodies and civil society. The Plan affirms that the protagonism of Municipalities, through decentralized and articulated actions, is fundamental for building resilience in the country (MMA, 2016).

In spite of this, the Working Group responsible for drawing up the NAP was formed by ministries and federal bodies, the representatives of Municipalities did not participate directly in the preparation of the Plan, which results in difficulties for its implementation. The more challenging and complex a policy is, the more important is its legitimacy with

relevant and interested stakeholders, which necessarily involves discussing its objectives and negotiating different opinions throughout formulation (CROSBY, 1996).

The governance for the NAP's implementation is under construction. The document itself recommends the creation of "a permanent forum for concertation with state governments and representation of municipalities, whose role will be to elaborate and propose guidelines and technical recommendations" (MMA, 2016: 38). The point is not only to make NAP's content to reach states and municipalities, but to foster the development of local adaptation agendas, adherent to the territories, which consider the National Plan and, at the same time, feed back the federal agenda, in a continuous cycle of implementation, monitoring and review of the capacity building and shared management of resources.

CHALLENGES TO ADVANCING THE ADAPTATION AGENDA AT THE LOCAL LEVEL

At the subnational level, currently, there is no up to date database with experiences on climate change policies. It is estimated that 16 state laws have been sanctioned and it is known that some states and municipalities have already developed adaptation programmes and plans, such as Espírito Santo, Minas Gerais, Paraná, Pernambuco and the cities of Rio de Janeiro, Salvador and Santos (ETHOS, 2016, MARGULIS, 2017).

Three categories of challenges lie in the formulation and implementation of municipal public policies on adaptation: governance arrangements - which involves the clear definition of roles and responsibilities at each level of government; institutional capacities - in particular skills and support networks within and outside government; and availability of resources - including technical knowledge, data and information.

Regarding governance arrangements, municipal instances need to be assigned or created to assess information, plan, design adaptive measures and monitor the implementation. The most challenging is that such instances, as climate change committees, are vertically connected to other levels of government, horizontally to other public policy agendas, and have the active participation of other sectors and social groups - as advocated by the PNMC and NAP. This broad movement of articulation between federation entities and social participation is necessary given the diversity of issues and agendas involved (e.g. infrastructure, mobility, housing) and the extent of impacts and vulnerabilities (reaching different groups and sectors in particular way). Therefore, effective adaptation policies (strategies, plans, programmes) demand that diverse points of view are represented and that many areas and types of knowledge are applied across the policy cycle: from formulation to monitoring and evaluation.

On the other hand, there is no point in a governance structure that addresses all this complexity if the institutions do not have the capacity to play the proposed roles. Opportunities for participation and access to resources can be frustrated if institutional capacities are not developed. Thus, this second category of challenges directly impacts the third, resource-related.

In addition to the financial resources, another valuable one for building adaptation strategies and measures is information; more specifically, information applicable to different sectorial and social dynamics, in accessible language and format. Knowledge management – meaning the systematization and sharing of what is learned and the results of

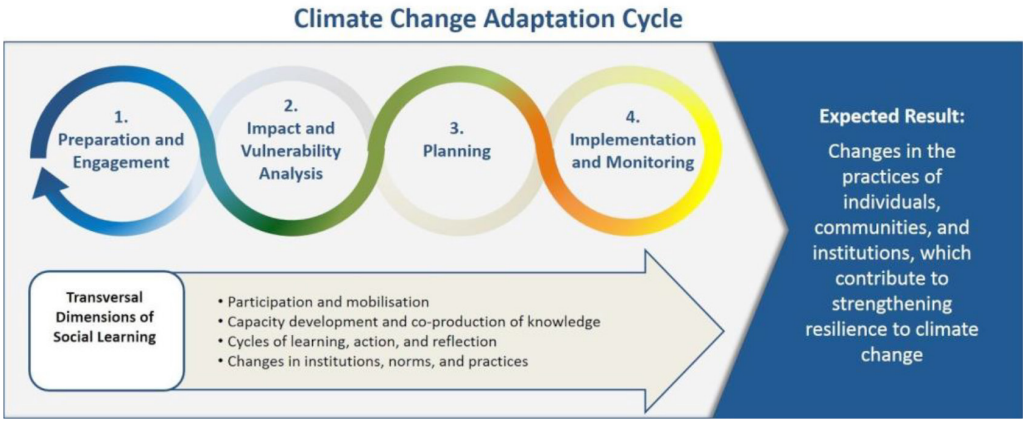

FIGURE 1: Cycle of Adaptation to Climate Change. Source: AdaptaClima Platform

the territories and, at the same time, crucial for optimizing investments, and articulating and coordinating efforts.

It is evident that the local governments, their agencies, managers and teams will not be able to respond to these challenges by themselves, but they have a central role in leading and conducing adaptation planning, stakeholder engagement, fostering knowledge management, and disseminating information amongst groups and organizations present in the territory(HALLEGATTE, LECOCQ AND PERTHUIS, 2011). To that end, state and federal governments should play the role of supporting capacity building in municipal institutions, alignment with the guidelines and principles of national and state plans, when they exist, and the exchange of experiences and knowledge between initiatives across the Country. It should be noted that such distribution and execution of orchestrated functions between levels of government depend on a structure of governance on climate, to be consolidated in Brazil.

PATHWAYS AND REFERENCES: WHAT THREE ON-GOING EXPERIENCES TELL US

The experiences of three cities are salutary to illustrate possible ways forward in the adaptation agenda at the municipal level, sometimes starting from creative and low cost solutions. The driving force of such experience is the combination of political will and leadership, rather than dedicated financial resources. At the same time, the fact that those two elements are decisive denotes a certain fragility of these initiatives; the experiences bring in common the struggle for institutionalization of the adaptation agenda so that it becomes less susceptible to political cycles and individuals' inclinations.

Porto Alegre Resilient is an example of how a strategy of broad participation can work in the planning phase, creating the necessary social base for implementation; Santos illustrates how to bridge scientific and empirical knowledge; and in Recife, the climate lens has gradually been applied to planning instruments and policies of other government departments.

MOBILISATION AND PARTICIPATION WITHIN THE RESILIENCE STRATEGY OF PORTO ALEGRE

Porto Alegre has launched its urban resilience strategy in 2016 aimed at addressing the stresses and shocks to which the city is exposed, including those derived from climate change. The process was participatory from the outset, but participation has gained importance and got deeper to the extent that it showed to be essential for behaviour change and for implementing the planned of measures. Thus the strategy was co-created based on participation,. More than 500 representatives from different sectors, organised in communities of practice (working groups with shared objectives) by common territories and interests, were involved. The fundamental elements for the work of these groups and for the cohesion between them were: the facilitation by the technical team of the city hall and partners; the design and clear communication on decision-making processes; and an online platform, as an instrument for continuous communication and dissemination of information among those involved. Another important element was the leadership of the mayor and the involvement of secretaries and influential organizations in the territories, which conferred legitimacy to the initiative (POA Resiliente, 2016).

MAINSTREAMING AND INSTITUTIONALISING ADAPTATION IN RECIFE

A milestone of the adaptation agenda in Recife was the *Policy of Sustainability and Climate Change Coping*, of 2014. Among its goals, one is to build a resilient city through the integration of society's stakeholders to work together on that aim, prioritising the communities in situation of vulnerability (LAW N. 18,011 / 2014). From then on, three factors were especially relevant for the theme to be reflected in the territory: the formation of *Climate Committees* with the participation of different sectors of society; participation of political and technical leaders in national and international networks, such as the CB27 and the Urbanet project, counting with the support of ICLEI; and insertion of the theme in the *Plan of Government*, which meant public commitment to clear goals and targets. Moreover, climate change adaptation and mitigation (reduction of greenhouse gas emissions) has been integrated and, in this way, as a unique agenda, it gained space in the *Resilient and Low Carbon Master Plan* in 2018. Also, different urban designing instruments and territorial planning strategies started to consider climate change, such as the *Recife Park City*.

SCIENTIFIC BASES SUPPORT THE SANTOS MUNICIPAL CLIMATE CHANGE PLAN

In 2015, Santos was chosen to host the Metropole Research Project, supported by the Belmont Forum and implemented in Brazil by Cemaden, INPE, FAPESP and UNICAMP. The hypothesis of the study was that the climate risk is assimilated when scientific knowledge is produced alongside different sectors of economy and society. Based on a historical database of tide levels, future scenarios were projected for the municipality. Another action was to access the perception of civil society on the theme by applying a questionnaire. Workshops were held to share information and, in those occasions, local actors could draw potential adaptation measures, which then were technically and finan-

cially analysed regarding their impacts on real estate assets.

Based on the research and, mainly, on the mobilisation achieved, the *Municipal Commission for Adaptation to Climate Change* (CMMC) was created in 2015 and the *Municipal Plan for Climate Change* (PMMCS) was published in December 2016 (Santos, 2016). The application of scientific information into public policy processes was the driving force behind Santos' experience and an *Academic Advisory Committee* is currently supporting the implementation of the Plan.

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CHAPTER 19

JUSSARA DE LIMA CARVALHO [1]

The Climate Adaptation Policy in the State of São Paulo

> Even if we limit the rise in global temperatures, climate change is here to stay. Communities are already facing more extreme and frequent droughts, floods, and other weather events. These consequences will only intensify. [...] Some argue that the global economy cannot afford adaptation. But, as the latest evidence shows, delaying action will mean higher costs later. If we truly want to build a sustainable, prosperous, and equitable future, we cannot afford to wait. (STEINER, 2015).

In 2019, the World Economic Forum, puts on its agenda the concern about the failure of the global agreements of the nacional governments around the Paris Agreement, and points the climate changes, as well as the increase of extreme events, as one of the biggest global concerns (WORLD ECONOMIC FORUM, 2019).

The vulnerability of the cities to the climate changes depends on factors such as standards of urbanization, economic development, physical exposure, urban planning and disaster resilience (UN-HABITAT, 2016). The convergence between urbanization and climate change threatens with unprecedented impacts on economy, life quality and social stability (UN-HABITAT, 2011).

Therefore, it is fundamental the climate adaptadion, to make cities and regions more resilient to the frequent and extreme events. However, to do so, amongst the most important tools there are the Vulnerabilities Identification and an Action Plan.

A multilevel government cooperation, with shared responsabilities between the diferent levels of government, may bring sinergies on the search of greater resilience, without forgetting about the importance of other social actors, as the private sector, and the civil society. The climate policies, properly adressing responsabilities about both mitigation and adaptation, and defining instruments of its operacionalization, constitute great tools to build resilient societies (UN-HABITAT, 2011).

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THE STATE OF SÃO PAULO AND THE CLIMATE ADAPTATION

Created in 2005, the Climate Change and Biodiversity Paulista Forum/Forum Paulista de Mudanças Climáticas e de Biodiversidade (FPMCB), tripartite organ, aimed to raise conscience and mobilization of the São Pauo society to discussing and position making about the global climate changes fenomenon, the urge of the biologic diversity conservation and the sinergy promotion between both themes. One of its main goals, was to collaborate with the elaboration of standards to institute a State Climate Change Policy, in conjunction with the Nacional Climate Change Policy and the Climate Change Convention (the United Nations Framework Convention on Climate Change). The Environment Secretary of São Paulo State, was the responsible for the administrative support and the necessary means to execute the Forum actions, once it had been already working on climate changes subjects for 10 years with the PROCLIMA, State Programme of Climate Change of the State of São Paulo, which had its implementation gradually assumed and coordinated by CETESB (Environment Company of the State of São Paulo)(SÃO PAULO, 2005).

As a result, it was aproved the Law 13.798 in november 2009, the Climate Change Policy of the São Paulo State - PEMC and, in the next year, its regulator Decree, of number 55.947. With this law, the State of São Paulo pledged to address the impacts of the climate change, even before the nacional climate policy institution. As its main goal, PEMC disposes about the condition to the necessary adaptations to the impacts from the climate changes, as well as contribute to dim or stabilize the GHG (greenhouse gas) concentration on the atmosphere, stablishing a 20% reduction on GHG goal until 2020, based on the emissions of 2005.

The law stablishes tools (instruments, strategies and measures) to mititgation and adaptation as well, which, to be implemented, need diferent sorts of sectoral policies (energy, transport, environment, water resources) to be articulated. (VARGAS, 2012).

From the governance point of view, to the law implementation, it has been created the Management Comittee of the Climate Change Policy and the Climate Change State Council. The Management Comittee, the highest deliberative sphere, has the assignment to follow the elaboration and the implementation of the plans and programmes instituted in the Decree that regulates the Law, besides fomenting and articulating actions in the different levels of government and provide technical support to the Climate Change State Council. The Climate Change State Council, in its turn, has an advisory character, was created to follow the implementation and inspect the execution of the Climate Change State Policy. Due to its tasks and tripartite composition, the Council replaced the FPMCB. Since 2014, however, both the Management Commitee and the State Council find themselves inactivated, bringing as consequence, the paralysis of the articulation in order to unite the climate change management of São Paulo State.

INSTRUMENTS

Among the instruments related to adaptation, one of the most importants is the Participative Plan of Adaptation to the Climate Change Effects, that had its first version

elaborated in 2011, and is available in the SMA website until the present day to public consultation (SÃO PAULO, 2018). Many instruments, however, are in continuous operation. Below, we will describe a few of them.

The Forest Remnants Programme, one of the most successful, is composed by most of the projects and programmes of the Subsecretary of Environment of São Paulo State, specially turned to forest restoration. It is important to emphasize that, inside this Programme, the Programa Nascentes (SÃO PAULO (STATE), 2019)(reinstalled after the water crisis of 2015 in the São Paulo Metropolitan Region), was the first and only adaptation based on nature component, related to the water shortage episode, aiming to increase the protection and conservation of water resources, biodiversity, riparian forests, springs and for the protection of aquifer recharge areas, to increase the native vegetation cover in springs, and others.

The Inventory of the native vagetation of the State of São Paulo – responsability of the Forest Institute, is another important instrument of the PEMC, to subsidize the climate change mitigation and adaptation actions, as well as the maintenance and restoration of the conservation units systems and other protected areas.

The Economic Ecological Zoning - ZEE for the SP State - in the final phase of elaboration, aims to prevent and avoid the disorderly occupation of areas of direct and indirect vulnerability of the entire state, having as one of its main guidelines the resilience to climate change to a state with low environmental and social vulnerability.

The other zonings of the coastal region, which are important instruments directly related to climate adaptation, are directly mitigating the effects of disasters, preventing and reducing impacts, especially in areas of greater vulnerability. The mapping of risk areas, the State Program for the Prevention of Natural Disasters and Reduction of Geological Risks - PDB (SÃO PAULO, 2011), the PPDC - Civil Defense Preventive Plan, which aim to reduce vulnerabilities, are very important instruments, this last one being updated annually, having the Geological Institute, the IPT and the Civil Defense as responsibles.

In terms of economic incentives, also provided in the PEMC, payment for environmental services (PES) to conservationists landowners, as well as economic incentives, such as conversion of fines to environmental restoration services, are also part of the Programa Nascentes (SÃO PAULO (STATE), 2019).

Regarding the funds provided for in the PEMC, there are specifically two, the State Fund for Water Resources - FEHIDRO and the State Fund for Pollution Control and Prevention – FECOP, where the application of resources began to contemplate climate change, especially in the definition of the most vulnerable areas, and the actions of prevention, mitigation and adaptation to the climate change.

In addition to these, the Sectorial Plans, especially Water Resources, Sanitation and Farming, were initially elaborated in the period of 2011 to 2013, with updates every 4 years, where is possible to notice the inclusion of the climate dimension of the impacts on their assets, and the insertion in their budgets of resources to adapt to impacts.

FINAL CONSIDERATIONS

It should be noted that several instruments and initiatives have been implemented, although not consolidated in an Adaptation Plan. The paralization of the activities of the Management Committee of Climate Change and the State Council of Climate Change resulted in the lack of discussion and the needed articulation to guarantee the mainstreaming integration of Climate Change in the São Paulo sectorial policies. Consequently, it brings to São Paulo society a confusing vision of the importance of Climate Change, for one side with PEMC – the state recognizes the importance of Climate Change, but without a convergence of actions it places the Climate Change as a minor issue when compared to other agendas.

Particular emphasis to the instruments of Environmental Planning, Urban Planning and Ecological and Economic Zoning, where there are real possibilities of work linked to the local scale, where the adaptation actions must be developed. Infrastructure projects such as drainage, collection and disposal of solid waste, collection and treatment of sewage, production and distribution of water for public supply and urban mobility should be adapted to climate change.

In methodological terms, it is necessary a paradigm break. It is fundamental to incorporate the climate scenarios in the studies of vulnerability and feasibility of projects and actions to increase resilience. The simple use of historical series of probability of occurrence without considering climate change no longer meets the current challenges.
On the other hand, research institutes should make an effort to provide climate scenarios on an appropriate scale and with a high level of security to support decision-making.

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CHAPTER 20

EDSON GRANDISOLI [1]

Education for adaptation: a brief guide to protagonism, creativity and co-responsibility

The influence of human activity on the climate is complex and is specially related to our energy production and use, resources overconsumption, the means of transportation we choose daily, among other factors. "The effect of climate change triggers human migration, destroys livelihoods, alters economies, undermines development, and exacerbates gender inequalities." (JACOBI et al., 2011)

The main ways of coping with the impacts of climate change are roughly divided into groups with complementary characteristics: mitigation and adaptation. Mitigation is related to strategies aimed at reducing climate change itself, such as measures to decrease greenhouse gas emissions. Adaptation, in turn, refers to efforts to expand our resilience, increasing the chances of survival and reducing losses related to extreme events (SULAIMAN, 2018). Therefore, adaptation does not necessarily seek to solve the causes of these impacts.

Despite all the effects of climate change and its diverse socio-environmental consequences at local, regional and global scales, most of the solutions proposed at political, economic, scientific and educational levels still have a reductionist and behaviorist focus, once they have focus on palliative solutions which do not effectively take into account the complexity of the challenge (LIMA & LAYRARGUES, 2014).

On the opposite way of this depoliticization scenario, Education plays a central role in the shaping of citizens more capable to organize themselves collectively and proactively aiming the construction of more sustainable societies, since it directly contributes both to a better understanding of the processes and challenges, and to a more effective social mobilization (SULAIMAN, 2018).

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EDUCATION AS A PROCESS. ADAPTATION AS AN OUTCOME

The search for adaptation measures should be considered as a significant moment considering stakeholder's involvement, dialogue, collective construction and the use of more active learning pedagogical strategies.

Active learning involves a set of pedagogical practices that place the learner as responsible for his/her own and peers' learning process. That way students play a more protagonist role, so that they seek solutions for complex challenges, for instance, through the development of projects and prototypes, becoming more responsible for the building of a new and contextualized knowledge (VALENTE, 2014). Among different strategies related to active learning stand out the project-based, the problem-based and investigation--problem learning; all three intimately related in terms of objectives and processes once they focus on solutions for the real-world challenges (MORAN, 2015).

It is worth mentioning that both project and problem-based pedagogies are capable of (adapted from Lima and Layrargues, 2014):

- Promote the articulation of school, curriculum, and territory through the search for solutions to different local socio-environmental challenges;
- Stimulate the search for quality information, research and, as a result, the collective construction of a new and more contextualized knowledge;
- Empower students to be protagonists on the construction of his/her knowledge;
- Develop autonomy and systemic, critic and empathic thoughts;
- Recognize the complementarity and transversality of knowledge.

Considering the pedagogical practice, some steps can be considered core for the creation of adaption measures considering climate change. The following guide has no intention of being definitive and, in particular, of annulling the creativity of students and teachers. It is important to highlight that every step has a time of collective construction and maturation that must be respected, always considering the possibility of returning to previous stages for adjustments.

STEP 1: INVESTIGATION, CONTEXT, AND OBJECTIVE

Understanding the key features of climate change and its social-environmental impacts may be the first key step that fosters comprehension of local, regional and global links. The challenge here is to recognize the connections between daily choices and the emission of greenhouse gases, which has led to the gradual increase of the average temperature of the planet (JACOBI et al., 2011).

Considering this collective built complex knowledge, the next step is to collectively identify (using different participatory strategies that foster dialogue) a local challenge to be addressed by the group focusing on adaptation measures. This participatory process is vital and creates legitimacy and establishes a relationship based on trust, increasing the chances of engagement and co-responsibility.

At the end of this step, and as a result of this participatory process, the identification of a common challenge should emerge, together with the determination of a clear, assertive and feasible objective.

STEP 2: PROPOSITION AND CREATIVITY

Concrete ideas of prototypes related to local adaptation measures must emerge from this step. Educators, along with students and ideally different stakeholders, must foster brainstorm without limiting possibilities, desires, and visions of the future. This open-minded strategy helps to free the creative process of its individual and institutional moorings. However, and despite the relevance of all ideas, the group must choose only one (or two) viable prototypes to be initially tested.

These processes of collective creation, selection and testing are, in a simplified way, the model based on design thinking, a methodology that considers the human being as the center of the process of creative solutions, focusing on participation and collaboration as inseparable components of the maker culture.

STEP 3: PROTOTYPE TESTING AND PARTICIPATORY MONITORING

The final steps of the design are the testing and the participatory monitoring, which evaluate the efficiency and effectiveness of the prototype created.

The outcomes indicate the strengths and fragilities of the adaptation prototype, allowing adjustments in the previous steps, reinforcing the importance of a cyclical creation process. In some cases, the participatory monitoring can lead to a restart of the whole creative process (step 1), a fact that must not be faced as a failure, but a necessity regarding the initial objective.

STEP 4: COMMUNICATION

The participatory and democratic creative educational process depends on time, expertise, physical space, budget, etc. Because of these and other impediments, many schools contribute to perpetuating a culture of passivity, competition, and individualism. A fundamental step (frequently forgotten) that gradually improves the interest of different actors is communication. Create and establish different communication channels and strategies whereby the outcomes of the creative process, as well as the effectiveness of the designed prototype, can increase engagement and collaboration. Communication, although essential, is hardly cited or considered a step of active methodologies or approaches such as problem-based learning or design thinking. Poster, blog, vlog, community newspaper, photo mural, community radio are just some of many communication tools and strategies linked to the educational process and adaptation to collaborate to improve people's quality of life in the face of climate change.

BEYOND SKILLS AND COMPETENCIES

Education, as a way to stimulate a maker culture through research and the collective creation of prototypes, contributes to the creation of contextualized knowledge, and raises awareness about the climate change and its local, regional and global impacts, leading in a playful and challenging way to the gradual increase in the capacity of adaptation of the school, community and territory.

This creative trajectory helps to develop, and improve different competencies, skills, abilities and values together with the development of systemic, critical, reflexive and complex thinking (GRANDISOLI, 2018). The development of these features is, at the same time, an individual and collective process, as mentioned in the recent conceived Base Nacional Comum Curricular (BNCC) of Brazilian's basic education, where competence is defined as

> "The mobilization of knowledge (concepts and procedures), skills (practical, cognitive and social-emotional), attitudes and values to solve complex demands of everyday life, the full exercise of citizenship [...]" (Brasil, 2018; 8)

However, the collective construction of adaptation measures and the teaching of competencies demand, in particular from educators, a new attitude towards knowledge, teaching-learning strategies and the type of relationship established with the students and other community stakeholders. It is imperative that teachers work as tutors and in partnership with students, becoming learners as well. The search for adaptation solutions connected to a maker culture resignifies the educational process and the role of the school as a more dynamic, participatory and therefore a more diverse and interesting everyday place to be in. This implies, besides the urgent need for more frequent and competent teacher's formation, know how to work in multi and interdisciplinary groups to understand and collectively solve local challenges related to climate change (DAVIDSON & LITH, 2012).

In Brazil, still little has been done considering both previous concerns, as indicated in the Annex to the Monitoring Report of the National Plan for Climate Change (2016-2017) (BRASIL, 2016). Related to the Goal 2.1 - "Adaptation training strategy developed and implemented for diverse audiences"-, the report mentions the development of a single online course for teachers and general public entitled "Environmental Education and Climate Change", which seems insufficient considering the complex and urgent demands related to mitigation and adaptation measures.

Finally, beyond the educational point of view related to the development of skills and competences, the creative search for adaptation (and mitigation) strategies must be primarily responsible for (1) stimulate assertive dialogue among different stakeholders based on the vision of a larger collective good; (2) establish new relationships of trust and complicity and; (3) foster understanding of the importance of co-responsibility in the face of the uncertainties of the present and the future.

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CHAPTER 21

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ANA LIA LEONEL [2]

Adapt to who and how? Adaptation and environmental justice at the São Paulo Macrometropolis

In the current debate on climate change, whether in academia, government or civil society, the link between adaptation, vulnerability and risk is common and frequent, especially in countries with a poorer majority and pronounced social inequalities, as is the reality in most territories of the so-called Global South, as the case of the São Paulo Macro metropolis (SPMM) region. But vulnerability and risk do not necessarily have roots in urban development nor are they found in analyzes in the demand for recognition, rights and justice.

The present authors draw attention, therefore, to the necessary interface between the rights and justice agenda and the climate change debate, specifically in relation to the theme of adaptation that offers the possibility, since it is a question of planning the territory for future variability, that resources - technical and financial - be invested in new ways of producing cities, with the reduction of inequalities, thus reducing environmental injustices.

In this sense, it is imperative that the environmental justice component be taken into account in the construction of Adaptation Plans - be they municipal, state or federal; of regions, of basins or carried out by civil society, as well as a strategy of community planning, both insurgent and participatory.

But what, in fact, is environmental justice? The notion of environmental justice originates in the studies of the sociologist Robert Bullard, in the 1980s, who first exposed the connection between racism in the United States and environmental inequalities, that is, that there was a relationship between race and exposure of toxic wastes, environmental impacts, pollutants, etc. For this purpose, Bullard created a map of environmental inequa-

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quality using as an empirical basis the denunciations of movements affected by these diseases (ACSELRAD, 2009 and 2010). In Brazil, environmental justice is contoured beyond the racial question, despite the income issue of the most vulnerable groups and those affected by environmental impacts.

Around here, the movements began to associate themselves with environmental justice from the 2000s, with the creation of the Brazilian Environmental Justice Network (RBJA) in 2001, serving as a facilitating secretariat for Brazilian social networks and movements, as well as researchers of academia engaged in the cause[3]. For Acselrad (2010), the notion of environmental justice reflects a redefinition of the movement of the environmental issues, resulting from the issue of ownership by sociopolitical dynamics traditionally involved with the construction of social justice.

The strategy anchored in the notion of environmental justice, in turn, identifies the unequal exposure to risk as a result of a logic that makes accumulation of wealth based on the environmental penalty of the most deprived (ACSELRAD, 2010).

But it must be asked how the current guidelines of the federal government, based on the National Adaptation Plan (PNA), were instituted on May 10, 2016 by means of Ordinance No. 150? How does this agenda appear, if it appears, from the view of the Brazilian state, on the subject? How can public managers, secretariats, ministries and municipalities, as well as civil society and academia, contribute to this debate? Are there data and indicators that public policies can contribute to these issues?

FEDERAL GOVERNMENT / NATIONAL ADAPTATION PLAN

In the content library of the AdaptaClima platform[4], coordinated by the Federal Government's Ministry of the Environment, there is not a single mention of the word "justice" in the extensive list of contents (content library). The platform was launched in 2017 with the purpose of achieving the first objective of the National Plan of Adaptation, which foresees among its goals an "online adaptive knowledge management platform created and available to society."

The National Plan for Adapting to Climate Change was published on May 11, 2016, with the objective of promoting management to reduce climate risk:

> "in order to take advantage of emerging opportunities, to avoid losses and damages and to build instruments that allow adaptation of natural, human, productive and infrastructure systems" (BRAZIL, 2016, p.5). The main strategy presented is based on the "insertion of climate change risk management into existing sectorial and thematic public plans and policies, as well as on national development strategies" (BRAZIL, 2016, p.5).

[3] RBJA has more than 90 affiliated entities, among them RENAP - National Lawyers and Popular Lawyers Network, PACS - Alternative Policies Institute for the Southern Cone, Xingu Movement Alive for All, MAB - Movement of Dam Affected People, Global Justice, INESC - Institute of Socioeconomic Studies, IBASE - Brazilian Institute of Social and Economic Analysis, FASE - Federation of Organs for Social and Educational Assistance, among others.
[4] Available at http://adaptaclima.mma.gov.br - access January 2019.

There is recognition in this document about the vulnerability of traditional populations (indigenous, "quilombolas" and "caiçaras") to the risk associated with climate change, and that there should be approaches with racial, ethnic and gender sensitive criteria. (BRASIL, 2016b, p.19). Among the sectorial strategies presented by the Plan, one of them concerns vulnerable peoples and populations, aiming to promote their adaptation through three goals: 1) "Diagnosis of Vulnerability to Climate Change of the target populations of the National Territorial and Environmental Land Management Policy Indigenous Peoples (PNGATI)" (BRASIL, 2016, p.11) under the responsibility of FUNAI; 2) "Diagnosis of Vulnerability to Climate Change of the target populations of the National Plan for Food and Nutrition Security (Plansan)" (BRASIL, 2016, p.11) under the responsibility of the Ministry of Social Development; and 3) "Diagnosis elaborated and reduction of vulnerability to change of the climate promoted in vulnerable populations and beneficiaries of agro-extractive public policies" (BRASIL, 2016, p.11) under the responsibility of MMA.

Although the National Plan for Adapting to Climate Change considers the populations most vulnerable, the term "justice" does not appear in the executive summary, nor in volume 1 - General Strategy. In the second volume, the term "just" appears among the principles, referring to "adaptation as a strategy to promote the productive sector with a just transition for workers and economic growth, aligned with poverty reduction strategies, socioeconomic and regional inequalities, including considering the principle of prevention and precaution" (BRASIL, 2016b, p.19).

The second volume of the National Plan for Adapting to Climate Change deals with sectorial and thematic strategies and in its scope uses the term "justice" four times, one of them being to explain the scope of another plan (National Plan for the Promotion of Socio-biodiversity), articulated with NAP as a guideline to promote adaptation, through the strategy of Food and Nutrition Security (BRASIL, 2016c, p.233). In Chapter 3, entitled Cities Strategy, the term "justice" appears with the same theme discussed in this chapter and supported by Marengo (2009), where "although all are affected in some way, the impacts of climate change (BRASIL, 2016c, p.65), are mainly due to the concentration in areas of high risk and limited access to services and resources of a population that already faces the effects of extreme events under the stress of climatic variability. In this sense, the Plan also presents itself as an instrument of inter-sectorial and intergovernmental articulation in the elaboration of the capacity to respond.

In the chapter on the strategy of vulnerable peoples and populations, specifically in the section on "Indigenous Peoples and Climate Change: Vulnerability, Adaptation and Traditional Knowledge," the term "Climate Justice" appears (BRASIL, 2016c, p.159). The idea of this term is that those who are least responsible for the impacts that lead to climate change, such as greenhouse gas emissions, are most impacted by the effects of this change. Therefore, the need presented is to "address the ethical dimensions of human rights of climate change in order to reduce the vulnerability of social groups disproportionately affected by climate change" (BRASIL, 2016c, p.159).

In addition to the Plan itself, the Ministry of the Environment's Secretariat for Climate Change and Environmental Quality produced the Adaptation Review (MMA, 2016) during the time of public consultations for the construction of the PNA, aimed at technicians, civil society, entrepreneurs and researchers working with climate change. The objective

of the journal is to support dialogue and to gather the different visions of the partners involved in the process of drawing up the Plan. Looking at the publication, the terms fairness, fair, just or right do not appear at all. The environment or environmental terms added are repeated 50 times, development appears 28 times and vulnerability (s) 27 times. The term management is used 19 times, while governance appears only 3 times (MMA, 2016). We can say that this is not due to lack of data, indicators or scientific production, since, as discussed here, the relationship between social and environmental vulnerability is crucial to policies related to adaptation to climate change.

There are several indicators, data and extensive mapping on inequalities and vulnerabilities in Brazil and for the State of São Paulo[5]. A recent indicator, and like the other indexes, one that can be used in the design and preparation of plans to adapt to climate change, is the Drought Natural Disasters Vulnerability Index in the context of climate change (IVDNS). The IVDNS considers the meteorological drought "the main agent deflator of the dry disasters in Brazil" (MMA, 2017a, p.8). Using "climatic, physical-environmental, socioeconomic and public policy variables, which are related through the sub-indices of exposure, sensitivity and adaptive capacity" (MMA, 2017a, p.12), it is possible "to identify critical dry" (MMA, 2017a, p.20).

The relevance of looking at this index illustrates, on one hand, the importance of the problem of water scarcity that is constantly increasing for SPMM, while on the other hand it is because it is built by subscripts that look beyond climate models. The sensitivity sub-index, for example, "represents the socioeconomic and environmental context that contributes to broadening or reducing the effects of exposure to climate change" (MMA, 2017a, p.9) and is composed of the socioeconomic percentage of the population with income below 25% of the minimum wage, infant mortality and population density, and also land use and water demand and supply index (MMA, 2017b, p.45). The adaptive capacity sub-index "represents the ability of human systems to respond and react to drought-related climate changes" (MMA, 2017, p.9) from the variables of HDI, GINI and illiteracy (MMA, 2017b , p.45).

In turn, the exposure subscript "represents all weather changes related to the components that cause the meteorological drought" and is constructed with the mean and variability of precipitation and the occurrence of climatic extremes of droughts. This subindex is presented in four scenarios and consequently the complete IVDNS, "Conjugation of the Sub-Indices of Exposure with Sensitivity, also interacting with that of Adaptive Capability" (MMA, 2017b, p.100) presents a certain degree of uncertainty and difference of assertiveness between the applied model and the real conditions.

Figure 1 presents the Drought-Related Disasters Vulnerability Index in the context of Climate Change in the 2 scenarios for the 2 climate models for the municipalities of the SPMM (EMPLASA, 2018). "The values of the IVDNS are presented in a scale that varies practically from 0.00 to 1.00, and the larger this value is the vulnerability of a certain locality" (MMA, 2017, p.24) and in the SPMM region with no municipality, there is a very high vulnerability index in any scenario/model. In this region, the municipality of Itaquaquecetuba is

[5] IVS - Social Vulnerability Index (IPEA), IPVS - Paulista Social Vulnerability Index, IVSE - Socioecological Vulnerability Index, Urban Wellbeing Index (IBEU), among others.

the one with the highest vulnerability index values for the 4 scenarios (from 0.496 to 0.618) and, together with Arujá, are the only municipalities with the high vulnerability classification of the IVDNS table in the model / scenario Eta-MIROC 4,5. Embu is the municipality that presents the highest value for the sensitivity subscript and presents the IVDNS moderately high in the 4 cases, while Natividade da Serra presents the lowest value for the subscript of adaptive capacity and IVDNS Low in the 4 models / scenarios.

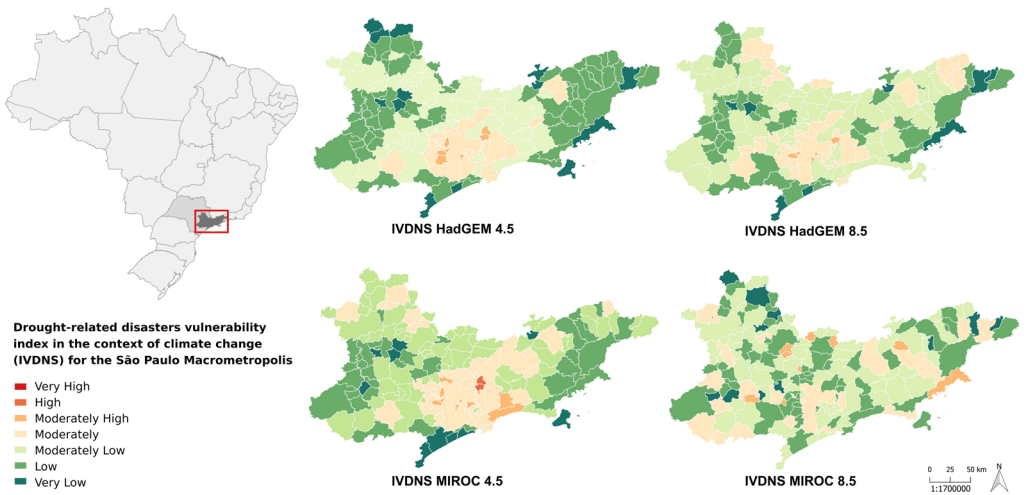

FIGURE 1: Maps of the IVDNS (composed of the Subindices: Exposure, Sensitivity and Adaptive Capability), for the period 2011-2041 with a cut in the SPMM. Source: MMA, 2017; Emplasa, 2018. Adapted by Ana Lia Leonel, 2018.

With the tendency of more frequent phenomena related to climatic variability, whether they are periods of rains or more periods of droughts, floods, landslides or water scarcity, to mention some concrete examples that already reach the SPMM, the municipalities that integrate the region will need to rethink the way cities are being planned. In this sense, adaptation plans should be instruments that seek greater resilience in the face of possible disasters and changes in the territory.

In the southeast of the country (except for the north of MG), the management of water use combined with strong environmental degradation is a challenge to be overcome. In several municipalities it is already possible to verify a scarcity of water resources and, consequently, they appear on the high vulnerability index, according to IVDNS. The supply of water in these localities is no longer enough to meet all demand safely due to vectors of pressure such as population increase and economic growth, as well as the enormous amount of waste, pollution of rivers and forests, deforestation and non-recovery of riparian forests and springs (MMA, 2017, p.34).

In Brazil, specific plans for adapting to climate change are still rare. This confirms that the country has directed its actions in the last decades towards mitigation rather than adaptation. Yet it does open up the possibility, which must be taken advantage of, that the

adaptation plans that may be produced in the future incorporate fundamental aspects of combating poverty and social inequality. Such assumptions are not being considered in several examples of adaptation plans carried out worldwide, whether in cities in the Global South such as Jakarta, Medellin, and Santiago, or in the north, such as Boston and New Orleans (ANGUELOVSKI et al., 2015).

In this sense, it is necessary to look at some questions as to whether the interventions proposed by adaptation plans and projects affect or lead to the removal of poorer populations and, at the same time, afford privileges to richer populations. In order to seek the democratic and participative construction of these adaptation plans, it is imperative that they contain in their initial construction a considerable representation of the local population, integrating the issue of environmental justice in both the integration of the planned infrastructure and interventions and their implementation (SHI et al., 2016).

In the case of the SPMM, there are few efforts in terms of public policies for the implementation of plans, policies and projects in the adaptation area. Considered the main document of actions and future plans for the Macrometropolis, the Plan of Action of the SPMM does not even approach the subject directly. Regarding climate change, there is only a mention in the document "Vision of the Macrometropole" (SPMM-AP, 2014) about the implementation of existing programs such as the "Forest Remnants Program" and the institution of the State Policy on Climate Change, in addition to environmental services (PSA) projects for owners of private areas that are subject to environmental preservation.

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REALIZATION