 doi:10.20944/preprints201607.0006.v1

Article

Governing Climate Change Risks: Subnational Climate Policies in Brazil

Fabiana Barbi *, Leila da Costa Ferreira

Center for Environmental Studies and Research, University of Campinas, 13083-970 Campinas, São Paulo, Brazil

* Correspondence: fabarbi@gmail.com; Tel.: +55-19-3521-7690

Abstract: Subnational governments play a key role responding to climate change risks in terms of policy strategies and instruments. This article analyzes how Brazilian municipal and state governments have developed and implemented public policies to mitigate and to adapt to climate change risks. We surveyed all cities' and states' climate policies within the country. The methodological approach includes five main points of analysis: 1. mitigation targets and intentions; 2. adaptation actions; 3. stakeholders' participation; 4. policy implementation; 5. participation in networks related to climate change. Our results suggest that even though subnational climate policies in Brazil are isolated initiatives within the national context, they play an important role responding to climate change risks in different scales and levels. The strongest Brazilian policies with both mitigation and adaptation actions counted on previous mobilization for the climate issue involving different stakeholders from several segments of the society. These governments have also participated in transnational cooperation networks related to climate change.

Keywords: adaptation; Brazil; climate change policy; mitigation; risks

1. Introduction

Climate change has affected people around the world causing great loss of human lives, disturbing the economy, agriculture, health and seriously impacting ecosystems. Climate change poses threats to important development issues such as water supply, food security, human health, natural resources and protection against natural hazards [1,2,3]. Societies worldwide are challenged to respond to climate change risks and increasing threats arising from changes in the climatic system.

Climate change risks can be interpreted as contemporary environmental risks since they are characterized as consequences of the development process of industrial society, directly influenced by the globalization process. They are closely related to the future and uncertainties. The risks make present something that does not exist yet, that is, future events that may occur and cause threats. In this case, a consequence of this relationship with the future is the uncertainty, since it is not possible to know exactly what the world will be like in 20, 30 or 40 years. However, it is possible to mention probabilities and scenarios. These risks are often unpredictable, inevitable and incalculable, often cause irreversible damage and are invisible to the senses. They are both local and global and threaten all humanity. Their causes and consequences are not limited to one geographical location or space, causing them to be "omnipresent" [5, 6, 7, 8, 9, 10, 11, 12, 13].

In terms of responses to climate change risks, it is argued that governments are important stakeholders who play a key role in defining appropriate rules, institutions and modes of governance to address these risks at different levels and scales [11, 12, 14, 15, 16].

Research on the global and regional levels of governance, prioritizing the development and implementation of an international climate regime that covers norms, rules and decision processes occupy most of the literature on climate policy [17, 18]. Despite these necessary contributions, the local dimension of the theme is also relevant, since many human activities that contribute to global climate changes occur at this level and, at the same time, this level is the most affected by the impacts of these changes [19, 20, 21, 22].

The climate issue permeates different levels of government, which are interconnected, turning climate change into a multilevel challenge. Subnational governments (state and municipal) represent important forums on global climate governance. Certainly, the nation-state remains a central stakeholder in global governance processes, but the role of subnational governments cannot be ignored. The nation-states no longer monopolize the formulation of policies, which also happens because of the need for collective decision-making on complex problems and because subnational governments are interconnected by policy networks. Thus, the multilevel governance perspective becomes an alternative approach to the analysis of the role of subnational governments in the development of climate policy [23, 24].

Climate change risks faced by humanity can be avoided by political action taken on behalf of endangered humanity [8]. Risks can be changed by modifying the initial activity or event or by minimizing its impact [25]. In the case of climate change, societies can reduce greenhouse gases (GHG) emissions (mitigation), thereby decreasing the rate and magnitude of change and, at the same time, adapt to its impacts. These responses can and should be complementary [26].

Identified the main activities that contribute to climate change, some alternatives have been proposed in order to minimize it, such as the replacement of fossil fuels with biofuels, the use of energy from renewable sources, proper management of agriculture and farming, carbon market and especially changes in the pattern of consumption, waste reduction and energy efficiency [17, 15].

This kind of action goes towards mitigating the problem, that is, promoting the reduction and stabilization of GHG emissions. Mitigation actions include all human activities intended to reduce GHG emissions or increase GHG sinks [26, 27, 28]. The emission reduction costs and political will are among the main barriers to implement mitigation policies [29]. Other factors affect mitigation policies, such as the relationship between experts and non-experts, the perception of risk, regulators-industry relations, the power and influence of interest groups, historical culture and self-perception of a nation [30]. Mitigation actions are directly related to economic development issues since they imply changes in the foundations of the industrial society development.

Literature on this issue [14, 17, 26, 29, 30, 31, 32] identifies five key sectors that concentrate the responses to climate change mitigation at the subnational level: urban development (territory planning strategies), built environment, urban infrastructure (power systems, water, sanitation and solid waste), transport and carbon sequestration (conservation, reforestation, etc.).

The adaptation in the context of climate change refers to any adjustment that occurs in natural or human systems in response to actual or expected impacts of climate change, aiming to deal with the consequences, moderate harm or exploit beneficial opportunities. Adaptation can reduce vulnerability in the short and long term [26, 27, 28, 33]. Adaptation actions have multiple drivers, such as economic development and poverty reduction, and are incorporated into the broader development and sectoral planning initiatives, regional and local, such as water resource management, coastal management and disaster and risk reduction strategies.

Considering the risks of climate change, the key sectors for adaptation responses at the subnational 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 subnational level and also the variety of government sectors involved in these two aspects of climate policy.

In order to deal with such a complex issue as climate change, solutions are equally complex, involving several fields of human activity and different stakeholders and sectors of society, such as multilateral agencies, governments, companies, associations and pressure groups and society in general aiming to clarify the facts that trigger the risks and determine the conditions for their confrontation. Organized civil society, research institutions, universities, private sector and other stakeholders play an important role in the production of responses to the climate crisis together with governmental representatives [15].

Another relevant point for analysis of climate policies at the subnational level is the transnational networks of governments specifically related to climate change. They promoted the development of an explicit urban approach to climate governance [34]. At the time they emerged, in the 1990´s, three

 doi:10.20944/preprints201607.0006.v1

networks played a key role: Cities for Climate Protection (CCP) ICLEI, Climate Alliance for European Cities (Alliance for Climate European Cities) and Energy Cities (formerly Energie-Cites). In the 2000s, these networks developed and became broader and more politically significant also with the appearance of the C40 network, in 2005. They have provided subnational governments with inspiration, information, experience, concrete projects, access to finance, examples of good practices and informal structures of recognition and rewards, which have led to significant responses of these governments worldwide. The participation of subnational governments in these networks is a possible path with great potential for the development of effective policies and actions as responses to climate change in urban areas [35].

The intention of this article is to add to the literature on subnational political strategies regarding climate change by presenting a detailed case study aimed at the analysis of climate change subnational actions in Brazil. The particular focus of attention is the analysis of how Brazilian municipal and state governments have developed and implemented public policies to mitigate and to adapt to climate change. This study can provide elements to efforts that seek to compare these strategies across countries in order to draw a composite global picture of emergent climate change actions at the subnational level.

Brazil is an important player in the debate on climate change governance since its GHG emissions are significant, thus contributing to the worsening of the problem. At the same time, national, state and municipal GHG emissions are different within the country and come from different sectors of activity. Therefore, mitigation policies should consider these differences across scales. Moreover, climate change impacts are felt differently depending on the scale and locality and also involve different sectors of activity depending on the level of governance, as it will be explored in the following sections.

2. Methodological aspects

In terms of methodology, we conducted a survey of Brazilian municipalities and states with specific and approved legislation to address the climate issue until 2016. Therefore, the analysis of state and municipal policies is based on the following characteristics related to climate governance discussed previously:

1) Climate change mitigation actions: presence of specific GHG emission reduction targets or intention;
2) Climate change adaptation actions: intention to develop adaptation plans;
3) Articulation among stakeholders: presence of climate forum or institutional structures that include the participation of different segments of society in the development and elaboration of climate policy;
4) Multi-sectorality in the policy implementation: policies implemented by different sectors of municipal and state government that are related to the climate issue;
5) Participation of governments in transnational networks related to the climate issue.

3. Results

This section is divided into two parts. First, the municipal policies related to climate change risks are presented. Next, the climate change state policies are discussed.

3.1. Political Responses to Climate Change Risks in Brazilian Cities

The first Brazilian municipal climate change policy is from 2003, in Palmas, Tocantins. However, the most important policy came in 2009, a pioneer in the country to establish concrete targets for reducing GHG emissions. This was in the city of São Paulo, and it influenced the State of São Paulo and the national policies to also set reduction targets in the same year [36]. Other cities that have policies establishing municipal climate policy in Brazil are: Belo Horizonte, in Minas Gerais, Feira de Santana, in Bahia, Recife, in Pernambuco and Rio de Janeiro, in Rio de Janeiro. All of them were

 doi:10.20944/preprints201607.0006.v1

approved in the period from 2011 to 2014. Figure 1 shows the Brazilian cities with approved climate change policies.

Figure 1. Brazilian cities with approved climate change policies. Source: Elaborated by the author.

The policies of Belo Horizonte, Recife, Rio de Janeiro and São Paulo set concrete targets for reducing GHG emissions and deadlines. The policy of Belo Horizonte (n. 10.175/2011) establishes the reduction of 30% of the municipality's GHG emissions by 2015. The GHG inventory will be elaborated by 2016 in order to follow up the cities´ emissions. The sectors involved in the mitigation strategies are: transport, energy, solid waste and construction. The policy of Recife (n. 18011/2014) establishes the reduction target of 14,9% in 2017 and 20,8% in 2020, based on the 2012 emissions. The policy of Rio de Janeiro (n. 5248/2011) determines the progressive reduction of emissions by up to 8% in 2012 to 16% in 2016 and 20% in 2020, compared to emissions recorded in 2005. The mitigation strategies involve solid waste, transport and energy sectors. São Paulo established the goal of 30% reduction of GHG emissions by 2012, based on 2005. Instead of decreasing, emissions increased during this period, mainly due to the increase of the car fleet. This is the great challenge for the city. Although the policy in Feira de Santana (n. 3169/2011) does not set goals, it aims to reduce GHG emissions. The policy of Palmas (n. 1182/2003) does not define goals, but it aims to regulate projects related to forestry and energy targeting GHG emissions reduction.

Regarding adaptation, the policies of Belo Horizonte, Recife, Rio de Janeiro and São Paulo plan the establishment of an adaptation policy. The promotion of adaptation strategies in Belo Horizonte should involve civil defense, land use and health sectors. Recife´s adaptation plan is to be defined yet. In the case of Rio de Janeiro, the municipal civil defense is in charge of activities related to adaptation. In São Paulo, adaptation strategies involved mainly the requalification of housing in risk areas and the recovery of permanent preservation areas, in order to prevent or minimize the risks of extreme weather events. Feira de Santana´s policy is the vaguest, determining only that it aims to "define and implement measures to promote adaptation". Palmas´ policy makes no mention of actions or adaptation plans, either.

Belo Horizonte, Recife, Rio de Janeiro and São Paulo counted on institutional arrangements that allowed the articulation of different stakeholders from different segments of society in the policy-making process. In the case of Belo Horizonte, the discussions around the climate policy began in 2006 with the creation of the Municipal Committee on Climate Change and Eco-efficiency under the municipal government and linked to the Department of Environment. The Committee was created

 doi:10.20944/preprints201607.0006.v1

to give advice, consultancy and articulate existing environmental policies in different municipal agencies to reduce GHG emissions.

In Recife, the articulation for the climate policy started in 2013, with the creation of two municipal forums: Comclima and Geclima. Comclima is comprised of stakeholders from the local, state and federal government, academia and organized civil society. Geclima counts on representatives from the local government from different sectors of activity. Both groups are coordinated by the Department of Environment and are intended to subsidize the municipality in issues involving climate change.

In Rio de Janeiro, discussions about the policy were supported by the municipal Forum on Climate Change in 2009. The institutional structure of the Forum follows the same as the Brazilian Forum on Climate Change, with the participation of different segments of society. The main purpose of these forums is the articulation to the development and establishment of a climate policy. Currently, the Forum of Rio de Janeiro is one of the key agents of management and consolidation of the climate policy.

In São Paulo, the articulation to the climate policy began in 2005 with the creation of the Municipal Committee on Climate Change and Sustainable Eco-economy, an initiative of the local government, with the aim of promoting and encouraging actions related to the mitigation of GHG emissions. The elaboration process of the policy took four years and involved the participation of stakeholders who were actively involved, such as the Department of Environment, the Research Center for Sustainability of Foundation Getulio Vargas, ICLEI - Local Governments for Sustainability and Fabio Feldmann Consultants [37].

Feira de Santana did not have this kind of institutional arrangement before the law was passed. However, the policy provides for the establishment of the Forum on Climate Change "for the manifestation of social movements, scientific sector, the business sector and all others interested in the subject, in order to promote transparency of the process and social participation in the development and implementation".

In the case of Palmas, the approval of the law took place without the participation of other stakeholders, at a time when the city was looking for a tool that would allow the sale of carbon credits and hiring consultants to carry out projects in the area of climate change, which was possible through the law [38].

Regarding the implementation of the policies in Belo Horizonte, Recife, Rio de Janeiro and São Paulo, climate governance can be considered multi-sectoral. In this case, these municipalities counted on an institutional arrangement prior to the approval of the law, with a multi-sectoral profile for conducting the policy. In Belo Horizonte, the Municipal Committee on Climate Change and Eco-efficiency is responsible for implementing the policy, with the participation of other sectors of the municipal and state governments, representatives of the City Council, universities, NGOs and organizations representing industry and commerce.

In Recife, the implementation of the policy counted on the elaboration of a low-carbon plan, which had the participation of the civil society, the private sector and several sector of municipal and state governments.

In the case of Rio de Janeiro, although the policy is coordinated by the Department of Environment, its implementation is through its Climate Change and Sustainable Development Unit, in a crosscutting manner and with the participation of several areas of the municipal administration and partnerships with academic institutions. For example, the Vulnerability Map of Rio de Janeiro Metropolitan Area, which identifies the impacts on the physical environment and their respective vulnerabilities in socio-economic and natural systems, was elaborated in partnership with the National Institute for Space Research (INPE) and the University of Campinas (Unicamp) [39].

As a result of the policy in São Paulo, the following work groups were created under the Municipal Committee of Climate Change and Eco-economy: Transport, Energy, Construction, Land Use, Waste and Health. They were responsible for the preparation of the Guidelines for Mitigation and Adaptation to Climate Change, in order to detail the strategies prescribed by the policy.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 7 July 2016 doi:10.20944/preprints201607.0006.v1

In Feira de Santana, the implementation of the policy is linked to the preparation of the Municipal Plan on Climate Change by the Department of Environment and Natural Resources, under the coordination of the Municipal Council of Environmental Defense. Its preparation should rely on public consultations through the Climate Change Forum. In Palmas, the implementation of the policy is responsibility of the Department of Environment and Public Services.

Finally, Belo Horizonte, Palmas, Recife, Rio de Janeiro and São Paulo are members of the cooperation network ICLEI – Local Governments for Sustainability and were members of ICLEI's CCP campaign (Cities for Climate Protection). Palmas participated in the campaign between 2002 and 2004, when its policy was approved. The other cities are still part of the network. Under the CCP campaign, Belo Horizonte and São Paulo participated in the project "Sustainable Construction Policies (PoliCS)" whose goal was to establish the commitment of these local governments for the development and implementation of sustainable building policies, focusing on energy efficiency and the promotion of low-carbon technologies. These cities also joined another project, "Model Communities in Local Renewable Energies (Rede Elo)", in order to promote the generation and use of energy from renewable sources and energy efficiency, focusing on the roles and responsibilities of local government as a driving force for technological innovation and investment in sustainable development. São Paulo also participated in the projects "Green and Healthy Environment (Pavs)" and "Promoting sustainable public procurement in Brazil (CPS-Brazil)" aimed to change consumption patterns by the government. Recife participated in the project "Urban Leds", aimed at urban development based on low GHG emissions.

Rio de Janeiro hosted ICLEI in Brazil from 2000 to 2006 and São Paulo hosted the network after that until 2012. These two cities are also members of the C-40 network of cities and hosted the organization's summit meetings in 2011 and 2012 respectively. This kind of involvement with cooperation networks brings many benefits to the cities, because there is great exchange of experiences with cities around the world in relation to actions and strategies dealing with climate change [40]. In addition, by occupying these positions, these cities also set targets and goals facing climate change. Table 1 summarizes the main characteristics of climate policies in Brazilian municipalities.

Table 1. Main characteristics of climate policy in Brazilian cities.

City	Year of policy approval	Targets / intentions to reduce GHG emissions	Adaptation strategies	Stakeholder participation in the policy-making process	Multi-sectoral policy implementation	Participation in climate networks
Belo Horizonte	2011	X	X	X	X	X
Feira de Santana	2011	X	–	–	–	–
Palmas	2003	–	–	–	–	X
Recife	2014	X	X	X	X	X
Rio de Janeiro	2011	X	X	X	X	X
São Paulo	2009	X	X	X	X	X

Source: Elaborated by the author [37].

Most climate policies adopted in Brazilian municipalities were approved from 2009, when the issue of climate change was among the first in the international political agenda. The policies in Belo Horizonte, Recife, Rio de Janeiro and São Paulo present more robustness since they determine both mitigation and adaptation actions and targets related to climate change. As discussed earlier, climate policies should combine mitigation and adaptation actions. In these municipalities, there was a mobilization on the climate issue before the adoption of the law, with the participation of different

 doi:10.20944/preprints201607.0006.v1

stakeholders from different societal segments. The involvement of different stakeholders is needed to deal with a complex issue as the climate issue. It is noteworthy that most of the analyzed policies refer to the climate issue in a multi-sectoral way in their implementation, a necessary feature to confront the problem, which is not exclusively a responsibility of the environmental sector. Combined with this, most cities are involved in international cooperation networks related to climate change, emphasizing the importance of this kind of engagement in the development and approval of climate policies.

3.2. Political responses to climate change risks in Brazilian states

The first Brazilian states to approve their climate change policy were Amazonas, in 2007, Tocantins, in 2008, and Goiás, Santa Catarina and São Paulo, in 2009, even before the National Policy on climate change was approved in December, 2009. Since this period, the approval of climate policies has been intensified: 18 out of the 27 Brazilian states have sanctioned law or bill to regulate the state policy on climate change.

In total, 14 Brazilian states have approved their climate policy (see Figure 2). Out of these, only Paraíba, Rio de Janeiro and São Paulo have set concrete targets to reduce GHG emissions. However, some other policies also have intention to stabilize or reduce GHG emissions. In such cases, the policies provide for the development of mitigation plans that will set GHG emissions reductions goals. Most policies, nine of them, have the intention to develop an adaptation plan to the impacts of climate change. The only policies that cover these two aspects of climate policy are Distrito Federal, Paraíba, Rio de Janeiro and São Paulo.

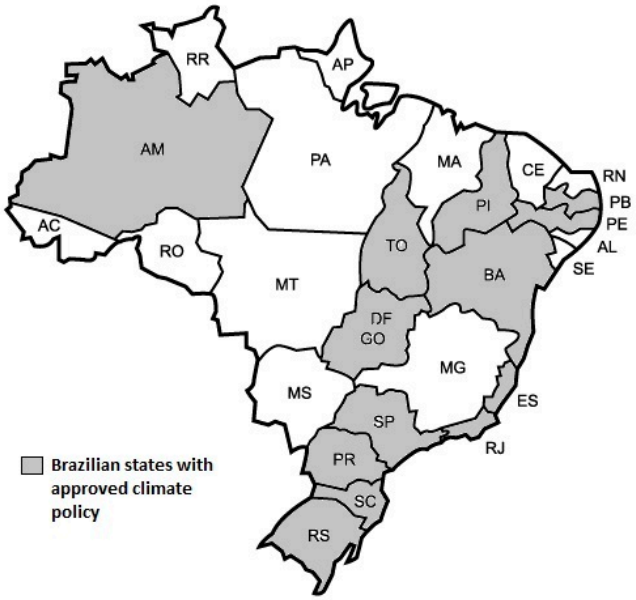

Figure 2. Brazilian states with approved climate change policies. Source: Elaborated by the author.

In the case of state policies, the State Forums of Climate Change were fundamental for their approval: 16 states have created their Forum between 2005 and 2009, and 12 out of 14 states with climate legislation had a climate forum before their policy was approved. Only Amazonas created its Forum after the approval of the state policy on climate change. The State Forums are planned in the Brazilian Forum of Climate Change, the national forum established in 2000. They focus on regional complementation and acting in accordance with state specifications. The importance of this institutional arrangement is the possibility of dialogue between the government and the society in the search for incorporating climate change issues in the different stages of public policy.

The Brazilian Forum is chaired by the President of the country. In the case of states, the governors preside over them. They also include the participation of civil society organizations, universities and research institutes and the private sector.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 7 July 2016 doi:10.20944/preprints201607.0006.v1

Regarding the climate policy implementation, 9 out of the 14 states have assumed a multi-sectoral perspective of climate governance by creating a multi-thematic spaces of sectoral coordination, which involve several departments and stakeholders from different segments of society and consider climate change a cross-action issue. Amazonas, Espírito Santo and Paraná have chosen to create specific institutional structures to address the climate issue and coordinate the implementation of the policy.

Finally, 8 of the states participate in transnational cooperation networks related to the climate issue. Table 2 shows the main characteristics of Brazilian states´ climate policies.

Table 2. Main characteristics of climate policy in Brazilian states.

State	Policy number / Year of policy approval	Targets / Intention to reduce GHG emissions	Adaptation strategies	Stakeholder participation in the policy-making process	Multi-sectoral policy implementation	Participation in climate networks
Amazonas (AM)	3135/2007	-	-	X	X	X
Bahia (BA)	12050/2011	-	X	X	X	X
Distrito Federal (DF)	4797/2012	X	X	X	-	-
Espírito Santo (ES)	9531/2010	-	X	X	X	-
Goiás (GO)	16497/2009	X	-	-	-	-
Paraíba (PB)	9336/2011	X	X	-	X	-
Paraná (PR)	17133/2012	-	X	X	X	X
Pernambuco (PE)	14090/2010	-	X	X	X	X
Piauí (PI)	6140/2011	X		X		-
Rio de Janeiro (RJ)	5690/2010	X	X	X	X	X
Rio Grande do Sul (RS)	13594/2010	-	X	X	X	X
Santa Catarina (SC)	14829/2009	-	-	X	X	-
São Paulo (SP)	13798/2009	X	X	X	X	X
Tocantins (TO)	1917/2008	-	-	X	X	X

Source: Elaborated by the author [37, 41, 42].

The states of Bahia, Pernambuco, São Paulo and Rio de Janeiro are members of the cooperation network Iclei - Local Governments for Sustainability through projects within the CCP campaign. Bahia and Pernambuco joined the project "State Policies for Climate", whose focus was to support state action to tackle climate change. As a result of the project, these states have instituted and strengthened their forums. Bahia and Pernambuco approved their policies and Mato Grosso, also part of the project, presented the bill of the state policy on climate change. São Paulo and Rio de Janeiro integrated projects on sustainable public procurement, focusing on the use of state purchasing power as an important tool to implement climate change policy.

The states of Paraná, Rio de Janeiro, Rio Grande do Sul, São Paulo and Tocantins are members of the Network of Regional Governments for Sustainable Development (NRG4SD). The network has

a working group on climate change directed to the territorial dimension of the international carbon market mechanisms.

4. Discussion

This article presented and analyzed the profile of policy responses in Brazilian subnational governments to climate change. By 2016, 6 municipalities out of 5,570 and 14 states out of 27 had a specific approved legislation related to the climate issue. Most of them were approved from 2009 on, at a time when the climate change issue was among the top first of the political agendas in the world, before the Conference of the Parties (COP) 15, in Copenhagen.

Following the growing international movement of subnational responses to climate change [15], in Brazil, this type of action was more expressive first at the municipal level of government, extending to the state level and only then reached the federal level. In this movement, the municipal climate policy of São Paulo is highlighted, since it played a leading role in establishing GHG reduction targets and influenced the approval of the state policy, which also exerted influence on the federal policy process of approval.

Brazilian subnational policies are isolated initiatives in the national context. Thus, according to the results shown not all policies include the two main aspects of climate policy: mitigation and adaptation.

An important point in the case of the approved subnational policies was the existence of previous institutional arrangements with the participation of stakeholders from different segments of society, such as the Municipal Committees and the Municipal and State Forums of Climate Change. They allowed the articulation among different stakeholders and sectors of activity involved in the climate issue and played a key role in the elaboration and adoption of climate policies.

Moreover, most of the subnational policies focus on the multi-sectoral nature of policy implementation, an important factor in the case of the climate issue since it permeates the different sectors of government action. This point demonstrates a greater understanding of the climate issue, which is not strictly related to the environmental issue, but also involves the sectors related to urban development, built environment, urban infrastructure and services, transport, carbon sequestration, disaster management and health at the subnational level.

Another point to be noted was the participation in transnational cooperation networks linked to climate change, which occurs in most municipalities and states with climate policies and in all of them with both mitigation and adaptation actions. Certainly this factor also favored the adoption of policies by those governments.

Added to this, both at municipal and at state level there were ongoing actions related to climate change which were consolidated and better articulated when they were incorporated into a specific climate policy [37]. It is noteworthy, therefore, the importance of a specific policy to address the climate issue and provide greater consistency and effectiveness to these actions.

Although few Brazilian municipalities and states count on a specific climate policy, the analyzed experiences are important initiatives to deal with the problem in the country and the most robust policies, that count on mitigation targets, adaptation plans and multi-sectoral implementation could be extended to other municipalities and states within the country.

5. Conclusions

Climate change risks set up an unprecedented challenge to contemporary societies and responding to them will greatly influence the future life on the planet. Within the understanding of the social and political dimensions of the climate issue, this article highlighted governments as relevant stakeholders in proposing appropriate forms of climate governance, considering that they are not the only ones facing this challenge. However, emphasizing the importance of this stakeholder does not mean defending a "top-bottom" government.

A specific group of stakeholders, such as subnational governments, cannot solve the climate crisis, since this is a complex, multilevel and multidimensional problem. The intent of this article was to deepen the knowledge about the role of subnational governments in the Brazilian context as key

players, but not the only ones. The involvement of non-governmental stakeholders, organizations of civil society, the private sector, universities and research institutions is critical to the production of efficient and successful responses to the problem.

This article analyzed how Brazilian municipalities and states have responded to the challenge of climate change risks. Even though these initiatives are important, they are not enough facing climate scenarios presented by scientists [43].

Every action and political intervention at all different levels of governance have a determining effect on tackling climate change. The establishment of climate policies is the first step, however, the law enforcement is fundamental in this process in order to ensure that mitigation and adaptation actions are taken.

The transposition of the climate change issue into the political agenda can be considered a first movement of response [12]. The next move must involve the introduction of this issue in institutions and daily concerns of citizens. And there is certainly a lot to be done in this direction.

The social and political dimensions of climate change have shown to be important extensions of research, given the complexity of the relationship between knowledge, policy recommendations and changes in current development standards.

Acknowledgments: This research was supported by São Paulo Research Foundation (Grant 2014/03101-5).

Conflicts of Interest: The author declare no conflict of interest. The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

References

1. WMO – World Meteorological Organization. The Global Climate 2001–2010: a decade of climate extremes. Genève. 2013.
2. Zwiers, F. W., Alexander, L. V., Hegerl, G. C., Knutson, T. R., Naveau, P., Nicholls, N., Schar, C., Seneviratne, S. I. E Zhang, X. Climate Extremes: Challenges in Estimating and Understanding Recent Changes in the Frequency and Intensity of Extreme Climate and Weather Events. In: Climate Science for Serving Society: Research, Modeling and Prediction Priorities. Asrar, G. R.; Hurrell, J. W., eds. Springer: Netherlands, 2013, pp. 339-389.
3. IPCC – Intergovernmental Panel on Climate Change. Working Group I Contribution to the IPCC Fifth Assessment Report. Climate Change 2013: The Physical Science Basis. Summary for Policymakers. 2013.
4. Adam, B.; Beck, U.; Loon, J. V. The Risk Society and Beyond: critical issues for social theory. Sage Publications: London, 2000.
5. Beck, U. Risk Society: Towards a New Modernity. Beverly Hills: Sage. 1992
6. Beck, U. Ecological Politics in an age of risk. UK: Cambridge. 1995
7. Beck, U. Risk Society Revisited: Theory, Politics and Research Programmes. In: The Risk Society and Beyond: critical issues for social theory; Adam, B.; Beck, U.; Loon, J. V., eds. London: Sage Publications. 2000.
8. Beck, U. World at risk. Cambridge: Polity Press. 2009.
9. Beck, U. Climate for Change, or How to Create a Green Modernity? Theory, Culture & Society, 2010, 27(2–3): 254–266.
10. Giddens, A. The consequences of modernity. Stanford: Stanford University Press. 1990.
11. Giddens, A. Runaway world. How Globalization is Reshaping Our Lives. New York: Routledge. 2000.
12. Giddens, A. The Politics of Climate Change. Cambridge: Polity Press. 2009.
13. Barbi, F.; Ferreira, L. C. Governing climate change risks: Implications for mitigation and adaptation. Fudan J. Hum. Soc. Sci., 2016, vol. 1., pp.1-18, DOI 10.1007/s40647-016-0141-z.
14. Bulkeley, H.; Kern, K. Local Government and the Governing of Climate Change in Germany and the UK. Urban Studies, 2006, Vol. 43, No. 12, pp. 2237–2259.
15. Bulkeley, H.; Newell, P. Governing Climate Change. New York, Routledge, 2010.
16. Ferreira, L. C.; Martins, R. D.; Barbi, F.; Urbinatti, A. M.; Souza, F. O.; Andrade, T. H. N.; Mello, L. F. Risk and Climate Change in Brazilian Coastal Cities. In Risk and Social Theory in Environmental Management, Measham, T. G.; Lockie, S., eds. Collingwood: CSIRO, 2012, pp. 133-146.

17. Betsill, M. M.; Bulkeley, H. Looking Back and Thinking Ahead: A Decade of Cities and Climate Change Research. Local Governments, 2007, 12:5, 447-456.
18. Okereke, C., Bulkeley, H.; Schroeder, H. Conceptualizing Climate Governance Beyond the International Regime. Global Environmental Politics, 2009, 9:1, 58-78.
19. Storbjörk, S. Governing Climate Adaptation in the Local Arena: Challenges of Risk Management and Planning in Sweden. Local Environment, 2007, 12, 5: 457-469.
20. Dodman, D. Blaming cities for climate change? An analysis of urban greenhouse gas emissions inventories. Environment and Urbanization, 2009. 21: 185-198.
21. Satterthwaite, D. The Contribution of Cities to Global Warming and their Potential Contributions to Solutions. Environment and Urbanization Asia, 2010, 1: 1.
22. Hoornweg, D.; Sugar, L.; Gomez, C. L. T. Cities and greenhouse gas emissions: moving forward. Environment and Urbanization, 2011.
23. Bulkeley, H.; Betsill, M. Cities and Climate Change – Urban Sustainability and Global Environmental Governance. New York: Routledge. 2003.
24. Gupta, J. The multi-level governance challenge of climate change. Journal of Integrative Environmental Sciences, 2007, 4:3, 131-137.
25. Renn, O.; Klinke, A. Complexity, uncertainty and ambiguity in inclusive risk governance. In: Risk and Social Theory in Environmental Management. Measham, T. G.; Lockie, S., eds., Collingwood: CSIRO, 2012, 59-76.
26. IPCC – Intergovernmental Panel on Climate Change. Summary for Policymakers. In: Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds.)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2007.
27. Klein, R. J. T.; Schipper, E. L. F.; Dessai, S. Integrating mitigation and adaptation into climate and development policy: three research questions. Environmental Science & Policy 2005, 8, 579–588.
28. IPCC – Intergovernmental Panel on Climate Change. Summary for Policymakers - Climate Change 2001: Impacts, Adaptation, and Vulnerability. In: A Report of Working Group II of the Intergovernmental Panel on Climate Change. 2001.
29. Winkler, H.; Baumert, K.; Blanchard, O.; Burch, S.; Robinson, J. What factors influence mitigative capacity? Energy Policy 2007, 35, 692–703.
30. Burch, S.; Robinson, J. A framework for explaining the links between capacity and action in response to global climate change. Climate Policy 2007, 7 (4): 304-316.
31. Bizikova, L.; Burch, S.; Cohen, S.; Robinson, J. Linking sustainable development with climate change adaptation and mitigation. In: Climate Change, Ethics and Human Security, O'brien, K. L.; St. Clair, A. L.; Kristoffersen, B., eds., Cambridge University Press, Cambridge. 2010. 157–179.
32. UN-HABITAT (United Nations Human Settlements Programme). Cities and climate change: global report on human settlements. Earthscan. 2011.
33. Adger, W.N.; Huq, S.; Brown, K.; Conway, D.; Hulme. M. Adaptation to climate change in the developing world. Progress in Development Studies, 2003, 3: 179-195.
34. Schroeder, H.; Bulkeley, H. Global Cities and the Governance of Climate Change: What is the Role of Law in Cities? Fordham Urban Law Journal. 2009.
35. Lindseth, G. The Cities for Climate Protection Campaign (CCPC) and the Framing of Local Climate Policy. Local Environment, 2004, Vol. 9, No. 4, 325–336.
36. Barbi, F.; Ferreira, L. C. Climate Change in Brazilian Cities: Policy Strategies and Responses to Global Warming. International Journal of Environmental Science and Development, 2013, Vol. 4, No. 1, pp. 49-51.
37. Barbi, F. Mudanças climáticas e respostas políticas nas cidades. Campinas, Brazil: Editora da Unicamp, 2015.
38. Almeida, L. A.; Silva, M. A. R.; Pessoa, R. A. C. Políticas Públicas, Mudanças Climáticas e a participação de cidades em Redes Transnacionais: o caso de Palmas – TO. Paper presented at VI Encontro Nacional da Anppas, Belém, Brazil, 2012.
39. INPE, UNICAMP, SMAC. Vulnerabilidades das Megacidades Brasileiras às Mudanças Climáticas: Região Metropolitana do Rio de Janeiro. 2011.
40. Martins, R. D.; Ferreira, L. C. Climate change action at the city level: tales from two megacities in Brazil. Management of Environmental Quality: An International Journal, 2011, Vol. 22 Iss: 3, pp.344–357.

41. Fórum Clima. Ação empresarial sobre mudanças climáticas. O Desafio da Harmonização das Políticas Públicas de Mudanças Climáticas. São Paulo. 2012.
42. Fórum Clima. O Desafio da Harmonização das Políticas Públicas de Mudanças Climáticas. Volume II. São Paulo. 2013.
43. Rogelj, J.; Elzen, M.; Höhne, N.; Fransen, T.; Fekete, H.; Winkler, H.; Schaeffer, R.; Sha, F.; Riahi, K.; Meinshausen, M. Paris Agreement climate proposals need a boost to keep warming well below 2 °C. Nature, 2016, 534, 631–639.