Cities and climate change: challenges to Brazilian municipal Master Plans

Cidades e mudanças climáticas: desafios para os planos diretores municipais brasileiros

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Abstract

Considering that cities have their political relevance recognized in current global agreements, this article questions whether the master plans of Brazilian capitals contribute not only to promote urban development and planning, but also to overcome challenges related to climate change. We analyzed qualitatively the plans instituted after 2015 and checked if the legislation addresses climate change, containing, for example, references to mitigation and adaptation plans. Data from the Basic Municipal Information Survey were used, as well as data provided by IBGE and the websites of the capitals' municipal governments. It is concluded that few plans provide guidelines for local climate issues. Of the analyzed cases, only one plan addresses climate change, which shows that this topic has been scarcely considered in municipal urban public policies.

Keywords: master plan; urban planning; climate changes; climate policy.

Resumo

Este artigo, considerando que as cidades têm sua relevância política reconhecida em acordos globais atuais, questiona se os planos diretores das capitais brasileiras contribuem não somente para o desenvolvimento e planejamento urbano, mas também para a superação dos desafios relacionados às mudanças climáticas. Analisa-se, qualitativamente, os planos instituídos após 2015, verificando se a legislação é direcionada às alterações climáticas, contendo, por exemplo, menções a planos de mitigação e adaptação climática. Utilizam-se dados da Pesquisa de Informações Básicas Municipais, do IBGE e dos sites das prefeituras das capitais. Conclui-se que poucos planos trazem diretrizes para as questões climáticas locais. Dos casos analisados, somente um plano aborda as mudanças climáticas, mostrando que esse tema é pouco contemplado em políticas públicas urbanas municipais.

Palavras-chave: *plano diretor; planejamento urbano; mudanças climáticas; política climática.*

Introduction

Anthropic actions are accountable for many changes in contemporary society. Environmental issues are included in this set, which includes ecological, political, economic, ethic and social issues (Serpa, 2008). Considering the countless environmental issues that affect contemporary society, the present work intends to contribute to the debate on how cities are reacting (or not) to the changes in the planet climate, from the point of view of municipal public policies. Climate change impacts cross borders, and do not respect territorial and political limits of states, making more necessary joint actions involving governments and society to mitigate consequences and seek the adoption of practices to achieve a state of balance in human activities in the environment. However, this responsibility is not only of federal governments, so, the participation of state and municipal governments to reach the goals proposed by governments in their plans to fight climate changes is required (Bai et al., 2018; Ürge-Vorsatz et al., 2018).

In this process of climate changes, cities, here understood as a "complex system with multiple interdependences of form (rural and built environment), activities and flows" (Lemos, 2010, p. 114 *our translation*), play an important role, both for suffering with these climate changes and for contributing to this process intensification. Apollaro and Alvim (2017) remark that the number of disasters[1] resulting from climate changes in urban areas has quadrupled in the last thirty years. According to Bai et al. (2018), some of the most recent example would be the floods that reached cities in Southeast Asia, including Dhaka, in Bangladesh, and Mumbai in India. The authors indicate that 45 million people were affected by these events. Another example would be the extreme drought that Cape Town, in South Africa, faces since 2015. Rio de Janeiro is also mentioned by these authors, due to floods and landslides occurred in the last years.

Braga (2012) reminds that greenhouse gases (GHGs) emission is acknowledged as the main cause of the ongoing climate changes. In global terms, Bai et al. (2018) indicate that 75% of these gases generation, caused by anthropic actions, originate in urban activities such as transport, construction, industry and energy. This important role of cities arises chiefly from their population concentration and accelerated urban growth.

The growth of the population residing in cities was representative, going from 10% of world population in 1900 to over 50% in 2010, according to Braga (2012). According to data from Undesa (2019), 55% of the world population lived in urban areas in 2019. Expectations are that 68% of the world population will be living in urban areas until 2050. The number of megacities with over 10 million inhabitants is projected to be 43 until 2030, particularly in developing countries. Currently, there are 33 urban centers with populations exceeding 10 million people (ibid.).

According to the United Nations (ibid.), the growth of megacities will probably result in accelerated change of rural areas to urban areas worldwide. With regard to the accelerated urban growth, particularly in Brazil, geographer Wagner Costa Ribeiro (2008) argues that many cities have undergone a period of uncontrolled growth and development, without following a planning. The result was the occupation of

risk areas and degraded environments, directly impacting the environment, which was changed to meet populations' demands. For Braga (2012), population concentration in urban centers is one of the factors demonstrating how these areas can be sensitive to impacts of climate events like floods and hurricanes, since they affect populations that reside in these locations.

And the responses to climate changes' effects and consequences are vulnerable to the inertia incorporated in certain infrastructures, technologies and institutions existing in the cities, as mentioned by Ürge-Vorsatz et al. (2018). For the United Nations (Undesa, 2019), the fast population growth in urban areas is a challenge to achieve Sustainable Development Goals (SDGs) and to overcome the challenges imposed by climate changes. Though large urban centers are capable of absorbing practically the whole future growth of world population, they end up by combining all four global demographic megatrends[2] in one single area. That generates relevant implications both for economic and social development and for environmental sustainability.

It is worth reminding that the political relevance of cities has been increasingly recognized and explored in the current global conjuncture. According to Mauad and Betsill (2019), this bond has been explored for at least twenty years to understand and encourage the participation of cities as important players in the global climate governance. Examples include from dissemination of methods for population participation, new institutional arrangements turned to empowering communities (like local committees of climate changes), bottom-up approaches, to the development of inter-municipal knowledge and collaboration networks. (Sathler, Paiva & Baptista, 2019; Macedo & Jacobi, 2019). Mauad (2018) mentions transnational networks like C40 (Cities Climate Leadership Group)[3] and Iclei (Local Governments for Sustainability), which showed that cities found their spot in climate change issues.

Hughes, Chu & Mason (2018) and Mauad (2018) argue that both in the Intergovernmental Panel on Climate Changes (IPCC) assessment and in global agreements, like the Paris Agreement, Sustainable Development Goals (SDGs) and the New Urban Agenda - Habitat III (2016):

> [...] cities were recognized as drivers of transforming actions, particularly in terms of their capacity to face sectorial, demographic, spatial and ecological challenges of climate changes and extreme risks of disasters. [...] all these global structures observe the centrality of urban communities and decision makers in response to climate changes. (Hughes, Chu & Mason, 2018, p. 2) (*Our translation*)

For Serpa (2008), the urban and metropolitan context must be considered and addressed within this current environmental issue, starting with the assumption that a society-nation relation exists. Thus, cities become key to the articulation and implementation of public policies turned to climate changes. And, for Mauad (2018), the participation of cities in the process of global governance of climate changes is also part of a larger frame associated to the process of inclusion of local actors in contemporary international relations.

Bai et al. (2018) propose arguments similar to those of Mauad (2018) and Serpa (2008). For Bai et al. (ibid.), cities must respond to the challenges imposed by climate changes. Not only for being places where the consequences of climate change are more perceptible, but also for representing opportunities of change and evolution. And scientists and researchers play essential role in this journey, since mitigation and adaptation to climate changes in urban areas require a joint work of several sciences. First, due to the need to expand data collected. Second, due to the need of new forms of interpretation of climate changes. And, third, due to the urgency of more comparative studies, simulations and also modeling based on climate changes. For these authors, this change is already taking place, mainly due to the union of scientists, urban planners and decision makers to develop new concepts, strategies and improvements for climate mitigation and adaptation. The concept of smart cities would be a result of this cooperation.

Based on the assumption that there is a relation between urban-territory planning and climate changes, and the State is responsible for protecting its population from any threat (natural or not), the present paper considers issues involving right, urbanism, local governance and environment to investigate whether the master plans of Brazilian capitals, instituted after the Paris Agreement (2015), in addition to contributing to the territorial urban development and planning, also include measures to overcome the challenges associated to climate changes and the reach of goals adopted in Brazil in its nationally determined contribution. Here we argue that municipal master plans, while technical-legal instruments to define municipal development and urban territorial order, are essential for the resilience and adaptation to climate change.

We hope this paper will contribute to the debate on the role of cities in global governance of climate changes, highlighting their relevance in the development and in the adoption of measure for mitigation and adaptation to climate change effects. Discussing about climate changes is more than essential in our current society, but more important is to put into practice the whole knowledge on the theme, seeking real and tangible outcomes. This function falls on national and local governments, and also on the private sector and the society.

Methodology and justification

For the development and reach of the paper objective, we first explain urban and territorial planning and the effects of climate changes in urban areas, highlighting the importance of the City Statute and the role of cities in the global governance of climate changes. Next, it was verified which of the 27 Brazilian capitals developed and approved Municipal Master Plans after 2015. For such, data from the Basic Municipal Information Survey (Munic) of 2015, published in 2016 by the Brazilian Institute of Geography and Statistics (IBGE, 2016) were used, as well as information from city halls of each Brazilian capital, given the need of recent data from each municipality.

The choice of Brazilian capitals as focus of this paper arises from the fact that these cities are large urban centers, capable of quickly mobilizing human, financial and political

resources, when compared to small towns. They are also capable of opening "interaction channels" and expanding "the possibilities of insertion and influence" in "knowledge networks" (Sathler, 2015, p. 10). Brazilian capitals are, in this regard, example for smaller cities, and are also places where urbanization processes occur more and cause problems to the population (Carlos, 2009). For Sathler, Paiva & Baptista (2019, p. 264), "Brazilian metropolitan regions (MRs) and Integrated Development Regions (Rides) catch more attention due to their demographic, economic and spatial relevance" (our translation). In addition to these characteristics, the authors also list "precariousness and high level of social vulnerability to climate changes" as attractive factors for the choice of these urban centers.

Bai et al. (2018) evidence need of interdisciplinary and comparative studies on cities and climate changes. For them, cities need spaces to share information associated to planning and confrontation of climate changes. They can only learn with each other by means of these spaces. Besides, Ferreira (2004) states that the study of environmental policies at local level, like cities, is still recent and needs analyses. In a climate change scenario, the construction of adapted and resilient cities given the uncertainties brought by climate changes should be a priority for urban management and planning (Lemos, 2010).

In the Municipal Master Plans selected for the study, an adaptation of the methodology developed by Lemos (Ibid.) will be used, initially applied to Rio de Janeiro Municipal Master Plan, and replicated to São Paulo Municipal Master Plan by Apollaro & Alvim (2017). The master plan will be qualitatively analyzed, checking whether the legislation is oriented to climate changes. That would include from the exhibition of mitigation plans to direct reference to climate changes in the master plan text, such as risk and vulnerability. Or whether there is any explicit mention to adaptation, reduction of social, economic, environmental and climatic vulnerabilities of the city. It is worth noticing whether climate changes are included in objectives, guidelines or other articles of the master plan.

Theoretical discussion

From urban-territorial planning to climate change effects in urban areas

Currently, cities became real territories of training, production and reproduction. They are urban agglomerations (Bitoun, 2009) whose planning and management apply aspects of law, architecture, urbanism, engineering, environment and local governance that determine their configuration and management, as well as the implementation of plans. Such factors can be associated to demographic, environmental, economic and socio-spatial transformations that cities face in the contemporary context. That is, urban planning must be oriented and review processes, methods, tools and conceptual foundations according to the city itself and the demanded situation.

Lemos (2010) states that, in face of world population growth, concentrated in urban area, urban territory planning and

management models should increasingly adapt to the reality of their populations. Since the mid 20th century, it emerges as something much more complex that demands constant studies in order to adapt to the reality and the population's needs. This constant re-design of urban territory planning and management models is indispensable to avoid obsolescence of plans and proposals.

Climate changes present a scenario of uncertainties and concerns even for cities. Martins (2009) say that understanding the climate change phenomenon and its consequences requires a solid comprehension that establishes dialogue among different dimensions and knowledge. From an urban and population perspective, the author remarks the importance of combining environmental, social, political, economic and demographic aspects in processes and policies at local levels. Hughes, Chu & Mason (2018), on the other hand, state that there are challenges that cross each other and are subjacent to the task of responding to climate changes in cities. The first challenge refers to the decision making process in the cities and is the result of a collectivity ground on actors and forces that act within the city limit. However, climate changes tend to surpass political and jurisdictional borders. Thus, it would imply, for these authors, that solutions transcend borders, and should be incorporated considering governance in multiple levels, not only that of the city.

The second challenge refers to the need of new means, mechanisms, approaches and strategies to manage the city. Hughes, Chu & Mason (ibid.) remind that, while urbanization rates in global scale are increasing, the demand for resources is increasing as well. However, climate changes generate a context of restrictions, both of resources and capacity. For the authors, "dealing with climate changes in a significant way requires, therefore, the development of new standards and processes for engagement, financing and collaboration" (ibid., p. 3). This innovation, therefore, must occur in all practices associated to urban governance, involving policies, institutions, people participation and financing mechanisms.

Lemos (2010) argues that, in the context of climate changes, all cities must be adapted to reduce the vulnerability generated by the changes, and should be resilient to ensure life quality to their population, avoiding impacts on the environment and not contributing to the worsening of climate change processes. Di Giulio et al. (2017, p. 78) complement, stating that cities should connect their mitigation and adaptation policies "to the housing policy, sanitation, master plans, policy and management of water resources and review of forms of urban mobility" (our translation).

Marques (2014, p. 2) observes that cities are increasingly more impacted with the consequences of "greenhouse effect, acid rains, extinction of natural environments, destruction of atmospheric ozone, erosion and loss of fresh water sources" (our translation). Among the consequences associated to climate changes in cities, the chart below (Chart 1) presents some of the possible impacts of climate changes on urban areas.

Considering the problems associated to climate changes in cities, Sathler, Paiva & Baptista (2019, p. 264) state that the scenario will involve "an expansion of urban risks particularly in areas with higher vulnerability and needing infrastructure". The higher

Chart 1 – Impacts of climate changes on urban areas

	Climate change	Impacts on urban areas
Change in average conditions	Temperature	Growing energy demand (heater-air conditioning); deterioration of air quality; urban heat islands.
	Rainfall	Growing risk of floods; growing risk of land sliding; migrations of rural zones; interruption of food supply networks.
	Rise of sea level	Coastal floods; reduction in income from agriculture and tourism; salinization of water sources.
Changes in extreme conditions	Extreme rains/tropical cyclones	More frequent floods; higher risk of land sliding; damages to houses, factories and urban infrastructures.
	Droughts	Water scarcity; higher food prices; disturbance in the hydroelectric system; migrations of rural zones.
	Cold/heat waves	Higher energy demand in the short term (heater-air conditioning).
	Abrupt change in climate (still unlikely, but growingly considered)	Possible impacts of extreme rise of sea level; possible impacts of a quick and extreme rise of temperatures.
Changes in exposure	Population movements	Migrations of affected rural habitats.
	Biological changes	Increase in disease vectors.

Source: developed by the authors based on Martins & Ferreira (2011) and Apollaro & Alvim (2017).

number of severe storms can, for example, affect the cities drainage and transport systems, causing impacts on public and private assets. For Lemos (2010), these factors are more than enough to remark that cities need to implant planning and management measures in their policies and agendas considering climatic phenomena. The authors complement this argument, stating that cities need regular assessments on climatic changes, especially the urban social vulnerability to these changes.

However, Di Giulio et al. (2018) state that, even with this latent need, the initiatives of municipal governments vary widely, and many of the actions face barriers and delays, chiefly due to lack of material resources and knowledge. Bai et al. (2018) argue that one of the difficulties is in the scope and applicability of the urban research associated to the effects of climate changes in cities. In addition to the lack of long-term studies on urban climate and its impacts, the authors state that many of the existing studies are isolated and/or focused on local needs. And that would be a failure, since the effects of climate changes are rarely restricted to one single place. For them, research associated to the theme should be increasingly more interdisciplinary and consider more than one location in their analyses, as the list of effects of climate changes in urban areas does not stop growing.

If the climate changes originate from the relations involving the local, regional, national and global, their resolution should then undergo different levels, counting on joint actions, even when they occur at different scales. Though efforts and research associated to the theme are minimum, when compared to the amount of data, information and works developed in foreign countries, Sathler, Paiva & Brant (2014) state that, even so, we can observe a reaction by Brazilian cities in favor of local policies of mitigation and adaptation, thus following the wave of international actions associated to climate changes.

In the next section, the Brazilian urban territorial legislation will be discussed, chiefly those related to municipal master plans. Demographic and socio-economic information on the areas of study will also be presented.

Municipal master plan, urban territorial planning and population estimates in Brazil

In Brazil, a great advance occurred with the approval of Federal Law n. 10.257 of July 10, 2001. Created to regulate articles 182 and 183 of the Federal Constitution of 1988, this law, also known as City Statute, established parameters and guidelines for urban policy in Brazil, determining instruments to ensure the right to the city, the fulfillment of the social function of the city and the property in the ambit of each municipality. According to Oliveira, Lopes & Sousa (2018, p. 2):

> The Brazilian urban legislation has as base both the Republic Constitution of 1988, chiefly its articles 182 and 183, and the City Statute (Federal Law 10.257/2001), which indicate that the present legislation, while instrument of urban policy, must always seek citizenship by guaranteeing the city social function and the well being of its inhabitants (our translation).

The City Statute establishes that the city management must be participative (Pintaudi, 2005) and presents, in its text, that the master plan is the basic instrument to guide the development policy and the organization of the urban expansion in the municipality. Under the terms of its article 41, the master plan is mandatory for cities:

> I – with more than 20 thousand inhabitants;
> II – integrant in metropolitan regions and urban agglomerations;
> III – where municipal public authorities intend to use the instruments provided in § 4th of art. 182 of the Federal Constitution;
> IV – integrant of areas of special touristic interest;
> V – inserted in the area of influence of undertakings or activities with significant environmental impact of regional or national ambit;
> VI – included in the national registration of Municipalities with areas susceptible to large impact land sliding, abrupt floods or correlated geological or hydrological processes. (Brasil, 2012)

According to IBGE (2016) data, of the 5,572 Brazilian cities, more than 50% count on an approved master plan, while 12.4% of municipalities were in process of preparation of their municipal master plans in 2015. For cities with population above 20 thousand

inhabitants, the percentage reaches 90%, according to data from the institute (ibid.). Thus, in population terms and considering the obligatoriness of Plan for municipalities with over 20 thousand inhabitants, the percentage of the Brazilian population influenced by determinations established in Plans is significant. That, for Ultramari & Silva (2017), is proof that Master Plans, while basic instrument for urban development and expansion policy, and along with the Federal Constitution and the City Statute, are legal marks that will transform the reality of Brazilian cities.

In the environmental ambit, the Basic Municipal Information Survey (Munic) of 2015 indicated that only 20.7% of cities had geographic information, 30.4% had some modality of environmental licensing,[4] 28% presented information on environmental zoning and 21% had some legislation on conservation unit. This survey, unfortunately, does not cover aspects directly associated to climate changes, like mitigation and adaptation policies and control of GHG emission. The absence of these studies and legislations can cause severe consequences to the municipality urban territorial planning, compromising important public policies, such as the city planning, fight against natural disasters and urban development.

The lack of specific legislations for climate changes in Brazilian urban centers, particularly for mitigation and adaptation is considered as a great obstacle by Lemos (2010) and Sathler, Paiva & Brant (2014). And, for Di Giulio et al. (2018), the situation is worse in large urban centers like Brazilian capitals, since they concentrate the main problems that affect the urban systems, for example land use planning and control of carbon gas emission. While studying the city of São Paulo, Di Giulio et al. (2018) estimate that the complexity of adversities affecting large urban centers is one of the main factors that render difficult the development of strategies for adaptation and reduction of climate changes.

A possible solution for these gaps would by an adaptation of municipal master plans' legislation. Though not addressing specifically climate changes in their guidelines and urban-territorial management instruments, the master plan should incorporate strategies aiming at urban adaptation and reduction of existing and future vulnerabilities of the population and the territory to the possible impacts of climate change. Environmental urban sustainability, such as environment preservation and protection, reminds Lemos (2010), are goals and guidelines established by the City Statute itself, which, therefore, should be present in each municipal master plan.

Finally, Brazilian cities should also comply with the two federal laws that associate climate changes to urban territorial planning: Federal law 12.187/2009, which institutes the National Climate Change Policy, and Federal law 12.608/2012, which institutes the National Civil Protection and Defense Policy (PNPDEC). Article 5th, line V of the National Climate Change Policy is responsible for encouraging "support to the participation of state, district and municipal governments as well as the productive sector, the academic environment and the organized civil society in the development and execution of policies, plans, programs and actions associated to climate change" (Brasil, 2009) (our translation). Articles 42-A and 42-B of

PNPDEC, in their turn, require that master plans of Brazilian municipalities included in the national registration of cities with areas susceptible to large impact land sliding, abrupt floods or correlated geological or hydrological processes perform: (1) mapping of risks, (2) preventive intervention actions and reallocation of population in areas under disaster risk; (3) prevention and mitigation of disasters' impacts (Brasil, 2012).

Moreover, Di Giulio et al. (2018) argue that the master plan, even without making explicit climate changes in its wording, addresses many themes that are indirectly related to climate changes. For Ribeiro (2010, p. 2), themes like "water supply, solid waste management, power supply, distinct forms of pollution (air, visual, noise), green areas and life quality", which are already included in the Brazilian urban planning scope, are associated to global climate changes.

Apollaro and Alvim (2017, p. 121) defend that the master plan "should provide mechanisms and indicators to potentially contribute to the minimization of climate change impacts on the city, its population and natural systems" (our translation). Therefore, it is with the master plan that municipal governments have the possibility of promoting and adopting policies that may have direct implications in the mitigation and adaptation of climate changes, thus improving the quality of life of their population (Mauad, 2018). Di Giulio et al. (2018) also observe that the weight and importance of mitigation and adaptation measures should be the same to achieve the expected outcome in the fight of causes, effects and consequences of climate changes.

As obvious as may be the role of cities in climate change governance, there is still a lot to be done. Many of the master plans of main Brazilian cities do not present explicit indications of policies turned to climate changes. That demonstrates the weakness of Brazilian municipalities in face of climate changes and the lack of adaptation and mitigation measures. In this context, it is worth mentioning that Apollaro & Alvim (2017) understand that mitigation actions act on the causes of climate changes, thus reducing, for example, anthropic aspects that intensify the production of GHGs. Adaptation actions, on the other hand, focus both on the effect and the vulnerabilities resulting from climate change.

For Di Giulio et al. (2018), in Brazil, the government agenda tended to present more proposals for mitigation than for adaptation. According to these authors, this choice resulted from the fact that adaptation policies are much more complex and are considered more costly and expensive to the cities, rather than as long-term outcomes. And in a country with economic, institutional and political restriction, Di Giulio et al. (ibid.) argue that mitigation measures present quick outcomes, and are understood as less costly for municipal governance. This divergence in perception and understanding of outcomes is just another item in the list of barriers to the development of a policy to climate at municipal level.

Marques (2014) indicates a disarticulation, both internal and external, of adaptation policies within Brazilian cities, which need a joint approach involving the city hall, the several secretariats and the local population. For Sathler (2015, p. 277):

> Few cities in the country are part of the consolidated knowledge networks on mitigation and adaptation policies. Local climate change committees and specific laws are in place only in a selected group of municipalities and focus almost exclusively on mitigation policies. The existing forums and panels in national and state level are poorly articulated with local administration and community groups. There is also lack of knowledge by Brazilian municipalities on the importance of local participation in adaptation and mitigation (our translation).

This lack of policies involving local urban issues and global climate changes is, therefore, a risk to the population. Cities like Rio de Janeiro, Salvador, Recife and Fortaleza, some of the country's state capitals, are under risk due to the rising of sea level, one of the possible consequences of climate changes (Lemos, 2010). For Ribeiro (2010), climate changes can intensify social inequalities in Brazil and increase urban risks. The implications of climate changes in cities and large urban centers are not limited to that. They are countless and must be considered in order to strengthen the cities' capacity to respond to climatic events.

In addition to partially cause the problem, cities are also places where changes' impacts occur. And the population in the cities will be the most affected by these impacts. It is worth reminding that large part of the population growth occurred in urban centers. In Brazil it was not different. Cerqueira & Givisiez (2004) argue that changes in spatial distribution of the Brazilian populations and the growth of urban population representativeness are linked to two factors, namely: 1) progressive urbanization and 2) growth of the relative importance of agricultural frontier regions. For the authors, these two factors influenced, for example, population displacements to economically more dynamic regions, like the Southeast region, and the population concentration in regions already densely populated (large and medium size cities).

Chart 2 presents some data on population and urban growth since the mid 20th century. We can observe that urban population already represents over 85.8% of the country's total population. During the 1960s, this percent stays below 50%, reaching 46.1%. Overtime, this representativeness increased. And, according to Undesa (2017 and 2018) projections, this growth situation tends to continue, since over 90% of the Brazilian population will probably reside in urban areas in 2035. In 2050, on the other hand, projections indicate that the urban population percent is to reach 92%.

According to IBGE (2017) estimate, population in Brazil is getting close to 207.7 million people. The most populated states are in the Southeast region, while the five less populated are in the North region. São Paulo state concentrates 21.7% of the country's population (45.1 million inhabitants), while Roraima concentrates only 3% of the total population (522.6 thousand inhabitants), being the least populated state. Half of the Brazilian population (117.2 million inhabitants) resides in municipalities with over 100 thousand inhabitants. Municipalities with more than 500 thousand inhabitants, on the other hand, concentrate 30.2% of the country's population (62.6 million inhabitants). Most

Chart 2 – Total and urban Brazilian population growth in the last fifty years

Year	Total population (in million)	Urban population (% of total population)
1960	72,208	46.1
1970	95,327	55.9
1980	121,160	65.5
1990	149,352	73.9
2000	175,288	81.2
2010	196,796	84.3
2015	205,962	85.8

Source: developed by the authors based on Undesa (2017 and 2018) data.

Brazilian municipalities (68.3%) counts on up to 20 thousand inhabitants, with only 15.5% (32.2 million inhabitants) of the country's population.

Brazilian capitals, on the other hand, total 49.4 million inhabitants, representing 23.8% of the Brazilian population. São Paulo, one of the capitals contemplated in this paper, is the most populous city of the country, followed by Rio de Janeiro, Brasília and Salvador. Among the capitals with higher population growth rate (in the 2016-2017 period), Palmas (2.48%) and Brasília (2.09%) are outstanding. The lower population growth rate among capitals were observed in Porto Alegre (0.26%), Teresina (0.33%) and Rio de Janeiro (0.33%) (IBGE, 2017). Chart 3 presents Brazilian capitals' information.

According to IBGE (2017), population reductions were estimated for almost a quarter of the country's municipalities, since 1,364 municipalities presented negative population growth rates. The South region (Paraná, Santa Catarina and Rio Grande do Sul) was the one that showed higher proportion of municipalities with negative rates. In municipalities with over one million inhabitants, it was observed that 9 of the 17 municipalities presented growth rates between 0.5% and 1% a year. It is worth mentioning that, even with these negative population growth rates, the country's population is still large and resides mainly in urban centers.

Given the anthropogenic responsibility for climate changes and the eminent possibility of impacts on populations residing in cities, it is more than imperative to analyze the cities and their process of urbanization, management, and planning from the point of view of climate change.

Chart 3 – Brazilian capitals' population and annual population growth rates

Capital	Population in 2017	Population growth rate[5] (%)
Aracaju	650,106 thousand	1,34
Belém	1,452,275 million	0,43
Belo Horizonte	2,523,794 million	0,41
Boa Vista	332,020 thousand	1,72
Brasília	3,039,444 million	2,09
Campo Grande	874,210 thousand	1,18
Cuiabá	590,118 thousand	0,81
Curitiba	1,908,359 million	0,76
Florianópolis	485,838 thousand	1,68
Fortaleza	2,627,482 million	0,68
Goiânia	1,466,105 million	1,21
João Pessoa	811,598 thousand	1,23
Macapá	474,706 thousand	1,98
Maceió	1,029,129 million	0,73
Manaus	2,130,264 million	1,71
Natal	885,180 thousand	0,86
Palmas	286,787 thousand	2,48
Porto Alegre	1,484,941 million	0,26
Porto Velho	519,436 thousand	1,61
Recife	1,633,697 million	0,50
Rio Branco	383,443 thousand	1,69
Rio de Janeiro	6.5 million	0,33
Salvador	2,953,986 million	0,54
São Luís	1,091,868 million	0,82
São Paulo	12,106,920 million	0,57
Teresina	850,198 million	0,33
Vitória	363,140 million	1,00

Source: developed by the authors based on IBGE (2017) data.

Analyses and discussion

Survey and analysis of Brazilian capitals' Municipal Master Plans

According to the current Brazilian political division, instituted by the Federal Constitution of 1988, the country counts on 26 states, the Federal District and their 27 capitals, namely: Rio Branco (Acre), Macapá (Amapá), Manaus (Amazonas), Belém (Pará), Porto Velho (Rondônia), Boa Vista (Roraima), Palmas (Tocantins), Maceió (Alagoas), Salvador (Bahia), Fortaleza (Ceará), São Luís (Maranhão), João Pessoa (Paraíba), Recife (Pernambuco), Teresina (Piauí), Natal (Rio Grande do Norte), Aracajú (Sergipe), Goiânia (Goiás), Cuiabá (Mato Grosso), Campo Grande (Mato Grosso do Sul), Brasília (Distrito Federal), Vitória (Espírito Santo), Belo Horizonte (Minas Gerais), São Paulo (São Paulo), Rio de Janeiro (Rio de Janeiro), Curitiba (Paraná), Porto Alegre (Rio Grande do Sul) and Florianópolis (Santa Catarina).

It was observed that all Brazilian capitals count on municipal master plans, however, of the 27 Brazilian capitals, 11 have their master plans outdated, that is, they exceeded the 10-year term for review, as established by the City Statute. They are: Belém (2008), Aracaju (2000), Cuiabá (2007), João Pessoa (2008), Macapá (2004), Maceió (2005), Natal (2007), Porto Velho (2008), Recife (2008), São Luís (2006) and Teresina (2006). Among these cities, it is worth mentioning that Aracajú, Campo Grande, Cuiabá, Natal, Porto Velho, Recife, São Luís and Teresina, their municipal master plans are in process of review.

Belo Horizonte (2019), Boa Vista (2014), Brasília (2012), Campo Grande (2018), Curitiba (2014), Florianópolis (2014), Fortaleza (2009), Goiânia (2013), Manaus (2014), Palmas (2018), Porto Alegre (2011), Rio Branco (2016), Rio de Janeiro (2011), Salvador (2016), São Paulo (2014) and Vitória (2018) are still within the 10-year term established by the City Statute. The results of this survey and data analysis can be seen in Chart 4.

Only Belo Horizonte (2019), Campo Grande (20018), Vitória (2018), Palmas (2018), Salvador (2016) and Rio Branco (2016) approved their municipal master plans after 2015. Thus, these Brazilian capitals were selected for the investigation. The choice of 2015 as base year for the analysis is grounded on the fact that, in that year, in Paris, during the (United Nations Framework Convention on Climate Change), a new agreement was adopted in order to strengthen the global response to the threat of climate change and reinforce the countries' capacity to address the impacts resulting from these changes.

Known as Paris Agreement, this document produced during COP21 was approved by the 195 member countries to reduce GHG emissions in the context of sustainable development (UNFCCC, 2015). It is important to remember that the Paris Agreement came into force only in 2016, after its ratification in at least 55 countries that correspond, jointly, to 55% of GHG emissions. Figure 1 displays the countries that ratified Paris Agreement until November 2017. As can be observed, Brazil is included in this group.

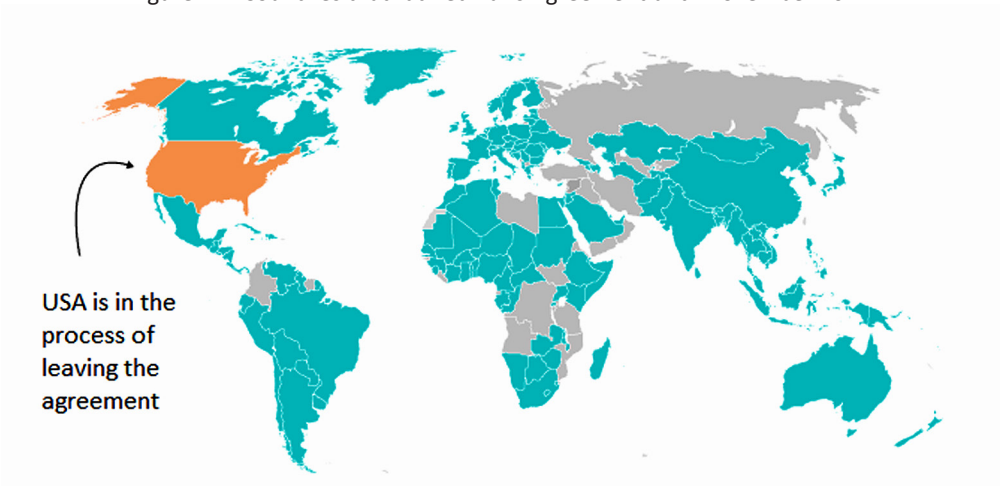
Considering that Brazil is one of the countries signatory of the Paris Agreement, it is expected that there will be incentive for cities,

Chart 4 – Brazilian capitals and municipal master plans until 2019

Capital	Year when the master plan was last updated	Current status (2019)	Municipal climate change laws
Aracaju[6]	Not updated	In process of review	Doesn't have
Belém[7]	Not updated	Belém Municipal Master Plan (law n. 8.655, of July 30, 2008) "expires" in 2018	Doesn't have
Belo Horizonte[8]	2019	Within the term established by the City Statute	Law n. 10.175, of May 6, 2011
Boa Vista[9]	2014	Within the term established by the City Statute	Doesn't have
Brasília[10]	2012	Within the term established by the City Statute	Law n. 4.797, of March 6, 2012
Campo Grande[11]	2018	Within the term established by the City Statute	Doesn't have
Cuiabá[12]	Not updated	In process of review	Doesn't have
Curitiba[13]	2014	Last review in 2014, so, within the term established by the City Statute	Decree n. 1.186, of September 22, 2009
Florianópolis[14]	Not updated	In process of review	Doesn't have
Fortaleza[15]	Not updated	Within the term established by the City Statute	Law n. 10.586, of July 13, 2017
Goiânia[16]	2013	In process of review	Doesn't have
João Pessoa[17]	2008	João Pessoa Municipal Master Plan (Complementary law n. 054, of December 23, 2008) "expired" in 2018	Doesn't have
Macapá[18]	Not updated	Plan out of the term established by the City Statute	Doesn't have
Maceió[19]	Not updated	Maceió Municipal Master Plan, in force through Law n. 5.486 of 2005, is out of the term established by the City Statute	Doesn't have
Manaus[20]	2014	Within the term established by the City Statute	Law n. 254, of December 1st, 2010
Natal[21]	2007	In process of review	Doesn't have
Palmas[22]	2014	Last review in 2018, so, within the term established by the City Statute	Law n. 1.182, of May 13, 2003
Porto Alegre[23]	2011	Within the term established by the City Statute	Doesn't have
Porto Velho[24]	Not updated	In process of review	Doesn't have
Recife[25]	2008	In process of review	Doesn't have
Rio Branco[26]	2016	Last review in 2016, so, within the term established by the City Statute	Doesn't have
Rio de Janeiro[27]	Not updated	Within the term established by the City Statute	Law n. 5.248, of January 27, 2011
Salvador[28]	2016	Last review in 2016, so, within the term established by the City Statute	Doesn't have
São Luís[29]	Not updated	In process of review	Doesn't have
São Paulo[30]	2014	Within the term established by the City Statute	Law n. 14.933, of June 5, 2009
Teresina[31]	2006	In process of review	Doesn't have
Vitória[32]	2018	Last review in 2018, so, within the term established by the City Statute	Doesn't have

Source: developed by the authors based on IBGE (2016 and 2017) data and information available on official websites of each Brazilian capital.

Figure 1 – Countries that ratified Paris Agreement until November 2017



Source: Quadros (2017).

particularly capitals, to endeavor to achieve the goals proposed by the country. Lemos (2010) states to be necessary that municipal master plans contemplate contributions to mitigation, minimization and adaptation to impacts of climate changes in their public policies for territory and urban planning. However, the survey of municipal master plans of Brazilian capitals demonstrated that the situation is different, and that many capitals do not provide for climate changes in their guidelines. That corroborates Sathler, Paiva & Baptista (2019), argument that, traditionally, master plans do not present guidelines to local climate issues. In few cases the MPs approach issues directly linked to climate changes.

In their analyses on urban planning in the main integrated metropolitan regions of development in Brazil, Sathler, Paiva & Baptista (ibid.) investigated and analyzed fifteen metropolitan seats based on the existence of: 1) local inventory of greenhouse gas emissions; 2) references/guidelines for climate changes in the master plan; 3) program for control or monitoring of air quality; 4) participation in knowledge networks; 5) local mitigation plan; 6) local committee or forum for climate changes; 7) local adaptation plan; 8) metropolitan plans or policies for climate changes; 9) municipal law for climate changes, state plans or policies for climate changes; 10) other relevant decrees or laws; 11) state forum for climate changes. São Paulo was the only capital that presented all items assessed in the research developed by these authors.

Though not being considered in this study, it is worth mentioning that the city of São Paulo is outstanding for initiatives turned to climate changes. Sathler, Paiva & Baptista (ibid.) argue that the capital has local plans, laws and institutional arrangements turned to climate changes. Regarding the inclusion

of climate changes in MP, only São Paulo, Rio de Janeiro, Recife, Florianópolis and Curitiba incorporate issues directly linked to climate changes in their respective master plans. Macedo & Jacobi (2019) observe that the city of Rio de Janeiro was the first in Brazil to develop an inventory of GHG emissions in 1998, due to Rio de Janeiro capital adhesion to Iclei and to the international campaign Cities for Climate Protection (CCP).

In the next section, master plans of Belo Horizonte, Campo Grande, Palmas, Rio Branco, Salvador and Vitória will be discussed, seeking to highlight their challenges, adaptations, needs and contributions regarding climate changes.

Campo Grande Municipal Master Plan

Complementary Law n. 341 of December 28, 2018, provides for the most recent Environmental Urban Development Master Plan of Campo Grande. The process of review and analysis was polemic and should have been approved in 2016, as expressed in the legislation of the City Statute and Complementary Law n. 94 of October 6, 2006, which instituted Campo Grande development policy and Master Plan (Planurb, 2018).

Differently from Belo Horizonte and Palmas MPs, Campo Grande Master Plan does not explicitly consider climate changes as goal or even as fundamental principles for the city urban and territorial development. The first explicit mention of climate changes appears in the section of priority sectorial policies. While describing the municipal policy for urban mobility and accessibility, one of the guidelines of priority sectorial policies contained in the MP, the texts explains that the Municipal Executive Power shall prepare the Municipal policy for urban mobility and accessibility considering the inter-relations involving urban mobility and accessibility and environment, in the light of climate changes" (ibid., article 47, line XII).

The next mention occurs in chapter III, which describes the municipal environment policy. Under the terms of article 54, the objectives of the municipal environment policy are "implementation, in the municipal territory, of the guidelines contained in the National Policy for the Environment, Environmental Education, Water Resources, Basic Sanitation, Solid Wastes, Climate Changes, National System of Conservation Units and other legislations in force" (our translation). The "prioritization of measures to adapt to climate changes, as determined by Law n. 12.187 of December 29, 2009, which institutes the National Policy for Climate Changes" is also presented as objective of the capital environment policy (ibid.).

Still in chapter III, climate changes are considered as one of the guidelines of the municipal environment policy. According to article 49:

> Art. 49. Guidelines of the Municipal Environment Policy:
> I – conserve and/or preserve biodiversity, remainders of flora and fauna;
> II – improve the relation and the quality of green areas per inhabitant;
> III – conserve and/or preserve the environmental quality of water resources, particularly that of supply springs;
> IV – improve mechanisms of incentive to environment recovery and protection;

> V – create mechanisms and strategies for protection of the wild fauna;
> VI – restore degraded areas and re-insert them in the urban dynamics;
> VII – minimize urbanization impacts on areas that provide environment services;
> VIII – minimize erosion processes;
> IX – contribute to reduce floods;
> X – fight noise pollution;
> XI – contribute to minimize the effects of heat islands and soil sealing;
> XII – adopt measures to adapt to climate changes;
> XIII – reduce emission of atmospheric pollutants and greenhouse gases;
> XIV – promote programs for energy efficiency, co-generation of energy and renewable energy in buildings, street lighting and transports;
> XV – adopt procedures for acquisition of goods and hiring of services by the Municipal Executive Power based on sustainability criteria;
> XVI – encourage urban agriculture;
> XVII – promote formal and informal environmental education;
> XVIII – articulate and participate in Pardo and Miranda Rivers basins Committees;
> XIX – make environmental protection compatible with sustainable economic development and life quality of the population;
> XX – encourage the establishment of public-private partnerships – PPP to the achievement of the Municipal Environment Policy objectives;
> XXI – propose preventive actions for the management of Conservation Units.

Campo Grande MP new text informs that the responsibility for the preparation of the Municipal Environment Policy falls on the Municipal Executive Power, which will have up to 24 months to conclude such task.

Belo Horizonte Municipal Master Plan

Law n. 11.181 of 2019, which provides for Belo Horizonte most recent Master Plan, was approved after a long period of review and discussion that started in 2014. According to Belo Horizonte city hall, the new Plan is based on

> the principle of the Social Function of Property and the City, under the terms of Art. 182 of the Federal Constitution of 1988 and Art. 2nd of Federal Law nº 10.257/2001 – City Statute, as well as on the dispositions of the New Urban Agenda (NUA) and the Sustainable Development Goals (Belo Horizonte City Hall, 2019).

The first explicit mention of climate changes appears in chapter I, titled "General principles of urban policy". Its article 2nd reiterates that "the promotion of sustainable development, in the universal perspective of combat to climate changes [...]" are general principles of the capital urban policy. Nevertheless, article 5th contained in chapter III – General goals of the urban policy, confirms as Belo Horizonte general goals the reduction of "Greenhouse gases throught the implementation of policies to fight climate changes" and fomentation of the development of "urban-environmental sustainability measures considering the principles provided in the policy to fight climate changes" (ibid.).

Chapter VI theme is the environment. Article 9th of this chapter indicates that the city's environmental policy has specific legislation on the theme. However, the

same article states that actions turned to "environmental protection and sanitation, as well as measures for prevention and combat to effective geological risk and solutions to the direction of territory planning" should be based on resilience and sustainability principles. Still about environmental protection in Belo Horizonte, article 11th links the adoption of "aspects of environmental dimension in urban undertakings, considering what if provided in the policy to fight climate changes" as goal linked to environmental protection in Minas Gerais capital.

Chapter V, called "Urban Operation", states, in its article 69, that the urban operation, in consortium[33] of Belo Horizonte is established in order to reach, among other goals, "environmental sustainability and fight of climate changes by means of rationalization of water and energy uses, reduction and recycling of solid wastes, among other measures".

About the municipal housing policy, Belo Horizonte new MP states, in its article 264, that among the directions about production of housing of social interest, the incentive to "constructive solutions that will reduce water and energy consumption and contribute to control climate changes", in addition to make compatible "social and economic development with environmental preservation, based on the principles of social justice and economic efficiency, ensuring the rational and equitable use of natural resources and contributing to improve the quality of life and climatic comfort".

With regard to the approach to climate change issues, it was observed that the new Belo Horizonte MP is concerned with contemplating theoretical and legal instruments that address climate change, and so corroborating Macedo & Jacobi (2019) arguments. However, no deep understanding was observed, or even expression of the problems linked to climate change. Though mentioning the policies to fight climate changes, the MP does not present them in the text. The plan does not count on a chapter exclusively dedicated to climate change cause, or incorporates proposals of actions to mitigate or adapt to climate changes. Given the complexity of climate changes and their relationship with urban and territorial planning, it is considered insufficient what was presented and addressed in Belo Horizonte new MP. One can notice that the Plan was much more concerned with the form rather than the content associated to climate changes.

Salvador Municipal Master Plan

While assessing Salvador Municipal Master Plan, in force in 2014, Sathler, Paiva & Brant (2014) state that it does not count on a local plan for mitigation and adaptation to climate changes. Except for Bahia State Climate Change Policy (Law n. 12.050/2011), the authors observed that Bahia capital needs specific municipal laws and local committees or forum for climate changes. Even after 2015, few things have changed.

Law n. 9069 of 2016, which describes Salvador most recent Urban Development Master Plan (PDDU), was sanctioned in July 2016, and establishes, in its first article, the need to consider "dispositions in national and state plans and laws related to Policies for Urban Development, Mobility, Housing

and Sanitation and Environmental plans and policies" Salvador City Hall, 2016).

It was verified that, with regard to the inclusion of issues referring to mitigation and adaptation to climate changes, the 2016 Salvador Master Plan does not count on a chapter dedicated to climate changes, and there is no information on the municipality risk and vulnerability in face of climate changes. In terms of contribution to the climate issue, Salvador Plan presents only two articles, 34 and 196.

In article 34, Salvador Master Plan establishes as objective of the Coastal Management Plan the promotion and "development of actions and research associated to measures for mitigation and adaptation to climate changes in the coastal zone". Article 196, on the other hand, states that the city's mobility system must incentive "the different modals to use clean energy, to contribute to mitigate climate changes".

Despite these two mentions, Salvador Master Plan corroborates Sathler, Paiva & Brant (2014) arguments that in many Brazilian cities the policies for mitigation and adaptation to climate changes are fragmented or even absent in terms of surveys and guidelines for local climate issues. Salvador Plan commitment is low for minimization of effects and adaptation to climate change. It needs an approach that highlights the reduction of socio-climatic vulnerabilities and shows which are the contributions of the territorial and urban policy of Bahia capital to the cause.

Vitória Municipal Master Plan

Bill n. 290/2017, which instituted the new Vitória Municipal Master Plan, was approved by councilors in Vitória City Council on March 27, 2018. As one of the newest master plans in Brazilian capitals, it was expected that it would contain guidelines on climate changes, thus complying with Paris Agreement and the need of participation of cities in the global climate governance. However, the situation is different.

In the first phase of analysis (orientation), it was observed that Vitória Master Plan of 2018, in its article 3rd, line V, states that the city sustainability is part of the list of principles of the Municipality Urban Policy, and that "the search for a sustainable city, economically feasible, socially fair and environmentally correct, aiming at the development with rational use of material and natural resources for present and future generations" (article 4th, line II) must be one of the general guidelines of the municipality urban policy. However, even with the presence of the environment in the master plan's guidelines, it is worth mentioning that climate changes are not included in Vitória environment policy guidelines, as described in article 7th of the city master plan. Though placing the search for environmental balance as basic condition to sound quality of life, there is no passage in the master plan containing information on climate changes.

Sathler, Paiva & Brant (ibid.) have already pointed out this characteristic of Vitória Master Plans since 2014. According to the authors, the old plan of the city did not mention climate changes, or instituted public policies turned to the subject, and that Espírito Santo capital did not count on local plans for mitigation and adaptation to this environmental issue. Since 2014, Sathler, Paiva & Brant (2014) argue that the city needed a local inventory plan for greenhouse gas emissions.

In this regard, it is argued that the new Vitória Master Plan is not oriented to climate change and does not present significant contributions to this environmental issue that affects the whole population. It is, therefore, a plan that needs commitment, that does not show how the city will react to the effects and consequences of climate changes. It doesn't explain which would be the municipality risk and vulnerability and doesn't establish, for example, greenhouse gases reduction as one of its goals or guidelines.

However, it is worth mentioning the Vitória counts on legislation for control and/or monitoring of air quality, local plan for mitigation and adaptation to climate changes, in addition to state forum for climate changes.

Rio Branco Municipal Master Plan

Law n. 2.222 of December 26, 2016 promotes Rio Branco municipal master plan review. It states that it is compliant with dispositions in the Republic Constitution, the City Statute, Acre state Constitution and Rio Branco municipal Organic Law. It was verified that Rio Branco Master Plan incorporates sustainable development as one of its guiding principles, but, differently from Palmas Master Plan proposal, it does not count on a chapter dedicated to climate changes. It is not a plan oriented to them. It needs explicit principles, guidelines and mentions to the adaptation and mitigation of climate change effects. The only passage that mentions climate is in article 194, which describe the Municipal Plan for Urban Afforestation. In line II of article 194, the Plan states "to establish procedures to improve bioclimatic conditions and environmental comfort, reducing sun exposure time in public spaces, thermal differences among urban fragments and control of atmospheric and noise pollution".

Like Salvador and Vitória municipal master plans, Rio Branco plan needs measures turned to climate changes. Rio Branco Master Plan is not, therefore, oriented and does not present significant contributions to the problem.

Palmas Municipal Master Plan

Sathler, Paiva & Brant (ibid.) state that Palmas was the first Brazilian capital to approve a legislation turned to climate changes. And that occurred in 2003. After more than fifteen years, the city disclosed, in 2018, Complementary Law n. 400, of April 2, 2018, describing the new Palmas Participative Master Plan. As a result of the review made from 2015 to 2017 of the 2007 Master Plan (Complementary Law n. 155 of December 28, 2007), the new Palmas Master Plan is a basic and strategic instrument for the municipality development policy.

With regard to the inclusion of issues referring to mitigation and adaptation to climate changes, the 2018 Palmas Master Plan presents among its goals the adoption of "mitigation and adaptation measures for climatic resilience" (article 6th, line III), the need to "foment, promote, develop and improve technological activities and processes that will reduce greenhouse gas emissions" (article 6th, line V). It is worth reminding that "adaptation and mitigation of impacts associated to the city climate changes, transversally addressing the themes covered in this Complementary Law" is presented as one of the Master Plan's principles (article 5th, line VIII).

Moreover, Palmas Master Plan of 2018 counts on a whole chapter dedicated to the environment and climate changes. Among the main aspects of this chapter, the Plan acknowledges as guidelines for environmental preservation and protection and for mitigation and adaptation to climate change impacts, the need to "integrate strategies for mitigation and adaptation to climate changes to other municipal, state and federal public policies" (article 93, line I). Among the policies, the Plan highlights those of "environment, urban planning, economic competitiveness, transport, energy, health, sanitation, industry, agriculture and cattle raising and forestry activities" (article 93, line I). In its article 93, Palmas Master Plan presents the need to:

> Art. 93.
> II – contribute to minimize the effects of heat islands and soil sealing:
> III – elevate urban and rural environment quality by preserving and recovering natural resources;
> IV – raise awareness in the population, by means of environmental education about environment preservation and climate changes' causes and effects;
> V – restructure the municipality landscape mosaic so as to connect specially protected areas and forest remainders in the rural zone to the Special Areas with Relevant Environmental Interest and other vegetated and permeable fragments in the urban zone by means of green corridors, to form the Municipality Green Infrastructure;
> VI – implement the Municipal Green Infrastructure System (SisMIV), in order to provide more adaptation capacity to urban and rural ecosystems and to maintain and recover environmental services, in addition to contributing as element of environmental comfort, economic development, urban qualification, low impact agricultural production and touristic activity;
> VII – prepare and execute programs destined to the recovery and preservation of Permanent Preservation Areas – APPs and water bodies of the city, especially for protection of springs, providing incentives to the population for preservation of these areas;
> VIII – strengthen and expand environmental inspection and monitoring of the Municipal Green Infrastructure System (SisMIV), with participation of surrounding communities;
> IX – introduce in the city environment management the concept of environmental asset aiming to value private financial benefits from public investments that can be raised for the collective good, so as to make feasible Environmental Compensation actions;
> X – keep updated, in the ambit of the Municipal Planning Information Registration, the conservation status of the city environmental patrimony, aiming at guiding and facilitating inspection and application of applicable penalties in face of eventual infractions against the environment;
> XI – create permanent program for prevention and response to natural and environmental disasters, including fires, with risk management and permanent monitoring, seeking the utilization of volunteers;
> XII – fight noise pollution and review legislation on noise generation;
> XIII – encourage the adoption of sustainable drainage system in urban

> areas, to reinforce the artificial drainage, recovering and expanding the capacity of retention, absorption and infiltration of rainwater in the soil, as part of the actions for optimization of the green infrastructure;
> XIV – implement Palmas Urban Afforestation Plan as instrument for the sustainable urban planning and development, providing details of guidelines and propositions, to be approved by specific legislation.

The 2018 Palmas Master Plan states, in its article 230, that the "Action Plan for Adaptation and Mitigation of Climate Changes" is part of the city planning process and development policy. It also defines that there must be "incentive to gradual adaptation of existing edifications as function of the effects from climate conditions" (article 238, line II). Based on the analyses of orientation and contribution, we conclude that Palmas Master Plan is oriented to climate changes, presenting solid contributions to minimize climate change effects.

Final considerations

This paper presents an original research that is different from traditional investigations on Brazilian capitals focused on Rio de Janeiro/ São Paulo area. While expanding the analysis to all capitals that had their MP changed after the Paris Agreement, the paper contributes to the discussion on the incorporation of the climate dimension and climate changes in territorial and urban planning policies in Brazil. Methodologically, the paper adopted the analysis of bibliographies that could reiterate the argument that Brazilian cities are still in precarious situation with regard to the global discussion on climate changes. And this situation should be changed in order to control the countless processes that feed climate changes. While analyzing Brazilian capitals, the present paper contributes to the discussion on the urban aspects of climate changes, which emphasize that cities should address environmental issues turned to climate change in their urban planning and management policies.

Cities must respond to the challenges imposed by climate changes. If they already present high levels of social, economic and environmental vulnerabilities and urban infrastructure needs, the situation tends to worsen with the worsening of climate changes. Cities, regardless of their geographic, demographic, economic, social and political characteristics, need to dedicate to the adaptation of their territories to the consequences and effects of climate changes. That is the only way to contribute to the mitigation and adaptation to this environmental problem that involves the global sphere, reflecting locally. These different scales of causes and effects show that adaptation to climate changes should join actions at different levels.

Alone, cities can't reach the necessary scale to avoid the rise of the world temperature. For that to occur, involvement of all levels of government is required, including the population in this process of changes and adaptation. Due to that, the implementation of policies turned to climate changes must also cover this local sphere. The leadership in this process must not fall on federal entities alone, for each local and regional agent has its role

to play to reach the metrics proposed by the Paris Agreement. Another important aspect is the higher involvement of researchers and decision makers, approximating science and research of political reality.

In Brazil, the master plan, regulated by the Republic Constitution of 1988 in its articles 182 and 183, and by the City Statute (Federal Law 10.257/2001), is outstanding as main instrument for urban planning within the country's normative frame, which guides the physical-territorial planning of cities. It is one of the greatest legal advances in terms of urban management and planning. Due to that, it should address climate changes in its wording.

By means of the analysis of municipal master plans of Brazilian capitals, it was observed that there is lack of integration and incorporation of climate change theme in several municipal agencies to face the problem. It was also noticed great difficulty to incorporate climate change scenarios in urban public policies, both in terms of mitigation and adaptation. Among the four master plans analyzed, Palmas Master Plan is outstanding for bringing surveys and guidelines for climate issues, working with local perspectives with regard to global climate changes.

However, in general, the conclusion is that master plans are not oriented to minimize the effects and adapt to climate change. There are no explicit passages associating them to the Paris Agreement goals. In addition to being a need to face this current environmental problem, it also renders difficult the establishment of parameters to compare the goals proposed by the Brazilian government, in their nationally determined contribution, and the master plans of the country state capitals. Belo Horizonte, Campo Grande, Salvador, Rio Branco and Vitória master plans present indirect contributions, without specific mention, in their principles and guidelines, of possible policies for adaptation or expansion of the effects of climate changes. This represents a huge need for Brazilian capitals.

Whether coastal or countryside capitals, or small and medium size cities, in face of this scenario of constant threats of climate changes, it is more than urgent to guide municipal planning and management to urban adaptation, mitigation of impacts, prevention and expansion of resilience of cities and their respective populations. If climate changes have an outstanding place in urban political agendas of many countries, they should also have their place in the planning and management of cities.

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Notes

(1) Understood here as the "consummation of the situation of vulnerability on an individual" (Ribeiro, 2010, p. 12).

(2) According to Undesa (2019), the four global demographic megatrends are: population growth, population aging, migration and urbanization.

(3) According to Mauad (2015), Cities Climate Leadership Group (C40) network was created in 2005. Gathering over eighty cities, C40 is considered as initiative of local governments (cities) with higher capacity of political articulation in the climate agenda.

(4) IBGE (2016) considered three types of environmental licensing in Munic: previous, to assess environmental feasibility; installation, which authorizes the start of works; and operation, which allows the undertaking operation.

(5) IBGE (2017) data are based on the state population projection and municipalities' growth trend, designed by municipal populations captured in the last two demographic censuses (2000 and 2010).

(6) http://www.aracaju.se.gov.br/planejamento_e_orcamento/plano_diretor

(7) http://www.belem.pa.gov.br/planodiretor/

(8) https://prefeitura.pbh.gov.br/politica-urbana/planejamento-urbano/plano-diretor

(9) https://www.boavista.rr.gov.br/prefeitura-legislacao-municipal

(10) http://www.segeth.df.gov.br/plano-diretor-de-ordenamento-territorial/

(11) http://planodiretorcampogrande.com.br/index.html

(12) http://www.cuiaba.mt.gov.br/planejamento/prefeitura-lanca-revisao-do-plano-diretor-de-desenvolvimento-urbano-nesta-sexta/15257

(13) http://www.curitiba.pr.gov.br/planodiretor

(14) http://www.pmf.sc.gov.br/sites/planodiretor/

(15) https://urbanismoemeioambiente.fortaleza.ce.gov.br/urbanismo-e-meio-ambiente/124-plano-diretor-de-fortaleza

(16) http://goianiadofuturo.blog/

(17) http://www.joaopessoa.pb.gov.br/secretarias/seplan/plano-diretor/

(18) http://macapa.ap.gov.br/noticias/leis-municipais/65-plano-diretor

(19) http://www.maceio.al.gov.br/plano-diretor/

(20) http://implurb.manaus.am.gov.br/legislacao/

(21) http://natal.rn.gov.br/semurb/planodiretor/

(22) http://planodiretor.palmas.to.gov.br

(23) http://www2.portoalegre.rs.gov.br/spm/default.php?p_secao=205

(24) https://www.portovelho.ro.gov.br/arquivos/lista/387/plano-diretor

(25) https://www.recife.pe.gov.br/pr/secplanejamento/planodiretor/

(26) http://riobranco.ac.gov.br/index.php/novo-plano-diretor-de-rio-branco.html

(27) http://www.rio.rj.gov.br/web/smu/plano-diretor1

(28) http://www.sucom.ba.gov.br/category/legislacoes/pddu/

(29) http://www.agenciasaoluis.com.br/site/legislacao-urbanistica-saoluis

(30) http://www.prefeitura.sp.gov.br/cidade/secretarias/urbanismo/legislacao/plano_diretor/index.php?p=1386

(31) http://semplan.teresina.pi.gov.br/planos-diretores-3/

(32) http://www.vitoria.es.gov.br/minhavitoriapdu.php

(33) According to the new Belo Horizonte Master Plan, "OUC is the set of interventions and measures coordinated by the Executive power, with participation of owners, dwellers, permanent users and private investors, intended to reach structural urbanistic transformations, social improvement and environmental valorization" (Belo Horizonte City Hall, 2019).

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