Building Codes concerning Climate Resilience in Brazil

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Abstract

The New Urban Agenda together with the 11th Sustainable Development Goal of the United Nations establishes the aim to increase the number of cities adopting policies and plans towards mitigation and adaptation to climate change and resilience to disasters. This aim is the starting point of this research. In this direction, a review in Brazilian legislation and policies at the main capitals of Brazil was held in order to identify initiatives that mitigate climate change consequences, such as landslides and floods. It was identified by this study that policies regarding prevention from occupation of vulnerable areas to disasters concerning inundation have been taken, however landslides do not meet an effective legislation to prevent it.
Keywords: Building Codes; Climate Resilience; SDG 11.

Introduction

In June 1992, the United Nations Conference on Environment and Development was held in Rio de Janeiro, Brazil. This conference resulted in the creation of the United Nations Framework Convention on Climate Change (UNFCCC), for which Brazil was the first country to sign. (LUDENA, 2011)

At the Intergovernmental Panel on Climate Change (IPCC, 2007) one of the main issues affecting Brazil were the expected to be the increase of sea level affecting coastal cities and the increase of rainfall in the South East region. In 2010 flooding affected more than 1.000 townships, 470 people were killed, and 12.000 people lost their houses as a result of natural disasters in Brazil. (Oxford Analytica, 2011)

According to IPPC's latest report, there is a trend in Northeast Brazil to decrease precipitation and higher temperatures. However, it has been observed a climate change in Southeastern South America in which precipitation has risen as well as the temperature values. (MAGRIN, 2014)

During the year of 2016, in a meeting held in Quito, Equator, world leaders "adopted the New Urban Agenda which set global standards of achievement in sustainable urban development, rethinking the way we build, manage, and live in cities through drawing together cooperation with committed partners, relevant stakeholders, and urban actors at all levels of government as well as the civil society and private sector." (UN, 2016)

One of the goals of the New Urban Agenda is to make cities inclusive, safe, resilient and sustainable and within this goal, one target is to increase cities adopting policies and plans towards mitigation and adaptation to climate change and resilience to disasters. (UN, 2016)

Following this data, questions were made. What is Brazil doing about that issue? What policies considering human settlements are actually taking into consideration adaptation to climate change?

In this paper an overview about what policies and legislation effectively intend to make cities resilient to the climate change issue was made.

Methods

Initially, to understand the United Nations goal to mitigate and adapt cities towards climate change in Brazil, two questions were made:

- What is Brazil doing regarding human settlements to adapt cities to climate change issues?
- Are there effective legislation and policies that avoid climate disasters to affect its population?

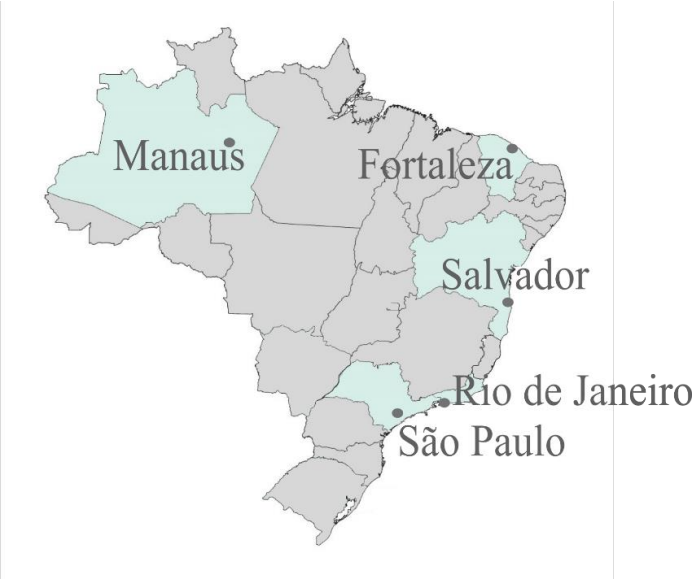

Figure 1. Capitals surveyed.

Considering these above, a matrix from International Housing Association (IHA) was used as a parameter for what the main problems are that involve climate change and affect human settlements.

Country	Cyclone/ Hurricane	Flooding	Tsunami/ StormSurge	Earthquake	Bushfire/ Wildfire	Snow	Landslide
Brazil		✓					✓

Table 1. Approach to Resilience in Building Codes. Source Adapted from International Housing Association, 2019

The table (Table 1) above considers all the events in consequence of climate, only the ones that are ticked have the presence in Brazil.
Brazil is mainly located in the tropical zone and for that reason most of its climate issues are related to rain, especially during summer when is common to happen floods, inundation, as well as landslides (UFSC, 2013).

After stating the issues that should be prevented by legislation or policies being inundation and landslides, a literature review was conducted. Starting from legislation, in Brazil construction is regulated mainly by Building Codes that have municipal area jurisdiction. Besides this, the Forest Code, although has this name, is also applied in urban areas, and has National level jurisdiction.
In Brazil, despite building codes are developed in county level, they follow a pattern and usually bigger cities in each region have their codes replicated by the smaller ones. For that reason and for the country having continental extension, only the main capitals were selected in order to obtain the research data. (Figure 1) The capitals were chosen for each of Brazilian's region. Capital that had too similar building codes were dismissed and only the five were described in this study. The chosen ones were Manaus, Fortaleza, Salvador, Rio de Janeiro and São Paulo.
Manaus represents the North region, and it is the capital of the Amazonas state, where Amazon Forest is mostly located with super moisty equatorial climate. Fortaleza and Salvador are capitals of the states of Ceará and Bahia, respectively. The climate in Fortaleza is tropical wet and dry climate, as most of the Brazilian shore. In Salvador Tropical rainforest climate.
São Paulo and Rio de Janeiro represents the Southeast Brazil, both are known for its frequent

landslides and inundations, especially during summer when rains pour significantly more. (IBGE, 2002)

Results

Results intend to provide an overview about legislations and policies that culminate in real actions that guarantee a safer human settlement, climate resilience and that mitigate climate change.

In the matter of city resilience, meaning in this research: desire to make human settlements more adapted to consequences to climate change, two main issues were selected: flooding and landslides. Brazilian regulation about buildings comes in two spheres. The national one that is regulated by the Forest Code and building codes that scope only municipal area.

Forest Code

The National legislation known as the Forest Code, is the one that prevents occupation in areas exposed to landslides and inundation. Regulated by the 12.561 Federal Law of 2012, this Code provides protection to water bodies and its surrounding. Basically, in the construction matter it limits occupation over the course of rivers by at least 30 meters and spring water by 50 meters assuring that no construction will rush in those sensible parts. Even though this measure aims to keep water bodies clean and avoid erosion in rural areas, it is applied in urban areas and prevent occupation in those vulnerable areas. (BRASIL, 2012)

Considering this, one of the most efficient actions over the last years has been the land regularization, in which in order to obey the Forest Code, people were removed from the river borders and placed in safer places, away from floods. This way houses are being prevented from inundation when the summer rains come, and the side river are being used for leisure or just preservation of the vegetation. (Figure 2 and 3)

Also legislated by the Forest Code, and related to building, is the prohibition of constructing and parceling lots in hills that have 45° or more slope. Even though this prohibition does not consider the kind of soil, it prevents bigger damages such as the one showed beneath. (Figure 4) After storms, hills with moisty soil tend to dissolve and causes disasters. (UFSC, 2013)

Ahead highlights of the cities researched are detailed. Together with Building Codes, in some cities, Environmental Codes and Drainage Plans boost policies that help climate resilience.

Figure 2. Occupations before land regularization. Source: Tássia. Regino

Figure 3. Urbanized community after its regulation. Unknown author

Figure 4. Land Slide in Nova Friburgo, Rio de Janeiro. 2011. Source: Jadson Marques.

Fortaleza

Fortaleza, one of the main cities in Northeast Brazil, has a tropical climate, and for that, the main problem related to climate are flood related. In that regard the city has its own rainwater plan that looks for prevention of inundation increasing the drainage network by a systematic massive investment. (FORTALEZA, 2015)

Also, the city's subdivision Law stands that in moisty soil or the ones sensible to floods only by a specific drainage system the license will be given. (FORTALEZA, 2017)

Manaus

The capital of the Amazon Forest, Manaus also suffers from repeated floods. In that matter, what has been done about it are the constant land regularization, in which people are being removed from more incident flooding areas to dry spots, where they can improve their life quality in terms of housing.

The city building code is also more restrictive than the Forest Code because it claims that vegetation that protects slopes and water bodies are considered of permanent preservation, that is, it is not allowed to build over it. So, it doesn't matter if the vegetation is within the 30 meters or further, it has to be preserved. (MANAUS, 2001)

Rio de Janeiro

Rio de Janeiro, as most of the populated cities in the world, has an extremely sealed soil and experiences the heat island effect. Considering that Rio is a very warm city, the heat island effects over the consumption of energy due air conditioning are incredibly significant.

So according to the municipal administration in order to improve the quality of buildings either old or new ones they created the *"Qualificação Qualiverde"*. A certification that awards projects that input sustainable practices in buildings by speeding its license. (RIO DE JANEIRO, 2012)

About inundation problems, Rio has a Drainage System Plan that aims to control the frequent inundations that take place in the city. According to the Municipal Master Plan every work that changes the existing outflow needs specific license for that alteration. It also recommends being avoided river piping so the flowrate remains original. (RIO DE JANEIRO, 2015)

However, a frequent problem in the city: landslides, does not have any kind of Norm or law to prevent an unsafe occupation or determine standards in order to those occupations to happen. Only the intention of the population safety is expressed by texts.

Salvador

Salvador has a Program entitled *"IPTU Verde",* based on the Law n. 8.474/2013, that offers direct discounts over the property tax of buildings that adopt sustainable techniques, whether new or old constructions. It also has an agreement with Edge Certification that speeds up project's license. (SALVADOR, 2016)

São Paulo

São Paulo has a serious issue considering impermeable ground and the heat island effect. Though cooler than Rio it also sees its energy consumption upsurge due to the use of air conditioning. And because of the heat island effect that use is lengthened.

The new Masterplan of the city has a proposal called *"Quota Ambiental"*, translating Environmental Quota, in which the permeable area of the building is not only considered the ground floor, but also other floors, such as balconies or rooftops. (Figure 5) The expected impact is the increase of green roofs and green walls application, which not only improve the drainage system but also regulates temperature, lowering the heat island effect. (SAO PAULO, 2016)

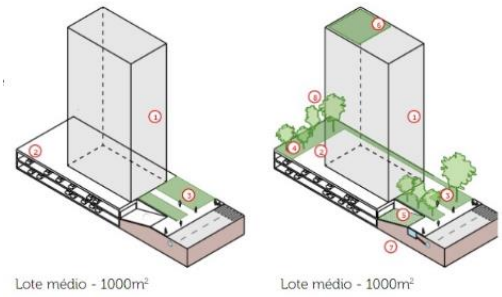

Figure 5. Quota Ambiental Proposal for the city of São Paulo. Source: Prefeitura Municipal de Sao Paulo, 2019.

Discussion

Brazilian most important climate issues are related to rain: inundation and landslides. The country has some policies that protect human settlements from disasters, such as Land Regularization, in which people are relocated from areas near rivers (at least 30 meters) and high slopes (over 45°) to safer places, preventing the impact of floods and landslides. Grounding Land Regularization policies, there is the Forest Code, renewed in 2012, being the most effective legislation that prevents problems regarding climate change. Effective regarding water bodies, concerning slopes, the 45° inclination are extreme abrupt and the obedience to this item does not guarantee a safe settlement.

In a narrower scope are the building codes, which only have municipal jurisdiction. Every big city in Brazil has its own Code and are regulated through a municipal Law. What can be observed is even though Brazil has many singularities in each one of its regions,

municipal codes are pretty similar. Having one city that is used as reference and its code replicated by several others not concerning whether its demands are being answered or not.
Considering climate resilience, Building Codes in Brazil mainly demand the minimum rate of permeable area, usually 25% of the lot. That area is employed to speed the water drainage and avoid inundation during intense rain.
The most updated municipal laws have tax breaks that encourage entrepreneurs to apply sustainable technics that are energy efficient and prevent inundation.
Other issues considering natural disasters do not affect Brazil. Earthquakes are extremely rare, and the very few that happened are in a small scale, so that is not an issue. Brazil is also not impacted by hurricanes or Tsunamis, so both are not object of regulation. Cyclones although rare and only in South Brazil, beneath the tropic, are becoming more frequent over the last years.

Conclusion

Even though Brazilian legislation have not changed due to the New Urban Agenda, still using the same legislation over the last thirty years with little renew, the country policies are improving constantly.
Inundations still affect the most vulnerable areas, where usually the poorest people live, in slums. However, over the last ten years, Brazil is holding a strong Land Regularization program and this issue is slowly being taking care of. Therefore, it can be concluded that Brazilian policies are improving towards adaptation to climate change.
Landslides, which also affect the same part of the population in slums, however, hasn't receive the same attention. Legislation is soft and besides the city of Fortaleza, no other requires soil drilling to permit construction in sloped areas. That is an issue that should receive more care for it is recurrent and affects the most vulnerable population.
Considering the New Urban Agenda and the Sustainable Development Goals of United Nations, especially the number 11, Brazil needs to play a more effective policy and legislation towards these ambitions.

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