1. INTRODUCTION

The National Policy of Protection and Civil Defense, established by Law 12,608 of 2012, divides the actions related to disaster management into the categories of prevention, mitigation, preparedness, response and recovery actions and incorporates the planning of urban expansion as a prevention tool of natural disaster. Given the low expertise of Brazilian governments and institutions in integrating urban planning and risk management, the Ministry of Cities in partnership with other Ministries, and the Japanese Government represented by JICA, built the “Project for Strengthening National Strategy of Integrated Natural Disaster Risk Management-GIDES.” The main goal of the Ministry of Cities in the GIDES Project is the development of urban planning methodologies applied to sediment disasters prevention.

The final product of the GIDES Project is the consolidation of manuals of the themes developed in the project. These manuals will serve as guides, with specific guidelines for risk management policies and actions, and will be available by the Ministries involved in the project. Each manual is associated with the disaster cycle as expressed in Table 1. This paper presents the methodology that is being developed for the Urban Expansion Planning Manual.

2. URBAN POLICY IN BRAZIL

2.1 The urbanization process

Brazil is one of the countries that most quickly performed the transition of its population (Fig. 1), from rural majority to urban majority. The only countries that had similar processes were Japan and Venezuela. However, only Japan has similarities in terms of absolute population migration from the countryside to the urban areas.

As can be seen in Fig. 1, in 1920 less than a fifth of the Brazilian population lived in urban areas. In 1960, more than two thirds of Brazilians were living in cities and towns, and in 2010, the urban population exceeded 80%. The Brazilian urbanization process was also concentrated in the territory (as shown in Fig. 2), fact
that had a strong impact on the territory. Equipment and urban services in general had no immediate conditions to meet the new imposed social demands. The cities in fact already had spatial inequalities. As a result, the spatial inequalities were reinforced with the arrival of more people and by the development of public policies that have tried to solve the problem, but that ended up strengthening it.

2.2 History of urban policy in Brazil

It is a common idea that Brazilian cities grew haphazardly and without any planning. Largely this statement seems consistent with everyday life and the urban experience, particularly considering the large cities. However, this common notion presents inaccuracies, especially regarding urban planning. It obscures the real understanding of the current Brazilian situation and the search for solutions to accrued liabilities and for the challenges currently present. In fact, three major stages of urban planning had major impacts on Brazilian cities: the technocratic urban planning; the crisis of urban planning; and the participatory urban planning.

The technocratic urban planning (or regulatory) consists of the conception of planning as the activity of elaborating spatial development plans for the ‘ideal city’ [Souza, 2003]. In this perspective, urban planning corresponds merely to territorial planning, particularly concerned with urban design, land use and occupation densities. It arises in the 1960 s, through the seizure of political power by the military coup [Baszil, 2005].

In this authoritarian political context, the first Brazilian urbanistic laws were created, especially the Law no. 6,766 of 1979, and the first metropolitan regions were instituted.

The Participatory urban planning gains strength in the democratization process, which fully restores the federalism in the country. In this period we see the construction of the 1988 Federal Constitution (1988)
and the a chapter on Urban Policy; and, ten years later, we have the Law 10,257 of 2001, known as the City Statute, was enacted [Brasil, 2001]. Currently there are still many challenges to be overcome in Brazilian cities, and for the full development of participatory planning. In addition, there are other external factors, such as the climate changes, imposing new challenges and the need for further improvement in the search for solutions.

2.3 Principles of Brazilian urban policy

The principles of Brazilian urban policy are set out in the Federal Constitution (FC) of 1988 in the chapters on Urban Policy (Arts. 182 and 183), of Social Rights (Art. 6) and of Political and Administrative Organization (Arts. 18, 24 and 30). The FC chapter of the Administrative and Political Organization gives the municipality the status of autonomous federal entity along with the States and the Union, with autonomy and competence to organize the territory (Art. 18) and to legislate on the planning of land use (Art. 30). In this legislative arrangement,

![Fig. 2 Municipalities with 50% or more of urban population 1940 – 2010. Adapted from Oliveira (2013).](image)

| Table 3 Articles from the City Statute |
|---------------------------------------|
| CITY STATUTE, LAW N° 10.257 - 2001. Establishes the general guidelines of the Urban Policy. Regulates the arts. 182 and 183 of the Federal Constitution. |

| ARTICLES | HIGHLIGHTS |
|----------|------------|
| Art. 2   | Urban policy is aimed at ordaining the full development of the social functions of the city and urban prosperity through general guidelines, which, among others, the control of land use in order to avoid: (b) population exposure to risks of natural disasters. |
| Art. 40  | The Master Plan is the basic tool of urban development policy and must cover the entire municipal territory. |
| Art. 42  | See Law 12.608/12, article 26. |

| Table 4 Articles from Law 6,766/79 |
|------------------------------------|
| FEDERAL LAW 6,766 – 1979 On the division of urban land. |

| ARTICLES | HIGHLIGHTS |
|----------|------------|
| Art. 3   | It will only be admitted the division of land for urban purposes in urban areas and urban expansion areas, as defined by the Master Plan or approved by other municipal law. The division of land is not allowed: I - in marshland and land subject to flooding, before taken steps to ensure the water flow; (...); III - on land with slopes above 30% (17°) unless it meets specific requirements of the competent authorities; IV - on land where geological conditions are not suitable to building; V - in areas of ecological preservation. |
| Art. 4   | Of the requirements for allotment |
| Art. 6 and 7 | Of the allotment project |

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the Urban Policy chapter defines the Master Plan as the basic instrument of urban development policy and urban Expansion.

In addition to the Federal Constitution of 1988, Federal Law 6,766/79 (Subdivision of Urban Land) and the City Statute, Law 10,257/2001, make up the main Brazilian urban laws. These laws associated with others specific laws, and the specific municipal legislation such as the Law of Land Use and Occupation, make up the legal framework for urban policy in Brazil. The Law 12,608/12, which creates the National Civil Protection and Defense Policy, amending the City Statute, is also part of this legal set.

Thus, the Union has the attribution of regulating only in general terms the urban development policy. In the City Statute, the guidelines and definitions of contents of municipal Master Plans are generic, and the municipalities have to detail it.

The following tables present the main provisions of the legislation governing Urban Policy in Brazil.

### 3. RISK CONTEXTS AND RISK MANAGEMENT IN BRAZILIAN CITIES

About 84% of the Brazilian population is concentrated in urban areas, scattered in its 5570 municipalities. Of this portion, a significant percentage is concentrated on the Atlantic Coast and occupying the Serra do Mar and the Atlantic Forest, local biomes of great environmental vulnerability (areas of steep slopes with high risk of mass movement disaster).

The vicious circle resulting in the occurrence of disasters is the result of lack of secure housing for a large portion of the population. These populations occupy unsuitable areas through self-help housing, cutting slopes or advancing on the banks of rivers and canals, without technical guidance. The tropical or temperate climate, mainly humid, implies in rainy seasons with great rain volumes, saturating exposed soils with prior instability conditions, causing landslides or flooding of silted riverbeds and illegally occupied (See Photo 1 and 2).

The National Housing Plan of the Ministry of Cities [Brazil, 2010] highlights the great social and economic inequalities and the resulting inheritance of the urbanization process as the main responsible for the 3.2 million households in precarious settlements. These settlements are characterized by informality of land tenure, lack of infrastructure, irregularity in the urban planning process, lack of access to services, and housing built by the residents themselves without technical and institutional support. This situation accounts for much of the disasters that occur in Brazil.

Master Plans almost never consider technical parameters that address the precarious settlements. Moreover, disasters are not treated as determining themes of urban areas occupation policies.

In January 2011, in the State of Rio de Janeiro, a mass movement disaster of major proportions, triggered by heavy rains, covering most of the cities in the mountain region (inserted in the Atlantic Forest biome), left approximately 20,000 victims, among dead or homeless. This disaster was a milestone in the country's risk management. After these catastrophic events, Law No. 12,608 was created, which obliges municipalities to introduce the dimension of risk in their urban planning parts.

In this context, the Urban Expansion Project is prevention instrument, and should pay attention to
other risk management instruments, in particular for the 3.2 million households in precarious those responsible for the analysis and mapping of risk or hazard areas. The current perception stage of the problems points to the need to review the Master Plans, especially in the most critical municipalities, appropriating new knowledge and setting technical parameters suitable for security in the most susceptible areas to disasters occurrence. In addition, it strengthened the conviction that the methodologies adopted for risk mapping needed to be revised.

In Brazil, the mass movements mapping works and geotechnical mapping began in 1965 with Professor Haberlehner, from the Federal University of Rio de Janeiro. After that, several methodological works were carried out, with a more intense production after the year of 1988. [Augusto Filho and Virgili 1998]. These studies have adopted various methodologies according to each of the institutions that deal with the geological and risk mapping. The risk maps have gained an important methodological improvement from 2003, with the methodology defined by the Ministry of Cities for application in Municipal Programs for Risk Reduction. The historical process of development of geotechnical and risk mapping in Brazil gained another dimension with the new National Policy for Risk Reduction and Response to Disasters and the promulgation of the Law 12,608/12.

Table 6 Attributions of the Federal Government, states and municipalities in the development of urban planning instruments focused on risk management.

| Item | Federal Government | States | Municipalities |
|------|--------------------|--------|----------------|
| Enactment of laws on the Master Plan and Urban Expansion Project | Enactment of federal laws relating to the general regulation of Master Plans and Urban expansion Projects | Enactment of state laws relating to urban planning and regional planning, especially for the metropolitan areas | Enactment of municipal laws for the Master Plan and Urban expansion Project |
| Preparation of Master Plans and Urban Expansion Projects | | Development and implementation of these plans and projects |
| Data Collection | Availability of data elaborated by the Union | Availability of data produced by the State | Direct data collection in the municipality |
| Preparation of plans and projects with popular participation | Preparation of manuals with concrete cases and forms of analysis and evaluation | Preparation of manuals with concrete cases and forms of analysis and evaluation | Human resources training |
| | Support for Institutional Strengthening actions for the development of projects and plans | Support for Institutional Strengthening actions for the development of projects and plans | Development and implementation of such plans and projects |
| Development of standards for measures to prevent mass movements disaster | Development of standards for measures to prevent mass movements disaster | Development of standards for measures to prevent mass movements disaster | Implementation of infrastructure and public facilities |
| | | Technical assistance related to environmental licensing | Licensing allotment and other projects developed by the private sector |
4. METHODOLOGY PROPOSAL FOR URBAN PLANNING

4.1 Methodology construction process

The Law 12,608/12 establishes the need for development of specific project for municipalities wishing to expand its urban areas. Although the law has determined the minimum content of this project, it is necessary to detail this instrument’s contents, such as its objective, the guidelines for its preparation, and the territorial scope of the specific project.

The first step for the construction of the manual was to establish the routine schedule of debates, design, consultations and tests of the proposed methodology in the pilot municipalities. The second step was to mobilize the technical and state and municipal managers was carried out, to raise the various scenarios of the problem.

With the structuring of these two steps the Technical Meetings tried to define points to guide the elaboration of the methodology:

1. The planning of urban expansion is a risk prevention tool and should include planning the use of municipality territory in a multiscale manner, working in stages between the preparation of the Master Plan and urban design itself, in conjunction with all environmental and geological guidelines existing;
2. The planning process of urban expansion areas should include prior analysis phase which demonstrates the necessity of spreading the urban perimeter and should establish precisely the area needed to accommodate the demand for expansion;
3. The methodology should be applicable to all municipalities vulnerable to risk of sediment disasters, regardless of territorial planning phase they are at. Therefore the methodology generated must be applicable in municipalities at different stages of planning, such as in development phase of the master plan, the intermediate planning phase and in review phase of the master plan, respecting the scales of each of these stages.

4.2 Methodology proposed

The advancement of the methodological debate was based on the following assumptions:

4.2.1 Planning as a preventive measure

The Law 12,608/12 launched the challenge of urban planning development as part of prevention measures. This challenge is divided into two parts: the first relates to the lack of expertise in the association of urban planning pieces to risk analysis instruments; the second is related to the weakness of the risk and hazard mapping tools in Brazil. These mapping instruments are still underdeveloped by municipalities, and generally, they do not include the entire municipal area, particularly the non-urban areas destined for urban expansion. Faced with these challenges, the method seeks to support itself on the available risk and hazard analysis tools. However, the method also required the development of a new mapping piece in areas with potential for urban expansion, the hazard map.

4.2.2 Multiscale planning

Urban Planning in Brazil is structured on two levels. There is a scale at municipal level, established in the Master Plan, with its determinations in macrozoning urban scale, and another on allotment level, with use and occupation determinations and construction parameters. So the lack of an intermediate scale was identified, and this methodology should help fill this gap. Therefore, we opted for a land planning strategy in three scale levels: the Master Plan, the expansion plan and the specific urban design Project.
Fig. 3 Territorial scope of the Urban Planning Manual.

Fig. 4 Flowchart of procedures for planning urban expansion.
Fig. 5 Previous analysis of the definition of urban expansion projects.
| Item | Data | Main Content of Analysis |
|------|------|--------------------------|
| I – Population dynamics | Increase and / or decrease in population, urban population, future population, migration, daytime population, etc. | Population distribution, population growth. |
| II- Industry / trade / services | Number of persons employed Number of establishments, economic growth prospects. | Growth of business activities, development pressure, commercial dynamics. |
| III- Mobility and Transport | Traffic volume and degree of congestion of the main trunk lines, general characteristics of the system and public transport infrastructure. | Degree of congestion, public transport system, geographical coverage. |
| IV - Land value | Land value situation broken down by municipality area. | Average land value map. |
| V - Land Use and Construction | Land use situation, land and property unused or underutilized, development situation of residential communities, average utilization coefficient of neighborhoods, distribution of empty properties, number of floors of buildings, qualitative and quantitative housing deficit. | Urbanization status, area of land unused or underused, especially in central areas, with infrastructure and services. Situation of buildings unused, potential for densification. |
| VI - Infrastructure / services | Location and design of urban infrastructure, the roads situation, etc. characterization of infrastructure systems and their geographical coverage; network analysis of urban services (special focus on education, health and social care). | Coverage and condition of infrastructure systems and municipal services (water and sewage infrastructure, road and mobility, etc.). |
| VII - Natural Environment / Areas of special interest | Topographic, hydrographic and geological conditions, weather conditions, state of vegetation, protected areas, capacity of systems, environmental, etc. Tourism situation, landscape and historical resources; intangible heritage and territories, protected areas, etc. | Characterization of physical and environmental conditions, development constraints. Identification of special landscape interest areas and the preservation of heritage. |
| VIII - Disasters | Disaster occurrence situations, readiness centers for disaster and shelters, escape routes, etc. | Risks of floods and mass movement of disasters. |
4.2.3 Previous analysis of the need for urban expansion

Brazilian municipalities have few instruments to control urban sprawl. Sometimes cities grow through spontaneous movements of the population occupying urban land without permission, and other times through actions of the public administration, with no proper assessment of the impacts of the expansion of the urban area. Thus, a model of analysis of the need for urban expansion is necessary, considering its impact and possible occupation scenarios, in order to consider the characteristics and limitations of the territory, in particular the restrictions related to the risks of natural disasters.

Fig. 3 indicates the areas in the city that should be subject of study for the planning of urban expansion.

Fig. 4 shows the flow of procedures for planning the urban expansion process. The procedures are conditioned to the verification stage of the need for urban expansion. With the need to expand analyzed and verified the feasibility, methodology demand the interactions with the regional planning process at three levels:

1) Master Plan: Settings in the Master Plan level to large urban macrozones, especially the definition of the location of the urban expansion macro-area or areas of change in urban density and land use change.

2) Expansion Plan: Settings focused on the level of the expansion macrozone, with zoning details, definitions of land use and occupation rules, delimitation of areas of restricted use, and other requirements from the City Statute.

3) Urban Expansion Project: Settings on urban design level, with the actual definition of the urban design, of construction standards, the definition of the necessary countermeasures for occupation.

The method seeks to dialogue with the mapping tools developed by the Geological Survey of Brazil-CPRM. Thus, it proposes the interaction with the following mapping tools: Susceptibility Municipal Maps, and Hazard Maps. This last instrument is also being developed in the GIDES Project.

It must be noted that all steps are subject to the results of the studies to verify the need for urban expansion. The method proposes the establishment of analysis prior to defining the urban expansion projects that minimally evaluate the elements listed in Fig. 5, which are: a) the demand for urban expansion area; b) the possibility of consolidated urban areas of housing the demand for expansion; c) the viability of urban expansion projects, either by territorial expansion or by raising urban density.

To this end, a framework was developed with elements and content that should be analyzed by the
For each of the analysis items a method of analysis at two levels of complexity is proposed. This approach seeks to respect the municipal institutional capacities for the production of territorial diagnoses. In this line of reasoning, the municipalities with more robust management structures should choose the most complete methods of analysis of the items proposed for the characterization of the urban expansion process and the municipal territory.

Fig. 6 shows a flowchart with the urban planning instruments and their interaction with risk mapping instruments.

For planning in macrozoning scale, to be established by the Master Plans, the main instrument is the Municipal Susceptibility Map, with scale of 1 : 25.000, developed by the Brazilian Geological Survey. In this planning scale, the main goal is to define the Urban Expansion Zones. Fig. 7 illustrates the analysis of land use scenarios and the choice of the urban Expansion area.

Fig. 8 Reference table for the institution of limited urbanization areas.

Fig. 9 Reference table for establishment control and restriction zones for occupation.

The following level of detail, regarding the definition of Urban Zoning and the requirements of Law 12, 608/12, which determines the demarcation of restriction areas and control areas, the manual suggests...
the correlation described in the above mentioned table, for purposes of correlation between the CPRM hazard letters and the Urban Zoning.

In this perspective the hazard categories of the critical and dispersion areas would be aggregated in a single category of urban zoning, the Zone of limited urbanization. Given this uncertainty regarding the destructive energy of the mass movements on the hazard areas divided in P 1, P 2, P 3 and P 4, this interpretation is recommended for the definition of urban zoning (See Fig. 8).

Municipal governments, through a specific study to characterize the energy effect of mass movements, aiming at the disaggregation between (See Fig. 9):
  i) areas where mass movement has sufficient impact energy to destroy buildings;
  ii) areas where mass movement does not have sufficient impact energy to destroy buildings;

With this detailing of Hazard Maps or other geological-geotechnical cartography that accurately trace the trajectory and strength of mass movements, it is suggested to adopt the following classification for urban zoning purposes.

6. CONCLUSION AND FUTURE STEPS

In the present work, the construction process of urban planning methodology aimed at preventing risks in sediment disasters was contextualized, and the progresses made so far were presented.

Despite the complexity of Brazilian federal system, and the fragility of urban planning in the country, the GIDES project is achieving concrete progress in reformattting urban planning methodologies.

Although still in development stage, the methodology already points the direction for reformattting the risk mapping and analysis instruments, with regard to the conditions to meet the demands of urban planning area.

The development of the methodology is now at its final steps, which consists on formatting guidelines for the design and implementation of urban projects. Given the limited expertise of Brazil in promoting resilient urban interventions, it is understood that this methodology step is central to the improvement of living conditions in Brazilian cities, especially since the stage objectively deals with the orientation for the actions of urban interventions.

However, despite the advances, the problems are huge. Even with the advancement of methodology, Brazil still has the enormous effort to capacitate its more than 5,700 municipalities, scattered in a territory of continental proportions.

In addition, at this moment of reviewing of the risk management policies and actions in the country, there remains the challenge to highlight and strengthen the strategic dimension of urban planning and recognition of the territory as the basis for disaster prevention.

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