



## RESTRICTIONS ON THE USE AND OCCUPANCY OF FLOOD AREAS AS A TOOL FOR DISASTER REDUCTION

Viviane Japiassú Viana<sup>1</sup>, Rosa Maria Formiga Johnsson<sup>2</sup>

1. *Ph.D. Candidate, Postgraduate Program on the Environment - Rio de Janeiro State University (UERJ)*
2. *Associate Professor, Department of Environmental and Sanitary Engineering, Postgraduate Program on the Environment - Rio de Janeiro State University (UERJ)*

**ABSTRACT:** In Brazil, disasters related to floods causing human damage, pecuniary loss and environmental damage, are mainly due to greater exposure of the population; urban densification on the riverbanks and margins, incurring vulnerability due to changes in river level. The territorial and environmental management policies have not been enough to prevent disasters considering the lack of articulation among the States and the Federal Government, water management by hydrographic basin, and the Municipalities, which are responsible for performing the territorial management. Several efforts have been made in recent years following the tragedy of the Região Serrana (mountainous region) of Rio de Janeiro State, which seems to have put the matter on the political agenda of the whole country. The paper lies within this context, as it deals with the theme of urban flooding from the point of view of prevention of the emergence of vulnerabilities and the consequent reduction of the risk of flood-related disasters. A survey is conducted of the legal basis (urban and environmental) in order to assess the potential for development of public policies to prevent occupancy of areas subject to inundation, especially in regions of great urban expansion, avoiding or reducing the risk of such disasters. Furthermore, assessment is made of the recent government actions, focused on flood prevention, performed at Federal and Rio de Janeiro State level.

Keywords: flood management; flood risk prevention; land use plan; ICFM6

### 1. INTRODUCTION

In Brazil, the trend of absence of preventive measures in the risk management has resulted in frequent disasters related to floods causing human damage, pecuniary loss and environmental damage, mainly due to greater exposure of the population; urban densification on riverbanks where there is vulnerability to rises in river level. The territorial and environmental management policies have not been enough to prevent disasters due to lack of articulation among the States and the Federal Government, water management by hydrographic basin, and the Municipalities, which are responsible for performing the territorial management.

In this context, this paper aims to explore urban flooding from the vulnerability prevention perspective and consequent disaster risk reduction.

This paper also analyses the legal basis for land occupancy (urban and environmental) in order to assess the potential for devising public policies to prevent occupancy in areas subject to inundation, especially in regions of major urban expansion, in order to avoid or minimize the risk of flood-related disasters.

In the territorial planning, the legislation prohibits use of swamps and land subject to flooding, before taking measures to ensure water drainage, and sets criteria that classify areas where building is prohibited. However, the municipal master plans, mostly, do not insert these restrictions in the zoning, nor do they consider it in the land use management in their territories.

Next, this paper also assesses the recent actions of the Federal Government and the Rio de Janeiro State Government focused on flood prevention and the inclusion of the Municipalities in the process of flood risk management, showing that disasters are mentioned in the legislation of several areas, such as health, the environment, civil defense and territorial planning, but especially droughts and floods, by virtue of their significance in the national scene.

## 2. FLOOD RISK MANAGEMENT IN BRAZIL

In 2008, Brazil occupied 13th position among the countries in the world most affected by natural disasters. National Civil Defense Office data show an increased occurrence of disasters in the last 20 years, registering a total of 31,909 in the period from 1991 to 2010, of which 73% occurred in the decade from 2000 to 2010, as opposed to 27% in the 1990s (CEPED UFSC, 2012).

In the period 1991 to 2000, floods were responsible for 40% of those affected and almost 50% of the deaths caused by disasters in the country, as shown in Figure 1 (CEPED UFSC, 2012).

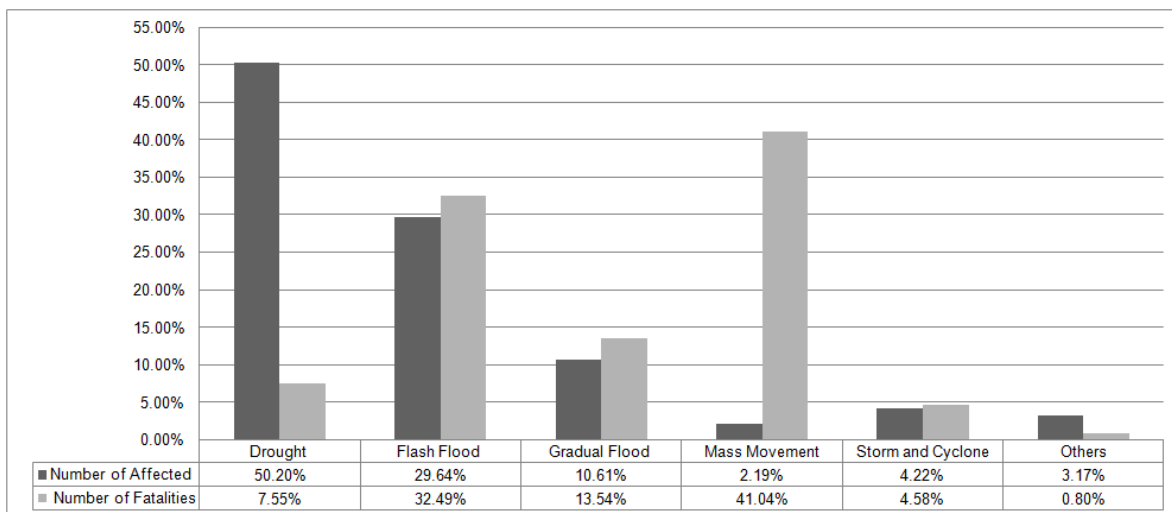


Figure 1: Number of affected and killed by disasters (1991 – 2010)

In this same period, the southeast region was the only one that exceeded the national average of 20 dead per million inhabitants in disasters. It is precisely in this region, where the metropolitan regions of São Paulo and Rio de Janeiro are located, which are the main urban centers of the country., In 2010, they concentrated most of the Municipalities that have declared emergency situations or State public calamities due to the occurrence of flooding - spates, inundation, runoff and waterlogging (ANA, 2012).

Clearly, the number killed in disasters in the southeast has been growing along with population increases, showing that the Brazilian urban centers are highly vulnerable to such damage. With regard to floods, this vulnerability is growing, mostly due to greater exposure of the population to modifications in level of water bodies as a result of urban densification on their margins.

In the last few years, the cost of floods in the States of Santa Catarina (2008), Pernambuco and Alagoas (2010) and Rio de Janeiro (2011) has reached R\$ 15.5 billion (World Bank, 2012). These data indicate an extreme need to invest and prioritize urban planning that reduces the population's vulnerability to floods, minimizing the risk of disaster, especially those leading to environmental, social and economic damage.

## 2.1 Brazilian legislation and flood prevention

The 1988 Constitution adopts an approach focused on participative, decentralized management, delegating to the municipal authorities responsibility for problems on the local scale, as it is in this government sphere that there is knowledge of the specificities of the problems faced by the population (Carneiro, 2008).

In the context of disaster management, this Constitution attributes to the Federal Government the planning and promotion of permanent defense against public calamities, especially droughts and floods. Nevertheless, it does not determine that instruments, tools or procedures will be used for execution of these attributions, leaving this regulation at the discretion of complementary laws and other regulatory instruments to be devised by the competent bodies.

In Brazilian legislation, it is noteworthy that there is mention of disasters related to policies in several areas, such as health, the environment, civil defense, territorial planning. These policies highlight droughts and floods, by virtue of the significance of these events on the national scene. However, none of these legal instruments clearly defines what methodologies and procedures should be adopted to make viable the integration of water management with territorial planning, with the aim of preventing water-related disasters.

In the ambit of territorial planning, land use is restricted to criteria defined by the municipality's master plan or approved by municipal law, which prohibit building in marshlands and areas subject to flooding, before taking the necessary measures to ensure water drainage. The municipal governments are responsible for indicating in the plans submitted, along with the applications for allotment, the sanitary ranges of the land necessary for rainwater drainage and the ranges where building is forbidden. This range is 15 meters on each side of waters courses.

In the cases of allotments located in areas of special interest, such as where there is protection of water sources, it is the responsibility of the States to exercise discipline in the approval by the Municipalities of allotments and dismemberments (Law no. 6.766/1979, amended by Law no. 9.785/99).

Amendments made to the Federal legislation in 2011 determined that, in cases where the municipality has qualified technical staff and the minimal administrative structure required, municipal approval of the urban allotments should go beyond urban licensing of the project, include too the environmental licensing. In cases in which the municipality does not have legislative jurisdiction for environmental licensing, the regularization of land of social interest in permanent preservation areas is the responsibility of the State, the requirement for urban licensing by the Municipality being maintained (Law no. 6.766/1979).

The City Statute (Law no. 10.257/2001) regulates the use of urban property, establishing social order and social interest norms for the benefit of all, security and welfare of the citizens, as well as environmental equilibrium. In its current text, amended and supplemented by the National Protection and Civil Defense Policy, it determines that urban policy should consider in its planning and control guidelines for land use, the need to avoid exposure of the population to disaster risks, as well as their proximity to incompatible uses.

The National Water Resources Policy, established in Brazil by Law no. 9.433/1997, determined as one of its purposes "*the prevention and defense against critical hydrological events of natural origin or arising from inadequate use of natural resources*", and, as one of its guidelines, the articulation of water resource management with land use. Additionally, it creates water resource plans, as one of the guiding documents of water management in the hydrographic basins, and these should present diagnoses of its hydrographic basins, identifying the areas at risk of droughts and floods, aiming at the protection of water resources.

This policy provides for participatory management of the water resources via the interaction of hydrographic basin committees, composed of the State environmental agency, Municipalities, civil society, water users, among other interested parties.

Lastly, in 2012, Law no. 12.608/2012 created the National Protection and Civil Defense Policy - PNPDEC, encompassing the prevention, mitigation, preparation, response and recovery actions directed to protection and civil defense. Among the guidelines of this policy, are the prioritization of preventive actions related to minimization of disasters, and the adoption of the hydrographic basin as the analysis unit for the preventive actions of disasters related to water bodies.

The cross-sectional nature of this policy is noteworthy, as it determines its integration with the policies of territorial planning, urban development, health, the environment, climate change, water resource management, geology, infrastructure, education, science and technology, and with the other sectorial policies, the aim being the promotion of sustainable development.

Furthermore, aligned to the concept of participatory management in other Brazilian policies, the National Protection and Civil Defense Policy brings the possibility of voluntary community organizations, or other entities with significant involvement in local actions of protection and civil defense, integrating with the National Protection and Civil Defense System (SINPDEC), creating the role of the civil protection agent, who can serve as a volunteer trained in prevention and management actions in disaster situations.

The National Protection and Civil Defense Policy determines coordinated action among the Federal Government, the States and Municipalities for the reduction of disasters and makes provision for support for the affected communities, the responsibility for duties more focused on preventive planning and monitoring of disasters lying with the Federal Government and the States, and that for measures to execute preventive urban planning based on prior mapping, with the Municipalities (GANEM, 2012)

The meteorological, hydrological and geological monitoring of the risk areas are the responsibility of the three government levels to be conducted in a coordinated manner. On the other hand, the mapping of the risk areas and the studies to identify threats, susceptibilities, vulnerabilities and risk of disaster should be performed by the States, with support from the Federal Government and the Municipalities.

The States are required to implement the State Protection and Civil Defense Plan and support the Municipalities in conducting the risk area surveys, the preparation of the Contingency Plans for Protection and Civil Defense, as well as the divulgation of protocols of prevention, alert and emergency action.

The Municipalities are expected to supervise the disaster risk areas and prohibit new land tenure in these areas, as well as incorporate protection and civil defense actions into the municipal planning. Thus, the master plans should be updated and made compatible with the provisions of the water resource plans.

The Municipalities should also train and inform the local population and agents regarding the occurrence and risk of disaster, provide the relief resources necessary to meet the basic needs of the population affected, prepare the Protection and Civil Defense Contingency Plan, as well as assess the damage and losses.

Also, registration of the Municipalities with risk areas was introduced, the aim being to promote monitoring of disaster risks by the Federal Government, and provision was made for the creation of a disaster information system, which may be integrated with the Water Resources Information System, once again promoting a link between the two policies.

## **2.2 Investment in flood prevention**

The Federal Government's Multiyear Plan (2012 to 2015) dedicates the thematic Program 2040 to risk management and disaster response, showing that the Federal Government considers this theme a priority in its planning.

This Program allocates a budget of R\$11.5 billion for application in its six objectives with the purpose of promoting the structuring of the support system for decisions and alerts of natural disasters, except droughts (BRASIL, 2011).

This investment is intended to make available technological and systemic support for the National Civil Defense System. R\$ 10 billion is earmarked for structural measures that involve drainage, macro drainage and slope stabilization, as well as structuring measures, such as mapping, monitoring of settlement in risk areas, and a support system for decisions through the implementation of the National Monitoring and Natural Disaster Alert Center – CEMADEN, and training more than 4,500 people in prevention and response to disasters involving .

In 2012, the Federal Government launched the National Risk Management and Natural Disaster Response Plan 2012 – 2014 with the purpose of protecting lives, ensuring the safety of people, minimizing the damage arising from disasters, and preserving the environment, for which investments of R\$ 18.8 billion were allocated to coordinated actions of prevention and reduction of the response time to deal with occurrences. Specifically, R\$ 15.6 billion were intended for prevention, R\$ 162 million for mapping, R\$ 362 million for monitoring and alert, and R\$ 2.6 billion for response (BRAZIL, 2011).

Notably, in the civil defense sphere, the preventive actions are focused on structural measures that involve implementation of new works and improvements in slope stabilization, drainage, flooding containment, dams, aqueducts and water supply systems. For the structuring measures necessary for prevention of settlement in risk areas, the investments to be made will not be so high as those for the works, which shows a view that the problem still lies essentially in the engineering field.

### 3. FLOOD RISK MANAGEMENT IN RIO DE JANEIRO

Rio de Janeiro State is sixth on the list of Brazilian States with the highest number of disasters in the period from 2007 to 2010. In 2007, it ranked third and second in 2009, according to National Civil Defense Office data.

Floods constitute the main type of disaster in Rio de Janeiro State. In 2013, 88% of its Municipalities declared they had been affected by them (IBGE, 2014), and the municipal civil defense records indicate that the number of Municipalities hit in the last 20 years has been increasing considerably (CEPED UFSC, 2011).

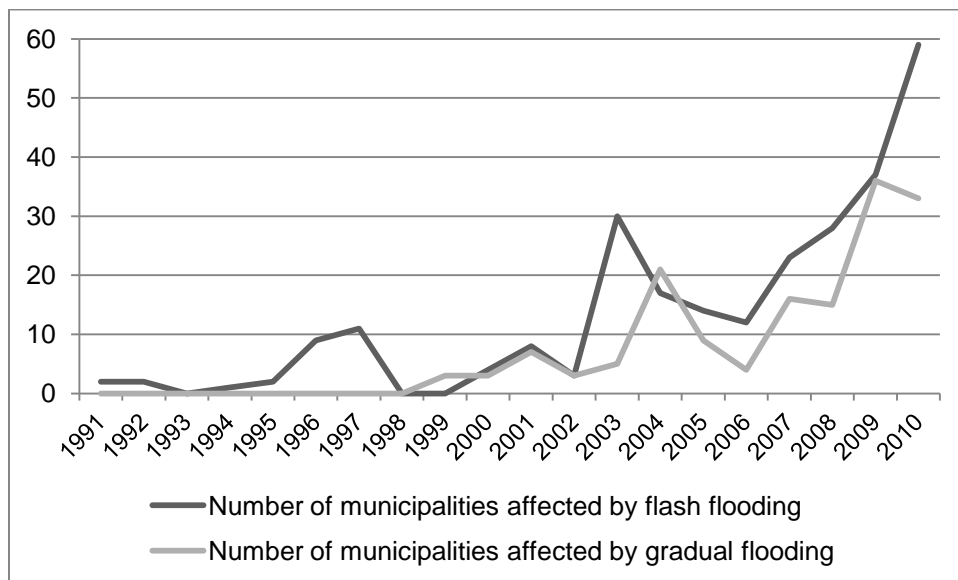


Figure 2: Number of Municipalities affected by floods in the Rio de Janeiro State (1991 – 2010)

The rugged relief, rivers and streams with steep gradients and the high rainfall in the period from December to March are characteristics of Rio de Janeiro State that favor the intensification of floods and the damage they cause.

The adoption of public policies of land occupation integrated with water resource management could substantially reduce the damage that has been occurring in the State over the last few years. However, despite the measures set forth in the legislation, the fact is that the master plans and municipal zoning still do not correspond to the reality of the cities, and they consider neither important environmental aspects nor the vulnerabilities and risks of local disasters.

In the scope of the risk management of disasters, the majority of the actions being undertaken at the three levels of government seek to monitor and act on an already existing risk, in order to save lives and minimize property damage among the most vulnerable population. Little or almost nothing is done in terms of preventive action in order to avoid the occurrence or aggravation of vulnerabilities in flood risk areas.

In this context, in the last few years, the Instituto Estadual do Ambiente – INEA [State Institute of the Environment], in its role as the water resource management agency for Rio de Janeiro State, has been involved with the theme and performed mapping of areas susceptible to flooding.

Nevertheless, the mapping is only one stage in the risk management of disasters, it being necessary to proceed to the remaining steps after its completion. The following stage consists of defining the limitations of land occupation in areas mapped as subject to inundation, incorporating the occupation restrictions into the instruments and tools adopted in the urban planning.

However, although the Municipalities are responsible for land occupation management, they have been unable to prevent settlement in flood-risk areas, and, in general, the municipal urban legislation has not yet incorporated this issue into its proposals and zoning restrictions.

This reality reflects a scenario in which, in 2013, out of the 92 Municipalities in Rio de Janeiro State, 81 reported to the IBGE [Brazilian Geographical and Statistical Institute] that they had been suffered inundation in their urban centers in the last 5 years.

Concerning the participatory councils, only 2 Municipalities reported that they do not participate in a hydrographic basin committee, only 1 reported that it did not have a municipal council for the environment, and 61 had begun Agenda 21.

With respect to land use legislation, 70 have a Master Plan (6 in the process of preparation), 64 have specific legislation about zoning or land use and occupation, and 24 have this as part of the Master Plan.

Aiming to avoid or minimize the damage caused by floods, 15 Municipalities reported actions of population relocation in risk areas, and 16 reported revegetation action.

Of the 83 Municipalities that reported they possessed disaster risk management instruments, the number having the following items are as follows (IBGE, 2014):

- Flood risk map: 55;
- Housing program for relocation of the low-income population from risk areas: 36;
- Control and supervision mechanisms to avoid settlement in areas susceptible to disasters: 25;
- Contingency plan: 68;
- Engineering projects related to disasters: 16;

- Systems of early disaster alert : 21;
- Registration of risk: 36;
- None of the items: 8

As regards the structure to act in the prevention of risks and disaster response, the Municipalities reported as follows:

- Fire Service: 44;
- Municipal coordination: 80;
- Community civil defense centers: 24;
- Municipal civil defense with own career structure: 16;
- Another structure to address the issue: 17;
- No structure to address the issue: 9.

Additionally, although the Brazilian Forestry Code determines that the banks and margins of rivers constitute Permanent Preservation Areas (APP), having the function of preserving the vegetation and biodiversity. In the Municipalities of Rio de Janeiro State, disrespect of the settlement restrictions in APPs along water courses is a reality, it being common to find irregular settlements in these areas.

These practices are at odds with the Brazilian environmental legislation, and have resulted in soil sealing, removal of gallery forest, in addition to the direct disposal of solid waste into water bodies and courses, intensifying the damage arising from floods and causing serious public health and social problems.

Since 2013, the Rio de Janeiro State urban legislation determined that the public service providers must issue an urban and environmental classification document (DEUA) to be submitted to the consumer requesting the service(s), informing the possibility of being attended or not based on the characteristics of the real estate in question, taking into account the urban and environmental land use and occupation restrictions established in the local urban planning legislation, in laws of the federative entities, or resolutions issued by bodies that are part of the National Environment System. This measure may be used to discourage irregular settlement in areas presenting a risk of flooding, in accordance with the mapping performed by the competent bodies.

On the other hand, the State Water Resource Policy (PERH), established by Law no. 3.239/99, among its objectives of flood control, flood prevention and zoning of areas subject to inundation, grants the Executive Power the function of integrating it with the other sectorial policies.

The State Water Resource Policy determines that the Municipalities promote its integration with the local policies related to land use and occupation, environmental preservation and conservation, and meteorology.

Lastly, the policy determines the preparation of a State Water Resource Plan, which should be updated at least once every 4 years, submission of proposals for the formation of areas subject to use restriction, the aim being protection of the water resources, as well as presentation of guidelines for the protection of the banks and margins of rivers, lakes and other water bodies.

The State Water Resource Fund (FUNDRHI), created by the State Water Resource Policy (PERH), has financed the preparation of the State Water Resource Plan, which was concluded at the end of 2013, and includes the Mapping of Areas Vulnerable to Critical Events.

Finally, Law no. 6442/2013 determined the obligatoriness of the Municipalities of Rio de Janeiro State to incorporate, in their Master Plans and other regulatory instruments of land use and occupation, the official State documents concerning studies and mapping of risk areas.

INEA is the management agency responsible for implementing the State Water Resource Policy (PERH), dealing with disasters, and making or validating the mapping of flood risks.

The agency has performed the mapping of areas subject to flooding and the zoning of flood risk areas in the Região Serrana (mountainous region), as shown in Figure 3 below.

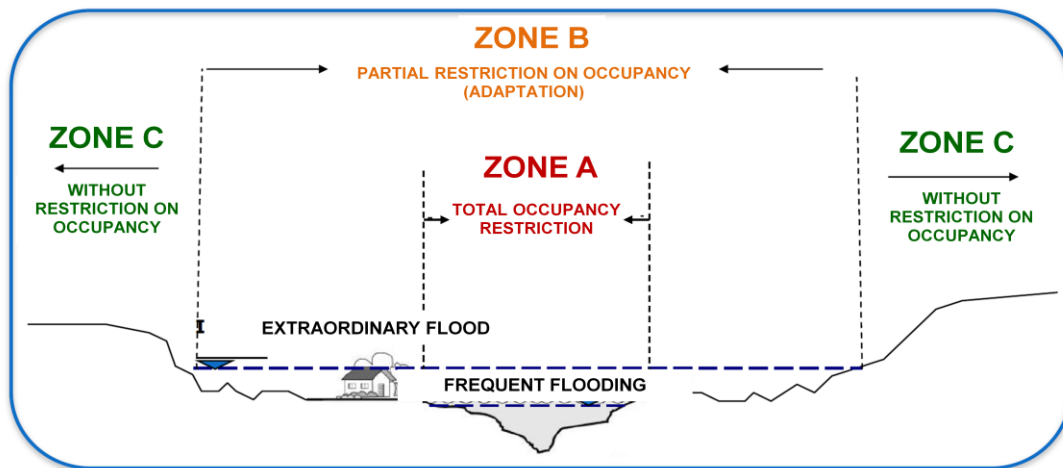


Figure 3: Flood Risk Zoning in the Região Serrana, Rio de Janeiro State

In this zoning, Zone A includes the lowest channel of the river, where total restriction of settlement was established, resulting in the removal of residents living in this zone. The residences located in Zone B are at risk of eventual flooding, and, therefore, may choose to remain on the site, and those located in Zone C are exposed to a low risk and so not subject to settlement restriction.



Figure 4: Demolition of residences lying in the floodplain with total occupancy restriction (Zone A) in the Região Serrana, Rio de Janeiro State (<http://www.rj.gov.br/>)



Due to the emergency nature, this mapping was performed with strictly technical criteria, without the active participation of the Municipalities and civil society, generating conflicts and resistance to moving to the next stage of the risk management, that of following up with incorporation of the local master plan into the urban planning.

#### **4. CONCLUSIONS**

The prevention of settlement in areas prone to flooding for the purposes of civil protection and ecological interest is a complex matter, as it involves not only the mapping of riparian areas susceptible to flooding, but mainly the observance of restrictions on or prohibition of settlement. This is not only a problem of water resource management and territorial planning, but also one of a social and economic nature, because almost always the risk areas are occupied by low-income population, who have no alternative housing option.

The current Brazilian legislation is clear in relation to the need and obligation of the government to integrate land use management with disaster management. It is crucial that Municipalities act in an integrated manner with the State, effectively applying the flood risk mapping in their territorial planning and management, putting into practice the measures necessary to change from the current approach, focused on already existing risks, to acting from the perspective of flood risk prevention.

To make the process more effective, avoid resources invested in mapping resulting only in documents being filed away without ever becoming part of the local public policies, it is necessary to involve the stakeholders at all stages of the process, so that they understand the methodologies adopted, monitor and support the data survey and planning of policies and studies prepared with the objective of preventing the emergence or expansion of areas vulnerable to flooding.

In short, the solution to this problem requires much more than the risk mapping performed by the State or a federal agency, and the internalization of these restrictions by the Municipalities in their instruments of land use and occupation management. Alone, command-and-control on the part of the government has been shown to be important, but limited to deal with complex problems like this. The search for solutions should involve the population, especially in the surrounding areas, and the participatory bodies that are interested, or may be interested, in the issue (hydrographic basin committees, local Agenda 21 forums, municipal environment councils, community associations).

#### **5. REFERENCES**

ANA, 2012: Conjuntura dos recursos hídricos no Brasil – 2012 [Conjuncture of water resources in Brazil - 2012 report: Special edition] Brasília, BR.

Brasil, 2009: Política Nacional sobre Mudança do Clima [National Policy on Climate Change]. Brasília, BR.

Brasil, 2011. Plano plurianual para o period 2012-2015 [MultiYear Plan of the Union for the period 2012-2015]. Brasília, BR.

Brasil, 2012: Plano Nacional de gestão de risco de des [National Plan for Risk Management and Disaster Response 2012 – 2014]. Brasília, BR.

CEPED/UFSC, 2011: Atlas brasileiro de desastres naturais 1991-2010: Rio de Janeiro [Brazilian Atlas of Natural Disasters 1991-2010: Rio de Janeiro]. Florianópolis, BR.

CEPED/UFSC, 2012: Atlas brasileiro de desastres naturais 1991-2010: Brasil [Brazilian Atlas of Natural Disasters 1991-2010: Brazil]. Florianópolis, BR.

IBGE, 2014: Pesquisa de Informações Básicas Municipais – Perfil dos municípios brasileiros 2013 [Survey of Basic Municipal Information - Profile of Brazilian Municipalities 2013]. Rio de Janeiro, BR.

Paulo Roberto Ferreira Carneiro, 2008: Controle de inundações em bacias metropolitanas, considerando a integração do planejamento do uso do solo à gestão dos recursos hídricos. estudo de caso: bacia dos rios Iguaçu/Sarapuí na Região Metropolitana do Rio de Janeiro [Control of Flooding in Metropolitan Hydrographic Basins, with regard to the Integration of Land Use Planning for Water Resource Management. Case Study: Basin of Iguaçu / Sarapuí rivers in the Rio de Janeiro Metropolitan Region.] Rio de Janeiro, BR.

Ministério da Integração Nacional, Secretaria Nacional de Defesa Civil [National Secretary of Civil Defense], 2007: Política Nacional de Defesa Civil [National Civil Defense Policy]. Brasília, BR.

Roseli Senna Ganem, 2012: Gestão de desastres no Brasil. Relatório de Consultoria Legislativa da Área XI - Meio Ambiente e Direito Ambiental, Organização Territorial, Desenvolvimento Urbano e Regional [Disaster Management in Brazil. Report - Legislative Advisory Area XI – The Environment and Environmental Law, Territorial Organization, Urban and Regional Development]. Brasília, BR.

World Bank, 2012: Avaliação de Perdas e Danos: Inundações Bruscas em Alagoas - Junho de 2010 [Damage and Loss Assessments: Flash Floods in Alagoas – June 2010]. Brasília, BR.

World Bank, 2012: Avaliação de Perdas e Danos: Inundações Bruscas em Alagoas - Junho de 2010 [Damage and Loss Assessments: Flash Floods in Pernambuco - June 2010]. Brasília, BR.

World Bank, 2012: Avaliação de Perdas e Danos: Inundações Bruscas em Santa Catarina – Novembro 2008 [Damage and Loss Assessments: Flash Floods in Santa Catarina - November 2008]. Brasília, BR.