



## ORGANIZING COMMUNITY PARTICIPATION FOR FLOOD MANAGEMENT: EFFECTIVE RESPONSES IN AN URBAN WATERSHED IN BELÉM (PARÁ-BRAZIL)

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**ABSTRACT:** Environmental and economic losses during flood events are the result of many factors which make the mitigation more difficult. The goal of this paper is to assess the range of impacts that experiencing recent flooding in Belém (Pará-Brazil) has had on people, their attitudes and behaviors; and to establish which measures work with particular population groups and locations in relation to flood prevention campaigns and flood warning/dissemination systems. The study employed both quantitative and qualitative approaches. The flood impacts in Belém are generated from both natural and human-made factors. Belém is located on former floodplains, where natural waterways and wetlands were replaced by urban structures. The results showed that floods affected people's socio-economic livelihoods and critical aspects, such as health, education, housing, water, sanitation, property and assets. The implementation of the recommended measures could be carried out by different instruments and at various levels, such as the engagement of communities in moving permanently to higher grounds; the zoning of non-flood and flood areas; the deployment of systems to warn the populace about the risk; and the preparation of community plans of action explaining what to do in case of flooding. If the flood control devices work for preventing the events, some of the damage should be avoided.

Key Words: flood management, urbanization, urban watershed, floodplains.

### 1. INTRODUCTION

The hydrographic basin functions allow the integration between physical, biotical, social, economic and cultural aspects in a specific environment. Therefore, adopting the watershed as an ideal planning and intervention unit is an alternative to promote the management of areas that suffer with constant flooding (Machado, 2003; Tundisi, 2008). The Metropolitan Region of Belém (Pará) has a drainage system marked by the presence of rivers, streams and channels, and a history of occupation that prioritized proximity to watercourses, which prevails to the present day, tending to concentrate low-income residents with substandard housing in flood-prone areas (Pimentel *et al.*, 2012).

It is noteworthy that physical and natural features of the city of Belém also favor flooding areas because part of its territory is located in low areas, near to sea level (Lima *et al.*, 2013). Added to it, we have the climate characterized as type Af (always wet) according to Köppen classification, with the rainy season (months of December, January, February, March, April and May - DJFMAM) recording around 388 mm (monthly average of precipitation during the rainy season) (Bastos *et al.*, 2002; Tavares and Mota, 2012). These factors directly influence the urban drainage system, which has proved inadequate, inefficient and unable to drain the entire volume of precipitated water.

The distinction between the behavior of a natural watercourse and a watercourse induced by urban environment is sometimes difficult to identify. The occurrence of flood is associated with a high volume of

water in a watercourse, resulting from intense rainfall with consequent overflow of the riverbed and its banks (Campana *et al.*, 2007). To understand the formation of floods, it is necessary to analyze the hydrologic cycle. Rainfall is partially retained by vegetation and the remainder is retained in the soil surface; where, depending on surface conditions, it can infiltrate the soil and reach groundwater or drain into the surface systems, slowly and continuously (Sausen and Narvaes, 2013).

The flow on the surface depends on permeable areas like the ones with vegetation cover, whereas the impervious ones (paved areas) allow very little infiltration and runoff. Therefore, waterproofing is the main aggravating factor of floods, while maintaining permeable surfaces reduces the risk (Olszewski *et al.*, 2011). The relationship between the urbanization process and the natural aspects marked by the strong influence of river water systems and climatic factors (especially in the rainy season) in Belém demands an interdisciplinary analysis to investigate the perception of people who inhabit the areas subject to flooding and waterlogging, once intensely occupied areas imply in a situation of environmental risk. Considering the scenario presented, this research proposes the characterization of social, economic and cultural indicators of populations occupying areas of urban flooding in Belém, as well as the preventive management measures and precautions associated.

## 2. MATERIALS AND METHODS

### 2.1 Study area

The expansion of the Metropolitan Region of Belém has contributed to the occupation of the area around Belém's Environmental Park, where there is an increase of popular buildings, in disagreement with the urban master plan. In this context, it was selected for this research the neighborhood of Curió-Utinga, which covers the area of supply sources of Belém (Figure 1).

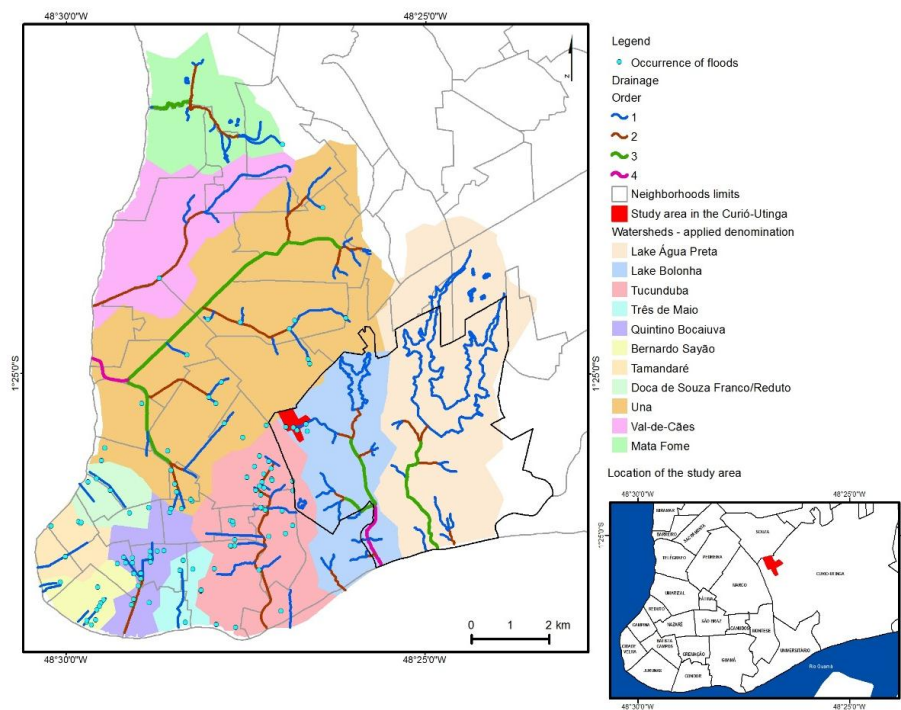


Figure 1: Study area in watersheds and neighborhoods of Belém-Pará. Source: Prepared for this work; flooding records from Civil Defense of Pará; base vectors from IBGE and Lima et al. (2013).

Before legalization, the district was divided into two sectors: the Environmental Preservation Area (Utinga) that represents 80% of the territory; and the area of Curió, occupied by residents (20%). With legalization occurred the junction of these areas, now called Curió-Utinga district. It corresponds to a region located upstream to one of the tributaries that drains toward the Lake Bolonha basin; in the edges of John Paul II Avenue's extension, where there are disordered occupations, which, according to Santos (2008), are responsible for the formation of slums inhabited by newly migrated people with almost no professional qualifications and no fixed sources of income.

The residents of this area are subject to constant episodes of flooding with aggravating consequences related to the accumulation of garbage and the appearance of animals that are harmful to the health. This form of spatial planning, according to Castells (2009), emphasizes the structuring of urban space not by chance, but as product of a structure that starts with social processes in certain historical periods (Santos, 2009). In Curió-Utinga neighborhood this process has happened. The Elvira Street and the areas around the Utinga Environmental Park were previously occupied by forests, but, over time it became occupied irregularly by the residents, who used illegally harvested wood from the park to build houses over the channels, where residents deposit landfill to solve the flood problem. However, it is only a local softening effect, which generates consequences to the areas around. The lack of information is also present in the daily life of residents in the area, especially about the importance of the Environmental Park and of the water supply sources. Some of these sources are already seriously compromised due to water pollution since the 80s.

## 2.2 Research structure

The research is structured in two phases: field surveys and data analysis. Information provided by Civil Defense of the Pará State and municipal and state agencies have also been used. Interviews and forms (objective questions) were applied with local residents as instruments. When the meetings were held during workshops, the methods employed were "Brain Storming or Brainstorm" (Bernardi, 2010) and "The Tree of Whys (or technique of why-why)" (De Toni *et al.*, 2008), usually involving more than 20 people, seeking support in community associations and municipal and state schools.

## 3. RESULTS AND DISCUSSIONS

The following results are product of three stages of field survey in Curió-Utinga, corresponding to a sample of 95 households. This survey was realized during 3 workshops and one was realized in loco. The workshops consisted of a lecture entitled "Floods in urban areas" and a research activity using the technique of "Brainstorm", following the script in Table 1.

Table 1: Script of activities held during workshops.

Order	Activity	Duration
1	Presentation of the workshop objectives and guidelines on activities	5 min
2	Introductory lecture "Floods in urban areas"	15 min
3	Warming-up: Brainstorming (a) What led you to live in this place?; (b) Why, if there are so many problems, do you continue to live in this place?; (c) Which problem becomes more intense when it rains?	20 min a 30 min
4	Reading all the answers	10 min
5	Assembling the order of answers: the most and least frequent	
6	Transfer the questionnaires to answer	10 min
7	Finalization and acknowledgments	

The data were tabulated and organized in percentage according to the general characteristics of the residents. The majority of dwellings (51%) are occupied by families formed by 4-6 people, in second place are those formed by 1 to 3 people (36%). These families are not agglomerated, what happens is a small family organization where families with few people occupy the houses. One of the characteristics of flood risk in Belém is the qualitative and quantitative changes resulting from human activities, such as space organizing, especially during the rainy season. It demonstrates a focus not only on physical components, but in the recognition of the inextricable link between physical and social environment (Kenyon, 2007; Andrade Filho *et al.*, 2009).

Gupta and Nair (2011) consider that unplanned urbanization has drastically altered the drainage characteristics of natural catchments, or drainage areas, by increasing the volume and rate of surface runoff. Given the high spatial concentration of people and values in the cities, even small-scale floods may cause considerable damage.

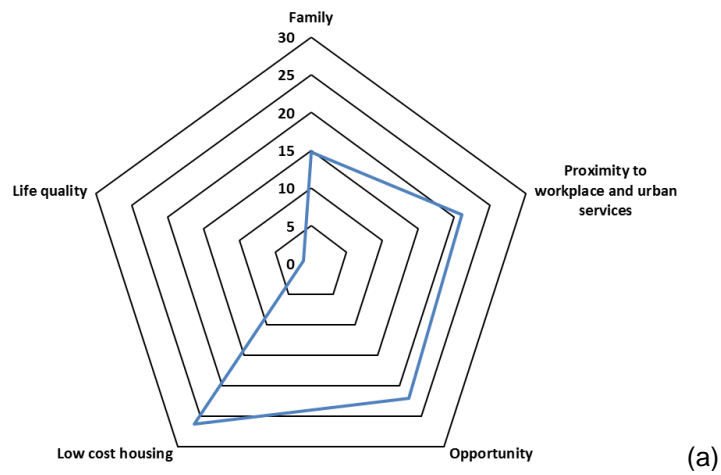
The majority of respondents (68%) consider the houses their own properties, although they have received only a receipt of purchase and sale, when they occupied the area in the extension of John Paul II Avenue) most of them do not have any documentation regulated by official agencies. The other parcel of residents lives in rented dwellings. They claim that the rental cost contributes to their stay in the place. In relation to family income, part of the respondents receives around a minimum wage (37%) and another part (31%) receives less than this. These data showed that income and low-cost rent of dwellings motivate people to remain in the area. The resilience of society to flood risks refers to their capacity to cope with it by means of integrated management of hazards, exposure and damage. For Kubal *et al.* (2009), the urban approach includes a specific urban-type set of social criteria, which focus on urban issues: population and vulnerable groups, differentiated residential land use classes and areas with social and health care.

The discussion on urban space in floodplain areas (such as Belém) focuses on how to minimize the effects of flooding and to organize the occupation, avoiding the impacts in the riverbed (Hora and Gomes, 2009). Regarding the environmental conditions, it was reported by 45% of respondents that the streets remains flooded and after 6 to 12 hours they dry, depending on rain intensity. In addition, another part (31%) responded that the streets stay flooded for a short time (2 to 4 hours) and after they dry a large amount of mud remains, besides the strong smell produced by the accumulation of rainwater and by sewage discharged into the drainage network.

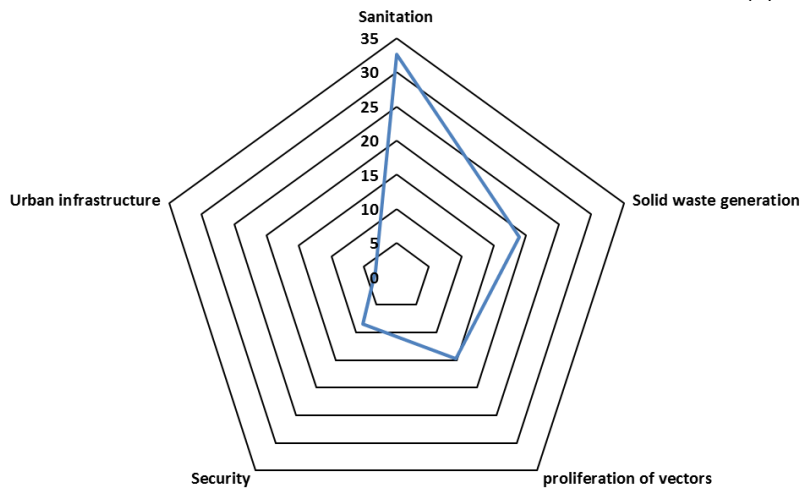
The measures adopted after the rains by the authorities concern garbage collection (34%) and channels cleaning (31%). However, it is reported that only a few streets actually have those services, due to difficult access and insecurity. In assessing local mobility, 80% of respondents said they wanted to live somewhere else and 20% said they have the intention to stay in place, because it is near the service delivery, the family and the center of the city. In Curió-Utinga and in other neighborhoods that grew around watersheds in Belém, the common consequence of urbanization is the deterioration of community relationships and the increase of social vulnerabilities, such as insecurity and health problems (Kenyon, 2007; Costa *et al.*, 2012).

In the classification of the following categories (Figure 2): Motivation (What led you to dwell in this place?), Problems (Which problem becomes more intense when it rains?) and Permanence (Why do you continue to live there?), the results indicated that the reasons that lead people to these locations are the low cost of buying or renting the property, as well as accessibility to their workplaces, schools and hospitals.

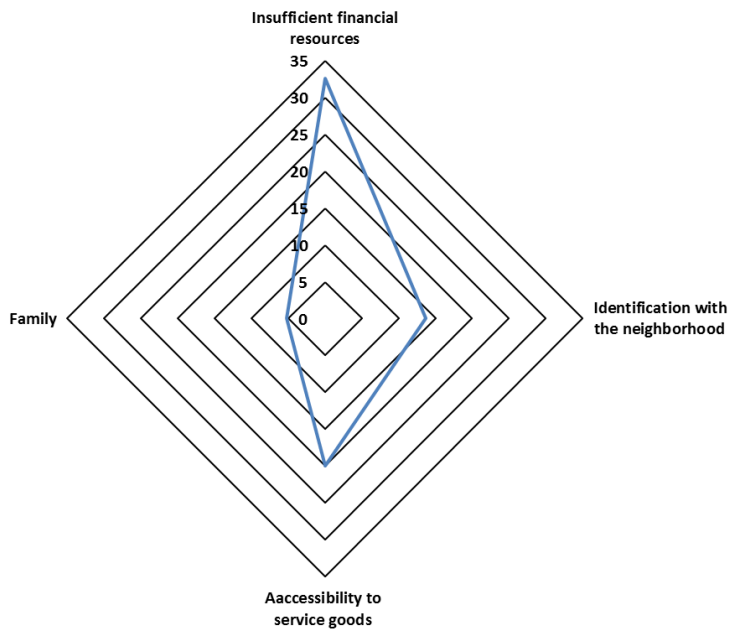
The main problem is the lack of suitable sanitation facilities, with large solid waste generation, proliferation of vectors that spread diseases and damage health (mouse, insects, snakes, frogs and lizards in general). The most common complaint is the proliferation of snakes with floodwaters towards the houses. The accessibility to service goods and the availability of a place to live contribute to the permanence of people in these areas. Despite constant flooding, people claim that they cannot afford to buy or to pay rent of another property having the same advantages, such as proximity to workplace and urban services (hospitals, supermarkets, schools, public transportation).



(a)



(b)



(c)

Figure 2. (a) Motivation, (b) Problems and (c) Permanence categories (% distribution).

These data may help the government to identify social vulnerabilities that can be used in programs and actions to reduce the social impacts in flooding areas of Belém. Muller et al. (2011) and Travassos (2012) argue that individuals, households and neighborhoods are able to influence their level of vulnerability; complying the following variables: structural flood protection measures; main building material (of dwellings); buildings position in relation to the river level; proportion of permeable areas; residents level of education; employment status; and the knowledge about flood hazard and protection measures (Table 2).

Table 2: Relevant variables for the assessment of flood vulnerability, adapted from Muller *et al.* (2011).

Variable	Relevance
<b>Physical</b>	
Main building material (of dwellings)	It determines the physical fragility towards flood events and indicates the resistance to damage, as well as the social status. Some types of building material allow humidity to remain in the walls or floor after flood events, which can cause health problems.
Buildings position in relation to the river level	It determines the constructions likelihood of suffering damage in case of a flood event.
Proportion of permeable areas	The higher amount of permeable areas decreases the flood hazard.
<b>Social</b>	
Level of education	It contributes to a better knowledge about natural extreme events and their origins and about methods to reduce and mitigate the hazard.
Employment status	It indicates the regularity of income and therewith the possibilities of a household to save money for flood mitigation measures or to cope with negative effects.
Knowledge about flood hazard and private protection measures	The more knowledge and information available, the lower the vulnerability.

#### 4. CONCLUSION

The quality and quantity of damage caused by flooding has changed because of urbanization and more intensive land use. The damage potential has increased with the scale of flooding. In Belém (Pará) few existing measures can reduce the vulnerability of floodplains, and these measures are not effectively regulated in flood-prone areas, especially in areas of irregular occupation, such as Curió-Utinga.

The local communities and governments may reduce the flood risk by implementing measures that prevent the occurrence of certain events. Such measures include: reducing the runoff in catchments, flood-wave propagation downstream, and inundation; reducing exposure vulnerability; and mitigating or compensating damage.

Promoting disaster prevention activities in local communities is another important action being developed. The proximity of the lakes (Bolonha-Água Preta) of water supply (for human consumption) demands effective government actions to reduce the pressure of urbanization in Curió-Utinga.