STRUCTURING OF DETENTION AND RETENTION RESERVOIRS AS A PROTECTION AND CIVIL DEFENSE ACTION AGAINST FLOODS

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ABSTRACT

This article seeks to point out alternative solutions to municipal governments to deal, within their urban zoning, through the structuring of detention and retention reservoirs as a civil protection and defense action, recommended by the National Policy for Civil Protection and Defense (PNPDEC), in the face of floods, seen as disasters that affect many victims and cause great losses. The authors, through a bibliographic and documentary research, approach the theme in a qualitative way, using the view of authors specialized in the triangulated areas, thus justifying the proposed idea, trying to solve the problem presented, where it was concluded that in fact alternative structural engineering measures, related to reservoirs can, when of interest to the Government, avoid and minimize the effects of disasters that occur, through the installation of these in cities.

Keywords: Civil Protection and Defense. Flooding. Detention and retention reservoirs.

INTRODUCTION

PROBLEMATIZATION

How can structural measures be used to avoid or minimize the effects of disasters such as floods in cities?

OBJECTIVE

Present structural engineering alternatives in order to avoid and minimize the harmful effects of flooding in cities, when in the period of normal disasters**.**

JUSTIFICATION

Floods are adverse events that, according to the Brazilian Classification and Codification of Disasters (COBRADE), Brazil (2022), usually occur in densely populated urban watersheds, where urban land occupation has occurred without proper control and the soil has been highly impermeable.

In Brazil, in 2012, the National Policy for Civil Protection and Defense (PNPDEC) was introduced, which made several agencies responsible for carrying out prevention, mitigation, preparation, response and recovery actions, seeking to avoid the occurrence of disasters or reduce their effects, so that the municipalities, through their governments, since then, began to have to carry out several interventions for this purpose (Brasil, 2012).

The removal of the vegetation cover from the soil and its waterproofing interfere with the natural hydrological cycle, with the water that no longer undergoes evapotranspiration, which with the reduction of the infiltration of these waters into the soil, reducing the recharge of the water table, increase the surface runoff and reduce the concentration time of the basin, overloading the drainage systems such as gutters, culverts, plumbing and galleries.

In recent decades, most developing countries, including Brazil, have experienced urban sprawl with poor drainage infrastructure, with flooding problems arising mainly from the rapid expansion of the urban population, the low level of awareness of the problem, the lack of long-term plans, the poor use of non-structural measures, and the inadequate maintenance of flood control systems (Canholi, 2014)

Figure 1 shows an example of flooding in Praça da Bandeira, Rio de Janeiro.

Figure 1: Flooding in Praça da Bandeira.

Source: Daniela Caruncha/06-04-2010 - Jornal EXTRA - Online

These events cause great damage to society, present themselves as disasters, and are observed more and more frequently in several Brazilian cities (Brasil, 2022). The urban drainage model by rivers and canals, which are only intended to transport the flows and transfer the floods downstream, no longer account for the volume of surface runoff caused by the rains and the expansion of this system in some situations becomes unfeasible or very costly, due to the need to interrupt traffic and expropriate properties. (PDMAP, 2014)

These problems could be minimized or avoided with non-structural measures, those that do not require works, by introducing standards, regulations and programs that control the occupation of the land, delimiting its use and planning its occupation. Non-structural measures can be effective at lower costs and with a long term of action. (Canholi, 2014)

With the flooding framework in place, only interventions with structural measures remain, which are engineering works classified as intensive and extensive measures.

It is also understood that in cases of disasters, conceptualized as such in Brazil (2023), non-structural and structural measures are tools that should be installed during the period of normality, preceding adverse events, which should be carried out as prevention, mitigation, or even preparation actions, as the agents who will intervene in the event of a flood, They will need to be prepared and knowledgeable about these structures. Also, they can be installed as a recovery action, after the event occurred, after the so-called period of abnormality, where responses are executed, seeking to provide aid to victims and reduce damage and losses caused by the hydrological event. (Brazil, 2012).

For Macedo (2004), intensive structural measures are those that act directly on watercourses, through the construction of structures such as dikes, retaining walls, accumulation and retardation reservoirs, diversion channels and engineering works that modify the morphology of the watercourse and aim to change the natural configuration of the watercourse flow, or by the acceleration, retardation and diversion of the flow, thus mitigating the effects of a flood in certain areas.

According to Tucci (1993), extensive are the measures that act in the basin, modifying the relationships between precipitation and flow, so that through direct physical measurements in the basin it can reduce the runoff coefficient and reduce the effects of erosion and, as a consequence, reduce the risk of flooding.

Extensive measures include: control of vegetation cover, widespread storage in the basin, devices that increase infiltration and percolation capacity: permeable pavements, infiltration ditches, percolation basins and soil erosion control. (Souza, 2013)

Detention or retention reservoirs are an alternative increasingly used in solving urban flooding problems, as they are highly efficient as long as they are correctly sized and executed. These reservoirs can store a large volume of water and promote its disposal after the critical peak rainfall period. (PROSAB, 2009)

METHODOLOGY

This article was developed through a literature review of books, theses, articles and magazines about the problem of urban drainage, focusing on detention reservoirs, a solution increasingly used in the control of flows in urban watersheds. Where, through a bibliographic and documentary research, data were sought that would justify the theme addressed in order to correlate areas such as engineering, civil protection and defense and other related areas (Lakatos and Marconi, 2017).

The study of urban drainage is widely addressed in scientific works, with several works presented, in this way, basic concepts such as hydrological cycle, hydrographic basin, concentration time, rational method, maximum precipitation, are recurrent in the literature, in this article will be addressed aspects of this subject, aiming to avoid the occurrence of the disastrous event such as flooding or the minimization of damage and losses to people living in cities.

DEVELOPMENT

THE EFFECT OF URBANIZATION

Urban growth in the vast majority of Brazilian cities occurred with a total lack of planning and control by the responsible agencies, this occupation brought several problems to the population that lives in these areas, due to the impacts of urbanization on the environment.

Canholi (2000) states that "the problem of flooding was particularly aggravated in emerging countries, due to the speed of the population densification process and the precariousness of the infrastructure, combined with the lack of planning and the lack of resources". The main effects of urbanization are: the increase in the maximum flow, the anticipation of the peak and the increase in the volume of surface runoff.

Tucci (2009) states that "the consequences of urbanization that most directly interfere with urban drainage are the alterations of direct surface runoff".

Floods and urban floods affect several Brazilian cities and have become chronic problems, the impermeabilization of the soil, the occupation of floodplain areas and the hygienist solution adopted of only transposing the waters far away through canals and rivers, trying to avoid waterborne diseases, have only transferred the problem from one place to another, causing floods downstream.

Table 1 presents a survey of Brazilian municipalities with urban areas that suffered floods, it was carried out by the Brazilian Institute of Geography and Statistics (IBGE) in 2008, this survey already pointed out, at that time, that of the 5564 Brazilian municipalities, 2274 suffered floods in urban areas, this represented more than 40% of the municipalities, the southeast region presented the worst scenario, More than 50% of municipalities have suffered flooding in urban areas.

Table 1: Municipalities, total and with floods and/or flooding in the urban area, in the last five years, by areas in which floods and/or flooding occurred, according to Major Regions and Federation Units – 2008.

Grandes Regiões e Unidades da Federação	Municípios					
	Total	Com inundações e/ou alagamentos ocorridos na área urbana, nos últimos cinco anos				
		Total	Áreas em que ocorreram inundações e/ou alagamentos			
			Áreas urbanas ocupadas, inundáveis naturalmente pelos cursos d'água	Áreas de baixios naturalmente inundáveis, ocupadas irregularmente e/ou inadequadamente	Não usualmente inundáveis	Outras
Brasil	**5 564**	**2 274**	**1 381**	**1 093**	**698**	**156**
Norte	**449**	**150**	**95**	**83**	**28**	**11**
Rondônia	52	20	13	8	6	2
Acre	22	14	9	7	4	-
Amazonas	62	24	18	14	2	-
Roraima	15	5	2	2	2	-
Pará	143	66	43	43	10	5
Amapá	16	3	1	3	-	-
Tocantins	139	18	9	6	4	4
Nordeste	**1 793**	**644**	**375**	**319**	**201**	**41**
Maranhão	217	63	36	36	19	7
Piauí	223	61	30	24	37	-
Ceará	184	78	50	40	20	4
Rio Grande do Norte	167	55	35	27	11	-
Paraíba	223	75	43	39	24	2
Pernambuco	185	91	58	50	27	6
Alagoas	102	40	24	11	17	3
Sergipe	75	35	17	18	9	5
Bahia	417	146	82	74	37	14
Sudeste	**1 668**	**851**	**563**	**393**	**229**	**57**
Minas Gerais	853	409	277	159	117	14
Espírito Santo	78	67	48	47	15	7
Rio de Janeiro	92	78	64	53	19	5
São Paulo	645	297	174	134	78	31
Sul	**1 188**	**508**	**287**	**237**	**195**	**42**
Paraná	399	137	68	61	50	15
Santa Catarina	293	172	105	92	71	8
Rio Grande do Sul	496	199	114	84	74	19
Centro-Oeste	**466**	**121**	**61**	**61**	**45**	**5**
Mato Grosso do Sul	78	34	15	15	19	1
Mato Grosso	141	34	19	18	12	2
Goiás	246	52	26	27	14	2
Distrito Federal	1	1	1	1	-	-

Source: Adapted from IBGE, National Survey of Basic Sanitation, Coordination of Population and Social Indicators, National Survey of Basic Sanitation 2008.
Note: The municipality may suffer flooding and/or flooding in more than one area.

ALTERNATIVE URBAN DRAINAGE TECHNIQUES

The increase in the occupation of the urban area occurred without the proper infrastructure investments and after the installed problem, all that remains is to seek alternatives to control this runoff, implementing alternative urban drainage techniques.

A technique widely used in developed countries is the infiltration of rainwater, which promotes the recharge of groundwater, being a solution with a greater environmental attachment, this technique uses infiltration trenches, infiltration wells, permeable pavements and coatings, ditches and infiltration ditches. (SUDERHSA, 2002)

In developing countries, measures are usually adopted to retain these waters for release after the peak of rainfall events, this technique is criticized when measures to reuse these waters are not jointly employed, which can be used for non-potable purposes, this technique uses retention reservoirs. (PDMAP, 2014)

HOLDING RESERVOIRS

The concept of slowing down runoffs is antagonistic to the hygienist concept, which accelerated runoff through pipes. Delaying flow through retention reservoirs is a technique used to readjust or increase the efficiency of drainage systems, by increasing the concentration time and reducing maximum flows. (Ramos, 2015)

This solution can be used at the microdrainage level, that is, in lots, shopping malls, soccer stadiums, etc., or at the macrodrainage level, in rivers and streams. Retention reservoirs can be open air or underground, they can be operated by gravity or by hydraulic pumps. (PDMAP, 2014)

OPEN-PIT RESERVOIRS

They require an extensive area for their implementation, they must have green and leisure areas as aggregates, valuing the presence of water urbanistically, taking care to maintain continuous maintenance, so as not to cause the proliferation of disease vectors and aquatic vegetation. Figure 2 presents an example of an open-pit reservoir. (City Hall of Rio de Janeiro, 2016)

Figure 2: Detention Reservoir at Júlio Andreatta Square (Water Squares), Porto Alegre – RS - Adapted

Source: Porto Alegre City Hall – PMPA, Department of Rainwater Sewers – DEP (2011).

UNDERGROUND RESERVOIR

They do not require large areas for their implementation, as their storage capacity is not limited to the dimensions of the land, and can be compensated by the depth, they are usually a solution for densely populated urban areas, after their construction the area over the reservoir can be used for public leisure such as squares and recreation areas. Improper disposal and failures in the collection of solid waste cause the accumulation of this waste in the reservoir, requiring its cleaning after heavy rainfall events. (Nakazone, 2005)

Figure 3 presents an example of an underground reservoir under construction and Figure 4 presents this same reservoir ready.

Figure 3: Praça da Bandeira Detention Reservoir (under construction), Rio de Janeiro – RJ – Adapted.

Fonte: g1.globo.com, 2013.

Figure 4: Praça da Bandeira Detention Reservoir - Ready, 2015, Rio de Janeiro - RJ - Adapted.

Source: Wikipedia.

CONCLUSION

Therefore, from the above, it was found that detention or retention reservoirs can, in fact, be an alternative to be used by municipal governments within the urban planning of cities to avoid floods, as well as a solution when these become disasters recommended by the National Policy for Civil Protection and Defense (PNPDEC), where agents should act in the response to rescues and in the reduction of damage and losses. Therefore, the structuring of these reservoirs can also be seen as prevention and mitigation actions, within the same PNPDEC, as addressed in this scientific work.

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