



Decreasing flood risk perception in Porto Alegre – Brazil and its influence on water resource management decisions

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Abstract. Porto Alegre is the capital and largest city in the Brazilian state of Rio Grande do Sul in Southern Brazil with approximately 1.5 million inhabitants. The city lies on the eastern bank of the Guaíba Lake, formed by the convergence of five rivers and leading to the Lagoa dos Patos, a giant freshwater lagoon navigable by even the largest of ships. This river junction has become an important alluvial port as well as a chief industrial and commercial centre. However, this strategic location resulted in severe damage because of its exposure to flooding from the river system, affecting the city in the years 1873, 1928, 1936, 1941 and 1967. In order to reduce flood risk, a complex system of levees and pump stations was implemented during 1960s and 1970s. Since its construction, not a single large flood event occurred. However, in recent years, the levees in the downtown region of Porto Alegre were severally criticized by city planners and population. Several projects have been proposed to demolish the Mauá Wall due to the false perception of lack of flood risk. Similar opinions and reactions against flood infrastructure have been observed in other cities in Brazil, such as Itajaí and Blumenau, with disastrous consequences. This paper illustrates how the perception of flood risk in Porto Alegre has changed over recent years as a result of flood infrastructure, and how such changes in perceptions can influence water management decisions.

1 Porto Alegre and its floods

Historically, human society has positioned itself in areas with locally sustainable water supplies, in the form of runoff, and/or river and stream flows (Vörösmarty et al., 2005). This is the case of Porto Alegre, the capital and largest city in the Brazilian state of Rio Grande do Sul. Founded in 1769 by Manuel Sepúlveda, on the eastern bank of the Guaíba Lake, where five rivers converge to form a delta system (the Jacuí Delta), followed by the Guaíba Lake and the Lagoa dos Patos, a giant freshwater lagoon navigable by even the largest of ships. Porto Alegre, located at this five-river junction, has

become an important alluvial port as well as a chief industrial and commercial centre of Brazil.

The city today has a population of 1 509 939 inhabitants (2010) – the tenth most populous city in the country, and Brazil's fourth most populous metropolitan area, with 4 405 760 inhabitants (2010). The administrative and commercial heart of the city grew in a complex area that includes 27 streams that flows in-between hills as well as lower flatlands, which were mostly marshes. This region is located at an average altitude of 3 meter above sea level and only slightly higher than the streams mean water level, and represents 35 % of the urbanized area. Consequently, this strategic location has also resulted in material and human losses

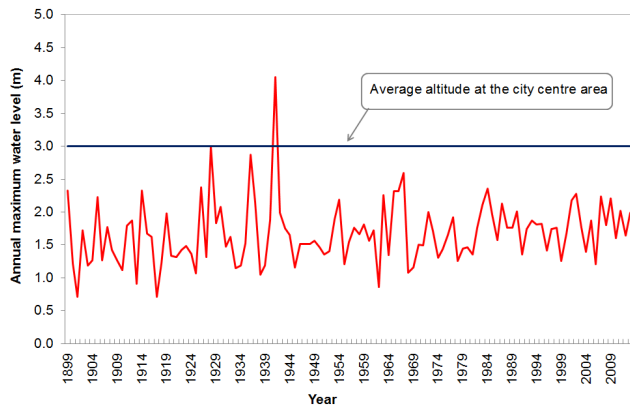


Figure 1. Maximum recorded flood levels at Guaiba Lake (1899 to 2013).

caused by severe flooding that affected the city in the years 1873, 1928, 1936, 1941 and 1967 (Fig. 1).

The Guaiba Lake contributing water basin has an area of approximately 100 000 km² that struggles to pass in a small channel with a width of only 900 m, exactly at the most dense urban area at the city's central district. The flooding in the city's central area is caused by interrelated factors such as Guaiba Lake basin floods, inner city heavy rainfall, and Southern wind-induced surge.

This combination of factors led to the worst and best known of these events, in May/June 1941 when the flooding reached the most populated and wealthier areas of the city, leaving more than 70 000 homeless (about 25 % of the tot. pop.), and the unavailability of potable water and electricity supply for about a month (Fig. 2). A total of approximately 800 mm of precipitation was registered during a period of 20 days in the city and Guaiba Lake basin (that means half the year average), combined with an strong South-westerly wind.

In response, a complex flood infrastructure system of 68 km of levees as well as 18 pump stations and several pressurized conduits was designed and implemented during 1960s and 1970s, with support from the now extinct DNOS (National Department of Works and Sanitation), a national institution for financing and implementation of infrastructure projects, active during the Military Government of Brazil. The system includes dikes protecting the city from the Guaiba Lake's floods, as well as levees in internal streams. The system also included a wall (the Mauá Wall) with height of 3 m and length of 2 km in the commercial and administrative heart of the city (Fig. 3). Since the construction of this protection system, not a single large flood event has occurred.



Figure 2. Photograph of flood refugee (source: Globo Magazine, 1941).

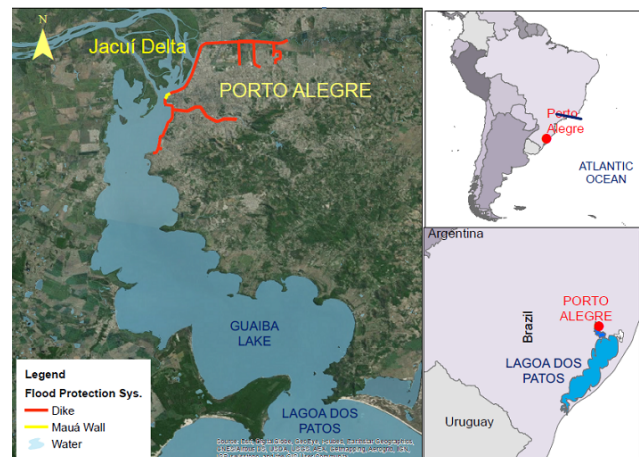


Figure 3. Porto Alegre and its flood protection system.

2 Public perception against the Mauá Wall

The levees in the commercial and administrative heart of the city were projected as a wall: the Mauá Wall, with length of 2 km out of a total of about 68 km of dikes.

It is important to note that, at the time of construction of the Mauá Wall, the public consultation process was incipient in Brazil; the decisions on public works were taken strictly at legal and administrative level. Consequently, little discussion was recorded at that time. However, in recent years, the Mauá Wall has been severally criticized by city planners and population for “being ugly”, “obstructing the view of the lake”, and “restricting the access to the Port and to the lake” (Goldenfum, 1999). Also, as the wall was built during the Brazilian Military Government, some sectors of the population attribute an ideological component to it, even if the selection of this structure was made considering technical and economic criteria. Consequently, several projects and even a city law were proposed in order to demolish the wall due to the false perception of danger elimination.

A law in 2010 proposed to demolish the Mauá Wall before March 2014 (Fifa World Cup) with the aim of “returning the

view of this landmark to the people of Porto Alegre, because 40 years after its construction, the wall is no more justified” (Scomazzon, 2014).

Another example is given by the initiative of the Rio Grande do Sul State Government, in the revitalization and transformation project for its Capital, proposing that the Mauá Wall should be lowered by half its present height. If we consider that the flood reached a height of 1.7 m at the Wall side, this means that the proposal establishes a height 20 cm below 1941’s flood. Another project suggested the substitution of the wall by a series of modular gates, similar to those being constructed under the MOSE project in Venice (Guarino, 2014).

Other projects by individuals are not discussed here, but it is important to emphasize the following facts: the political organization of some wall’s critics; that the wall removal is clearly in the political agenda, as laws were proposed, and 7 out of 8 candidates for Mayor in 2008 were pro wall removal (Zero Hora, 2008); many of the proposed actions include very expensive solutions, practically unfeasible considering the economical reality of Brazil; and, maybe more important, that all of those proposals, even being millionaire revitalization projects, had no hydraulic or hydrological studies. It is important to note that the 2008 elected Mayor, when in charge of Porto Alegre’s Municipality, refused to take any responsibility for removing the protective structure.

3 Discussion

Unfortunately, important lessons from the past are frequently forgotten by great part of the population and city planners. For example, in 2002, in Germany, the Elbe reached the highest level ever with records spanning from XVII century, with damages of over 2.5 billion. The Mississippi had a big flood on 1927 (damages of 1/3 of USA government income) that was only exceeded in volume in 1983, after 66 years (Trotter et al., 1998) and after that at least in 1997, 2008 and 2011. In Brazil, the city of Blumenau is a classic example, as, after important floodings in 1852, 1880 and 1911, the Itajaí River stayed below flood levels for 72 years, causing a false perception of low risk levels that led to floodplain settlements, with enormous damages in the 1983/1984 floods.

The argument of restricted access to the Port or to the Lake is also fallacious. Even before the construction of the wall, this access was not free, as there were several warehouses and administrative buildings between the City and the Port (Fig. 4).

Even with the existence of the Mauá Wall, there is no limitation to the Port as there are 7 access gates in the Mauá Wall (out of a total of 14 access gates in the system), and, in any case, apart from the wall, the view of the river is obstructed by the metropolitan railway that accompanies the wall. Nevertheless, even among the most dedicated wall’s defenders



Figure 4. Aerial photography of Porto Alegre in the 1950s (source: Simon, 2014).

there is a consensus that the wall is ugly and disconnects the city from the lake.

The lowering of the wall proposed by the State Government Revitalization Project, has some logical arguments, as the lower Guaíba level in the last years suggest a reduction on flood risk. Recent studies (Consórcio Ecoplan/Magna Engenharia, 2009; ABG Engenharia e Meio Ambiente, 2014) estimate a return period of around 1000 years for the maximum height of the Mauá Wall. However, this proposal fails to include a complete hydraulic study and does not take into account the shortage of recorded level data that only spans from 1889 to the present. Still, from the 1970s, the capital has increased by 46 %, largely through unplanned urban occupation, generating intensive deforestation and consequently large impervious areas and high erosion rates that, allied with deficient solid waste collection and disposal, lead to drainage problems in its inner streams.

Also, the Guaíba Lake basin has suffered large deforestation rates as Rio Grande do Sul is one of the largest agricultural producers of Brazil. Moreover, in the Guaíba basin, joint losses due to extreme events in the basins of nearly 5 % of State’s IGP were seen in the last couple of years (Allasia et al., 2012) with regional rainfall in levels similar to those observed in 1941. Moreover, almost all climate change forecasts indicate an increase of 10 % in average rainfall, with important intensification of extreme values (Marengo, 2006). All these facts suggest that lowering the wall is not a good idea.

The main problem for substituting the Mauá Wall by a series of modular gates is the lack of maintenance observed in the drainage network (Goldenfum et al., 2007), which signals to the adoption of structures with minimal maintenance and need for human action. For example, in the 1983 flood, the existing gates at the wall were stuck and some of them could not be closed (Simon, 2014). Fortunately, the flood did not inundate the city. Also, in 2011 when the existing gates were reopened during maintenance activities, the gate only closed in the eighth tentative (Block, 2011).

A few initiatives from experts and from the Municipality of Porto Alegre have been implemented in order to try to change this negative perception of the wall by the public and city planners, but with limited results.

Articles in local newspapers, such as Goldenfum (1999, 2005) were published, explaining the reasons for the existence of the Mauá Wall, as well the risks of eliminating this structure without providing a feasible structure with at least the same degree of protection. Also, participation on TV and radio debate shows happened. Unfortunately, the results of such efforts have limited reach in audience and, more important, in time, as people quickly forget the lessons from these debates.

Another example is the National Architectural Competition, organized by DEP/PMPA (Department of Rainwater Sewers/Municipality of Porto Alegre) and IAB/RS (Institute of Architects of Brazil – Section Rio Grande do Sul) in 1994 in order to award architectural interventions that maintaining the Mauá Wall improve the integration between the city and Guaíba Lake. The awarded project, that mixed parks, ramps, stairs, platforms and the natural environment, was considered sophisticated and economically realistic, but it was never implemented (Sommer and Almeida, 1994).

4 Conclusions

Due to the absence of large flood events in Porto Alegre in the last 60 years, there is a popular belief that a flood catastrophe is very unlikely. In this light, several proposals that privilege architectural design over safety stimulated the idea of elimination of the existing levee system, or its replacement by costly technologies not economically feasible considering the Brazilian economic reality. The fact that those proposals are fostered by the politicians, even if they are resisted by technicians, emphasizes the necessity of a more clear and categorical warning about structure failure consequences (money and lives losses) and the responsibility involved and the elaboration of alternative projects that coexist with the integrity of the levee system.

A few initiatives from experts and from the Municipality of Porto Alegre have been implemented in order to try to change this bad perception of the public and city planners, but with limited results.

It is important to ensure that the elimination of the levee system, even if supported by the population and politicians, can only be implemented after extensive hydrological and hydraulic studies, and the agreement of the relevant public agencies.

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