

# Flood Control, Urban Legislation and City Development in Santa Catarina, SC, Brazil

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**Abstract—** This article analyzes the Itajaí Valley, in southern Brazil, with focus on the city of Blumenau. Since the founding of the German colony in 1850, the city has struggled with the Itajaí waters, main river that crosses its territory. The historical floods in the beginning of 1980s, when the water level surpassed 15-meter-high, resulted in the revision of the laws regarding land use and occupation, as well as the correction of city master plan. Once again in 2008, a large-scale environmental catastrophe strokes the valley. Therefore, this paper analyses the several actions that have been taken in the last decade seeking to find a reasonable solution for the flood control.

**Keywords—** city development; flood control; urban legislation

## I. INTRODUCTION

Located in the mesoregion of the Itajaí Valley, the city of Blumenau is considered one of the most important cities of Santa Catarina (SC), in south Brazil. Founded in 1850, the city is now the third biggest of the state. Crossing the area, the Itajaí river flows through the city and due to the average altitude of 21 meters, the water speed flows calmly, for almost 300 km until it reaches the ocean in Itajaí (Blumenau City Hall).

Through a colonization plan coordinated by Mr. Herman Bruno Otto Blumenau, the first occupations in the Itajaí Valley took place in 1850, when the region was mostly colonized by Germans and Italians.

Looking back the history of Itajaí Valley, it has always faced significant floods from its main river, the Itajaí-Açu. The most known and striking downpours occurred in 1983 and 1984. They led to changes in city planning and revisions of the Municipal Master Plan (PDM), which has been in force since 1977. The change in the Municipal Master Plan in 1989 sought to reduce conflicts in the development of urban areas with water management needs.

In 2008, occurred in Blumenau a great flood which is considered to date the largest environmental catastrophe in the state, that resulted in loss of many human lives, enormous environmental damage, and the paralysis of commerce, jeopardizing the regional economy. This article highlights the main changes that occurred after those tragical raining seasons and what actions were taken to reduce future impacts in the city of Blumenau, and to improve the flood control in the entire Itajaí Valley region.

After the impacts incurred by the floods along the history of the city is important to emphasize some actions taken by the Brazilian Government seeking to find a solution for the problems caused in the rainy season. At last this paper highlights the studies made by JICA (Japan International Cooperation Agency) that have guided/orientated the planning towards the constructions of three dams along the riverbeds in Itajaí river.

## II. METHODS

The study area falls to the State of Santa Catarina and the region known as the European Valley.

A comprehensive study involving the use of old journals, books and related literature was employed as main methodology also field trips were planned to understand the relation establish between the city and the river.

## III. FIRST OCCUPATIONS. THE FORMATION OF BLUMENAU.

According to the National Water Agency (ANA), Blumenau is situated in one of the three hydrographic macro-regions of the state of Santa Catarina. These are the hydrographic regions of Paraná, Uruguay and South Atlantic, (Figure 01).

All those three water basins have the mountains of "Serra Geral" as a natural water splitter, forming two main slopes, the first one running into the interior of the state, (Interior Slope) and the other towards the ocean (Atlantic Slope). (Geographic Atlas of Santa Catarina, 2014)



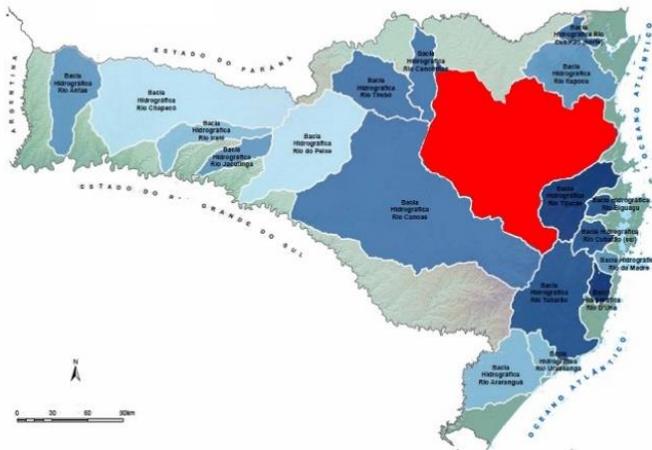


Figure 1 Geographic situation of the Itajaí Basin, located in SC, Brazil. The three maps show the location of 3 macro-regions hydrographic and division of the basins of the state of Santa Catarina. SOURCE: Geo Atlas of Santa Catarina

HANNAS 2016 describes the process of development of a settlement as dependent on the original configuration of the site, on the different interests of public and private agents, and even dependent on local culture, which directly influence the occupation of space. (HANNAS, 2016).

The region had an unusual beginning in Brazil, once it resulted from a regular colonization plan. The occupation of the Itajaí Valley began in the year of 1850, when Herman Bruno Otto Blumenau arrived along with another 17 settlers. Settlement started in Itajaí city, from the seacoast. The settlers sailed up the river Itajaí-Açu to the region of the streams of Garcia and the "Velha", where they founded the Colony of Blumenau. Thus, the first occupations of Blumenau happened between the streams of the "Velha" and the "Garcia" and the first lots were located near the Garcia stream.

The implantation of the lands followed the south direction, occupying the plains near the river. The subdivision of the soil was held according to the German model "Stadtplatz" (place of the city), which is very common in Germany, occupying the low areas, bordering the river and streams, facilitating the practice of agriculture and the use of the river as main mean of locomotion.

In the plan of urbanism, lots of land were divided "[...] into narrow and long slices, parallel to each other and perpendicular to the course of water ...". The settlement of the lots provided security, access to water for agriculture and consumption for the settlers, as well as a transport route to the seacoast through Itajaí-Açu river. (SIEBERT 2009) (Figure.02).

Jose Deeke, historian of the German occupation in the region of the Itajaí valley, describes that in the process of occupation at the beginning of the colony, the lands already presented divided lots, even before the first settlers arrived, and in this sense the first clearings were opened in the cliffs and in the river plains.

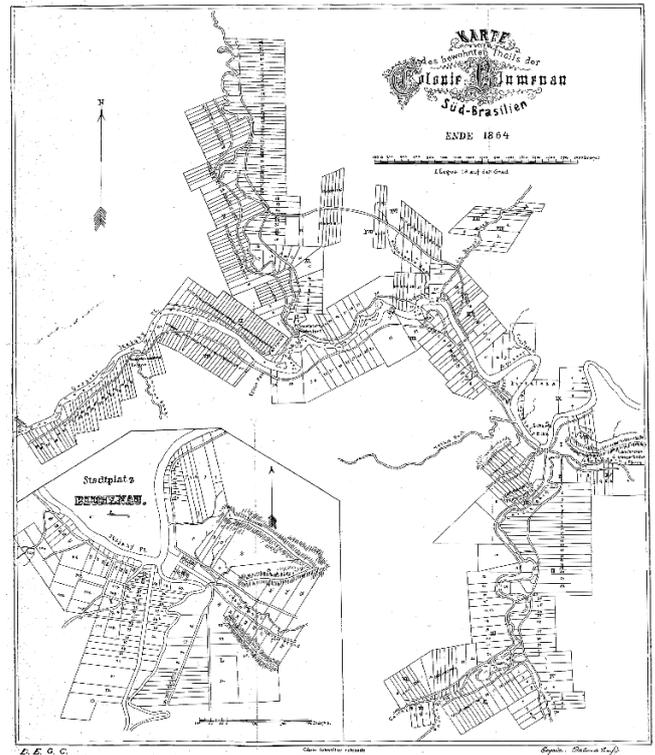


Figure 2 Map of the colony of Blumenau with the division of lots along the Itajaí, dated 1864. SOURCE: Arquivo Histórico José Ferreira da Silva, Blumenau.

"The first clearing was opened at the mouth of Ribeirão da Velha, on the line of the jungle, where the first house was erected.- (On the site, today is the headquarters of Bradesco bank) – Giving sequence to the settlement of the colony, large areas were deforested on the margins of the Ribeirão Garcia, and in the opened clearings were grown grass for pasture, maize, cassava, potato and black beans, for the colonists' consumption". (DEEKE, 1995, p.17)

The location of the Colony of Blumenau, near the old port, in the bar of the river, potentiated the evolution of the colony. Access to water facilitated river navigation, favoring trade with the rest of Santa Catarina. Thus, in 1874, the "Companhia Catarinense de Navegação", and with the "Vapor São Lourenço", was established, inaugurating a regular line between the city of Gaspar and city of Desterro, for the transportation of cargo, passengers and postal bags. (SCHULT 2016). This navigation in the first colonization was the main route of communication of the city with the coast, later came the railroad and later the highways, now main means of locomotion. Thus, in the correlation between the natural space and the human action in Blumenau there is a "bidirectional relation, where every human settlement is influenced by its natural site" (SIEBERT 1999). Also, Anne Sprin states more broadly that the formation of identity of the territory stems from:

"The natural environment of a city and its urban form, taken together, comprise a record of the interaction between natural processes and human purposes over

time. Together, they contribute to the unique identity of each city "(SPRIN 1995, p. 28)

According to LACAZE, it is important to highlight the choice of the site for the implantation of a city in the proximity of the river and navigation, as commercial facilitators, as expressed:

"The city is first of all a natural site of geographical space. Two main logics explain the selection of this site. The most characteristic is the economy of transport, and therefore refers to the commercial role of cities. The cities-ports, the cities set up at the point where two rivers meet or in a privileged place for crossing a river (the islands of Paris) have developed there because it was easier to control the flow of goods flows." (LACAZE, 1999 p.16)

In the case of Blumenau, the natural site presents specific and prominent determinants, such as the remarkable presence of mountains and the valley with an interdigitated river. Thus, with a rugged relief, where the Itajaí Açu River, which has widths varying between 50 and 250 meters between its banks, traces along with its tributaries a sharp cut of the territory, becoming a structuring element of the landscape. (SIEBERT 1999) The Itajaí Valley region has always faced the forces of nature. This concept is then: the union of two factors was decisive for the development of vulnerability throughout the Itajaí Valley, formed by human action and physical pre-availability to natural events. (ESPINDOLA, NODARI, PAULA 2014).

It should be noted that the division of the lots into the territory through the "*Stadplatz*" (place of the city) was based on the settlement of the population following the course of the river, as described by MATTEDI:

"This form of land distribution, was adopted for rural areas, was called "*Waldhüfen*" (forest lines), widely used in eastern Germany in the Middle Ages. The urban model was called "*Stadplatz*" (place of the city), in which the settlers resided near the waterways and moved to the farms destined for agriculture. With urban development, roads along the *Glebas*, and with them, the "*Strasserdorf*" model, which laid the settlers in their own lands, appeared. (MATTEDI, 1999, p.10).

In summary, this model dictated the occupation of the cities of the Itajaí valley, but unfortunately it brought very undesirable environmental and urban consequences. The urban design pattern used led to undue occupation of the riverbed, which was inadequate to reality, with exceptional indices and pluviometry irregularities, together with deforestation and the physical geological structure of the site. The result was increased recurrence of flooding and frequent landslides. Thus, anthropic action resulting from the rapid urbanization process and lack of continuity in disaster prevention programs have led to the worsening of natural disasters, causing recurrent floods and landslides over the years. Unfortunately, the urban history in the Itajaí valley and in Blumenau is strongly linked to the floods and the risks caused by natural disasters. From the beginning of its occupation in the year 1850 when the initial nucleus of the colony

of Blumenau was established, there was periodic confrontation of the waters of the river Itajaí-Açu.

Today the risk situation is not resolved to the satisfaction, with constant threat of new disasters. The city of Blumenau, despite the threats, has been growing a lot. Currently the municipality has a population of approximately 334,002 thousand inhabitants, being the third largest agglomeration of the state of Santa Catarina, behind Joinville, the second, and of Florianópolis which is the largest and capital of the state (IBGE 2014).

Deepening the understanding of the process of urbanization of Blumenau, the development took place between the river and mountain. Initially, it occurred in a linear way, following the valley bottoms and later climbing the slopes, which due to their geological formation present great risks when occupied inadequately. Another factor that conditioned the most recent occupation of space was the industry. The production was born from the transformation of the surplus into artisan products in an early stage and later evolved into industrialized production. This industrial vocation of the region was mainly due to the profile of the first settlers who arrived, since they were mostly domestic artisans, a common activity in the rural subsistence units of Europe. They had to leave Germany, due to the rapid transformation of the economy and society, caused by growing competition and strong industrial development, apart from wars.

The industry configured the formation of the territory when receiving the privilege of choosing the place to settle. POLICARPO 2012, p.27, says that:

"Analyzing the history of Blumenau and the modes of territorial configuration - which still strongly influences the current conflicts faced by urban planning in place - is the role of industry and, more specifically, of the agents that own the means of production, which could historically choose the most suitable places for the installation of industrial plants"

The history of Blumenau led to the fact that at the end of the 20th century, it became one of the largest poles of the Brazilian textile industry, as well as an important tourism center. (SIEBERT, 1999).

#### A. City growth and changing of legislation

In the early years the colony was maintained by its founder, Herman Bruno Otto Blumenau. Following, in 1880, it was elevated to the category of municipality, by means of the law nº 860, of February 4 of the same year. In fact, the municipality can only be installed three years later in 1883, due to the heavy rains, which resulted in the overflowing of the waters and the great damages caused in the region in 1880 and 1928, happening to the category of city. In the 1930s several dismemberments of the municipal territory began, creating new municipalities such as: Rio do Sul (1930), as well as Gaspar, Indaial, Timbó and

Ibirama (1934), now composing the urban network of the Itajaí Valley.

The first Code of Postures of Blumenau was approved by the Legislative Assembly of Santa Catarina in 1883, soon after being created the municipality in 1880. This code remained in rigor until 1905, in the context of an eminently rural society. The rural characteristics of this code are evident in the prohibitions, such as frightening wild animals, having cattle on the street, [...]. But at the same time some urban requirements already appeared as the obligation to construct streets with at least twelve meters wide and coverings made by tiles, in addition to the 1.80m footpaths; showing the intention to present Blumenau, as an established city. (SIEBERT 1999).

In the Code of Postures, from 1905 there was simplification of the norms. The issues of hygiene, order and safety were maintained, but more detail was added in the construction regulations. Later, in 1923 the City Council approved a new Code of Positions, which predicted the advance of urbanization and the presence of the motor vehicle, limiting the speed at 20 km per hour within the city. This code was also sanitary, but presented different issues from the previous ones, because it placed the first concerns with patterns of occupation of the soil. In this way, it limited the height of the buildings, the width of the streets and required a free space of 30m<sup>2</sup> of free area on the grounds. (SIEBERT, 1999)

Of great relevance, the 1923 posture code placed important and technically correct references to the environment. The Code of Posture 1923 - art. 188 determines that in the hills that constitute water splitters deforestation would be allowed only up to a distance of fifty meters, counted from the respective summit. (Code of Postures 1923, Santa Catarina, Brazil). Shortly afterwards, the state of Santa Catarina began to interfere more intensely with urban space decisions.

To do so, in 1939 the Construction Code was established, based on Decree 45/1939, which defined the rural and urban areas of the municipality.

It is important to emphasize that Brazil, from 1968, with determinations of the SERFHAU - Federal Service of Housing and Urbanism, now requires Plans for Brazilian cities. In this methodology for the development of urbanism was outlined a plan for the development of the city that details the main elements of circulation, use and occupation of the soil and technical and social equipment. The Municipal Master Plan (PDM) represents a legal mechanism that aims to guide the ways and the way of occupation of the land, requiring the cities to prepare the plan for an orderly advance of urbanization. Accompanying this process, Blumenau has its first PDM - Municipal Directorial Plan, approved by the city council in 1977, with revisions made after the catastrophic floods in 1983 and 1984. At that time, new strategies were also developed to deal with the floods of the Itajaí- Açú.

In this way, Law 2422 - 77 of the PDM of Blumenau established the zoning code for land use in the city, which had as one of its main objectives to guide the expansion of the city, according to different urban and rural areas. Within the thematic of this article, stands out the article 22 that orders the quotas of occupation, predicting possible floods, as expressed:

"Art. 22 For the purposes of this law, for the urban area of Blumenau, three different ranges of quotas for occupancy by buildings are established: I - Below quota 10 (ten): only for recreational or cultural equipment in the open, or to dependencies on such equipment. " [Law 2242/1977 - Santa Catarina, GOV. Federal]

The development of the main events in urban planning, urban design and the environment that took place in Blumenau from the foundation in 1850 until today are synthesized in the timeline:

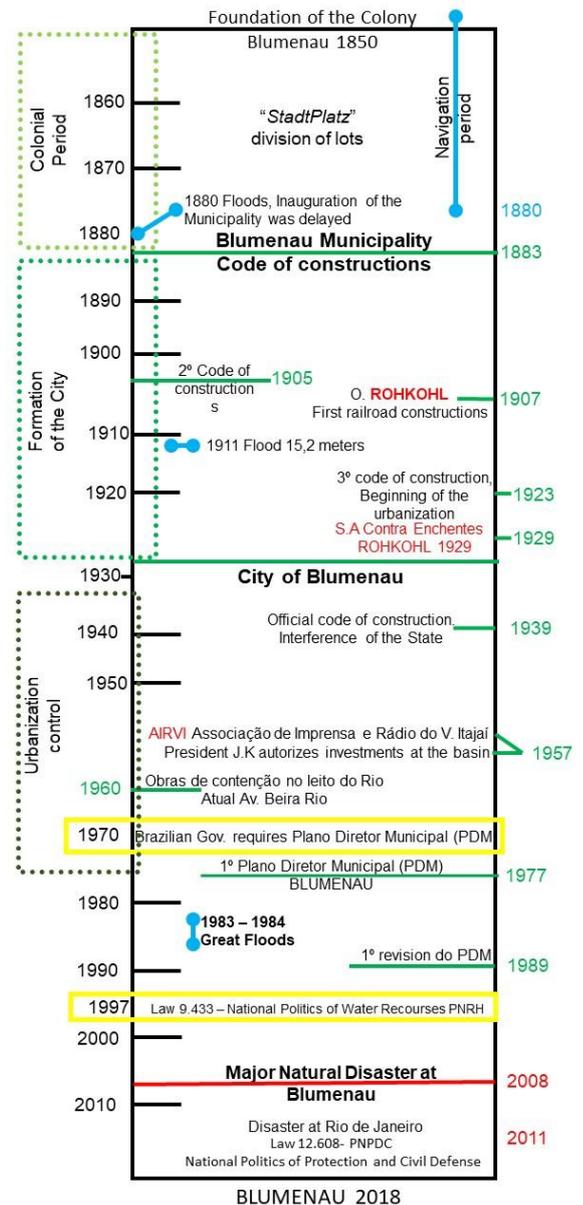


Table 1 – Timeline of legislation chances. SOURCE authors

Unfortunately, it's possible to say that the diagnosis for the reasoning of the law was erroneous, since the established water levels was insufficient. As a result, in the following years, in 1983 and 1984, floods surpassed the 15-meter height, thus repeating those occurred in the tragedies of 1911 and 1957. Thus, the 1977 PDM is mistaken in its principles, since the planning was carried out by an external team, in a technocratic way, with little involvement of the local government and restricted participation of society. The outrage at the time can be evaluated by:

"Much of the damage caused by the floods of 1983 and 1984 could have been avoided if the population had been prepared ... The population was accustomed to experiencing small floods and this meant that it was not believed that a great flood would occur, considering that the last of great proportions had occurred in 1911. "[POLICARPO J, 2016 p. 92].

Several of the problems of the 1977 MDP were corrected in the revisions of the 1989 Municipal Master Plan. According to FRANK 1995, discussions on prevention, mitigation, and solutions to flood-related problems only became public in the months and years succeeded the floods of 1911, 1927, 1957, 1983, 1984 and 2008.

"The floods that may occur shortly after these so-called" big ones "help keep the mobilization going for longer. In each post-flood period, we can see a deeper understanding of defense alternatives "(FRANK, 1995, p.15)

In this reasoning, it was only after the tragic event in the Christmas of 2011 in the state of Rio de Janeiro (RJ) that it led the National Congress to elaborate Law 12,608, which established PNPDEC - National Policy for Civil Protection and Defense. This law describes in its twentieth article, that it is the duty of the Union, the states and the Federal District, in addition to the Municipalities to adopt measures to prevent and mitigate natural disasters. PNPDEC also integrates planning and territorial policies seeking to reduce risks and sustainable development, as well as support, aid and post-impact recovery. The new law incorporated a major advance in disaster management, since the previous law (Law 12,340 / 2010) was focused on reconstruction actions after the events, leaving the prevention of accidents weak.

#### *B. Vulnerability and actions plans taken seeking to prevent floods.*

To better understand the policies of prevention and mitigation against natural events in the city of Blumenau, it is necessary to understand the connection of natural impacts with the development of urban design, generating vulnerability.

Nature's climatic variations such as droughts, floods, strong winds and even landslides have always been present, occurring frequently, in certain vulnerable locations.

The occurrence of disasters may or may not result in a catastrophe. The percentage of risk is lower when they occur in isolated regions, without the presence of man. Thus, natural events become emergency when related to territory occupation, when threats have the potential to turn into disasters. The size of the natural disaster is related to the vulnerability of local society. [Hewwit, Burton. 1971].

At an UN-sponsored event in the Japanese city of Hyogo in 2005, proposals for risk reduction in various situations were developed, proposing solutions by 2015. In the Hyogo Framework for Action 2005-2015, vulnerability was defined as:

"Conditions determined by physical, social, economic and environmental factors or processes that increase the susceptibility of a community to the impact of risks ..." (UN, 2015, p.4)

In a new meeting, also in Japan, in the city of Sendai, a new landmark was signed. The Sendai Framework for Action 2015-2030 presented new post-impact action plans. In this event danger was conceptualized as:

"Danger is defined as being a ... potentially harmful human phenomenon or activity that can cause loss of human life or injury, property damage, social and economic disruption, or environmental degradation. Dangers may represent future threats and may have different origins: natural or human-induced "(UN, 2015, p.3)

Thus, in this conceptualization of the UN, 2015, the danger and the vulnerability are related to the place, the occupied territory, the city, the anthropic action and the time. These concepts can be extended to the extent that man's interventions must be related to general processes, which operate at large scales, not only at the local scale, but should also be analyzed on a regional, national and global scale (POLICARPO 2016).

Major natural disasters can be mitigated or even avoided with the correct vulnerability assessment. Better management can only occur with the correct mapping and evaluation of risk areas. Through geotechnical studies it is possible to produce maps of susceptibility and, together with public management, guide urbanization (MARCELINO 2008).

As previously noted, discussions on solving water-related problems usually only surface after floods interrupt urban everyday life. It is striking how articles published in 1910 newspapers in the Blumenauer Zeitung show the local concern in Blumenau in constructing walls of support to delay the volume of the waters that arrived at the city. In the same edition, it accurately evaluates that this construction model would not solve the water conflict, and only postpone the execution of a definitive and effective proposal. The debate is recurrent, as FRANK writes 85 years later:

"Thus, some understand that a wall should be built on the right bank of the river, reinforcing the entire bank ... This way of facing the problem resists the vice of postponing the definitive solution to stick to the secondary order providence, because with the construction of this stone jetty, there would be no other result than to guarantee the banks of the river against landslides, but never to avoid floods "(FRANK 1995, p. 1)

Still in this same article the idea of an opening in the exit channel was taken up, avoiding the rapid elevation of the waters in the city, a concept that was later presented by the engineer Adolf Odebrecht, who proposed a new location for the city in higher regions [FRANK 1995].

The retaining wall suggested in 1911 was built decades later, after the new floods, in 1927 and 1953, as a result of the requests of the population and the city of Blumenau, demonstrating their uselessness. Thus, the 15th District of the Department of Ports, Rivers and Canals, of Florianopolis, accepted the requests and the work was completed in the 1960s, giving rise to Beira Rio Avenue. In this way, the retaining wall only avoids the landslides of the banks of the Rio Itajaí-Açu in the urban space and the construction of the same made possible the existence of Avenida Beira Rio, but the flood problem continues. [FRANK 1995]

Fundraising for effective action has always accompanied discussions of floods. One of the proposals was that of the German engineer Otto Rohkohl, who in 1929 suggested the creation of a joint-stock company, "S.A Contra Enchente", to raise funds for continuity in flood mitigation projects. Rohkohl also proposed the construction of dams along the whole municipality, noting the problem of another scale, not only locally and urban.

On the other hand, the engineer Adolf Odebrecht in 1930 believed that the acceleration and shortening of the river through several extravasation channels to its mouth would be the best solution to the flood problem. Odebrecht also points out that in the event of non-tendering, construction in the lower areas should be prohibited. This proposal only came more than half a century after the floods of 83 and 84 in the review of the 1977 master plan (Figure 4).

Effective flood control and management actions in the cities of the Itajaí Valley began to rely on meteorological bases only in the 1940s, through the action with TELESC - Telecomunicações de Santa Catarina (communication systems of SC) and CELESC - Centrais Elétricas de Santa Catarina (electrical distribution systems of SC). These companies connected to electricity and telephony, in the section from Blumenau to Itajaí, used the sides of the riverbed to distribute the wire network, requiring a proper inspection of the flood quotas. In 1984, DNAEE (National Department of Water and Electric Power) installed a new alert and control system, in which management became institutionalized. (FRANK 1995).

It is important to note that the water law (Law 9.433 / 1997) promulgating the National Water Resources Policy (PNRH) is later. Previously only the water code of 1934 was in force, very advanced, but unfortunately little applied. He gave the public power control and ways to encourage the use of water for industrial use and others, with supervision supervised by the Ministry of Agriculture.

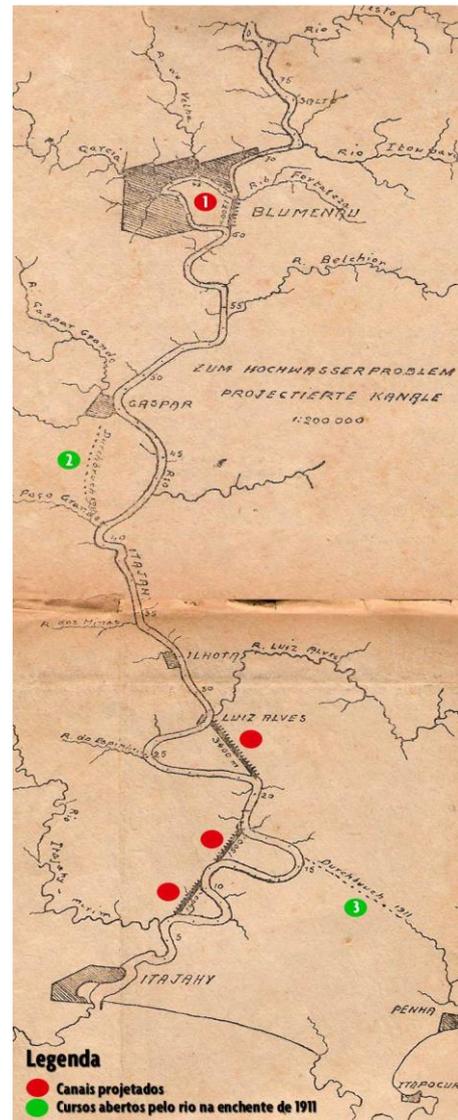


Figure 3 Engineer Adolf Odebrecht's proposal for channels to be opened on the Itajaí river, overcoming the meandering cuts, allowing acceleration of water flow. Relevant are the courses or overflows opened by the river itself in the flood of 1911. The original drawing was edited in the newspaper Der Urwaldsbote in issue 12 of August 15, 1930 with more recent caption of Cassio Eskelsen and comments of Rolf Odebrecht. SOURCE: Historical Collection José Ferreira da Silva. Blumenau, 2019

Only from the 1997 Water Law was there recognition and the need to protect waters within the environmental structure, in a management that was concerned with integrating water resources into the environment, to guarantee sustainable development and the maintenance of the ecosystem.

The institutionalized civil participation, only appeared in late nineties after the creation of AIRVI

(Association of Press and Radio of the Itajaí Valley), by the radio hosts that had like common interest, like the construction of the dams in the high valley of Itajaí.

In 1957 the then president of the republic, Juscelino Kubitschek signed a decree encouraging the economy in the basin of the Itajaí valley.

The floods of 1961 were decisive for new measures. João Goulart, president of the republic, and Juarez Távora, Minister of Transport and Public Works, determined that dams were built on the arms that form the river Itajaí-Açu. The Western Dam was completed in 1973. The South Dam was completed in 1975. The North Dam works began in 1976 and were only completed in 1992. During the construction of the North Dam, two consecutive floods occurred in 1983 and 1984, which exceeded the 15 meters. Absurdly, the National Department of Works and Sanitation, (DNOS) responsible for the work, did not consider the maximum quota of the flood of 1911, which reached the quota of 16.90m. When calculating the height of the dams in the Itajaí valley, he considered only the floods that occurred after 1911. For the DNOS, with the completion of the floods in the city of Blumenau, the quota of nine meters. Unfortunately, the tragic events of 1983 and 1984 and the JICA reports proved otherwise. [FRANK 1995].

After the catastrophic flood of 1983, it was necessary to make decisions that represent continuity in the actions to combat natural disasters, due to the pre-availability of the region.



Figure 4 Downtown of the city of Blumenau during the flood of 1984. SOURCE: Historical Collection José Ferreira da Silva. Blumenau, 2019

In Blumenau, the Civil Defense had great importance from the end of the 1980s, jointly with the State Coordination of Civil Defense - CEDEC. In 1984, Deputy *Moacir Bértoli* approved Law 6,502 / 1984, which gave the potential to transform the state of Santa Catarina into one of the states most prepared to face possible catastrophes, but only part of the proposals succeeded again.

The serious situation that was happening Blumenau and the region also led to the involvement of the federal government to face the crisis. Thus, in

order to overcome the inefficiency of successive flood plans and repeated floods, DNOS, in partnership with the Japanese corporation JICA (Japan International Corporation Agency), drafted a proposal covering the entire Itajaí Basin, The Itajaí River Basin Flood Control Project. The first visit of the Japanese to Santa Catarina was in 1984. During the years 1986 to 1990 a contract was made between the Government of the State of Santa Catarina and Japan for the flood control project. Unfortunately, due to lack of guarantee of payment of the Brazilian part, there was no continuity of the agreement. [NIPPON KOEI CO LTD, 2011].

Again, only after the 2008 catastrophe did the state of Santa Catarina show again its intention to implement the integrated plan with the Japanese government. In 2008, a Technical Scientific Group (GTC) was created that developed the PLADE Integrated Plan for the Prevention and Mitigation of Natural Disaster Risks in the Itajaí River Basin. In this new partnership, the 1988 plan was revised and updated more comprehensively. According to the report produced by JICA, there are five dams, two for power generation (*Rio Bonito and Rio Pinhal*), which do not have the capacity for containment, as well as three other dams for water containment, built in the headwaters of rivers. In addition to this, there are also works to protect the channel on the right bank of the Itajaí-Açu River located in the urban area of Blumenau (Beira Rio Avenue) and other small works protecting the gutters along the riverbanks. The report did not observe other works to protect or contain floods that would improve the river's drainage capacity, such as levees and widening of riverbeds.

In recent years, with the increase in the recurrence of natural accidents, especially after the last one occurred in the mountain region of Rio de Janeiro in 2011, the federal government seeks national policies to mitigate and combat natural disasters. In 2013, in partnership with JICA, the Integrated Management of Natural Disaster Risk Management (GIDES) program was created to reduce the risks of geological disasters through non-structural preventive measures through the improvement of risk assessment and mapping systems, prediction and alert, also guiding urban planning. Also, the Ministry of Cities, together with GIDES, in partnership with JICA produced a manual to reduce risks applied to urban evolution.

In the case of Blumenau, the report delivered by JICA in 2011 showed that some of the flood risk reduction solutions were: to increase the containment capacity of the dams at the headwaters, as well as other structural and non-structural reforms. The report finds that urban expansion occurred predominantly in the flood plains, leading to an increase in flood recidivism and a decrease in runoff capacity in riverbeds. In addition, the slope areas were used as pasture areas, causing an increase in the discharge of floods, accentuating the number of accidents related to sedimentation and landslides. Thus, a number of structural measures were taken that were largely

based on improvements in existing infrastructure, considering a 60-year return period for the 2008 floods, which reached levels of 15 meters.

Amongst the structural measures proposed by JICA, there are changes in operation at the Rio Bonito and Pinhal dams, belonging to CELESC, and used exclusively for power generation, allowing greater containment of water during rainy seasons. Near the mouth of the Itajaí-Açu River in the cities of Navegantes and Itajaí, where the airport and international port are located, the exit canal construction was proposed. It was emphasized the elevation of the West and South dams in the headwaters of the river, which in the previous floods had the overflow of their spillways. In the North dam, in the 1992 project, the waters should never exceed the spillway. (NIPPON KOEI CO LTD 2011, JICA report). Among the non-structural measures, the most important is the strengthening and renewal of information systems and flood warning systems (NIPPON KOEI CO LTD 2011, JICA report).

In addition to the JICA reports presented earlier, other studies presented ideas of integrated plans for the management of the Itajaí-Açu basin, which has been under management since 1997 when the National Water Resources Policy (PNDRH) was promulgated.

Finally, it is worth highlighting that natural disasters fall on the perspective of interferences and omissions in the natural environment. When it comes to natural disasters, it is necessary to understand the various factors that cover the cause of these events, especially anthropic actions, that is, acts or abstentions of the man in the territory. They lead us to understand, in addition to the historical process of occupation, the "struggle" against nature, and how it is possible to prepare to face situations before and after catastrophes (POLICARPO 2016).

- Final Consideration.

The history of the municipality of Blumenau and the Valley of Itajaí is linked to the constant challenge of water elevation. Its more than 160 years of occupation are marked by several catastrophes and the omission and discontinuity in the projects of prevention and preparation for the situations before the impact of the disaster. According to the Civil Defense of Blumenau (2011), the city recorded a frequency higher than two floods per year and during its history Blumenau was adapting, revising its laws, avoiding the problematic of waters.

The discontinuity of management has its fulcrum in politics and in the financial question, added to the lack of preparation to face emergency situations. Still on the question of the economic management of the projects, a new approach to obtain resources, generated locally and autonomously, has already been observed in ROHKOHL's proposal. According to MATEDDI 1999, the funding proposal was based on obtaining resources through local donations made to the S. Contra Enchente. According to Rohkohl, it

would be very difficult to submit large-scale flood management programs with the availability of public resources due to frequent project disruptions. The Odebrecht engineer proposed in the 1930s the externalization of costs, involving more than one political sphere, because according to it, the costs to implant his ideas transcended the local availability.

The lack of continuity of political management is a negative factor, recurrent in Brazil. Specifically, several situations of discontinuities and interruptions are described throughout the history of the Itajaí Valley. Therefore, the criticisms of the teachers Baite Frank and Claudia Siebert, both with research focused on the urban space and the management of the floods of Blumenau, stand out.

Over 160 years after the arrival of German immigrants, what stands out in the history of Blumenau is the great number of interruptions in flood prevention and mitigation projects, the lack of popular participation and the articulation of local, regional, and national. It is necessary to overcome these shortcomings, to work together and to succeed in the development of these proposals.

In Brazil the number of occurrences of environmental disasters is increasing. In recent years, the most important are those in the states of Santa Catarina, Rio de Janeiro and Minas Gerais. These large-scale tragedies have become news in the world, by the size of the catastrophe, the number of families affected, resulting in loss of life, thousands of homeless and large losses.

According to Marcelino, 2008 it is necessary to identify, understand and evaluate risks as an essential basis for starting good management against events that may occur due to natural causes. POLICARPO, 2016 follows the same line of thought when affirming that when thinking about urbanization one cannot consider urban planning without environmental management.

It is important to think that the sum of the different systems, the built territory and pre-existing terrain result in the composition of a single space that may or may not suffer the consequences of human acts.

It is necessary to emphasize that it is the duty of the State to raise the awareness of the population that inhabits the areas of risk, through civil defense and trained bodies, since it is of great importance the participation of society in the prevention of accidents. Proper risk management reduces the potential of events and mitigates disasters. The main issue in relation to the challenges is that the constant struggle in the planning and the environmental management is not to be summarized the relation of the spatial and temporal vision of a territory. The challenge also involves addressing social and environmental issues. Thus, for the project to function, a huge range of knowledge is needed, including water resources, water supply, circulation in the city, means of transport, urban design, biodiversity and socio-cultural relations.

- References

AGÊNCIA NACIONAL DE ÁGUAS - ANA, Governo Brasil 2018 <http://www3.ana.gov.br/> visitado em 10/11/2018.

ATLAS GEOGRÁFICO DE SANTA CATARINA 2014 - Estado De Santa Catarina Secretaria De Estado Do Desenvolvimento Econômico Sustentável – SDS. Diretoria De Recursos Hídricos – DRHI Gerência De Planejamento De Recursos Hídricos – GEPHI. Santa Catarina, Brasil. 2014. [http://www.aguas.sc.gov.br/jsmallfib\\_top/DHRI/bacias\\_hidrograficas/bacias\\_hidrograficas\\_sc.pdf](http://www.aguas.sc.gov.br/jsmallfib_top/DHRI/bacias_hidrograficas/bacias_hidrograficas_sc.pdf), visitado em 19/02/2019.

BLUMENAU CITY HALL - 2018 - <https://www.blumenau.sc.gov.br/blumenau/as5d1a5sd4a4sd>. visitado em 19/02/2019.

BRASIL, Decreto nº 42.423 1957, 7 de outubro de 1957. Constitui um grupo de trabalho incumbido de estudar a situação econômica da Bacia Hidrográfica do rio Itajaí no Estado de Santa Catarina e de propor as medidas necessárias a seu desenvolvimento. Diário Oficial Brasília 07 out. 1957 Seção 1 - 9/10/1957, Página 23456.

DEEKE José. “O município de Blumenau e a história de seu desenvolvimento” Blumenau. Nova Letra 1995.

ESPINDOLA, Marcos; NODARI, Eunice; PAULA, Simone. “Urban growth and the floods of Blumenau (Santa Catarina) Brazil”. Revista do arquivo geral do Rio de Janeiro, n.8, 2014, p.201-212. Rio de Janeiro 2014

FRANK, Baite “Uma abordagem para o gerenciamento ambiental da bacia hidrográfica do rio Itajaí, com ênfase no problema das enchentes” UFSC, Florianópolis 1995.

HANNAS, Evy. Desenho ambiental e forma urbana. O caso do bairro de Riverside. Vitruvius online. 2016 Disponível em <http://www.vitruvius.com.br/revistas/read/arquitextos/17.196/6226> visitado em 25/09/2018.

HEWITT, K., BURTON, I. (1971). The hazardousness of a place: a regional ecology of damaging events. Toronto: University of Toronto.

LACAZE, Jean-Paul. A cidade e o urbanismo. Coleção: Biblioteca Básica de Ciência e Cultura. Tradução de Magda Bigotte de Figueiredo: Instituto Piaget, 1999.

MARCELINO Emerson “Desastres naturais e Geotecnologias: Conceitos Básicos” INPE, São Jose dos Campos 2008.

MATEDDI Marcos, “As enchentes como tragédias anunciadas: Impactos da problemática ambiental nas situações de emergência em Santa Catarina” UNICAMP. 1999 Campinas.

NIPPON KOEI CO LTD 2011, relatório JICA.

POLICARPO Janea, “Território e planejamento urbano em Blumenau: A disputa por espaços seguros” UFSC, Florianópolis 2016.

PORATH Soraia “A paisagem de rios urbanos. a presença do rio Itajaí-açu na cidade de Blumenau”. UFSC, Florianópolis 2004.

SIEBERT, Claudia. “A evolução urbana de Blumenau – o (des)controle urbanístico e a exclusão socioespacial” UFSC, Florianópolis, 1999.

\_\_\_\_\_. (Des)controle urbano no vale do Itajaí. In B. Frank, & L. Sevegnani (Orgs.). Desastre de 2008 no Vale do Itajaí: água, gente e política (p. 38-51). Blumenau: Agência de Água do Vale do Itajaí.

SPIRN, Anne W. O Jardim de granito: a Natureza no desenho da cidade. São Paulo: Edusp, 1995.

SCHULT, Edmundo. DIAGNÓSTICO E PROGNÓSTICO DAS DEMANDAS HÍDRICAS. 2016. Comitê do Itajaí Governo do estado de Santa Catarina. 2016. disponível em [http://www.aguas.sc.gov.br/SISTEMA\\_DE\\_INFORMACOES\\_DE\\_RECURSOS\\_HIDRICOS\\_DO\\_ESTADO\\_DE\\_SANTA\\_CATARINA](http://www.aguas.sc.gov.br/SISTEMA_DE_INFORMACOES_DE_RECURSOS_HIDRICOS_DO_ESTADO_DE_SANTA_CATARINA)