



**Relationships between floods and urban expansion in the Ipiranga
Stream Basin**

*Relações entre as inundações e a expansão urbana na
Bacia do Córrego Ipiranga*

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RESUMO

O propósito do presente artigo consiste em refletir sobre inundações e alagamentos em áreas urbanas agravadas pelo avanço demográfico e explorações imobiliárias, e como estudo de caso utilizaremos a bacia do Córrego Ipiranga no município de Juiz de Fora, uma vez que as características de sua expansão em muito se assemelham a várias outras localidades. Este trabalho se configura como uma revisão bibliográfica dedicada ao tema, abordando as explicações pertinentes às inundações e alagamentos. Análise que engloba considerações acerca do crescimento urbano, com um registro histórico destas inundações recorrentes. É realizada também, uma investigação dos mapas desta região urbana, complementada por uma análise dos principais córregos integrantes da bacia hidrográfica do Ipiranga sob a ótica das canalizações executadas no século 21.

PALAVRAS-CHAVE: Alagamentos, Áreas urbanas e Avanço demográfico.

SUMMARY

The purpose of this article is to reflect on floods and inundations in urban areas exacerbated by demographic growth and real estate developments. The study analyzes the Santa Luzia neighborhood in the municipality of Juiz de Fora as a case study, as its characteristics closely resemble those of various other locations. This work takes the form of a literature review dedicated to the topic, addressing explanations relevant to floods and inundations. The analysis includes considerations about urban growth, a temporal delimitation covering the history of the neighborhood and its surrounding region. Additionally, an investigation of local maps is conducted, complemented by an analysis of the main streams within the Ipiranga watershed from the perspective of canalizations carried out in the 21st century.

KEYWORDS: Floods, Urban áreas, Demographic growth.

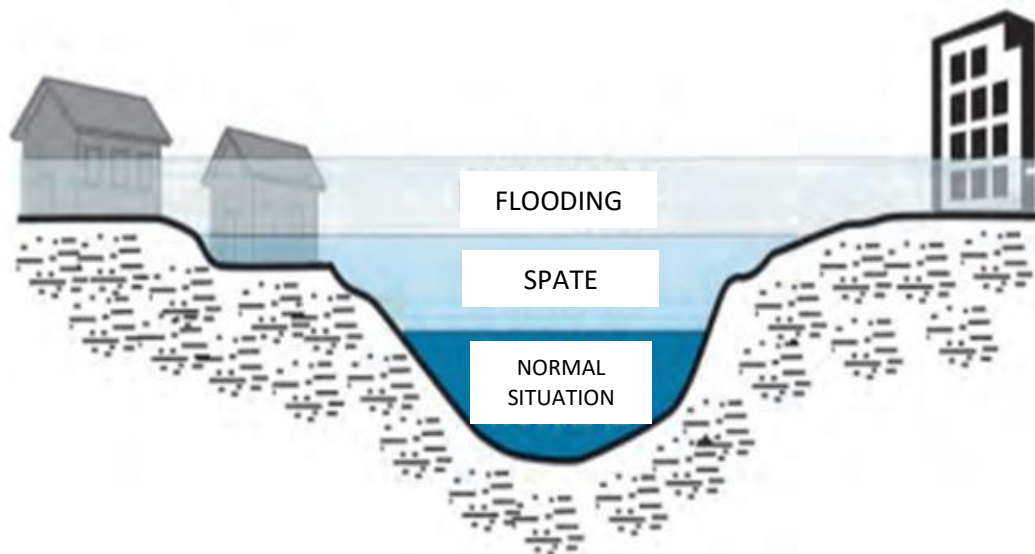
1 INTRODUCTION

The frequency of intense and long-lasting rainfalls is responsible for natural events that occur periodically in watercourses, such as flooding and inundation (Tominaga, 2009)

While the Ministry of Cities (2007, apud LICCO; DOWELL, 2015, p. 163) defines flooding as “the momentary accumulation of water in a given area due to problems in the drainage system, which may or may not be related to fluvial processes”. The agency responsible for disaster assistance known in Brazil as Civilian Defense of São Bernardo do Campo (2015, apud LICCO; DOWELL, 2015, p. 163), defines:

“Flooding” is defined as the overflow of water from a watercourse, reaching the floodplain area. “Floods or spates” are defined as the rise in water level in the drainage channel due to increased flow, reaching the maximum level of the channel, but without overflowing; swamping is the momentary accumulation of water in certain places due to deficiencies in the drainage system and torrents are concentrated when the surface runoff with high transport energy, which may or may not be associated with areas where fluvial processes dominate.”

Figure 1: Illustration of Flood and Flooding



Source: TOMINAGA, L. K. et al. Natural disasters: knowing to prevent. São Paulo: Geological Institute, 2009. p. 42. (apud MINISTÉRIO DAS CIDADES; INSTITUTO DE PESQUISAS TECNOLÓGICAS. Schematic profile of the flooding process. Brasília: Ministry of Cities, 2007.)

It is possible to observe that most of the problems related to flooding result from a distorted vision of control on the part of professionals who still focus on localized projects without a vision of the watershed and the social and institutional aspects of the city. However, enforcing sustainable solutions that limit the population makes it difficult for public authorities to achieve results (Tucci, 2003).

Unplanned urbanization and the process of urban occupation have resulted in changes to the energy balance and urban comfort levels, such as an increase in temperature and a decrease in



relative humidity. In addition, urbanization has made soils impermeable, which increases the problems related to flooding that often affect the population of these areas, causing loss of physical property and increasing the risk of contamination of water environments through the spread of disease (Santos and Rocha, 2013).

2 THE URBANIZATION OF JUIZ DE FORA

Ferreira et al (2015):

“Urbanization in the city of Juiz de Fora was no exception to the rule of the urbanization process in Brazil, i.e. it was quite rapid and unplanned. The city was founded in 1856 and experienced rapid growth as a result of industrialization, which led to many migrants coming to the city until 1912. Subsequently, the city saw a slowdown in its growth, both in terms of industrialization and demographic growth, and between 1912 and 1950, Juiz de Fora grew by only 40%, while the urbanization rate in Brazil reached 110%”.

The urbanization process in Santa Luzia has gained momentum since the 2000s, due to its proximity to the municipal center and the wide variety of urban facilities that would serve the population (Carvalho et al, 2023).

The current trend for new developments may lead to urban densification in neighborhoods close to the Santa Luzia district, intensifying the flow of people and cars - a fact that the government even encourages by upgrading some roads, adopting a more lenient approach to construction (2014, apud CARVALHO et al, 2023).

In a broader view, but with the same emphasis on urban development, we highlight Souza (2003) who warns us that there are fallacious statements regarding urban problems and their solutions. It is often argued that the size of cities is proportional to urban problems, which is not the case in reality. It cannot be said that London with 6.8 million inhabitants (EUROSTAT, 2018) would be 4.5 times more polluted than Recife with its 1.5 million inhabitants.

Even so, it can be ascertained that qualitative problems resulting from a historical process in which “(...) power structures, wealth distribution channels, etc. are vitiated and present a clear exclusionary bias and great social injustice, and where the quality of life is already threatened” (SOUZA, 2003, p. 105) tend to aggravate problems as the city expands. It is also possible to observe that these are influenced by various factors, which makes them complex, so the size of the urban area alone cannot explain the intensification of flooding in a region of the city, although it influences it.

Brazilian cities have undergone a process of urbanization that has accumulated social and environmental problems which require spatial planning and management of environmental resources, without which city growth results in their degradation and contributes to health problems, especially those related to water quality, air pollution, and public sanitation (FERREIRA et al, 2015).

From the 20th century onwards, the automobile played a major role in urban public policies, while “the water manifestations of nature refer to negative aspects, the rainy climate is considered ‘bad weather’, bringing traffic problems, floods, as well as discomfort” to contemporary urban man. (MESQUITA apud STORY, 2010, p. 10) For this reason, canalization

came to be seen as a short-term solution by the authorities in the face of sanitation and traffic problems that were becoming more intense.

When talking about the municipality of Juiz de Fora and its floods, it is important to note that the city was born and expanded along the Paraibuna River, which was the scene of the historic flood of 1940 that led to the straightening of the riverbed in order to facilitate the flow of water during intense periods of rain, and its delineation remaining as it is known today.

Figure 2: Flood of 1940, Halfeld Street, December 24, 1940



Source: Maria do Resguardo: (H. Ferreira archive).

Urbanization frequently develops around water resources, which play an important role in supporting water supply, transport, and other activities. However, the quality of this process has been compromised due to extreme events, such as flooding, inundation, and waterlogging (Anjos, 2023).

The study conducted by Anjos, 2023 aimed to analyze land use and occupation in Juiz de Fora over a period of time. A projection for the year 2030 was made using the Mouse plug-of the QGIS software. It is important to note that urban growth in Juiz de Fora was most pronounced between 1990 and 2000, followed by urbanization in isolated areas, such as townhouse developments.

Anjos' 2023 forecasts indicate that Juiz de Fora is destined to “stagnate” in its growth, keeping the urban scenario static. In addition, the author warns that the city is located in an urban area with high and very high susceptibility to extreme events.

According to Souza (2018) the increase in flooding is directly associated with the growth of urban centers, population increase, soil sealing and the lack or inefficiency of drainage systems. Souza also points out that the south/southeast region of the Atlantic Forest biome, where Juiz de Fora is located, has suffered intense interventions due to climate change, resulting in significant impacts from flooding and waterlogging.

Souza (2018) notes that Juiz de Fora experiences an increase in rainfall during the months of March, November, and December. The study predicts an increase in the events of



flooding and waterlogging in the region, emphasizing the need for public intervention to mitigate these impacts.

Oliveira (2021) investigated the synoptic conditions related to an extreme event that occurred in Juiz de Fora in 2016. The study also looked at the spatial distribution of rainfall impacts throughout the municipality, comparing them with the hourly distribution of precipitation. A high volume of rainfall was identified in a short period of time, particularly at the Milho Branco station (central-western region), where 70mm were recorded in 1 hour. Multiple areas of the city were affected, and the lack of urban drainage infrastructure exacerbated the situation.

Oliveira, 2018 notes that 09/12/2016 was characterized by a circulation of winds originating in the interior of Brazil, mainly from the Amazon region, which aggravated the climatic situation in the city that day.

2.1 Ipiranga Stream Basin

The southern region of the city of Juiz de Fora was no different, specifically the Santa Luzia neighborhood, which is our case study, and which in its history has the Ribeirão as the protagonist that gave rise to the “Cachoeirinha” locality

The Cachoeirinha farm, owned by Colonel José Mário Vilela, covered the area where our Santa Luzia neighborhood is today, in the mid-40s. At the same time, the Cachoeirinha farm was divided into property lots and from these lots came the process of urbanization of the place (DOCUMENTARY RECORD OF THE ARCHIVE OF THE MATRIX CATHOLIC CHURCH OF SANTA LUZIA).

The current streets of Porto das Flores, Água Limpa, Torreões, Chácara, Três Ilhas and Sarandira were the first roads that started the construction of the neighborhood, forming the “Jardinópolis” district. During this period, most of the pioneers of the small neighborhood worked in the city's factories. The neighborhood could only be accessed via a very steep and unpaved slope, the “buqueirão”, today the ascent of Chácara Street and Dom Silvério Street (DOCUMENTARY RECORD OF THE ARCHIVE OF THE MATRIX CATHOLIC CHURCH OF SANTA LUZIA).

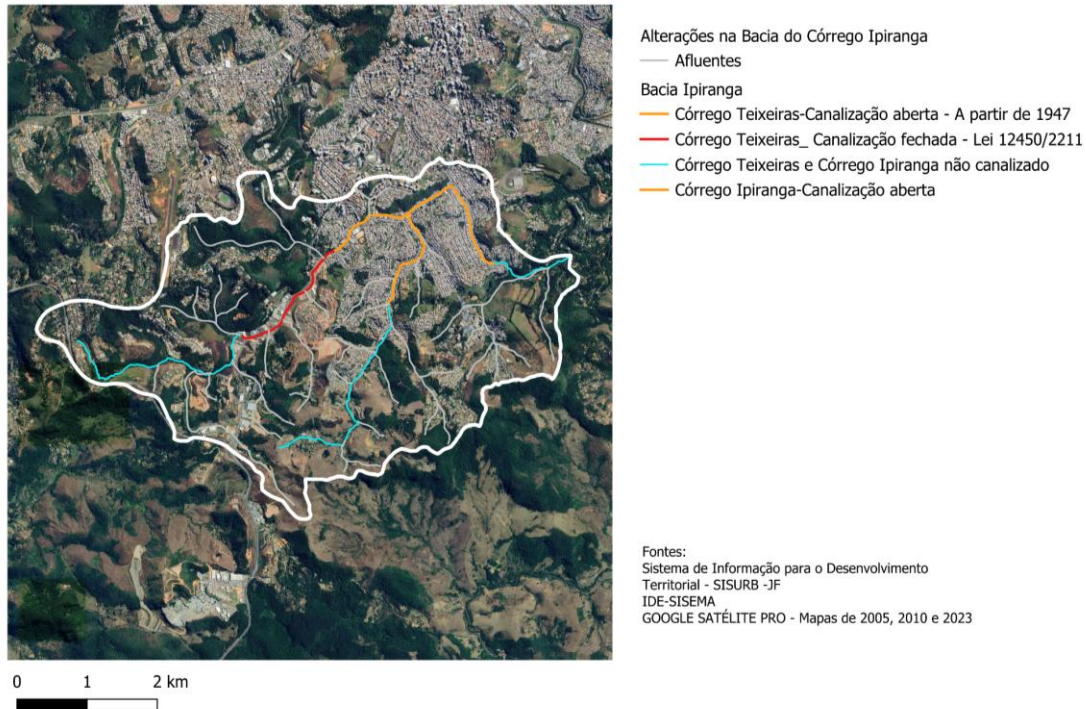
The Ipiranga stream ran through the neighborhood and in times of heavy rain there was frequent flooding, which caused a lot of damage to the inhabitants and the easy spread of diseases. Unfortunately, in 1945, it took a typhus epidemic for the government to worry about the area. The mayor of Juiz de Fora at the time, Dilermando Cruz, faced with a high number of deaths and a public emergency due to the lack of basic sanitation, was forced to carry out work in the neighborhood to correct and channel the Ipiranga stream, which ran through the neighborhood of Santa Luzia, as well as lowering the “buqueirão” road (DOCUMENTARY RECORD FROM THE ARCHIVE OF THE MATRIX CATHOLIC CHURCH OF SANTA LUZIA).

3 DATA COLLECTION AND ANALYSIS

Law 12450/2011 establishes the geometric project for Avenida Doutor Deusdedith Salgado, which refers to the duplication of the avenue and the closed canalization of the Teixeiras stream after 2010. The open channelization of the Teixeiras and Ipiranga streams

predates this period. Figure 3 shows the main works carried out on the stretch of the main streams, which are accompanied by successive drainage works on the tributaries.

Figure 3: Ipiranga stream basin - Canalization of the main watercourses in the basin



Source: Organized by the authors

The stretches of the Ipiranga and Teixeiras streams that were built from 1947 onwards are highlighted in orange. João Luiz Brandão, Professor in the Department of Hydraulics and Sanitation at the University of São Paulo, explains the possible consequences of canalization works downstream of the works where they are implemented:

(...) channelizing a stream increases the flow of water and the speed of runoff, which at first reduces the risk of flooding. However, by increasing the speed of runoff, the problem is transferred downstream, to the next stretch of the stream, which can suffer from flooding. This explains why areas that had never suffered from flooding in the city of São Paulo have started to deal with this problem (BRANDÃO, 2012, p 185-200 apud MESQUITA, 2013, p. 165).

For this reason, this type of intervention has been questioned as to its effectiveness in dealing with flooding in urban areas, as has also been observed in Belo Horizonte (MESQUITA, 2013).

The completion of the works implemented by law 12450/2011 associated with the “upward trend in the number of extreme episodes” of precipitation observed by Thiago Alves de Oliveira (2021, p. 216) may be factors that have been influencing the increase in the recurrence of flooding in the Santa Luzia and Ipiranga neighborhoods.

Figure 4: Densification and expansion of the urban network in the region of the Ipiranga stream basin



Source: Own collection, satellite images taken from Google Earth Pro.

By analyzing the satellite images above, we can see a continuous increase in urban densification when comparing the periods 2005 and 2013. In 2005, although there were already many occupied areas in the Santa Luzia, Santa Efigênia, Jardim de Alá, Ipiranga and Teixeira neighborhoods, there were still extensive green areas for water run-off. On the other hand, in 2023, the previously densified areas persist, and new regions, such as the Cidade Nova and Salvaterra neighborhoods, begin to experience urban growth, introducing new residential areas and reducing the areas available for rainwater runoff.

In addition to analyzing the map that shows the region's growth, Oliveira (2021) provides data that corroborates this observation. According to the author, the region has been experiencing continuous growth since 1991, and by 2010, the population had already registered a significant increase of 50.3%. In this context, the São Geraldo, Cascatinha and Teixeira neighborhoods stand out as areas that have experienced a notable population increase.

Another aspect highlighted by Oliveira is the growth of the region associated with occupation resulting from the Minha Casa Minha Vida program, indicating the influence of this housing program on urban development in the area.

Gerheim, 2016 investigates the situation of the Ipiranga stream and observes that the region has a very steep relief, characterized by slopes ranging from 0° to 30°, reaching up to 45° at some points. The author also highlights the urbanization lack of sanitary infrastructure, a factor that contributes to aggravating the adverse situations occurring in the Santa Luzia neighborhood.

On 24/01/2023, Tribuna de Minas published the headline “Heavy rain and flooding cause disruption in Santa Luzia”, reporting heavy rainfall in the city of Juiz de Fora. The neighborhood of Santa Luzia was particularly affected by the overflow of the stream, resulting in the invasion of local businesses and homes. The article also reports on a flood in the region at the beginning of December the previous year. It was observed that the water level reached a height that impressed the local population, who expressed surprise that they had not seen such a significant rise in the stream for a long time..



Figure 5: Flood in the Ipiranga stream on 24/01/2023



Source: Tribuna de minas, 2023

4 CONCLUSION

Flooding in the Santa Luzia neighborhood is historical and recurrent and is influenced by multiple factors, including population growth associated with stagnant infrastructure, densification of the areas upstream of the Ipiranga stream, and the topographical characteristics of the basin. The evidence of these characteristics shows their persistence in the environment. The importance of continued attention by public authorities to the area is emphasized, in order to effectively address the challenges related to flooding in a short- and long-term perspective.

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