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COLLAPSE OF ARRUDA STREET LOCATED NEAR THE BAIXA FUNDA STREAM IN ARAGUAÍNA-TO

DESMORONAMENTO DA RUA DA ARRUDA SITUADA NAS IMEDIAÇÕES DO CÓRREGO BAIXA FUNDA EM ARAGUAÍNA-TO

DERRUMBE DE LA CALLE ARRUDA UBICADA CERCA DEL ARROYO BAIXA FUNDA EN ARAGUAÍNA-TO

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ABSTRACT

This article is a study of the landslides that occurred on a stretch of Rua da Arruda, part of the widening of Avenida Filadélfia, TO 2022 in Araguaína-TO. According to Alencar and Vasconcelos (2011, p. 145), "As a strategic city for the state of Tocantins, Araguaína presents serious problems regarding urban planning." Therefore, the general objective of this work is to address these landslides, show the environmental problems that occur around them, but specifically in the Baixa Funda stream, as well as show the changes that occurred in the space from 2014 to 2025. The methodology used was a bibliographic survey of subjects related to the topic, on sites such as SciELO, Google Scholar, among others. Field research was also carried out, using Figuregraphs and interviews with some residents who live near this stretch of the road.

Keywords: Landslide. Environmental Degradation. Urban Planning. Clinic.

RESUMO

O presente artigo trata-se de um estudo sobre os desmoronamentos que ocorreram em um trecho localizado na rua da Arruda, ela faz parte da duplicação da Avenida Filadélfia, TO 2022 em Araguaína-TO. Conforme Alencar e Vasconcelos (2011, p. 145) “Sendo uma cidade estratégia para o estado do Tocantins, Araguaína apresenta graves problemas no que tange ao planejamento urbano.” Assim sendo, o objetivo geral deste trabalho é abordar esses desmoronamentos, mostrar os problemas de ordem ambiental que acontecem em torno, mas especificamente no córrego baixa funda, como também mostrar as mudanças que ocorreram no espaço de 2014 a 2025. A metodologia utilizada foi levantamento bibliográfico de assuntos relacionados ao tema, em sites como SciELO, google acadêmico dentre outros, pesquisa de campo também foi realizada, utilização de fotografias e entrevistas com alguns moradores que residem nas proximidades desse trecho da pista.

Palavras-chave: Desmoronamento. Degradação Ambiental. Planejamento Urbano. Clínica.

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RESUMEN
Este artículo estudia los deslizamientos ocurridos en un tramo de la Rua da Arruda, parte de la ampliación de la Avenida Filadélfia, TO 2022, en Araguaína-TO. Según Alencar y Vasconcelos (2011, p. 145), «Como ciudad estratégica para el estado de Tocantins, Araguaína presenta serios problemas de planificación urbana». Por lo tanto, el objetivo general de este trabajo es abordar estos deslizamientos, mostrar los problemas ambientales que ocurren en su entorno, específicamente en el arroyo Baixa Funda, y mostrar los cambios ocurridos en el espacio entre 2014 y 2025. La metodología empleada fue una revisión bibliográfica de temas relacionados con el tema, en sitios como SciELO y Google Académico, entre otros. También se realizó investigación de campo, utilizando fotografías y entrevistas con algunos residentes que viven cerca de este tramo de la carretera.

Palabras clave: Deslizamiento de Tierra. Degradación Ambiental. Planificación Urbana. Clínica.

1 INTRODUCTION

With population growth and the accelerated process of disorderly urbanization, land occupation in unsuitable areas has been a very recurrent practice in Brazilian cities, generating both environmental and social problems. (Brito; Baby; Silva, 2014). This is what happens in Araguaína-TO, a city located in the state of Tocantins, in the northern region of the state, in which it has been undergoing several changes to the detriment of the population increase that has occurred in recent decades, without urban planning, implying many environmental and social impacts for a significant portion of the city. "Population growth is a factor that causes changes in the dynamics of a city, which requires an infrastructure to meet the needs of the current population density." (Brito; Baby; Silva, 2014, p. 12).

Because the regulation on the use and occupation of Brazilian urban land was implemented late through Federal Law No. 6,766/79, of December 20, 1979, it did not occur differently in the city of Araguaína, the city began to expand in a disorderly way, totally without planning. (Sousa; Brito, 2012). Generating several problems due to this lack of planning, one of them concerns the contrasts that exist in society, as a result of the social differences imposed by capitalism.

Within the urban space, these differences are increasingly contradictory in their dynamics, which end up turning this space into a field of disputes and power that cause the most diverse consequences and conflicts among society, where the smallest portion appropriates the right to make urban land a commodity, subject to speculation and overvaluation, in the face of corporatist actions between the government and the owners of real estate developments, with infrastructure implementations that favor certain places in the urban space, making it restricted to those who have considerable financial purchasing power. On the other hand, the other part of society, vulnerable, at the mercy of the goodwill of managers.

Thus, this work aims to point out the factors that contributed to the landslides that occurred in a stretch of Rua da Arruda, as well as to highlight the degradation in this study site, and finally to highlight the changes that occurred between 2014 and 2025.

Regarding the road restructuring works that were being carried out in 2014, the machinery and transport agency of the State of Tocantins – (AGETRANS) informed at the time about a project with hydrological studies, prepared to solve the demand related to the roadway, as well as the drainage project, considering that the stretch is located in the vicinity of the Baixa Funda stream. (Agetrans, 2014). The place was full of dirt, rubble, antlers,

garbage and scattered shackles. In its surroundings there are some irregular occupations, a factor that can contribute to the increase in the degradation of this space.

Therefore, this work has as a general objective, to understand the collapse in a stretch of Rua da Arruda, which is close to the source of the Baixa Funda stream. This street is part of the duplication of Avenida Filadélfia. It should be noted that the changes that occurred between 2014 and 2025 were also pointed out, focusing on the actions carried out in this geographical space. Among the specific objectives are to point out the main reasons for the collapses in this section of the road, and the factors that contributed to it.

The interest in this research occurred through some observations in space. As it is a rapid transit road, after its fall it brought inconvenience both to drivers who use the lane to get around and to pedestrians for walking. With the constant landslides, this stretch of the road ended up being closed a few times, causing a lot of inconvenience to people who were passing through it.

In the years 2016 to 2017, they rebuilt the stretch of Rua da Arruda, however, the issue of the environmental problem remained. The works in this place began in the first term of former mayor Valderez Castelo Branco, since then according to reports from residents who live nearby, they emphasize that the environmental problem began from these works, bringing as a consequence the demolition of the native cover, a lot of dirt, and sediments taken into the stream, intensifying the silting process waterproofing the soil. The lack of an adequate micro/macro rainwater drainage system is one of the main points for the problems mentioned. (Brito et al., 2022). Therefore, the lack of planning in relation to natural resources corroborates the numerous socio-environmental problems.

The methodology used was the literature review on subjects related to the theme. For Sousa, Oliveira and Alves (2021), bibliographic research is relevant from the beginning of scientific research, considering that it is through this that the subject to be studied becomes known. Field research was also carried out, through on-site observation, Figuregraphs and interviews with residents who live in the vicinity of the study area. It is worth mentioning that Figuregraphic records are of great value and understanding for studies of this nature. (Vanderley; Silva, 2015).

2 BRIEF CHARACTERIZATION OF THE MUNICIPALITY OF ARAGUAÍNA-TO

The foresters of the Carajás tribe were the primitive inhabitants of the region between the Andorinhas and Lontra rivers, tributaries of the Araguaia river on the right bank. The

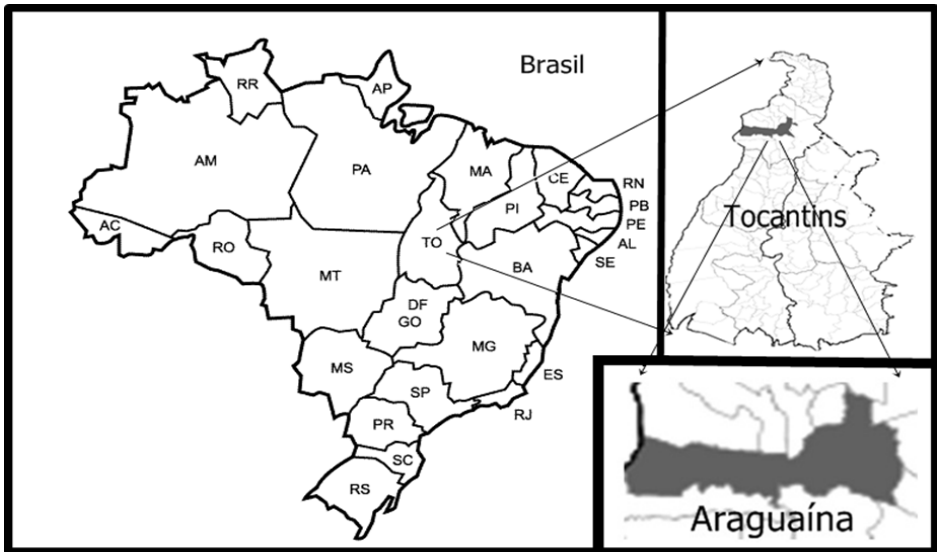
beginning of the clearing took place in 1876, with the arrival of João Batista da Silva and his family, from Piauí. They settled on the right bank of the Lontra River, in a place they called Save-nos Deus, for fear of attack by indigenous people and wild animals. Later, with the arrival of other families, the village was formed, with the name of Lontra, because this species was numerous in the place.

In 1949, the town became part of the newly created municipality of Philadelphia. In the same year its name was changed to Araguaína, as a result of the Araguaia River. In 1953, it was transformed into a District, and in 1958, the Municipality of Araguaína was created, installed in 1959. The great surge of economic and social development of Araguaína began in 1960, with the construction of the Belém-Brasília highway.

The municipality of Araguaína is located in the western mesoregion of the state of Tocantins and the homonymous microregion, at latitude of 07°11 '28 "south, and longitude 48°12' 26" west. In the first years of Tocantins' life, it was the largest city in the state, currently having 171,301 inhabitants, the second largest population in the federative unit, according to the IBGE (2022). It is a thriving regional hub, which stands out in terms of trade, education, health and services. Figure 01, below, shows the exact location of the city of Araguaína in the State of Tocantins, within the map of Brazil.

Figure 1

Location of Araguaína



Source: WWW. Figures imagens.net, Adaptation: MOREIRA, Cleydson Aires

The climate of the municipality of Araguaína is humid tropical, type AW in the Koppen-Geiger climate classification, with a defined rainy season between the months of October and May, and a dry season between the months of June and September, with annual precipitation above 1,700 mm.

2.1 LOCATION OF THE MICROBASIN OF THE BAIXA FUNDA STREAM IN THE CITY OF ARAGUAÍNA

The microbasin of the Baixa Funda stream is located in the southeastern area of Araguaína, where its source is under the urbanization of the neighborhoods São João, Setor Coimbra and Residencial Patrocínio. Further on, in the middle course, it bathes the Santa Terezinha and Vila Ferreira neighborhoods on the right bank of its course, while on the left bank there is only the presence of a vegetation of the typical altered Cerrado type. In the lower course, where this stream confluences with the Cará stream, the Santa Terezinha Neighborhood is on the right and the Itaipu Sector on the left. From the confluence with the Cará stream, a second-order segment emerges, forming the Tiúba stream, this last stream, in turn, will flow into the main river of the city, the Lontra River, one of the tributaries of the Araguaia River. (Sousa, 2005).

Figures 2

Erosive process in the middle course of the Baixa Funda Creek basin: From the impact in 2014 to the containment work in 2025

Source: Denia Carla Dias Costa Aires

The characterization of the soils in the area essentially comprises two main types of soils: Quartzarenic Neosols (quartz sands) and gleisols (hydromorphic soils). (Sousa, 2005). The predominant plant formation in the area is defined as a subdivision of the Cerrado in the strict sense: the thin Cerrado, with a predominance of shrubs and herbs and which currently presents a significant change due to the urbanization of this area. In Figuregraphs 2a and 2b, they show some changes made after the rupture of the lane that occurred in 2014, in Figuregraph 2b, it shows the intervention works around the stream, with the aim of containing erosion and siltation. However, until July 2025, the works were not completed.

2.2 RUA DA ARRUDA IN THE CONTEXT OF THE BAIXA FUNDA STREAM

The construction of the Arruda street lane, which is part of the duplication of Avenida Filadélfia, was built more than two decades ago, starting in the first term of former mayor Valderez Castelo Branco in 2001. With the work, some environmental impacts were caused, including the erosive process and silting of the Baixa Funda stream, which is located near the road. About this erosive process, the authors Maciel and Silva (2022, p. 29) point out that "It is inferred that the initial milestone of the erosive process in question, according to the direction of rainfall, is located 240 meters upstream of the source of the Baixa Funda, on the side of State Highway TO-222."

Stream pollution is also a critical issue, resulting from solid waste, wastewater, and sewage piped into it. This situation is aggravated by the removal of riparian vegetation, essential for the protection of the bank and consequently the stream, as Vanderley and Silva (2015) point out, in studies carried out on environmental degradation in the Mato Verde stream in Babaçulândia-TO, the erosive processes headed towards a stage of ravines and over time became a huge gully.

In Figuregraph 3a, recorded in 2014, the rupture of the lane is observed, this stretch is located, east of Araguaína, where its source is in a sedimented place, between the neighborhoods São João, Setor Coimbra and Patrocínio, the union of these springs is below Praça do Sipaúba, it is a critical point where the landslides occurred, due to the instability of the soil to the detriment of the springs having been sedimented and because it is a place where the waters of various downstream sectors meet and flow with greater intensity.

Figure 3

Crumbling and rebuilt section: Between 2014 and 2025

Source: Denia Carla Dias Costa Aires

With the collapse of this section of the road, it resulted in the need for alternative routes for drivers, forcing them to adapt to new routes, thus increasing the distance of their daily commutes. In addition, pedestrians who used it to walk were also directly impacted.

On this place where the collapse occurred, it is located close to the downstream of the stream, in which there is a significant accumulation of rainwater, suppression of vegetation cover causing instability in the soil, added to the fragility of the infrastructure present at the time, considering that the drainage system could not handle such demand, thus resulting in the fall of this stretch located on Rua da Arruda.

In addition, according to reports from residents about the work carried out in this space, they say the following: "Before the runway we used the stream for numerous activities such as washing clothes, dishes, bathing and even for consumption, after the construction of the avenue, this was no longer possible". With an even greater aggravating factor, due to the sewage channeling of the CAIC school, having been directed to the stream, demonstrating a lack of urban planning. This action, combined with the works carried out on the road, resulted in the degradation of the Baixa Funda stream, making it unsuitable for use.

The problem with the pollution of the stream, as reported by the residents, begins with the construction of the duplication of the road, before the action of man in this space, the stream was of vital importance for the life of the community that lived near the Baixa Funda stream, having the water resource for various purposes, essential to the life of the human

being, Today, this is no longer possible, because the stream is not only polluted, but also completely silted up.

Figure 4

Baixa Funda Stream in an advanced silting process in 2014, and intervention works in 2025

Source: Denia Carla Dias Costa Aires

The studied area includes a very sandy soil (Quartzarenic Neosols) that facilitates the erosive process, intensifying even more with the lack of vegetation cover, contributing to a fragile soil with intense erosive processes. The area around the road is without this plant protection, and when rainwater falls on the surface, it ends up causing the rupture of the aggregates as seen in Figuregraph 04, causing this process of erosion and siltation. This is a relevant factor that may have contributed to the ruptures and landslides in this section of the track, the constructions (works) that were carried out in this part of the track led to a stage of silting of the stream as a result of all the sediment taken into it.

> The erosive process caused by rainwater covers almost the entire earth's surface, especially in areas with a tropical climate, where rainfall totals are much higher than in other regions of the planet. In addition, in many of these areas, rainfall is concentrated in certain seasons of the year, which further aggravates erosion (Guerra, 2007, p. 17).

In 2014, some mitigating measures were taken with the aim of containing the effects of erosion, such as the planting of grass (kikuyu), and bamboo, however, they proved ineffective in the face of this problem.

Another important issue is the irregular occupations around the study area, an assumption pointed out by the literature shows that in recent years, the city of Araguaína has presented a high population growth in a disorderly way, evidencing a lack of municipal planning, enabling occupations in areas unsuitable for housing, such as in permanent preservation areas (APP's). About this, the authors below say the following:

> The largest portion of society suffers, not only from financial incapacity, but also from the omission of the public power in an attempt to reduce social inequalities, because the lack of programs aimed at popular housing, makes the low-income society establish its housing in the most diverse places (hills, slopes, environmental preservation areas, and etc.) and even in areas considered inhospitable to human habitation. These actions end up generating disastrous consequences, both for the society that is established in these places, and for the public power. (Sousa; Brito, 2012, p. 42).

There are many regular and irregular occupations around this area, in interviews with residents who live closer to the study area, some report that they were compensated, however, they were not forced to leave their homes. A resident states that: "The public administration removed some from this area claiming to be a risk area, compensating with a house in the Costa Esmeralda sector, but they were not forced to leave the place, due to the allegation of the inspection agencies saying that they would be within the allowed space." As can be seen, it is somewhat controversial, because at the same time that the public authorities compensate her, the bodies responsible for the inspection, claim that the residents are at a permitted distance, thus giving the go-ahead to continue in this space.

Regarding the problem of occupations in permanent preservation areas (APP), the following author says the following:

> The Forest Code Law No. 12,651/2012, in line with the aforementioned Master Plan, incorporates the importance of Permanent Preservation Areas (APP), but the Baixa Funda Stream over the years has been systematically suffering from the large amount of garbage, sewage and debris that is thrown along its entire length, including erosion in an accelerated process. (Barbosa, 2018, p. 25).

Another resident expresses her indignation at the attribution of the problem to the irregular occupation, for her the main cause was the construction of the track around the stream. According to this resident, "before the construction of the runway, the landscape was

very different, there was a variety of native plants, many buritis trees, mangoes, cashews, and now all that exists is erosion destroying all vegetation."

Figures 5

Buriti (Mauritia flexuosa) trees in the bed of the low sling and sandbanks

Source: Denia Carla Dias Costa Aires

In Figuregraph 4a, there are two buriti trees, (Mauritia flexuosa) trees that are part of the cerrado vegetation, typical of the region, they were uprooted by the flood, due to the fragility of the soil, because with the lack of vegetation cover the soil is left without its protection, which would give it firmness, and resistance in relation to erosive processes. In Figuregraph 5b recorded in 2025, it can be seen that the tree vegetation located in the vicinity of the watercourse, of the Baixa Funda stream, did not resist these erosive processes, leaving only the sandbanks, something that had already been evidenced since 2014.

> Both plants depend on the soil and the soil, as it has fundamental roles such as erosion, whether in natural conditions (geological erosion) or caused by man (anthropogenic erosion). In ecosystems with scarce vegetation cover, erosion is greater while in dense covers, erosion is less intense. (Lepsch, 2002, p. 55).

According to the author, there is an interdependence between soil and vegetation. In an ecosystem where vegetation cover is suppressed, the soil is unprotected, favoring its waterproofing, intensifying surface runoff, causing an increase in the erosive process.

Figures 6

Asphalt lane ruptured in 2014 and detention basin for rainwater accumulation 2025

Source: Denia Carla Dias Costa Aires

In the rainy season, the flood takes a lot of sediment, garbage and antlers into the stream, as it is a very steep area, the water gains strength and drains more quickly, and ends up aggravating the situation, in Figuregraph 6a it shows the stretch of Rua da Arruda destroyed, in this image from 2014, it is observed that the shackles used to drain the water were insufficient to the point of overflowing.

Causing a great impact and contributing to the landslides that occurred in this stretch of the track, in view of the absence of natural protection of the spring, it is exposed to these actions of physical and chemical weathering, accumulating natural and artificial waste that has been strengthening this lethal phenomenon at the head of the watercourse (Sousa, 2005).

Throughout the country's historical trajectory, native forest cover has been replaced indiscriminately, through the uncontrolled felling of trees, the use of fire to clear the land and the preparation of the soil for agricultural cultivation, seriously compromising riparian forests and water resources (Silva, 2011).

Figure 7

Satellite images help in the comparison between the years 2010 and 2025

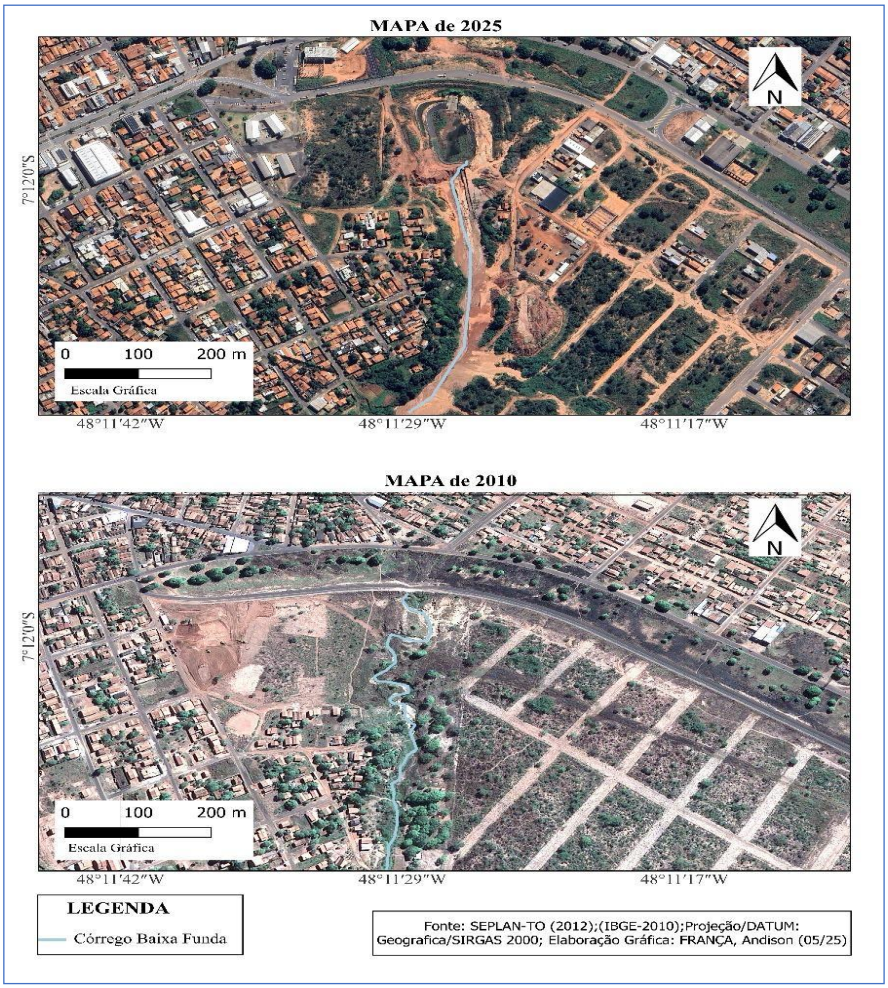


Figure 7 recorded in the years 2010 and 2025 shows some changes, including the reduction of vegetation, increased urbanization in this area, and infrastructure works around the stream.

> The use of geotechnologies with the geoprocessing of satellite images on the earth's surface, through Remote Sensing, is an indispensable tool for urban planning, from the perspective of spatializing and dynamizing events that occur in different time cuts, as well as helping in the monitoring of risk areas, and contributing with proposals for mitigating measures acting in the anticipation of aggravations or the emergence of new environmental damages. (Maciel; Silva, 2022, p. 18 and 19).

According to the authors above, the use of these remote geoprocessing technologies is indispensable to monitor risk areas, predict emerging situations, and anticipate future aggravations, contributing to the planning of cities.

One of the engineers (he preferred not to be identified) responsible for the works that have been carried out in this space, reported that "in relation to works (contracts for the provision of services through outsourced companies) we currently have 2 stages: The low founds 1st and 2nd stage". For the engineer, "the first stage includes the macro-drainage of the Baixa Funda stream from Rua da Arruda to Rua São Jorge, on the border between the Eldorado and Tiúba sectors. And the 2nd stage includes the macro-drainage of São Jorge Street until it flows into the Lontra River."

The works carried out and in progress have the objective of channeling the rainwater collected in the sectors adjacent to the stream and "transporting" it safely to its destination. This type of service is crucial to avoid erosive processes and flooding, depending on the situation in which it is applied. In theory, the macro-drainage services are open channel, upper face of the free channel and closed channel, by means of precast concrete staves. Aiming to mitigate siltation. The problem of erosion and siltation can be mitigated with the full operation of the drainage network implemented.

3 FINAL CONSIDERATIONS

In view of what was researched and analyzed, in the course of this work, it is perceived, mainly through Figuregraphs, that there were significant changes over the last decade, but properly from 2014 to 2025.

According to residents, the problem related to the landslides in this stretch of Rua da Arruda, was to the detriment of some factors such as: modification of the natural space through the removal of vegetation, successive erosions, and lack of planning on the part of the government.

In 2013 the Tocantins machinery and transport agency (Agetrans) reported that a project with hydrological studies had been prepared to solve the problem of the runway, in order to solve the demands that triggered the landslides, however, it was only around 2016 that the work was ready, and so far there have been no more problems of this magnitude in relation to the landslides.

Some works were carried out in the stream, one of them is the detention basin in order to accumulate, reduce speed and drain the waters downstream of the place that previously collapsed. Another purpose is the protection of the spring, in which there is an overflow, which accumulates water to a certain point, then begins to overflow and releases the water into the

channel itself. Currently the 1st stage, which are the works near Rua da Arruda, are stopped, with no forecast of return.

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