The influence of relief and surficial covers on urban land use and land cover: seasonal flooding on summits in Uberlândia/MG, Brazil

A influência do relevo e das coberturas superficiais no uso e ocupação das terras urbanas: alagamentos sazonais em topos de cimeira na cidade de Uberlândia/MG

La influencia del relieve y la cobertura de la superficie en el uso y ocupación del suelo urbano: inundaciones estacionales en las cimas de las cumbres de la ciudad de Uberlândia/MG

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Abstract: Flooding processes during rainy seasons are common in large and medium urban centers in Brazil, and their causing factors are very particular. In the city of Uberlândia, state of Minas Gerais, specifically in the Morumbi neighborhood, seasonal floodings have been observed since the settlement of houses, causing several urban and social impacts. The influence of relief and surficial covers may explain part of this phenomenon, which already happened even before the establishment of the neighborhood. In this perspective, we considered regional geological-geomorphological aspects to understand the dynamics of the pre-existing

existing natural systems to the population through image analysis, aerial photographs, radars available, and rainfall intensity, correlating such data to the flooding areas registered between 2012 and 2016 by the municipality's Civil Defense. We identified that the neighborhood was established on residual relief of the Uberlândia-Uberaba plateau, and the main flooding areas are in former summit surface depressions that store water during the rainy season in this geomorphological compartment. This process is intensified by the artificial impermeability of the land and by the rainfall intensity, which causes recurrent floodings in the rainy season.
Keywords: Urban flooding; Residual relief; Plateau; Extreme precipitation events.

Resumo: Em grandes e médios centros urbanos brasileiros, não são incomuns processos de alagamentos durante as estações chuvosas, sendo muito particulares os fatores que desencadeiam tais ocorrências. Na cidade de Uberlândia/MG, especificamente no bairro Morumbi, os alagamentos sazonais são observados desde a sua formação, desencadeando diversos impactos urbanos e sociais. A influência do relevo e das coberturas superficiais que ali ocorrem pode explicar parte desse fenômeno, que já acontecia antes mesmo da ocupação do bairro. Nessa perspectiva, o objetivo deste trabalho é ponderar sobre os aspectos geológico-geomorfológicos regionais para compreender a dinâmica dos sistemas naturais pré-existentes à povoação, por meio de análise de imagens, fotografias aéreas, radares disponíveis e intensidade das chuvas, correlacionando tais dados aos pontos de alagamentos registrados entre os anos de 2012 e 2016 pela Defesa Civil do município. Por meio da metodologia aplicada, identificou-se que o bairro foi edificado sobre relevo residual da chapada Uberlândia-Uberaba, sendo que os principais pontos de alagamento do local ocorrem em antigas depressões de cimeira que cumprem o papel de armazenar água durante o período chuvoso neste compartimento geomorfológico, processo que é intensificado pela impermeabilização artificial das terras e pela intensidade das precipitações, o que provoca os recorrentes alagamentos em períodos chuvosos.
Palavras-chave: Alagamentos urbanos, Relevo residual, Chapada, Eventos extremos de precipitação.

Resumen: En los grandes y medianos centros urbanos brasileños, los procesos de inundación no son infrecuentes durante las temporadas de lluvias, siendo muy particulares los factores que desencadenan tales ocurrencias. En la ciudad de Uberlândia/MG, específicamente en el barrio de Morumbi, las inundaciones estacionales son observadas desde su formación, desencadenando diversos impactos urbanos y sociales. La influencia del relieve y de las coberturas superficiales que allí se producen pueden explicar parte de este fenómeno, que ya sucedía incluso antes de la ocupación del barrio. En esta perspectiva, el objetivo de este trabajo es ponderar sobre los aspectos geológico-geomorfológicos regionales para comprender la dinámica de los sistemas naturales preexistentes a la población, a través del análisis de imágenes, fotografías aéreas, radares disponibles e intensidad de las lluvias, correlacionando dichos datos con los puntos de inundación registrados entre los años 2012 y 2016 por la Defensa Civil del municipio. Mediante la metodología aplicada, se identificó que el barrio fue edificado sobre el relieve residual de la meseta Uberlândia-Uberaba, siendo que los principales puntos de inundación del sitio se dan en antiguas depresiones de cumbres que cumplen el papel de almacenar agua durante la época de lluvias en este compartimiento geomorfológico, proceso que es intensificado por la impermeabilización artificial del terreno y por la intensidad de las precipitaciones, lo que provoca las inundaciones recurrentes en épocas lluviosas.

Palabras clave: Inundación urbana, Relieve residual, Meseta, Eventos de precipitación extrema.

Introduction

Flat relief areas, located in the upper part of slopes, tend to be more valued by real estate development projects in urban centers in the interior of Brazil. Such valuation is related to low susceptibility to floodings, torrents, and mass movements, according to Andrade et al. (2014), and less need for cutting/embankment management in the subdivision/installation of urban infrastructure. However, there are exceptions in this scenario; for example, when geomorphological processes acting in the formation of relief are combined with specific geological structures, which was the case in this work.

The Morumbi neighborhood is located on a summit part of the relief in the city of Uberlândia/MG. The region faces a serious problem: recurrent seasonal flooding, as described by Mendes (2001), Silva (2013), Medeiros (2015), Silva and Mendes (2018), and Leite (2019). Floodings have been reported since the establishment of the neighborhood in the mid-1990s and highlighted in local news (Serafim, 2001; Corrêa, 2006). They have gained greater repercussion in the last decade due to the dissemination of photographs and videos on social networks by residents affected by the phenomenon, characterized as a chronic problem in the city.

The local hydro-geomorphological dynamics explain part of these occurrences since it was not considered in the real estate development in the neighborhood, underestimating the rainwater drainage network, which became inefficient. The rainwater drainage network does not support precipitation events of greater intensity and/or volume, causing damage to the health and economy of families currently living in the flooding hotspots in Morumbi.

Regarding the geomorphological genetic processes in this context, planation surfaces stand out. Marques Neto (2014) characterized planation surfaces as erosion or accumulation surfaces resulting from structural or paleoclimatic processes, carved in different geological periods/eras as short-term or prolonged events. Surficial covers on such planation surfaces – which consist of the source material of soils – inherit their textural characteristics. Thus, they affect the water infiltration capacity in the area of occurrence as well as the surface depressions features of the relief, favoring water accumulation.

Climatic influence is another equally important factor to be considered in discussions about flooding in summit reliefs, with emphasis on extreme precipitation events, as described by Vicente (2004). Tavares and Silva (2008) and Menezes Filho and Amaral (2014), using different complementary methodological approaches, add another factor: artificial impermeabilization promoted by urban settlement, which tends to increase over time. Finally, the city of Uberlândia has a poor rainwater drainage network, which was presented and debated by Medeiros (2015). The author listed the main problems of this network and highlighted floodings in the Morumbi neighborhood, thus concluding the main variables considered in this analysis.

Debating the processes of relief formation and the spatial distribution of planation surfaces and correlative deposits in the region brings to light issues related to spatial and urban planning. Several preventive tools should be followed by government agencies and real estate agents, such as the Municipal Master Plan, the Ecological Economic Zoning (EEZ), the Hydrographic Basin Plan, among others. These should be the starting point for urban expansion processes in order to reduce negative impacts on life quality and natural resources through sustainable real estate development projects (MMA, 2012).

Considering the scenario presented, our objective was to describe the main factors that cause flooding processes in the Morumbi neighborhood in Uberlândia/MG. To this end, we characterized and discussed the geological-geomorphological aspects of the study area through image analysis, aerial photographs, and radars available, associating them with precipitation events and urban impermeability.

We analyzed how these landscape elements influence floodings that affect the described area and the local population. Therefore, this research reinforces the need for planning future land use and land cover of other urban areas with similar topo-morphological characteristics, which may cause the same urban impacts.

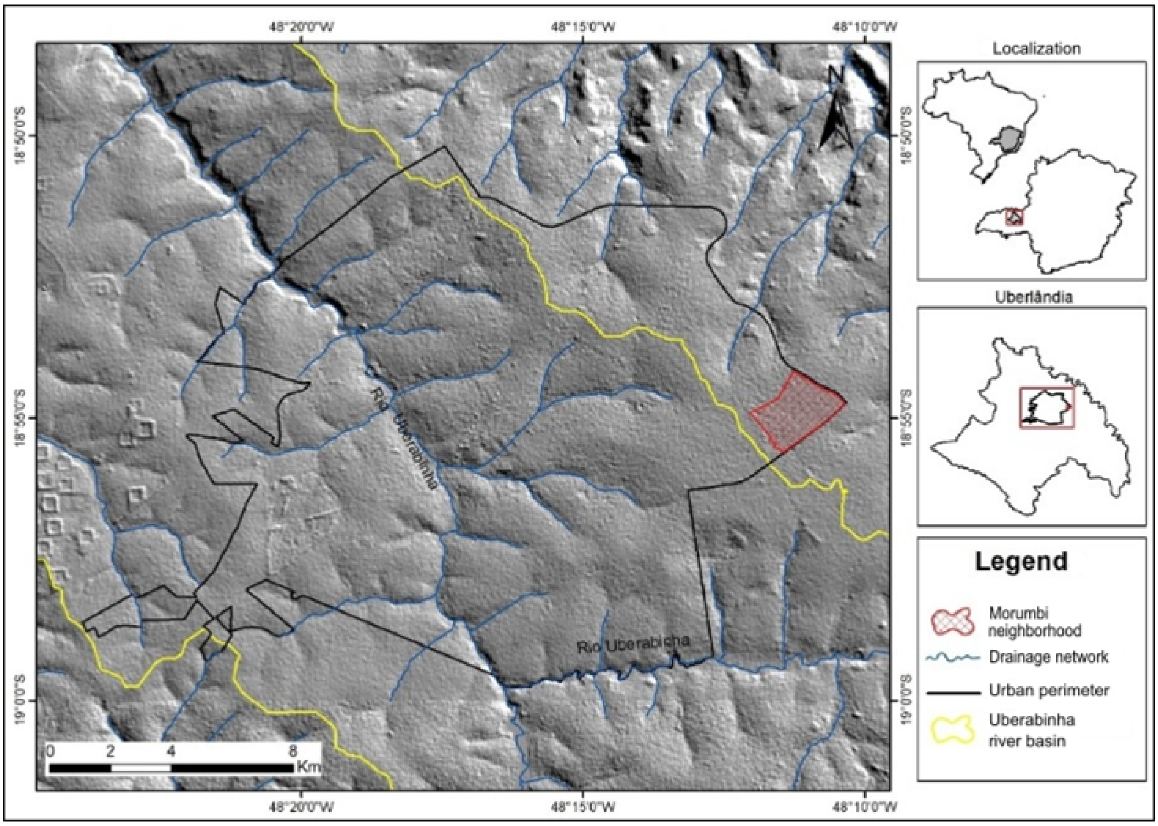
Characterization of the study area

The urban perimeter of Uberlândia/MG is mostly located in the middle course of the Uberabinha river hydrographic basin. However, the city's eastern edge occupies the Araguari river hydrographic basin, and the Morumbi neighborhood is located between both basins, as illustrated in Figure 1.

The geological-geomorphological considerations of this research started from the land division and settlement of the area for housing of the area for housing, which occurred in the 1990s. No rivers or streams cross Morumbi, so flooding is the predominant hydrological process identified in the area with the potential to cause risk to the population. According to Valente (2009), floodings are water accumulations caused by flash flood, which are surface runoff caused by more intense rains in areas partially or totally impermeable by natural processes or by human action.

In flat surfeces, such as Morumbi, rainwater does not drain quickly, as there is not enough slope and energy to do so; water accumulates in places slightly lower than the surroundings, resulting in flooding.

Figure 1 – Location of the study area



Source: ANA, 2015; PMU, 2019. Produced by the authors.

Geological-geomorphological and climatic aspects

To understand the processes related to the local geological-geomorphological characteristics, it is necessary to address them first at a regional scale, because part of the local landscape organization is a reflection of broader processes. According to Ab'Sáber (2003), the Triângulo Mineiro region is in the great "domain of interior tropical plateaus with Brazilian Cerrado and gallery forests", which consists of extensive plateaus ranging from about 600 to 1100 meters in altitude naturally covered by Cerrado vegetation. These plateaus appear in the landscape as stepped levels – corresponding to specific erosion cycles – and are sectioned by large rivers, with different dynamics and processes in each of these levels (MOREIRA, 2017).

Moreira and Perez Filho (2020) presented topo-morphological models that correlate the planation surfaces described by King (1956) to groups or rock formations found in the Uberlândia-Uberaba plateau – which is located close to the study area –, characterizing the altimetric levels and geomorphological features on each level.

The referred plateau corresponds to the South American surface and is the highest plateau in the region. It is supported by basalt flows of the Serra Geral Formation on Sandstones of the Bauru Group, which are covered by Detrital-lateritic Covers. These coverings are correlative deposits that generate superficial coverings with a very clayey texture, characteristic of this environment. This is the constitution of the tabular relief in the region. It provides favorable environmental conditions for the concentration of moisture on the surface, enabling geochemical subsidences through flaws in the underlying rock structure, thus forming depressions at summit (BARCELOS, 1984; CODEMIG, 2017; MOREIRA, 2017).

Summit surface depressions are characteristic geomorphological features of higher planated levels, usually identifiable in aerial photographs by the occurrence of Murundus micro-relief in its interior, which consist of convex, circular, or elliptical mounds of variable sizes, according to Schneider (1996). For this reason, such surface depressions and micro-reliefs are the main geoindicator of this environment, helping delineate the referred geomorphological level.

Climate is the second main factor for the analysis of flooding, and it is relevant to understand precipitation. According to Silva and Assunção (2004), Uberlândia is located in the humid subtropical climate region (Cwa), with an average rainfall of 1500 mm/year and poorly distributed rainfall. 86.75% of the annual rainfall occurs between October and March, and December has the highest monthly average, with precipitation of 318.6 mm.

In a more recent classification, Novais et al. (2018) classified a large part of Uberlândia as Southern Semi-Dry Tropical (Tr*m) – reaching climatic subtypes –, covering the study area. Only the most elevated areas of the Uberlândia-Uberaba plateau, above 1000 meters in altitude to the southeast of the study area, were classified as Southern Semi-Humid Tropical (Tr'm).

In assessing the highest rainfall volumes in 24 hours in Uberlândia, with a time series of 34 years, Petrucci and Oliveira (2019) identified a significant interannual oscillation, highlighting that the annual maximum ranged from 48.0 to 147.0 mm and happened in December 1996 and January 2002, respectively. According to Petrucci and Oliveira (2019), the highest precipitation concentrations in 24 hours identified were 147.0 and 126.8 mm, which happened in January in 2002 and 1983. Petrucci and Oliveira (2019) also concluded that the November-December-January quarter concentrates the highest values measured in the historical series, therefore having the greatest potential to cause flooding.

As for the main atmospheric systems that affect rainfall in the region and in Uberlândia, Mendes (2001) highlighted cold fronts (35.8%), tropical instabilities (26.1%), and stability production systems (27.6%), obtaining a relatively balanced proportion between systems. Complementing our literature review, Leite (2019) pointed out that a great part of the rainfall episodes that affect the region is related to the dynamics of the South Atlantic Convergence Zone (SACZ), Frontal Zones, and Frontal Systems.

Furthermore, statistical climatic considerations are relevant in this discussion. Santos and Ferreira (2016) and Petrucci and Oliveira (2019) carried out regional-scale studies and achieved relevant results on rainfall trends. They highlighted the importance of precipitation after dry spells during the rainy season and the greater intensity of rainfall in the first minutes, with a longer return period and higher volume precipitation.

Apart from the described averages, climate environmental systems are highly dynamic and systemic. They naturally and intrinsically vary their rhythm, with extreme, anomalous, or exceptional events, as described by Vicente (2004).

Therefore, identifying and standardizing positive extreme precipitation events may help understand these phenomena, which have at least three measurable practical effects: human, social, and economic. The measurement method can be understood through physical or statistical interpretation and also from a social point of view. The environmental conditions of affected areas can model the potential damage caused by a particular precipitation event in a way that its threshold is not purely statistical neither purely social (MONTEIRE; ZANELLA, 2017).

The combination of geomorphological characteristics of the landscape and atmospheric precipitation phenomena indicates the methodological path of this work, which addressed a spatial analysis of these phenomena.

Materials and methods

The elements of the landscape are complex and interdependent. Thus, the systemic approach in Geography, discussed by Christofoletti (1999), helps us understand the distribution of geographic elements in this research. Spatial organization results from interrelations between the physical natural environment and anthropic activities, and the latter occurs at a higher hierarchical level, according to Dias and Perez Filho (2017). Considering these premises, first, we addressed aspects of nature (geomorphology, geology, and climate), and then aspects of anthropic systems (land use and land Cover and anthropic impermeabilization) for subsequent correlation and measurement of the agent's responsibility, concluding the analysis of spatial organizations in the study area. Basic statistics and topo-morphological evolution models of regional landscapes were used to support the understanding and illustration of processes, as well as orbital and non-orbital images, which were important instruments for this research.

To prepare the digital elevation model, which correlates the study area to the adjacent plateau, we used Shuttle Radar Topography Mission (SRTM) images provided by United States Geological Survey (USGS) (2014), with a spatial resolution of 30 meters. This material was fundamental for understanding the regional geomorphological evolution.

We identified surface depressions and typical geomorphological features of the summit surface before urban settlement through the analysis of aerial photographs and satellite images, associating them with the main current flooding spots. To do so, aerial photographs from 1964 taken by the United States Air Forces (USAF) and images from different satellites from 2019, available on Google Earth Pro, were georeferenced.

To analyze the rainfall parameters between 2012 and 2016 and the correlation with flooding episodes identified by the Civil Defense, we collected precipitation data from the Uberlândia-A507 meteorological station of the National Institute of Meteorology (INMET-Brazil) (2020), located about 7 kilometers from the study area. Rainfall types were classified according to the methodology of Santos and Ferreira (2016), who analyzed the rainfall variability in the Triângulo Mineiro region for over 33 years. They used the following criteria to classify the intensity of rainfall in a 24-hour interval: <10 mm – light rain; from 10.1 mm to 20 mm – moderate rain; from 20.1 mm to 29.9 mm – heavy to moderate rain; and >30 mm – heavy rain. Through this systematization, the results were obtained using the Excel 2018 software.

The occurrences of flooding in Morumbi between 2012 and 2016 assisted by the Civil Defense of Uberlândia, listed by Silva and Mendes (2018) and by the rainfall emergency plan of Uberlândia's municipal administration (UMA) (2019a), correspond to the social aspects covered in our research, which was essential to identify flooding hotspots mapped and correlated with areas naturally susceptible to flooding.

For preparing the flooding spot density map, we used emergency call records of the Civil Defense of Uberlândia. The records provided the date of occurrence and the reason behind each call. We selected the calls from Morumbi associated with flooding and excluded other records in the period.

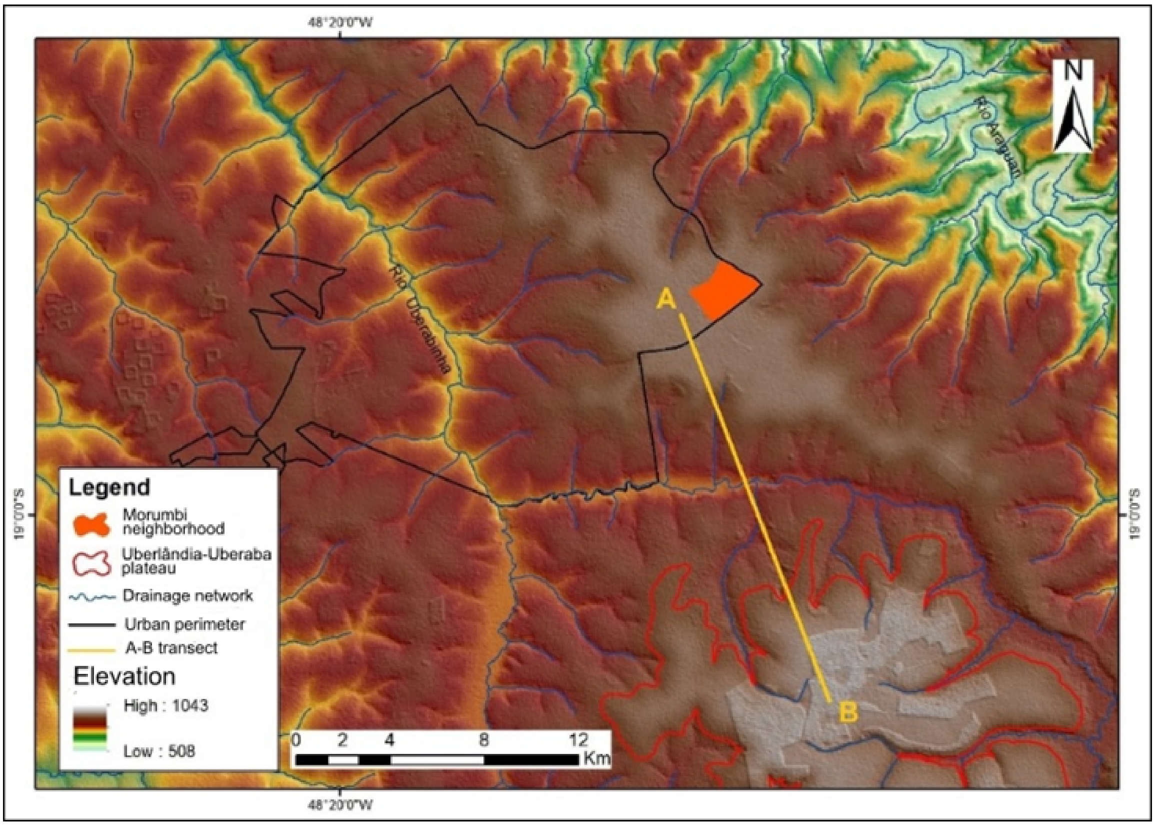
The georeferencing of the calls enabled the development of grid points, in which we identified the areas with the greatest recurrence of flooding through Kernel interpolation. All methodological procedures took place in a Geographic Information System (GIS) environment with the support of the ArcGIS 10.7 software.

Results and discussion

The Uberlândia-Uberaba plateau, situated near the urban perimeter of Uberlândia/MG, Brazil, is of great importance for understanding the regional geological-geomorphological context. When reconstructing past landscape scenarios, we observed that the plateau was larger previously, and the vertical fitting of river channels was responsible for its fragmentation, as can be seen in Figure 2. With altitudes higher than 900 meters, the non-dissected area between the Uberabinha and Araguari rivers, where Morumbi is located, consists of a residual relief of the plateau and is topographically classified with the same coloration according to the Digital Elevation Model (DEM) in Figure 2 (MOREIRA, 2017).

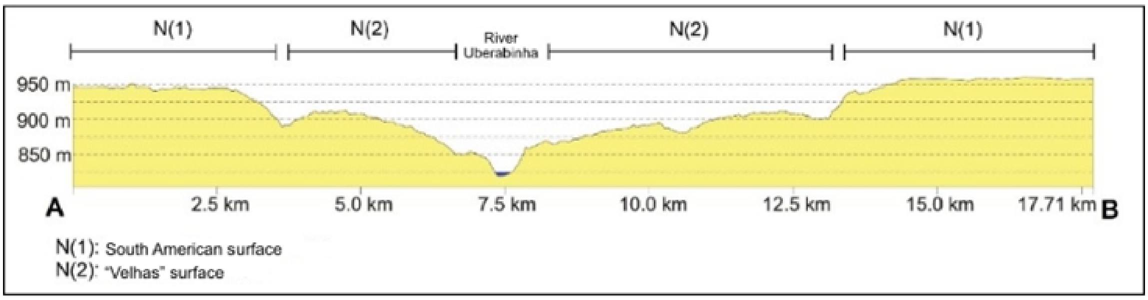
Figure 3 illustrates the N(1) level as corresponding to the South American surface, which was sectioned by the Uberabinha river. The portion on the left of the transect has the same residual relief described above. Lithological variation also shows this relationship, as it oscillates according to the erosive form of the valley and exposes the oldest rocks, which come to the surface as a result of erosive cycles after the generalized planation of the relief, such as the "Velhas" and "Paraguaçu" cycles.

Figure 2 – The Morumbi neighborhood on the residual relief of the Uberlândia-Uberaba plateau and location of the topo-morphological transect A-B



Source: ANA, 2015; USGS, 2014. Produced by the authors.

Figure 3 – Topo-morphological A-B transect between the plateau and the residual relief, separated by the Uberabinha river valley

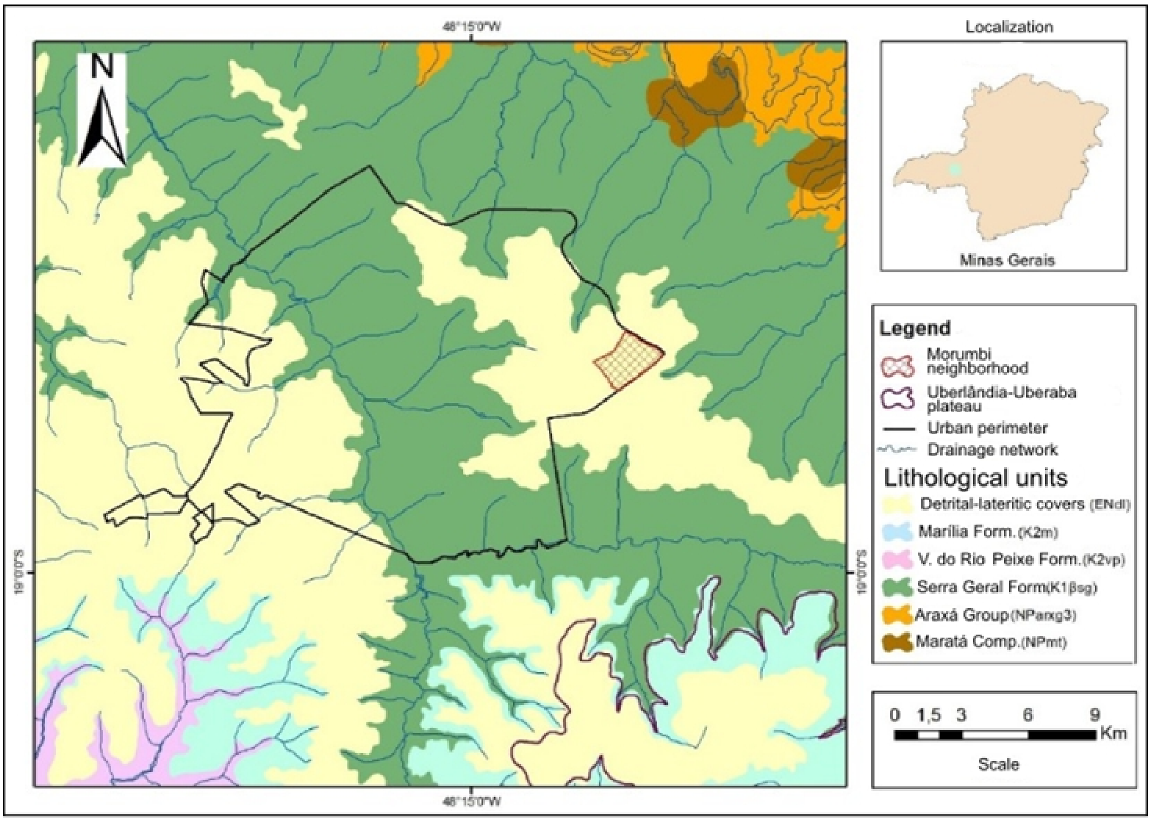


Source: USGS, 2014. Produced by the authors.

The city of Uberlândia expanded in the 1990s exactly on this residual relief, and the Morumbi neighborhood was established in the central portion of this area. The topo-morphological model presented and the geological context expressed in Figure 4 reinforce this scenario, showing the regional location of the mentioned processes.

The occurrence of the Detrital-lateritic Covers on residual relief, indicated in Figure 4, creates a low-permeability area in Morumbi. According to Moreira (2017), who analyzed several particle sizes on the surface covering of the Uberlândia-Uberaba plateau, the amount of clay fraction in the surficial covers exceeded 80% in almost all samples, even at depths greater than 2 meters. Clay, in this context, behaves as a natural barrier to infiltration due to its flat-parallel accommodation, which forms almost impermeable layers, causing water to remain for a long time on the surface of the ground.

Figure 4 – Geological context around Uberlândia and the Uberlândia-Uberaba plateau



Source: CODEMIG, 2017. Produced by the authors.

The higher amount of water in the rainy season on the planated surface is directed to the low-pressure areas on the plateau, which, in turn, accumulate moisture for weeks and even months depending on the rainfall regime. This water slowly feeds the first-order channels near the plateau under the surface, functioning as a water reservoir for the dry period. Moreira and Perez Filho (2017) described the dynamics of these surface depressions, characterizing their function as a source of this geomorphological level, and reiterated the importance of ecosystems and environmental services. Figure 5 illustrates surface depressions photographed at two different times, in the wet and dry seasons in the Uberlândia-Uberaba plateau.

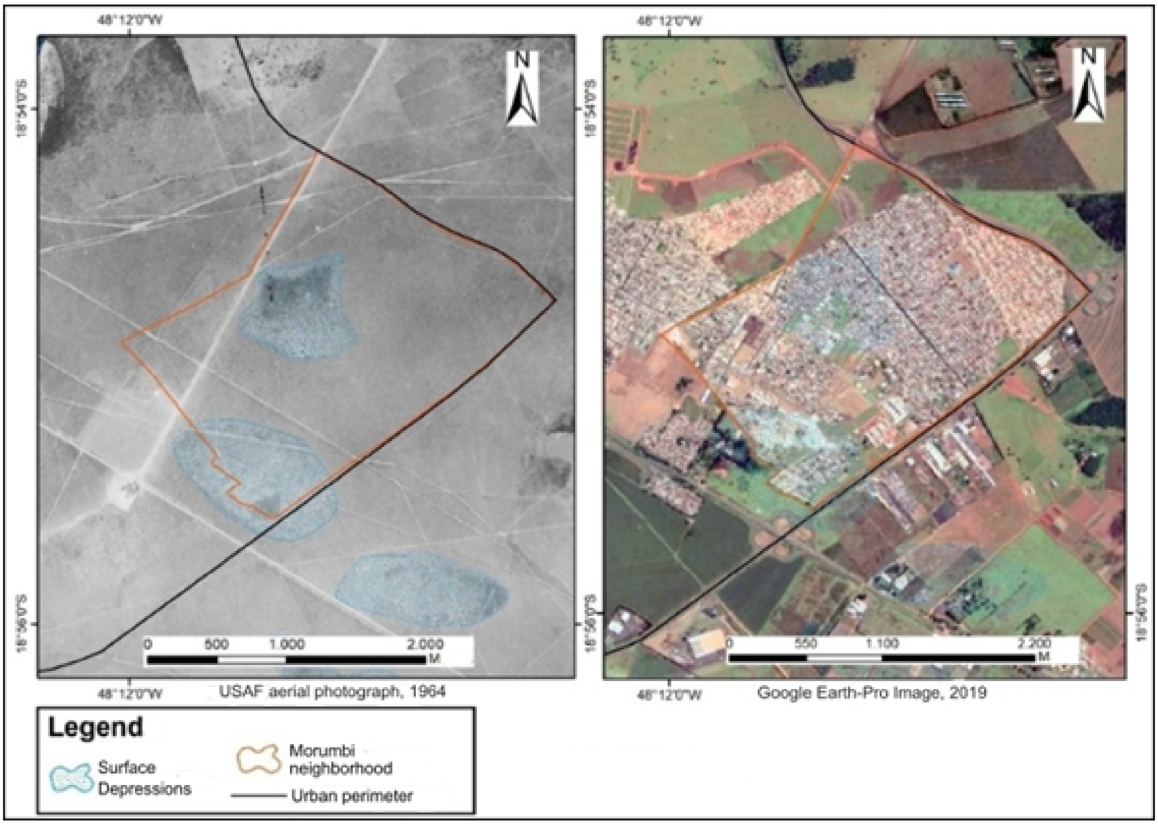
Figure 5 – Center of surface depression in the summits of the Uberlândia-Uberaba plateau: dry (August/2015) and wet (February/2015) seasons

Source: Moreira and Perez Filho, 2017.

These surface depressions were masked by urban land use and land cover. Thus, they are not easily observed. A detailed topographic survey or analysis of aerial photographs is necessary for such affirmation. Therefore, we vectored images and photographs before and after the urban settlement as shown in Figure 6.

In 1964, the entire area currently occupied by the Morumbi neighborhood was taken by pasture, with fragments of native vegetation in ellipsoidal-shaped areas. These areas were precisely the surface depressions areas that accumulate water in the rainy season. One of these depressions is located at the southern edge of Morumbi, presenting very distinct morphological characteristics. The other depression is in the central area of the neighborhood. Even in 1964, this area did not have this characteristic natural ellipsoidal shape, indicating that its edges had already been drained and changed for pasture use. Despite the absence of the characteristic shape, we can observe it due to its very different texture concerning the surrounding area, which is also a geoindicator attribute of other depressions. The darker coloration in the center of the depressions also indicates a greater presence of moisture in this type of photograph.

Figure 6 – Aerial images of Morumbi in 1964 and 2019



Source: Google Earth Pro, 2019; USAF, 1964. Produced by the authors.

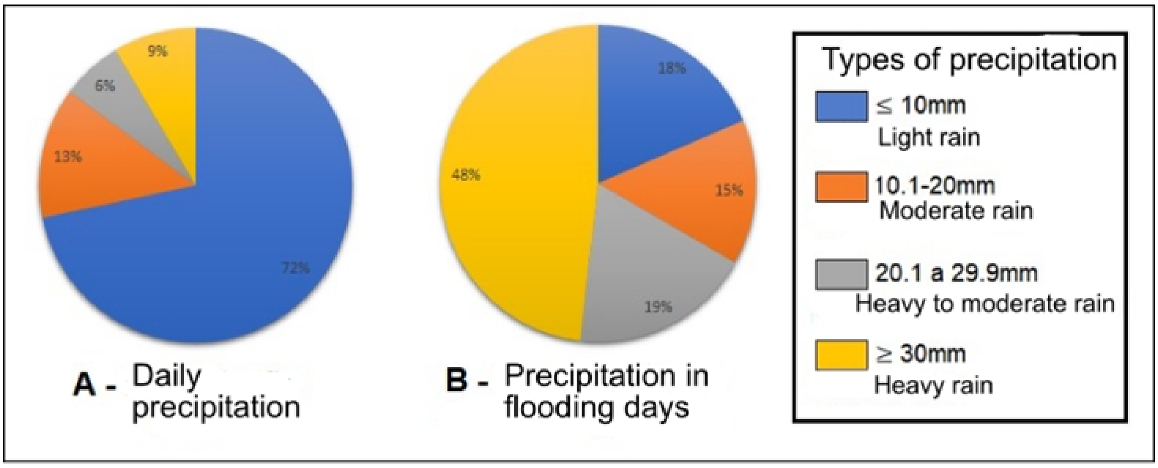
In 2019, built-up areas increased in Morumbi, and few green areas were left in the central area – which appear in some edges of the neighborhood, but they are possible areas for future expansion. Thus, the artificial superficial impermeability is an aggravating factor to a situation of natural low permeability, demanding a lot from the local rainwater drainage system.

Silva and Mendes (2018) introduced the rainfall variable into this discussion. They used data from the assistance center provided by the Civil Defense of Uberlândia in flooding areas between 2011 and 2016 and correlated flooding episodes to the type of relief and rainfall in the urban perimeter of the city. Silva and Mendes (2018) concluded that there are flooding spots throughout the city, but they are more concentrated and common in flat relief areas, which indicates the eastern part of the city, the Morumbi neighborhood, as a major focus of flooding.

Silva (2012) addressed rainfall intensity as an important factor in their analysis of rainfall disasters, which encompassed mediumsized cities in the state of Paraná and featured 30 years of rainfall data. The author considered extreme precipitation events above 50 mm per day, which was the basis for listing other classes of rain with the potential to cause disasters. Silva (2012) also assessed rain intensity and/or its slow/gradual evolution, thus managing to correlate these variables with the state Civil Defense service data.

Covering the Triângulo Mineiro region, Santos and Ferreira (2016) established the types of precipitation used as a reference in our work. They presented a time series suitable for climate studies and covered the same region of our study, considering extreme precipitation events above 30 mm per day. Thus, we classified rain considering rain intensity in percentage for daily precipitation events between 2012 and 2016, represented in Figure 7 (A). Later, we analyzed another sample group. We covered only the days of precipitation with calls from Morumbi to the Civil Defense of Uberlândia due to flooding. The average of extreme precipitation events was much higher when this second group was observed, which presents a direct correlation between heavy rains and flooding, as shown in Figure 7 (B).

Figure 7 – Distribution of types of daily precipitation (A) and types of precipitation on flooding days (B) in Morumbi between 2012 and 2016



Source: INMET, 2020. Produced by the authors.

Interpreting the percentages in graph (A), we observed a great predominance of rain events of low intensity. Thus, extreme precipitation events in the area are rare when all days of precipitation in the selected time frame are analyzed. However, graph (B) shows that heavy and moderate to heavy rain events are more common when considered only the days when the Civil Defense was called due to flooding.

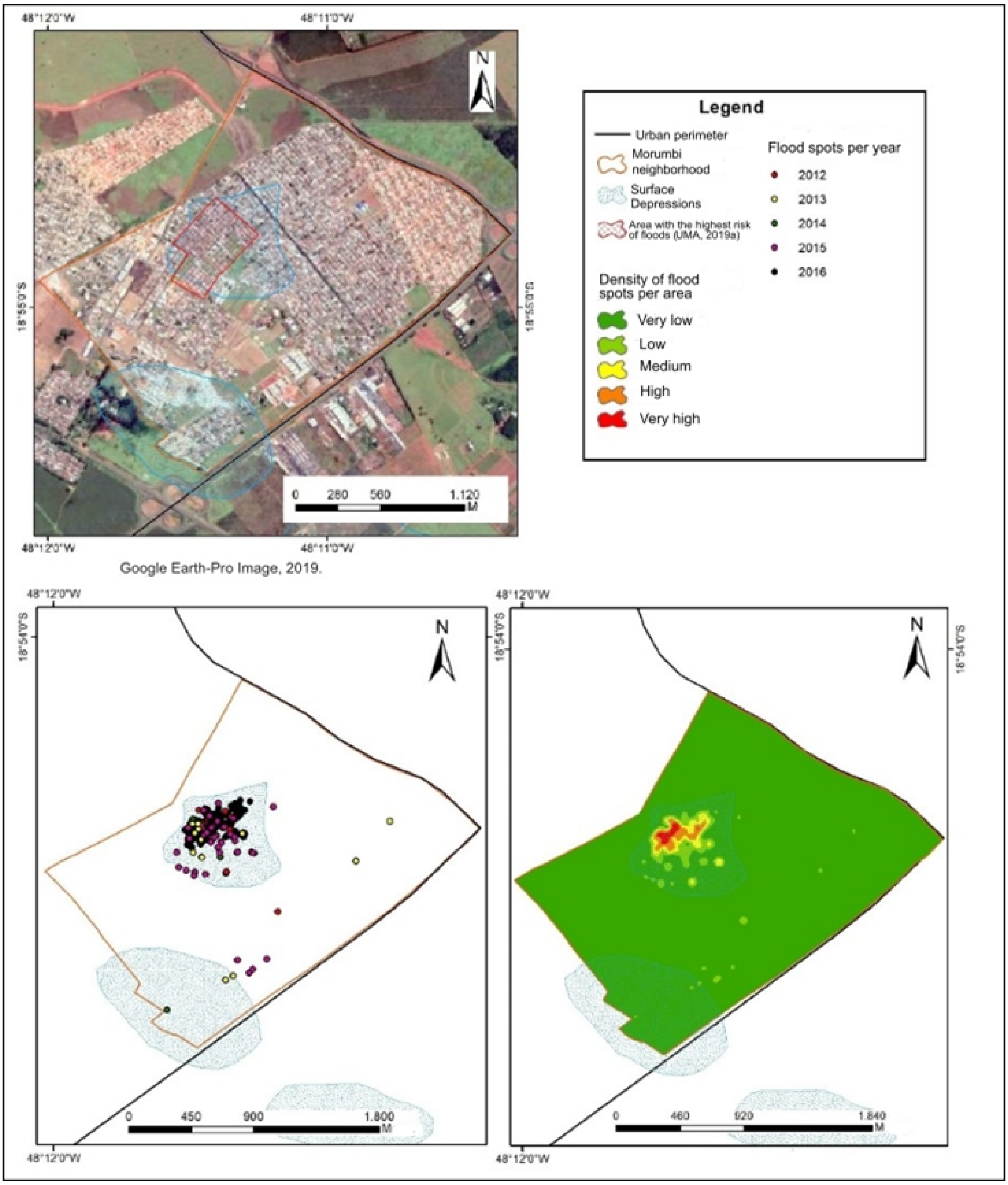
Nevertheless, there were still rains of low and moderate intensity on flooding days, leading to two important considerations. First, floodings in the Morumbi neighborhood are not exclusively correlated with extreme precipitation events, as less intense rainfall can also trigger the process. Second, some localized and short rainfalls unidentified by daily rainfall analysis data could also cause flooding. Silva and Mendes (2018) corroborated this second consideration. They pointed out that the occurrence of localized torrential rains also triggers such flooding, grouping part of the Civil Defense services between October and March.

Analyzing the data of occurrences recorded by the Civil Defense in Uberlândia, we identified that floods are annual. They caused several damages throughout the rainy season between 2012 and 2016, especially in areas where these processes already occurred but were aggravated when associated with densely occupied and impermeable areas, such as the Morumbi neighborhood. According to Silva and Mendes (2018), these areas become more vulnerable with each flooding because of the social profile of the population. Morumbi is a peripheral neighborhood that houses a low-income population.

Aiming to reduce the severity of flooding problems, the Civil Defense and the municipal government of Uberlândia launched the city's rainfall emergency plan. The aim was to inform the population about the risks of flooding and how to act in rainfall emergencies according to the severity of the events. The document presented a flooding risk map, in which Morumbi is the most prominent neighborhood, comprising 15 streets as high-risk areas for flooding (UMA, 2019a).

Figure 8 correlates the high-risk areas for flooding provided by the municipal government (UMA, 2019a) for the Morumbi neighborhood with three variables: surface depressions, artificial superficial impermeability, and flooding spots. Comparing the three scenarios presented in Figure 8, we observed that the area with high or very high density of flooding spots is also really impermeable, impairing the infiltration of rainwater. Thus, the denser center of spots may be associated with the topographic center of the surface depression, a lower area that accumulates surface water for a longer time, decreasing its intensity towards the edges of the depression. As described by Moreira (2017), the same the edges of the depression. As described by Moreira (2017), the same dynamics observed in non-anthropized depressions in the Uberlândia-Uberaba plateau occur, a phenomenon aggravated by artificial superficial impermeability.

Figure 8 – Risk area, surface depressions mapped, and flooding spot density in the Morumbi neighborhood



Source: Google Earth Pro, 2019; UMA, 2019a. Produced by the authors.

Even though the Civil Defense has not delineated the southern area of the neighborhood as an area of flooding risk – which also presents topographic depressions –, this location also had occurrences, but with less recurrence due to less impermeability of the soil.

Final considerations

The results obtained show how geomorphological processes influence flooding events in the Morumbi neighborhood, in Uberlândia/MG, Brazil. This influence highlights the role of planation surfaces and their correlative deposits, which enabled the formation of clayey surficial covers that allow natural flooding in depressions formed by geochemical subsidence, caused by flaws in the underlying structure. Flooding is accentuated by heavy rainfall and artificial impermeability of land. Moderate or high-intensity rains with torrential characteristics trigger flooding events, which cause financial, health, and quality of life losses for the population living in Morumbi.

By disregarding the preventive legal instruments previously described, urban planning is compromised, causing damage to the entire community. Even after government investments in more efficient rainwater drainage systems, flooding is still a problem in the Morumbi neighborhood until the present moment.

Disorderly anthropic actions, superimposed on the fragile dynamic balance of natural systems, provoked this negative response, and the current spatial organizations are consequences of such interactions.

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