475

MULTI-SLICE VISIBILITY GRAPH ANALYSIS

THE CASE OF THE BODOCONGÓ DAM IN CAMPINA GRANDE, BRAZIL

MAURO NORMANDO M. BARROS FILHO, ALEXANDRE A. B. DA CUNHA CASTRO &

LUCAS DE SOUZA JALES

UFCG, UFRN, UFCG

ABSTRACT

The Bodocongó dam is a symbolic reference of popular culture in the city of Campina Grande, Brazil. Its importance goes beyond physical existence and gains vital contours when considering the semiarid region where it is located. However, similar to most of the Brazilian urban water bodies, the dam is polluted and abandoned. Therefore, this article aims to assess how the visibility of the dam influences its recognition as an important element of the urban landscape and its current state of degradation. Initially, a digital 3D model of the area around the dam was built in SketchUp, considering its topography, buildings and vegetation cover. Then, this digital 3D model was cut into 42 slices every 2.5 metres high and a Visibility Graph Analysis (VGA) was run in Depthmap for each resulting DXF layer, assuming a 10m x 10m grid. Surface maps were then generated by IDW interpolation of the VGA values in each layer. Finally, an overlay analysis was performed in QGIS, in which the homologous point values across all surface maps were averaged, resulting in an overall visibility map of the study area. The results show that the topographic profile of the valley shapes the perception of the dam. On the one hand, the elevated portions of the relief allow its visualisation from a long distance and provide a visual emergency, in which its sudden appearance causes surprise to the observer. On the other hand, some areas near the dam impede its visibility due to barriers caused by buildings and vegetation. These results, therefore, reveal the importance of a landscape intervention that encompasses the appropriate local species for the composition of the biome, in addition to a greater control of construction indices, in order to promote friendlier interfaces between the dam and its surroundings.

KEYWORDS

VGA, 3D Model Slicing, IDW Interpolation, Overlay Analysis.

1 INTRODUCTION

Very present in the global context, urban water bodies in many cases originated the cities that border them. Large metropolises can exemplify this, such as London with the River Thames or Cairo with the River Nile. However, the treatment that has been given to urban water bodies and their surroundings has been quite different among cities around the world. In one hand, many cities from developed countries overcame the great problem of pollution of their urban waters, which had been a consequence of the early stages of the Industrial Revolution. In such cities, the greater awareness of the environmental importance made their rivers and lakes points of tourist attraction and urban regeneration. The present uses of these revitalised areas are mainly in leisure and contemplation activities, and as a result, their appropriation as a scenic element of the urban landscape is an incentive to preserve these water bodies both in their physical-chemical composition and in the visual elements present in their surroundings.

On the other hand, in most developing countries, a combination of factors - such as deficiency in the population's environmental education, absence of public policies for basic sanitation, and lack of appreciation of environmental aspects by the private sector - make the situation critical. In such cities, as a consequence of great social inequalities, the banks of their water bodies are kidnapping in two different ways: either through the invasion of riverside areas by excluded social groups, or through the speculation and spectacularization by real estate and business agents. As a result, the most recurrent problems are water pollution, gentrification and privatisation of neighbouring public spaces, as well as deforestation of riparian forests. According to Carrasco (2016), urban open spaces should be considered city heritage to be preserved, taking into account their special characteristics. Such spaces are understood as transition areas between the natural and urban environments. Despite having elements of natural fauna and flora, their treatment and modifications through human hands characterise them as places of anthropic influence. Thus, urban areas surrounding water bodies are of great value in the context of growing environmental awareness and an increasing urban population. These areas allow citizens to come into contact with nature, serving as important elements of visual contemplation.

In this context, the main objective of this article is to assess how the visibility of the Bodocongó dam in the city of Campina Grande, Brazil, influences its recognition as an important element of the urban landscape and its current state of degradation. In order to achieve this, the present paper is divided, beyond this introduction, into five parts. Firstly, it is presented the study area, highlighting its origins and occupation process. Secondly, it is described the main foundations and developments of the theory that supports this research. Thirdly, it is explained the methodology applied, detailing the steps and procedures done. Fourth, it is shown and discussed the obtained results. Finally, it is driven some conclusion, considering the importance, limitation and future developments of this research.

2 STUDY AREA

Despite being located in the periphery of the city Campina Grande (Figure 1), Bodocongó dam is an important urban reference and its presence does not go unnoticed by both the population and the visitors. It is the first significant viewing point for people coming from the interior of the state of Paraíba, being bordered by arterial urban roads. The importance of this water body goes beyond the mere question of its physical existence, as a symbolic element also present in the imagination of popular culture in Paraíba. Its importance also gains vital contours when analysing the geographic context of the insertion of the city of Campina Grande in the so-called polygon of droughts, characteristic of the semi-arid climate, which covers most of the Brazilian Northeast. However, even considering its historical, geographical and cultural importance, the Bodocongó dam, similar to most urban water bodies in Brazil today, is polluted and abandoned (Gorski, 2010). In view of this, we sought to carry out an analysis of the physical elements of the dam that negatively influence its visual appropriation as an important element of the urban landscape, and in its current state of degradation.

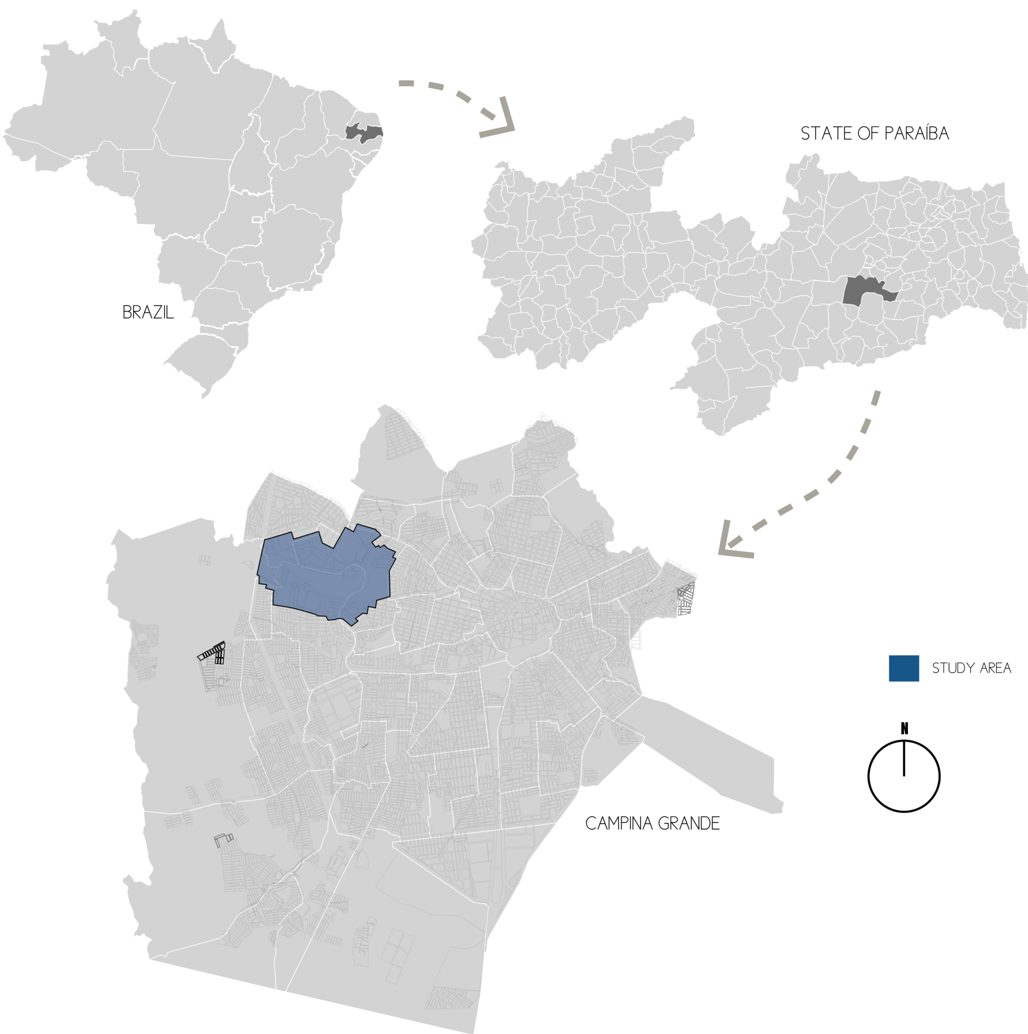

Figure 1: Location of the study area. Source: SEPLAN/PMCG, edited by Jales and Barros Filho (2020).

Due to its strategic location, Campina Grande emerged in the early 18th century as a trading post, a crossing point for the so-called "tropeiros", who travelled from the seacoast to the state's hinterland. With a slight population growth throughout the 1800s, it was elevated to the category of city in 1864 (Queiroz, 2008), already having in its urban area at that time the Velho dam, built in 1830. Revealing the difficult water reality of the region, the existence of large dams in the urban area is one of the references of the city of Campina Grande, being one of the outstanding factors of the local landscape.

At the end of the 19th century, the city emerged as a great producer and processor of cotton; and, due to the growing need for outflow, in 1907 the rail connection branch with the city of Recife was inaugurated, through which the largest part of the production was exported. From then on, the city had the greatest period of economic growth in its history, arriving in 1939 with a population four times greater than at the beginning of the century (Queiroz, 2008). Despite the water reality, population growth led to the need to build a new dam for local supply. Thus, in 1915, the construction of the Bodocongó dam began at the behest of mayor Cristiano Lauritzen, which took place by damming the Bodocongó and Caracóis streams, located at that time outside the existing urban limits (left photo in Figure 2).

With its opening in 1917, the Bodocongó dam began to attract the expansion of the city, thus creating the homonymous neighbourhood on its banks. According to Maria and Santos (2017), the remarkable presence of the dam is intertwined with the history and formation of the neighbourhood, which took place on its banks and the various uses made in its waters, mainly for leisure activities of the population. With the finding of the high salinity of its waters, making its intended use for human supply unfeasible (Araújo et al., 2020), its banks began to be used by the first manufacturing plants in the municipality, marking the prelude to the industrialization of Campina Grande.

One of the first factories installed was Tecidos Bodocongó Aires & Company, owned by businessman Aprígio Veloso, where it operated until the mid-1990s (middle photo in Figure 2). With the installation of industries, it began to attract a large population, formed mainly by people fleeing the drought in search of work. The initial occupation took place in a disorderly fashion, with typologies of houses on narrow terrain in the vernacular style, predominant in areas of urban expansion at the time (Queiroz, 2006).

With the installation of the new industrial district of Campina Grande, in the south of the city, the emptying of factories around the dam was a reality from the 1960s onwards, caused by the migration of companies. Notwithstanding at that time, the largest institutions of higher education in the city were installed in its vicinity: the Federal University of Campina Grande - UFCG, in 1952; and the State University of Paraíba – UEPB (1966), which brought a profile of student housing to the neighbourhood. Current efforts to revitalise the banks came with the construction of Bodocongó Park by the state government in 2017, which was completed in 2019. The park was implanted on the north bank in order to bring the population closer to the water body (right photo in Figure 2).

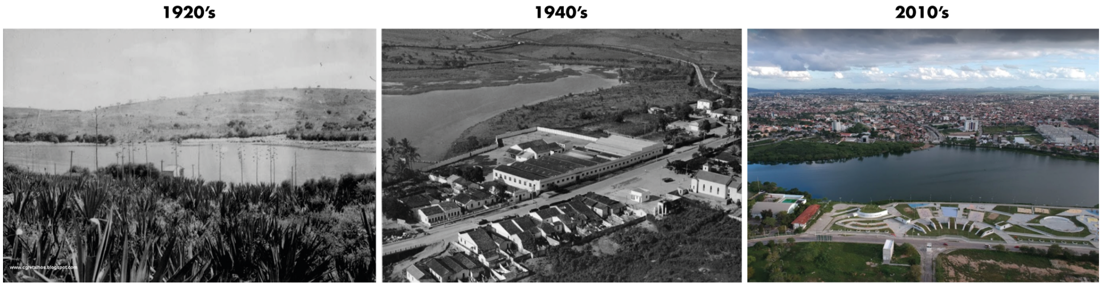

Figure 2: Three moments of the Bodocongó dam. Sources: http://cgretalhos.blogspot.com/

3 THEORETICAL CONTRIBUTION

With the growth of cities over the centuries, which have become the main means of existence of human societies, many scholars have sought to discover and describe the relationships between space and society. In the Renaissance, with the emergence of perspective studies, there were attempts to understand the relationship between monuments and urban buildings and the street (Medeiros, 2006). From the 18th century onwards, major urban interventions were carried out to highlight the monuments in the existing urban fabric, as the cases of Paris with Baron Haussmann and L'enfant's project for Washington. According to Benevolo (1996), the treatment and opening of large and wide avenues sought to bring an image of a modern city, in order to highlight elements that marked dominant ideologies, whether political or economic, as well as, in some cases, to be an attempt to erase or overcome the past.

With great importance for the visual analysis of urban space, the Serial Vision method proposed by Cullen (1961) seeks, through a specific route, to trace the city as an object of perception of its inhabitants. In his concept of urban landscape, human sensory perceptions are responsible for the assimilation of the city as a coherent and organised environment through the tangle of buildings, streets and monuments. Depending on the spatial configuration of the urban fabric, the return of these perceptions may or may not be pleasant, as well as generating in its users different ways of relating to or appropriating the place. The serial view can be used through Google StreetView (Jales and Barros Filho, 2021), providing a better spatial understanding of the study area, and making it possible to list the possible factors that influence the visual perception of the Bodocongó dam.

In parallel with Cullen's method, Lynch (1960) developed a study on the image of the city, highlighting how the urban fabric is perceived through its constituent parts through five elements: paths, boundaries, neighbourhoods, nodal points and landmarks. From this, the concept of legibility was formulated, which is the ease with which parts of the city can be recognized and organised as a pattern by the population, mainly derived from the visual aspects of the place. The great contribution of this study lies in the understanding of how users understand the city, in order to promote an identity and meaning of belonging to the urban space in which they live.

Given the importance of the dams in the formation of Campina Grande, Cullen’s and Lynch' concepts allow us to understand and systematize the current way in which the population of the city relates to the Bodocongó dam, and how its current state of visual and environmental degradation influences negatively on this appropriation.

With the deeper of urban studies, in the early 1980s, through computational advances, Hillier and Hanson (1984) created the Space Syntax Theory. Revolutionary in the evaluation of urban spatial configurations, Spatial Syntax provided a deeper analysis, based on the Natural Movement Theory, to explain how the configuration of space determines the pedestrian movement, explaining how the uses of the city follow its configuration (Hillier et al., 1993).
Coming from the field of Spatial Syntax itself, the Visual Graphic-Analysis (VGA) proposed by Turner et al. (2001) represents space as a sequence of visual fields and analyses the relationship of each point in space to the others. As a way to better understand the space, whether architectural or urban, the VGA proposes an analysis of the morphology and obstacles present in an area that can interfere with the spatial visualisation from a point or more points travelled by the observer.

Working at its core with the concept of isovist developed by Benedikt (1979), which is defined as the polygonal shape of the visual field from a certain point, the so-called Visibility Graph is generated from a grid of points. The processing result can be interpreted by a colour scale, from the warmest, such as red, which indicates the most visible areas, to the coldest (such as dark blue), which represents the areas of lower visibility.

DepthMap software enables to perform 2D VGA on both building and urban environments. It allows the user to import layouts in DXF format and to fill them with a grid of points to construct a visibility graph (Turner, 2001). However, given its limited two-dimensional processing, more recent developments in spatial syntax attempt to apply VGA in three dimensions (3D VGA).
From the initial perspective of the methods of Lynch (1960) and Cullen (1961), in parallel with the work of Morello and Ratti (2009) and Lui and Wang (2012), we seek to develop a methodology to achieve results closer to reality, contributing to 3D VGA becoming an increasingly useful tool for more suitable urban studies and urban interventions. During the research, some specific 3D VGA softwares, such as DS3D from Opoarch (University of Porto, Portugal), were still under development.
Therefore, the methodology presented below aims to overcome the two-dimensional VGA limitation of the DepthMap software to evaluate the three-dimensional space of the study area through the so-called multi-slice method applied by Silva (2017) in her study of Evaldo Cruz Park, in Campina Grande (Figure 3).

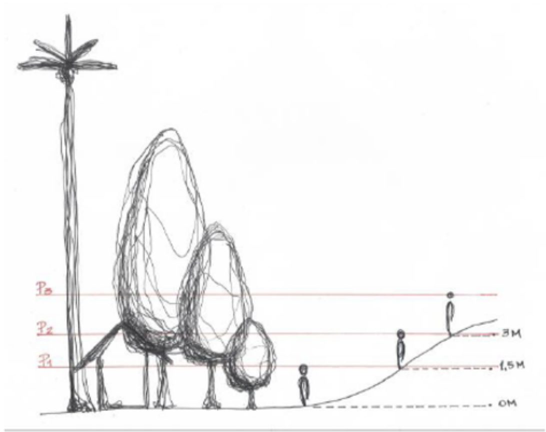

Figure 3: Schematic of cuts of the multi-slice methodology. Source: Silva (2017).

4 METHODOLOGY

The proposed methodology is composed of five main steps. The first step consists on the construction of the geo-referenced database. Initially, a survey was carried out of the spatial (in vector and raster formats) and non-spatial data available from the study area. Many of them were updated from a previous research (Sander and Barros Filho, 2019). Finally, all the geo-referenced data were organized into three classes: topography, buildings, and vegetation. The first class representing the relief of the study area, and the others classes, its visual barriers. The vegetation data was also divided into trees and shrubs, due to their different impact on the visualization. The second step involved the construction of a 3D model in SketchUp to represent the topography, buildings and vegetation classes of the study area. Initially, the topography was modelled through the Toposhaper plugin, using as a basis the altimetric contours from the base map of Campina Grande. Then, the buildings were modelled by extruding the height values which were assigned to their horizontal projection' map. Finally, the vegetation was modelled based on a local native flora survey done by Andrade (2018). Once the volumes were modelled, the three classes were overlaid (Figure 4) through the DropGC plugin to set the layers of buildings and vegetation in their correct position on the topography (Figure 5).

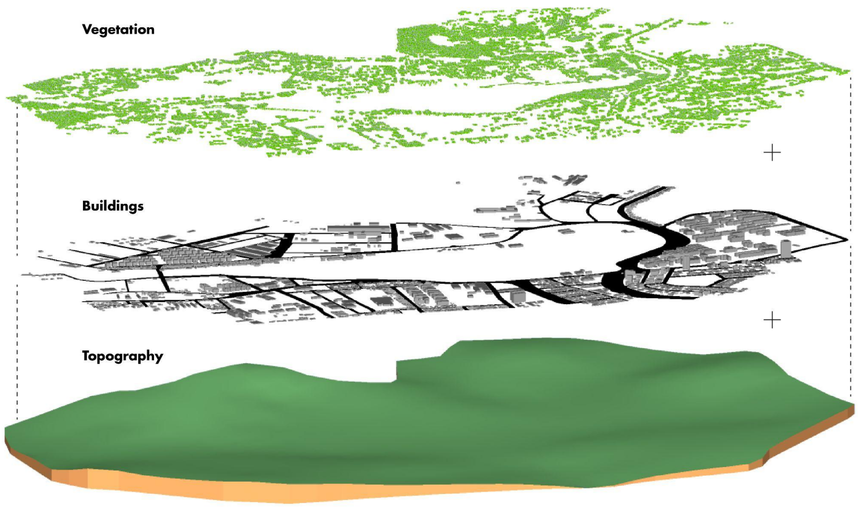

Figure 4: Schematic of the three overlaid classes.

In the third step, the 3D model was cut into 42 slices using SketchUp's native section tool. The elevation curves of the study area range from 500 m to 607.5 m, which gives a height difference of 107.5 m. Each slice was cut at every 2.52 m height, beginning at 1.5 m elevation that represents the height of the viewer's eye, according to Gehl (2013). The fourth step consisted on apply the 2D VGA for each slice. Initially, each slice was converted to DXF format. Then, the files were edited in AutoCAD. Finally, they were exported to Depthmap and the visual integration of each slice was calculated in the conventional way, assigning a grid of 10m x 10m.

Figure 5: Schematic of the model's volumetric unification.

The fifth and final step of the methodology was the construction of the 3D VGA map of the study area. Initially, the maps of each slice were converted to MIF format and exported to QGIS as a point file. Then, an Inverse Distance Weighted (IDW) interpolation (Bartier and Keller, 1996) was performed for each map. Finally, the average of the values of all the slices was calculated using the raster calculator tool, resulting in the 3D VGA map of the study area. Figure 6 shows the data generated for the slice 14 at 36.5 metres high, as an example.

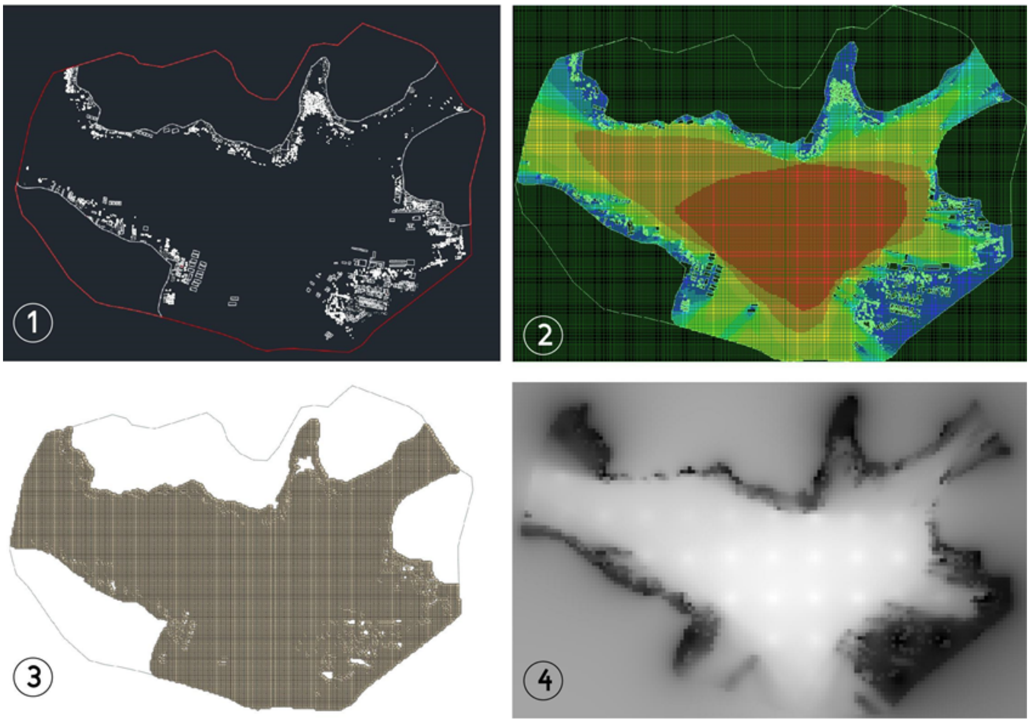

Figure 6: Example for slice 14 in DXF (1), GRAPH (2), and MIF (3) formats; and interpolated layer (4).

The five steps described above are summarized in Figure 7 below.

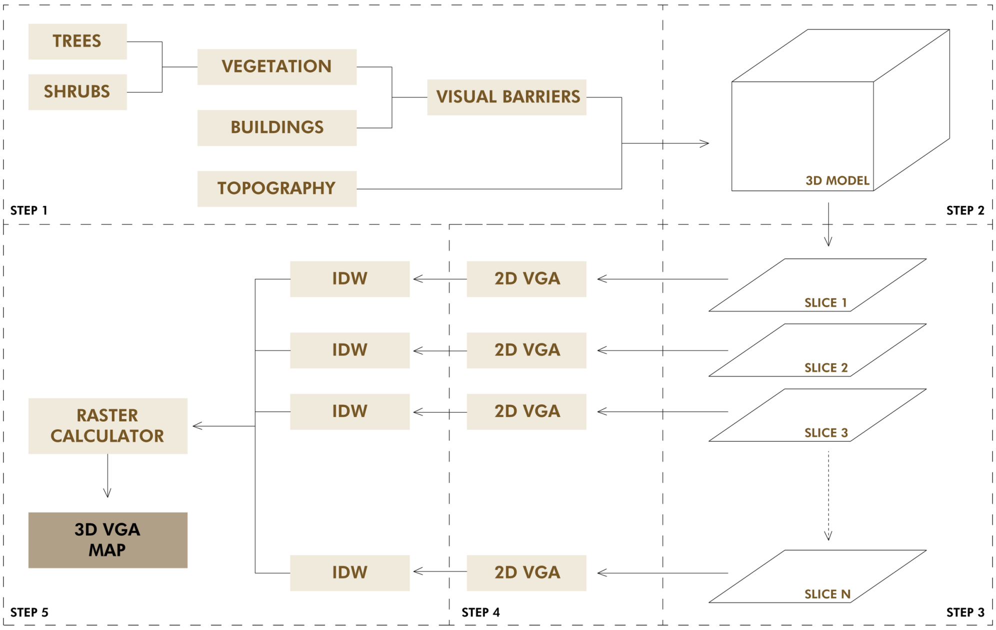

Figure 7: methodological scheme

5 RESULTS AND DISCUSSION

The visibility of the Bodocongó dam depends on the influence of anthropic and natural elements in its surrounding urban area. From the three analysed classes that could influence its visibility (topography, buildings and vegetation), the relief is the most preponderant natural physical feature of the site. The topography of the study area varies from 500 metres at the dam's drain

(extreme south of the study area) to 607.5 metres in the northwest portion of it, while the average height of buildings, trees and shrubs is less than 5 metres.
It is also noted that the study area characterises a valley region, into which the old streams that were dammed - still present through the floods to the northeast and west of the dam basin - flow. Due to this configuration, the study area has higher relief values on its edges (Figure 8), and because they are occupied locations, the influence of this relief is added to the height of some existing buildings.

Another major factor considered in the visibility of the dam was the building heights. Previously seen as prevalent in the concealment of the water surface view by Google StreetView tools (Jales and Barros Filho, 2021), it was seen that the buildings end up having their influence overcome by the topography in terms of the general average intervisibility of the area, which led to the following findings. The first is the predominance of the single-story residential typology, due to the low-income residential profile of the study area. Despite the exceptional presence of tall buildings, some recently built due to local real estate appreciation, the buildings of the study area do not influence the visibility of the Bodocongó dam as much as differences in topographic level. Regarding this point, there is also the factor that, as the dam is circumvented by roads and sidewalks and not by walls or the back of lots, its water surface is more likely to be visualised at the local scale of the pedestrian.

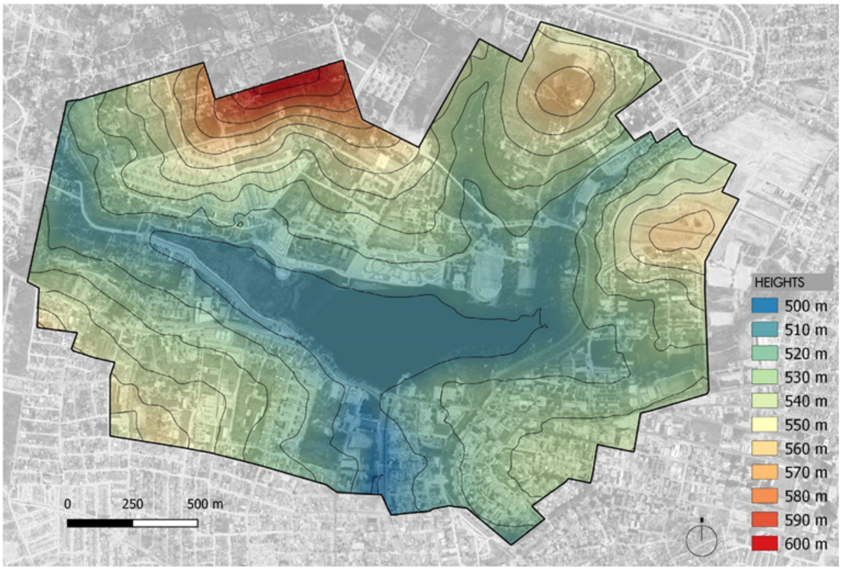

Figure 8: Topographic Mapping. Source: Tsuyuguchi (2017) edited by Jales and Barros Filho (2020).

Secondly, the negative influence by the buildings on visibility is caused by the sum of their heights with the topography of the site. This is the case of the university buildings between three and four floors in the north of the study area, which added to the altitude between 550 metres and 560 metres, hide the water surface for those who pass through the streets. There are also some residential buildings in height, the tallest with 18 floors and located on the southeast edge showed an abrupt and punctual visual impact on the results. The opposite situation also occurs in the southern portion, where there are two buildings with 10 floors, and due to its insertion in the lower area, its general influence on visibility becomes less evident.

The third factor influencing this visibility is vegetation. According to Andrade (2018), the local flora of the Bodocongó dam is quite characteristic of the Caatinga biome, with a large presence of mesquite, which have heights of up to 6.5 metres and small and medium-sized shrub vegetation with heights ranging from 1.5 to 3 metres. The vegetation has a greater visual impact at the pedestrian scale, especially in terms of shrub specimens, and covers a large part of the banks of the dam, so that in some stretches they make it totally impossible to see the water surface (Figure 9). Tree species, in turn, have less impact on the visibility of the dam because they only become visual barriers, playing the same role as shrubs, when the observer is at the same elevation as their crowns. However, of the three main factors listed above, the vegetation cover was the one with the least influence on intervisibility of the study area, especially when taking into account the difference in the proportion of height of existing plant specimens with the topographic unevenness and building heights.

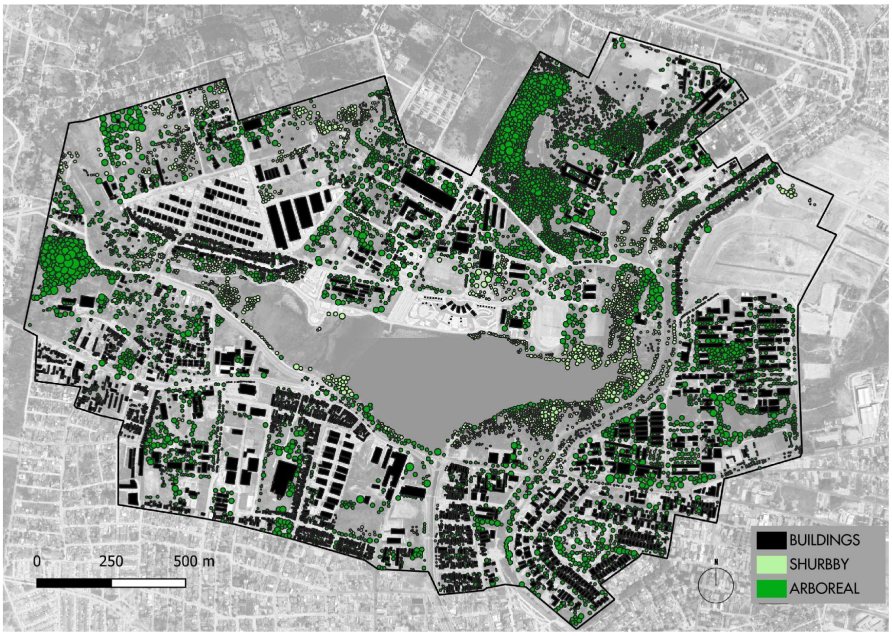

Figure 9: Map of vegetation and buildings (Jales and Barros Filho, 2020).

The 3D VGA Map (Figure 10) shows the average values of visibility considering all 42 slices. Visual barriers were superimposed on visibility values to allow a better analysis of this map. In general terms, it can be seen that the topographic profile of the valley existing in the study area shapes its visual perception. On one hand, locations with best visibility of the Bodocongó dam end up being very contained within its water surface area. On the other hand, locations far away from it, even at high elevations, tend to decrease their visibility values as the number of buildings and vegetation cover increase, becoming stronger visual barriers. However, it also should be notice that two high elevation locations close to the northwest and northeast borders of the study area have the lowest values, revealing that the visibility of the Bodocongó dam in such locations is more influenced by the arrangement of the buildings and plants.

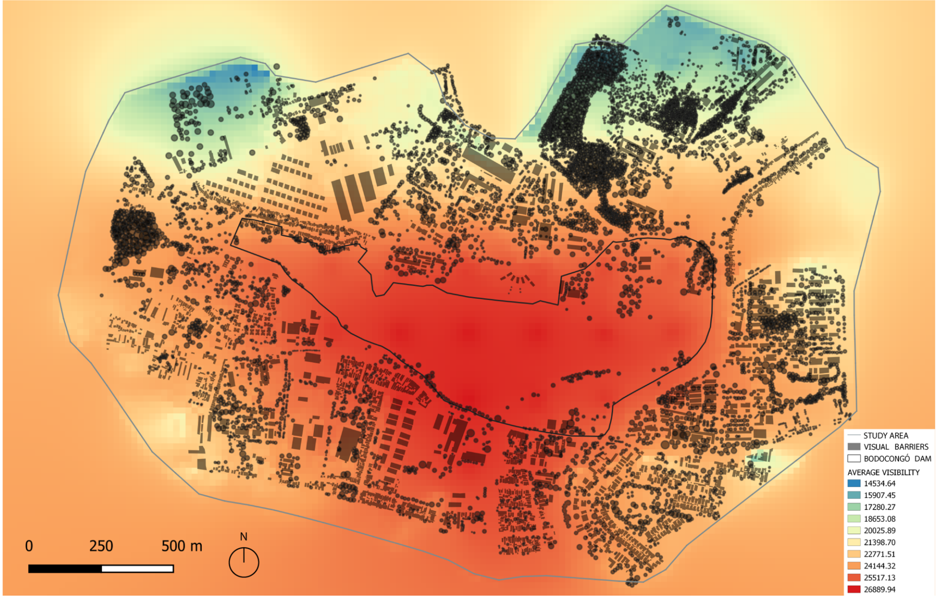

Figure 10: 3D VGA Map. Source: Jales and Barros Filho (2020).

Thus, the characteristic of the valley strongly interfere on the visibility of the dam, and, because it is the topographic profile commonly used for the damming of water, it can be said that the characteristics of the intervisibility seen here are common to other water bodies. With a field of view confined by the elevation of the relief in the southwest, north and southeast portions of the study area, the Bodocongó dam has the curious situation discussed above: its visualization is possible from higher locations far from the water body. In a way, visually interesting for its understanding as a landscape element, the higher locations provide the so-called visual emergency (Tardin, 2008), in which its sudden appearance in the field of vision causes surprise to the observer (Figure 11).

Figure 11: visual emergency of Bodocongó dam at a high and distance location from the water body

6 CONCLUSIONS

Due to its historical and cultural importance, the Bodocongó dam is an urban heritage site in Campina Grande. As it has a transition area from the natural to the urban environment, it requires specific treatment and intervention, in order to contemplate and enhance its landscape characteristics for the population that daily circulates on its banks. Unfortunately, due to its current high degree of environmental degradation, with the pollution of its waters through sewage and solid waste disposal, its image becomes negative. Like many of the current urban problems, its situation stems from a vicious cycle over the years, increasingly enhanced by the remoteness of the population, and its consequent devaluation as an important urban element.

It is also interesting to point out that among the causes of its environmental damage is the existing vegetation itself, exemplified by the mesquite trees, an invasive specimen of great impact on the Caatinga Biome. In this sense, we can see the importance of a landscape intervention that includes the appropriate local species for the composition of the biome, the environmental education of the population about its importance, added to the formulation, implementation and control of urban indexes, in order to promote more friendly interfaces between the dam and its surroundings. Therefore, promoting a good visibility of the dam from its surroundings is a fundamental design strategy to make it more perceived and used by the population, and the development of studies that assess urban visibility conditions play an important role in achieving this.

The proposed methodology of this paper based on a multi-slice method has the advantage of using two-dimensional VGA tools already available in DephMap to analyse a three-dimensional space, without relying on a new technology. In addition, it can be implemented by any researcher or institution even those from cities with very few economic resources. The accuracy of the results depends on the number of slices considered. The more slices the model is cut, the more sensitive it will be to identify visual barriers at different elevations. However, applying many slices requires greater processing power, which would make analysis unfeasible in some situations.

The results presented in this article only applied a global measure of visual integration and did not consider the limited vision capacity of human beings. Thus, a future development of this research will consist in applying and evaluating other VGA measures, such as visual connectivity, as well as visibility distance parameters, all these tools are already available in DepthMap. In addition, it is also intended to analyse other urban areas with different morphological characteristics and compare their results with these obtained here.

ACKNOWLEDGEMENTS

The authors thank the Federal University of Campina Grande (UFCG) for the support of this research.

REFERENCES

Andrade, L.R. dos S., Araújo, S.M.S., Andrade, M.Z.S. de S. and Medeiros, L.E.L. (2018). Degradação ambiental no Açude de Bodocongó na cidade de Campina Grande, Paraíba. Revista Verde de Agroecologia e Desenvolvimento Sustentável, [online] 13(1), pp.74–83. Available at: https://dialnet.unirioja.es/servlet/articulo?codigo=7083488 [Accessed 31 Jan. 2022].

Araújo, E.C. dos S., Gomes, I. and Silva, M.M.P. (2020). Avaliação de impactos ambientais: urbanização do Açude de Bodocongó, Campina Grande/PB. Revista Ibero-Americana de Ciências Ambientais, [online] 11(7), pp.787–797. Available at: http://www.sustenere.co/index.php/rica/article/view/CBPC2179-6858.2020.007.0060 [Accessed 31 Jan. 2022].

Bartier, P.M. and Keller, C. Peter. (1996). Multivariate interpolation to incorporate thematic surface data using inverse distance weighting (IDW). *Computers & Geosciences*, 22(7), pp.795–799.

Benedikt, M.L. (1979). To take hold of space: isovists and isovist fields. Environment and Planning B: Planning and Design, 6(1), pp.47–65.

Benevolo, L. (1996). History of modern architecture. Vol. 1. M.I.T. Press.

Carrasco, C.A.S. (2016). Espacios Abiertos Patrimoniales. [online] www.librosoa.unam.mx. Universidad Nacional Autónoma de México. Available at: http://www.librosoa.unam.mx/handle/123456789/2425 [Accessed 1 Feb. 2022].

Cullen, G. (1961). Townscape. London: Routledge.

Fischer, M.M., Scholten, H.J., D Unwin and European Science Foundation (1996). Spatial analytical perspectives on GIS. London ; Bristol, Pa: Taylor & Francis.

Gehl, J. (2010). Cities for people. Washington, Dc: Island Press.

Gorski, C. M. (2010). Rios e cidades : ruptura e reconciliação. São Paulo, SP: Editora Senac São Paulo.

Hillier, B. and Hanson, J. (1984). The social logic of space. Cambridge Cambridgeshire: Cambridge University Press.

Hillier, B., Penn, A., Hanson, J., Grajewski, T. and Xu, J. (1993). Natural movement: or, configuration and attraction in urban pedestrian movement. Environment and Planning B: Planning and Design, 20(1), pp.29–66.

Jales, L.S. and Barros Filho, M.N.M. (2020). Áreas urbanas em beira d`água: uma análise da visibilidade do Açude de Bodocongó em três dimensões. In: Proceeding of the XVII Congresso de Iniciação Científica da UFCG. Campina Grande: UFCG.

Jales, L.S. and Barros Filho, M.N.M. (2021). Visões Sequenciais: Uma análise da visibilidade do Açude de Bodocongo através do Google StreetView. [online] Available at: https://pluris2020.faac.unesp.br/Paper1090.pdf [Accessed 31 Jan. 2022].

Liu, Y. and Wang, X. (2012). Research on a New Method of Index in Three-Dimensional Space. Journal Of Space Syntax n. 3, p. 8, 2012.

Lynch, K. (1960). The image of the city. MIT Press.

Maria, D. and Santos, G. (2017). "Eu fui feliz lá no Bodocongó" : significados de violência e medo entre os moradores de um bairro popular em Campina Grande-PB. [online] repositorio.ufpe.br. Available at: https://repositorio.ufpe.br/handle/123456789/28417 [Accessed 31 Jan. 2022].

Morello, E. and Ratti, C. (2009). A digital image of the city: 3D isovists in Lynch's urban analysis. Environment and Planning B: Planning and Design, 36(5), pp.837–853.

Medeiros, V.A.S. de (2006). Urbis brasiliae ou sobre cidades do Brasil : inserindo assentamentos urbanos do país em investigações configuracionais comparativas. repositorio.unb.br. [online] Available at: https://repositorio.unb.br/handle/10482/1557 [Accessed 31 Jan. 2022].

Queiroz, M.V.D. de (2008). Quem te vê não te conhece mais: arquitetura e cidade de Campina Grande em transformação (1930-1950). [online] www.teses.usp.br. Available at: https://www.teses.usp.br/teses/disponiveis/18/18142/tde-01122008-171846/pt-br.php [Accessed 31 Jan. 2022].

Retalhos Históricos de Campina Grande. [online] Available at: http://cgretalhos.blogspot.com/search?q=bodocong%C3%B3#.XOBzitRKjcd [Accessed 31 Jan. 2022].

Sander, R. and Barros Filho, M.N.M. (2019). Áreas Urbanas em Beira D'água: análise de integração do Açude de Bodocongó com a Cidade de Campina Grande, PB. In: Proceeding of the XVII Congresso de Iniciação Científica da UFCG. Campina Grande: UFCG. [online] Available at: https://posgraduacao.ufcg.edu.br/anais/2019/resumos/xvi-cic-ufcg-5920.pdf [Accessed 31 Jan. 2022].

Silva, K. V. N. (2017). A Urbanidade do Parque Evaldo Cruz à luz da Intervisibilidade. Conclusion Work for Graduation in Architecture and Urbanism. Federal University of Campina Grande.

Tardin, R. (2008). Espaços livres : sistema e projeto territorial. Rio de Janeiro, RJ: 7Letras.

Tsuyuguchi, B. B. (2017). Macrodrenagem e ocupação do solo no município de Campina Grande: caracterização, simulação e análises sistêmicas. Ufcg.edu.br. [online] Available at: http://dspace.sti.ufcg.edu.br:8080/jspui/handle/riufcg/10677 [Accessed 31 Jan. 2022].

Turner, A. (2001). Depthmap: a program to perform visibility graph analysis. undefined. [online] Available at: https://www.semanticscholar.org/paper/Depthmap%3A-a-program-to-perform-visibility-graph-Turner/d940499fc935708b6d5f069c36a8b6a2069894c7 [Accessed 31 Jan. 2022].

Turner, A. et al. (2001). From isovists to visibility graphs: a methodology for the analysis of architectural space. Environment and Planning B: Planning and Design, 28, pp. 103-121.