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## UNA FINESTRA SU... CASCAIS&PORTO

### Envisioning the future in public urban green spaces planning and design. Lessons from Porto

Diogo Guedes Vidal, Stefano Salata, Helena Vilaça, Nelson Barros, Rui Leandro Maia

#### Introduction

Located in the littoral north of Portugal, the city of Porto is the leading city of the second biggest metropolitan area of the country with an area of 41.42 km<sup>2</sup> and a population density of approximately 5.000 inhabitants per km<sup>2</sup> (Pordata 2020b). The city has a warm-summer Mediterranean climate, with an annual average temperature of 15.3 °C, being the maximum annual average of 19.6 °C and the minimum annual average of 11.1 °C (Pordata 2020a). Due to the intense urbanization process of the peripheral territories in the second half of the twentieth century, the city has lost a significant part of the green structure (Andresen 2001). However, several parks and public gardens are still scattered in the middle of the dense urban fabric, varying by to age, location, use, spatial quality, surroundings, size, green structure and equipment. According to the inventory realized by Farinha-Marques *et al.* (2014), 95 urban green spaces were identified in the city. Along with the green structure diversity, Porto inhabitants socioeconomic profile varies, being considered a mosaic because of their huge heterogeneity (Alves 2012, 2016). The combination of these dimensions makes the city of

Porto a living lab to study Public Urban Green Spaces (PUGS) uses and functions and how this varies according to their location.

Porto has experienced profound social and urban transformations in the last century, resulting in changes in the urban landscape (Fernandes and Seixas 2018). Current trends in landscape urban planning and design should meet new life forms and patterns of urban societies and their reflection in urban space. This concern has been explicit in the need to move beyond a sustainable discourse to a regenerative one, which has been addressed in cities and urban planning (Crowley *et al.* 2021; Girardet 2010, 2014). A regenerative approach aims to restore nature-human connectedness and, most importantly, learn to live with nature (Mang and Reed 2013; Wahl 2016). The necessary transition should be done through the power of imagination to envision the future and prepare it.

Particularly, PUGS landscape urban planning and design should address some important questions: how to combine both ecological and social variables? How can these spaces provide both ecological and social benefits? This means to look to these spaces beyond the greenness. PUGS are vital components

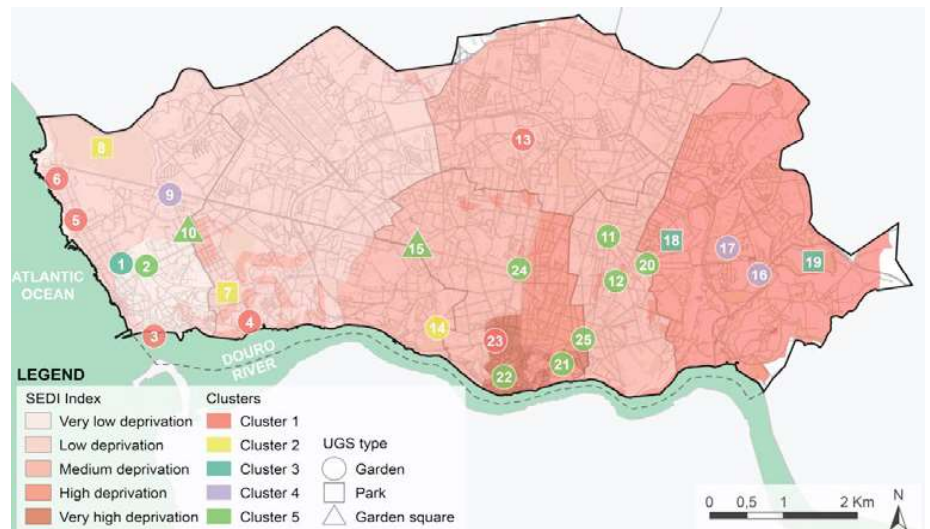


Fig. 1. Cluster distribution by socioeconomic and environmental deprivation areas according to PUGS type.

	CLUSTER 1 (n = 6)	CLUSTER 2 (n = 3)	CLUSTER 3 (n = 3)	CLUSTER 4 (n = 3)	CLUSTER 5 (n = 10)
PROFILE	Located in the littoral area of the city, being all from public gardens type, close to wealthy and touristic areas, with a strong presence of university students as potential users. These PUGS are used for fairs, sports activities, and some cultural festivals.	Mainly located close to the river or the sea, two of them in the occidental area of the city and another in the central/historic. They comprise PUGS with the highest dimension (two parks and one public garden). PUGS design does not condition its use, offering the users' freedom of movement.	This cluster contains two parks that are located in the eastern area of the city and a garden square located in the western area.	These PUGS represent small public gardens integrated into the dense urban fabric of the city. One of them is located in the western part of the city and the other two are in the eastern area.	These are mainly pocket PUGS, located in the central/historic and touristic area of the city, which are frequently used due to their proximity to the users' residence and work.
STRENGTHS	The Environmental Quality dimension attributes oscillate between good and very good.	Environmental Quality and Facilities dimensions present a very good score in all attributes assessed	Generally good Environmental Quality scores, but with fair scores in the Facilities and Security attributes.	The Security dimension is the only one that does not present poor scores.	The Environmental Quality, Security and Facilities dimensions presents.
WEAKNESSES	The facilities dimension presents some poor scores and the Security dimension have poor and fair performances.	In this specific cluster, the Security dimension scores imply a careful interpretation: the existence of quiet and demure spaces could be assumed as a positive factor when PUGS users prefer quiet and secluded spaces to rest and relax; on the other hand, it can be considered negative since it can result in the exposure to and greater vulnerability to crime.	The Activities dimension is the one that reveals the worst performance in almost all attributes assessed. The possibility to perform activities in these PUGS is reduced since only sports activities have been identified.	Worst scores in all dimensions assessed. This cluster represents the PUGS with fewer ecosystem services potential.	The Activities dimension presents the worst scores.

Tab. 1. Clusters profile, main strengths and weaknesses found through cluster analysis

of the urban ecosystem (Muqueeth 2021), characterized by “any vegetation found in the urban environment, including parks, open spaces, residential gardens, or street trees” (Kabisch and Haase 2013: 113) managed by the government, fully accessible and that fosters communication and interaction (Kohn 2004). Ecosystem services provided by PUGS are diverse and related to four mechanisms (Roy Haines-Young and Potschin 2013): improving air and environmental quality, mitigate extreme temperatures, reducing noise and depletion of air pollutants; enhancing physical activity; improving social connections between its users and residents in the surrounding area; contributing to restoration by reducing stress symptoms, contributing to the wellbeing (Astell-Burt *et al.* 2021; Hartig *et al.* 2014). Some ecosystem disservices have been pointed out in the literature, such as the displacement of native species and the introduction of invasive species in gardens and parks, the decreased possibility to use sunlight because of shade, the indirect costs caused by land-use restrictions, the direct costs caused by planting, maintaining and removing plant coverage and, also, the negative health effects related to the pollen released by some species and

acting as a vector of diseases by providing habitat to species species (Escobedo *et al.* 2011; Lyytimäki 2017; Lyytimäki *et al.* 2008; von Döhren and Haase 2015). Nevertheless, ecosystem disservices could be minimized by adaptive design and management of urban green areas (Teixeira and Fernandes 2016, 2017).

PUGS are spaces used to restore, relax and do exercise, while also being a space for socialization in the middle of the dense settlement system (Gao *et al.* 2019; Home *et al.* 2012; Song *et al.* 2015; Vidal *et al.* 2020; Vidal *et al.* 2021b). Recent literature also shows that PUGS can be designed and built as a means to develop a sense of belonging and promote social cohesion, especially in underserved communities (Jennings and Bamkole 2019; Liotta *et al.* 2020).

Measuring and modelling ecosystem services provided by PUGS through quantitative approaches has been commonly used for decision-making (Chang *et al.* 2017; Salata *et al.* 2020; Salata and Grillenzoni 2021). Despite its importance, identify clusters of PUGS based on ecosystem services potential and combine it with the patterns of human behaviour in the same spaces may be useful to ensure that both socio and ecological

benefits are properly delivered according to the PUGS main needs (Meerow *et al.* 2016). The behavioral mapping technique was developed by Ittelson *et al.* (1970) to capture and record behaviour that occurs in a specific setting and to understand the interaction between people and space. When applied to landscape urban planning, behavioural mapping data may support human experience and activities in different spaces (Ward Thompson 2013). Using the city of Porto, a medium-sized European city, as a case study, this contribution aims to explain how combining cluster analysis and behavioural mapping techniques may be useful for decision-making.

### Methodology

With the mission to look beyond the greenness, an ecosystem services potential evaluation grid has been applied *in situ* to 25 PUGS in the city of Porto (Vidal *et al.* 2021a) to assess: (i) Activities Performed, (ii) Environmental Quality; (iii) Facilities and (iv) Security. This application revealed inequalities regarding ecosystem services potential within the city, and in particular, the ecosystem services potential of PUGS is lower than in the clusters of high and very

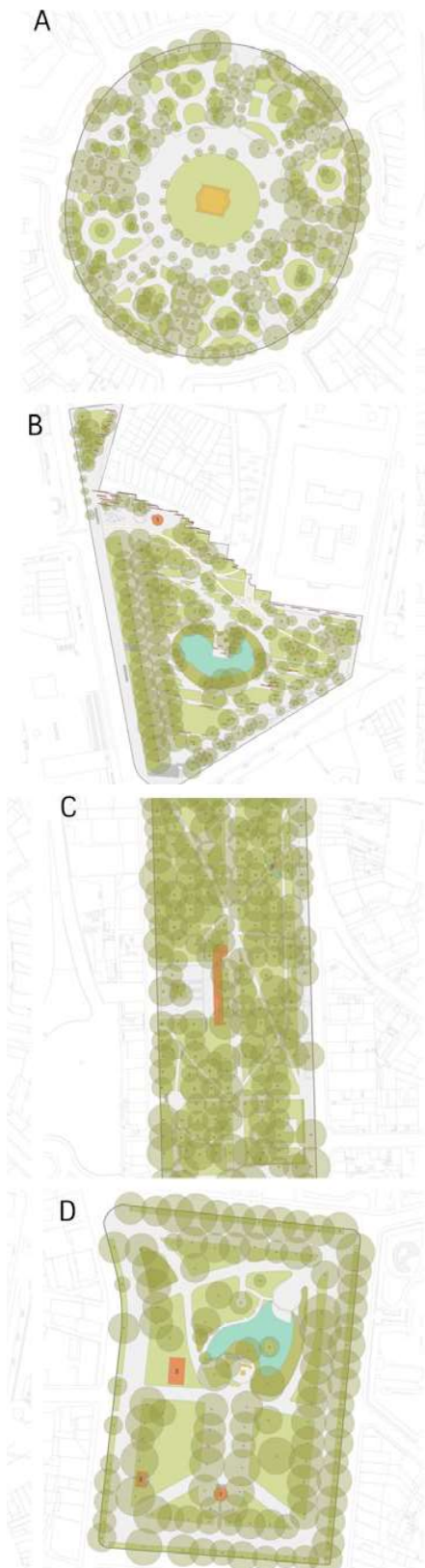


Fig. 2. PUGS where behavioural mapping was conducted: A - Mouzinho de Albuquerque garden square, corresponding to n. 15 in Fig. 1; B - João das Chagas public garden, corresponding to n. 23 in Fig. 1; C - Corujeira public garden, corresponding to n. 18 in Fig. 1; D - Arca d'Água public garden, corresponding to n. 13 in Fig. 1.

high socioeconomic and environmental deprivation. Despite this prior work importance, the recognition of user's perception is a path to understand their preferences and satisfaction level, which are clues to design effective place-based interventions in PUGS. Thus, an exploratory survey was applied in the 25 PUGS to 131 effective users (Vidal *et al.* 2021b). The findings helped to corroborate the previous spatial evaluation *in situ*, revealing that PUGS located in areas of the city with higher socio-economic and environmental deprivation are perceived by their users as spaces with lower quality. Through this evidence, two main conclusions emerged: PUGS ecosystem service potential is unequally distributed within the city; PUGS users perceive this inequity as affecting their opportunities to explore and benefit from these spaces fully. Here, the main challenge is: how to contribute to change this evidence?

Based on the data collected through the spatial evaluation and the survey, a hierarchical cluster analysis of PUGS ecosystem services potential was performed to identify similarities and dissimilarities among them, as well as a discriminant analysis to detect among the four dimensions assessed by the evaluation grid which are the main predictors of ecosystem service potential. This process is expected to be helpful to design effective intervention in PUGS since Portuguese municipal leaders, which are the main ones responsible for these spaces management, revealed a lack of knowledge regarding PUGS socio-ecological value, as a recent study showed (Dias *et al.* 2020). Also, the lack of data freely and accessibly available is identified as one of the main constraints undermining proper intervention in PUGS (Ordóñez *et al.* 2020). A normalization procedure was performed to compare the collected data. The score of each attribute assessed was divided by the number of PUGS in each cluster. In this way, a four-point rating ranging from (0) poor to (1) very good was applied to the attribute diagrams, in which scores closer to 1 were better.

Five groups emerged from the cluster technique (Figure 1), all with statistical differences in the four dimensions assessed ( $p < 0.05$ ). The discriminant analysis also revealed that the clustering process presents a high classification accuracy (84 %).

Through the discriminant analysis is possible to identify the main function of the clustering previously performed to the PUGS, which explains 89.0 % of the clusters variation ( $p < 0.001$ ). Among the four dimensions assessed by the evaluation grid, the Environmental Quality dimension was the

strongest predictor, while the facilities dimension was next in importance as a predictor. Based on this finding, to increase ecosystem services potential in PUGS in the city of Porto, these two dimensions are a priority. Secondly, it was necessary to draw the profile of each cluster. This step aimed to identify each cluster main strengths and weaknesses to support collective interventions to improve the ecosystem services potential (Table 1). Despite the major contribution of these findings (Table 1), a deep knowledge of PUGS social dynamics is still missing. Moreover, how PUGS design and urban furniture influence/condition users' social practices/behaviours in these spaces is also lacking. Therefore, how to design effective intervention in PUGS if data on social dynamics, i.e. what users do, how they do, with who they do and where they do is missing? More than never, policymaking procedures should be adjusted to the local specificities and consider spaces own dynamics. That is why a non-intrusive and systematic technique needs to be applied to improve the quality of PUGS. In this sense, the behavioural mapping technique is inserted on an "ecological validity", defined by Barker (1968) as direct and unobtrusive observation of naturally occurring behaviour. Another potentiality of this technique is the possibility to combine multiple variables and to explore the interaction among them, especially between social and ecological ones (i.e., sun, shade, aesthetics, leisure space, space design, gender, age group, among others) (Vidal *et al.* 2022). Previous works on this technique have been conducted mostly in Europe (Fernandes 2017; Goličnik and Ward Thompson 2010; Rodrigues 2015), but its consolidation concerning its integration in landscape planning and design is still emerging. Despite its undeniable contribution to the field, the studies were based on a comparison between PUGS located in different countries, with different socioeconomic realities (Goličnik and Ward Thompson 2010), or between PUGS from the same country but of different cities (Rodrigues 2015), or even about only one PUGS (Fernandes 2017). PUGS analysis in the same city is precious to design local policies or recommendations and to understand if within the same administrative space different patterns of human behaviour and practices are similar or not in the existent PUGS. This information is also missing.

Four PUGS from the city of Porto were selected from the 25 clustered in the previous analyses. These PUGS do not differ in size ( $p > 0.05$ ) but differ in type and geographical location: three public gardens and one garden square. The garden square



Fig. 3. Boavista garden square: A - User seated on a bench reading a book, close to a tree with shadow; B - Users lying on the grass sleeping close to a tree. Porto, Portugal (August 2020).

is named Mouzinho de Albuquerque square or "Boavista Square" (Figure 2A). Is located in the central area of the city, in a busy area, with intense people and road traffic, and integrates Cluster 5 in an area of medium socioeconomic and environmental deprivation. The first public garden is the João das Chagas garden or "Cordoaria garden" (Figure 2B). Is located in the main historic and touristic area of the city, close to the Clérigos Tower, and is part of Cluster 1 in an area of very high socioeconomic and environmental deprivation. The second public garden is the Corujeira garden located in the oriental area of the city (Figure 2C). This public garden is integrated into Cluster 3 in an area of high socioeconomic and environmental deprivation. The last public garden where the behavioural mapping of users' behaviour was conducted is the Arca d'Água garden (Figure 2D), located in the north part of the city, in an area of medium socioeconomic and environmental deprivation and belonging to Cluster 1. Each PUGS was visited 12 times, each visit during, on average, 30 minutes, and 979 users were registered from July to November 2020. The protocol was design previously and the methodological steps were performed according to Ittelson *et al.* (1970): (i) a base map to identify physical elements that could be of interest to the research objectives; (ii) the definition of behavioural categories and codes to be used when registering behaviours; (iii) the construction of an observation schedule; (iv) a systematic observation procedure; and (v) a system of coding and counting.

Buildings and intensive road traffic surround "Boavista" garden square (Figure 3). It presents a high tree density that provides intensive shadow during warm days. It holds many benches for socialization purposes



Fig. 4. Cordoaria public garden: A - User seated reading a book, close to a tree; B - Zoom into the public garden, the tree density and the socialization areas. Porto, Portugal (August 2020).

and small arteries that connect each corner of the PUGS with the surrounding streets. In this PUGS were registered 248 users whose social practices and behaviours were mapped. During the visits, it was possible to observe that this PUGS is mainly used as a crossing area and by adults and alone. The activities performed in these PUGS are quite diverse, being the most significant crossing, eating (most prevalent in these PUGS compared to the others), and using the cell phone (quite common among the others PUGS). It was rare to observe users dating, playing and doing physical exercise. Also, it is a space with a strong presence of the homeless because it is the meeting point for the delivery of meals. Despite being a PUGS surrounded by intensive road traffic, users used to relax and sleep on warm days due to the intense shadow provide by trees and also to eat their lunch during the summer.

"Cordoaria" public garden (Figure 4) is a PUGS located in the historical and touristic area of the city. The surroundings hold a strong presence of road traffic, and it is mainly used by the younger, being the garden crossed by the historic tram. Thus, in this PUGS were registered 232 users, which are mostly younger and tourists using this space accompanied. The presence of a high tree density is visible in the PUGS, a lake, a playground and many areas for socialization purposes. This PUGS is mainly used for dating (maybe because is mostly used by younger), to take some photos (due to the historical and touristic elements in the surrounding areas), and to rest. The Arca d'Água public garden (Figure 5) is located in a busy area but not central. It is close to a university and an urban highway. Among the four PUGS visited, those with the most frequented ( $n = 324$ ) are used mostly by adults, alone or accompanied. Is a public



Fig. 5. Arca d'Água public garden: A - Playground and users doing a picnic close to a tree. B - Users relaxing on a bench close to the main tree which is providing shadow. Porto, Portugal (Aug. 2020).

garden where users do physical exercise and relax by observing nature. It represents a space connection between humans and nature, an escape from urban life. This happens due to the quiet areas and the high three density, being a space with a lot of shadows, lake, playground and many socialization areas. In this PUGS were visible picnics due to the well maintained natural elements (grass). It has a car park in the PUGS surrounding area and is well served by public transports. Since it is close to a residential area, many people use it to walk the dog and many students to eat their lunch during the summer.

The last PUGS where the behavioural mapping of its users occurred was Corujeira public garden (Figure 6). 175 users were observed, being the PUGS with the low-frequency intensity, which is partly related to the fact that it is located in the middle of urban fabric but not in a central or historic area of the city. It is mostly used by the elderly who are in the PUGS with someone else. It is a PUGS with a high density of tree cover that produces intense shade during spring and summer. Are also visible many benches along the sidewalks that create opportunities for rest, relax and socialize. The activities mainly performed are talking, playing and walking the dog. Lying on the grass or doing picnics are undermined by the poor maintenance of the natural elements. In this case, presenting the geographic location of its users (Figure 6D), which corresponds to the 175 observations, allows understanding that its main path mainly uses this PUGS, and not the lateral areas where is the grass. This can be extremely useful for urban planning since the PUGS is not fully used or explored. When comparing these findings with those found in the cluster analysis (Cluster 3), it can be stated that PUGS in this cluster (such as

Corujeira), have reduced opportunities to perform activities.

### Findings and policy recommendations

Therefore, when combining the results found in the cluster analysis with those found in the behavioural mapping, some recommendations can be suggested to improve their ecosystem service potential: in cluster 1, it would be nice to improve recreational opportunities and activities, like creating connectedness between them through bike paths or “green corridors”. This would be a trigger to increase ecosystem services potential in cascade; regarding cluster 2, the most important is to maintain the strategy used until now since it has good results so far. However, create more opportunities for outdoor meetings and improve security are the main goals due to the PUGS size; in cluster 3 it is urgent to develop a coherent strategy to create more attractiveness concerning social dynamics, which can be achieved through outdoor meetings, table games, cultural initiatives. It is worth being aware that the social functions in these PUGS are inactive; cluster 4 represents the most challenging PUGS

since it presents the worst scores. PUGS are social and environmental disempower, which necessarily implies a profound regeneration of these spaces; finally, cluster 5 calls for a strong strategy to create connectedness among the PUGS, as similar to cluster 1.

As current evidence states being closer to PUGS stimulates human connection and a sense of community, belonging, empowerment and social support (Braubach *et al.* 2017; Elands *et al.* 2018; Hubbard *et al.* 2020; Jennings and Bamkole 2019; Vidal *et al.* 2021; Ward Thompson *et al.* 2019; Ward Thompson *et al.* 2019), the findings presented in this paper, which are a small synthesis of the global study, can be useful for authorities to identify the main dimensions that need priority improvement. Also, integrating behavioural mapping techniques in urban planning could result in accurate interventions based on data collected *in situ* and resulting from non-intrusive techniques. The importance of such combination relies on the fact that PUGS are spaces where city dwellers can get close to the natural world so, if these spaces do not provide that experience, they are not fully fulfilling their function. ■

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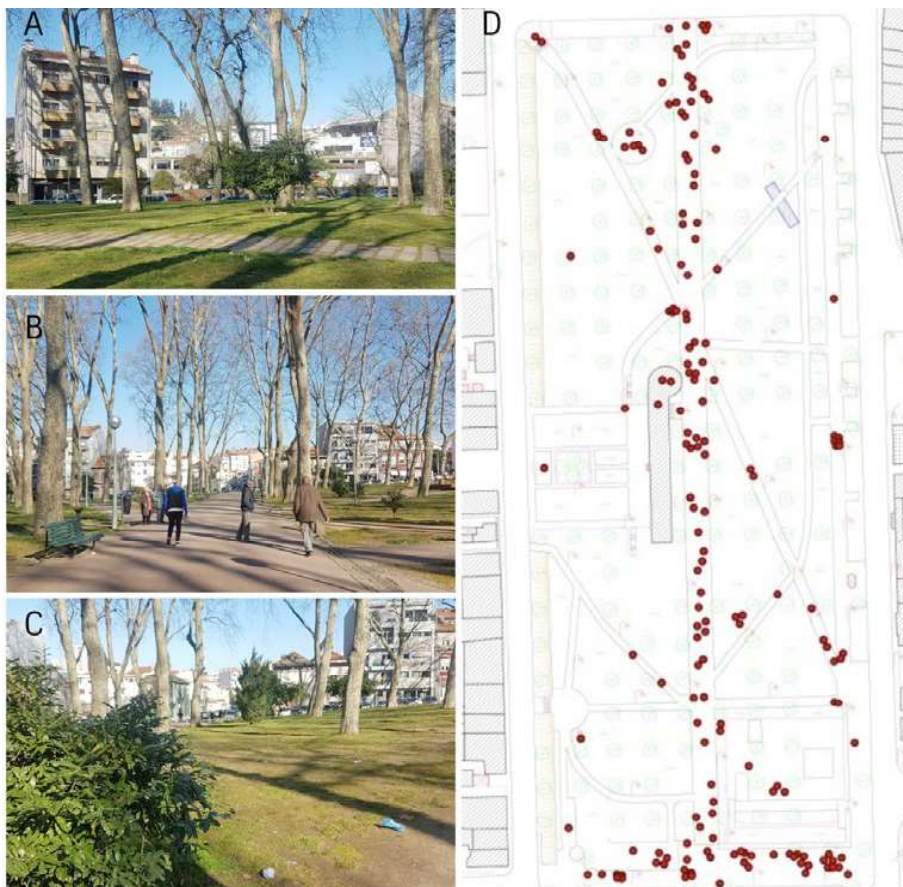


Fig. 6. Corujeira public garden: A - Path and some trees; B - Users crossing the PUGS in its main arteria; C - Grass with poor maintenance and cleaning; D - Geographical location of PUGS users through ArcGis software. Porto, Portugal (November 2020).

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