Hungarian University of Agriculture and Life Sciences

Institute of Landscape Architecture, Urban Planning and Garden Art

The role of vegetation in open spaces in urban health and social well-being. Evaluation of greenspaces in Campo Grande and Budapest

Theses of the Ph.D. dissertation

by

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1. RESEARCH BACKGROUND

"The more artificial a human environment becomes, the more the word 'natural' becomes a term of value." - Wendell Berry, environmental activist.

Society evolved from a group of nomads, hunters and collectors surviving from what they could gather from nature. With the domestication of fire about 300,000 years ago, and the Agricultural Revolution with the domestication of plants and animals that happened around 12,000 years ago, came the first permanent settlements (Harari, 2014). During the 19th century, the Industrial Revolution intensifies urbanization by attracting a larger number of people to the urban centres, therefore creating and/or enhancing urban pressure.

The transitional phenomenon of the industrial revolution made significant and irrevocable changes in the socio-economic structure, city morphology, land use, ratio between natural and built spaces, relation to the space and space use and, most importantly population size, aggravating urban pressure (ben Salem, 2021). This relation is well described by Kasri (2018, p. 21 cited in ben Salem, 2021) when she writes that "The industrial and technological revolutions of the early 19th century had a considerable impact on the development of societies and the expansion of cities. However, through their all-embracing approach rooted in the spirit of imperialism and globalisation, they have brought out the problem of the context and relation to the place."

Identifying and factoring the relevant problems of a specific topic is of extreme importance and urgency, thus for this research is the lack or properly planned and maintained greenspaces in urban environments, focusing on the applied planting design. Nowadays cities are becoming congested and polluted in an ever-increasing pace (Blanco et al., 2009) due to the unremitting and disorganized urbanization processes, thus the need of urban greenspaces for better urban health and social well-being.

2. RESEARCH AIMS AND QUESTIONS

"Landscape is a spectrum, from intangible subjective nature related cognition to tangible human-altered nature." - Feng Han, landscape studies professor.

It has already been proven that urban greenspaces can impact the environment and well-being in urban centres, such as with the improvement of air quality, decrease in temperature and the hability to provide an overall positive impact to daily life and wildlife habitat (Nowak & Dwyer, 2007; Scott, 2015). Furthermore, some research shows that greater biodiversity in such spaces can greatly increase the psychological benefits provided by greenspaces (Fuller et al., 2007).

In this perspective, the two main objectives of this study are to better understand how urban transformation and urban greenspaces affect urban health and social well-being; Strategize how to improve and/or create new urban greenspaces adapted to contemporary social needs and environmental challenges, for increased optimal benefits enhancing urban resilience. The main aim consists on addressing these issues with a planting design approach focusing on the vegetation, seeking to understand the negative effects of negligent or non-existing planting design as well. Additionally, it searches for ways to disseminate the acquired knowledge to all stakeholders.

Based on the above dilemmas and queries, this study presents the following hypothesis:

Greenery alone is not enough. Urban greenspaces need careful and thoughtful planning, with a multidisciplinary strategy. A probable and efficient approach could be to *direct more attention and greater importance to planting design and maintenance, increasing biodiversity and aesthetics.*

In order to address and confirm the hypotheses, this study puts forth four main research questions (and their sub-questions). These were formulated to be both theoretical and practical questions, the latter being related to the case studies of urban greenspaces in Campo Grande and Budapest:

1. **How do urban greenspaces affect urban health and social well-being?**

   a. What are the aspects of a healthy greenspace?

b. Is the current design functional and biodiverse or merely aesthetical?

c. Which factors should be excluded and modified to create valuable and stable greenspaces?

2. **What to consider when analysing urban greenspaces from a planting design perspective?**

a. What is the character of the applied taxon?

b. What are the maintenance situation and requirements?

c. What are the direct and indirect effects of vegetation on UGS?

3. **What methods and strategies can be adopted in order to improve the urban greenspaces?**

a. Which species can be more introduced to increase biodiversity?

b. Which species should not be considered for city usage?

c. How to plan the upgrading of UGS into a healthier space?

4. **Are there any methods, practices and identified species that can be transferable from one city to the other?**

a. Why is it important to sample areas in both cities?

b. What are the similarities and differences expected?

c. Why does a negative or positive evaluation from one city might be of value to the other?

On the whole, this research is a step towards enhancing the understanding of planting design in the sites of the case study and their implications, therefore enabling the elaboration of proposals and guidelines on how to improve such open spaces, focusing on the greenspaces in Campo Grande. As a result, possibly contributing to the increase of urban greenery in the future, in a city level further, moving towards greener, more liveable and resilient cities.

3. MATERIALS AND METHODS

In this study the author follows a pragmatic approach with a cyclic study method of analysing, observing, and assessing best practices and deficiencies of case studies, thus deducting reasonable conclusions. Furthermore, this chapter utilises the presented literature review as a basis for urban greenspace assessment strategy, and reinforcing the hypothesis that greenery alone is not enough. By providing contextualization and definitions of greenspaces, green system and biophilic design, this study analysed and deducted concepts and main factors to be considered as key elements for this research. In addition, the methodology also consists of best practices' case study analysis as well, by choosing urban greenspaces in Budapest – HU and Campo Grande – BR, assessing its historical development and current site situation, with a deeper planting design evaluation of each site. With the assessment and deductions from the selected Budapest urban greenspaces, improvement strategies can be proposed for the urban greenspaces in Campo Grande, suggesting urban green infrastructure as a method to increase urban resilience.

The graph below [Figure 1] presents a summary of the urban greenspace evaluation method proposed. Through an exploratory and analytical research, this study attempts to establish a well-developed and concise data collection in a way to better understand the planting design of the selected urban greenspaces, in order to enable them to provide optimal benefits for urban health and social well-being. Moreover, unveiling possible issues and conflicts as well as the areas with the highest potential for improvement. Owing to this, the author proposes two main assessment categorisations: tangible and intangible aspects. Tangible aspects comprise historical development, landscape and planting design, hard and soft landscapes and technical elements. On the other hand, intangible aspects encompass cultural values, social well-being, social relation to greenspaces, and space use and perception. Furthermore, the method proposed to evaluate the tangible aspects is based on the green system approach, whereas the intangible is based on the biophilic design approach. Both were developed by the author based on curated elements

from the reviewed literature, and which are considered most relevant to the purposes of this study.
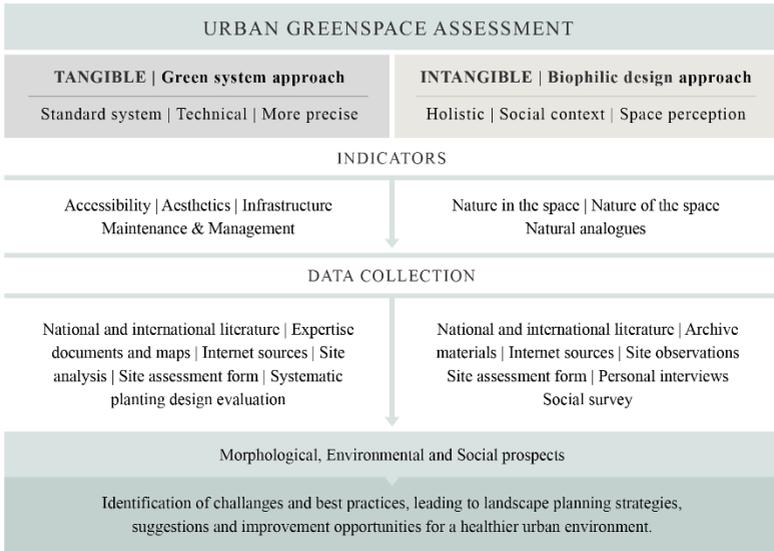
URBAN GREENSPACE ASSESSMENT	
TANGIBLE | Green system approach	**INTANGIBLE | Biophilic design approach**
Standard system | Technical | More precise	Holistic | Social context | Space perception

INDICATORS

Accessibility | Aesthetics | Infrastructure Maintenance & Management	Nature in the space | Nature of the space Natural analogues

DATA COLLECTION

National and international literature | Expertise documents and maps | Internet sources | Site analysis | Site assessment form | Systematic planting design evaluation	National and international literature | Archive materials | Internet sources | Site observations Site assessment form | Personal interviews Social survey

Morphological, Environmental and Social prospects

Identification of challanges and best practices, leading to landscape planning strategies, suggestions and improvement opportunities for a healthier urban environment.

Figure 1. Graph showing this study's methodology (Source: Author)

The green system approach elaborated to asses tangible aspects is a standard system consisting of technical, quantitative, qualitative and precise data, to some degree. Based on Roué Le Gall's (2015) research findings on greenspaces, urban design and mobility in relation to health, she suggests that the present challenge is moving from knowledge to action, to which she proposes the development of a causal model to assess greenspaces and its effects on urban health and social well-being. This section of the methodology consists of the simplified adaption of her method, which consists of four main greenspace aspects to be addressed: accessibility, aesthetics, infrastructure and maintenance & management.

The intangible aspects to be analysed with a biophilic design approach embodies a more holistic attitude, consisting of the social context, space quality, use and perception. In the literature review chapter the biophilia hypothesis was presented, and the method consists of translating it into design.

4. RESULTS AND DISCUSSION

The learnings from the *tangible aspects* of analysis suggests that the examples from Budapest show the benefits of having professional landscape projects for its UGSs. Having good infrastructure, biodiversity, multiple functions, appropriate maintenance and all the other aspects presented thus far, are an indication of the high space use and appreciation by the users. Having the community working together with participatory design actions, can also be an indicator of the aforementioned. Multiple studies that presented similar results, hence strengthen this argument, also presented increased park use after considering the factors mentioned (Cohen et al., 2009; Gibson et al., 2019; Kelly et al., 2022; Veitch et al., 2012b; Zhang & Zhou, 2018).

The UGSs studied in Campo Grande presented the issues created by neglected and/or unplanned urban greenspaces, such as littering, vandalism, inadequate maintenance, incorrect plant species, lack of basic infrastructure and functions, leading to low or no space use. This can be concluded from the results of both the site assessment criteria [Appendix A] and the learnings from the site use questionnaire [Appendix B]. In order for them to provide the desired optimal benefits for the city and community, a landscape architectural project is needed to reflect all the criteria presented in this study. Diminishing usage barriers, such as lack of functions, poor connectivity to the city, insufficient lighting, infrastructure, and maintenance, can ensure greater park use. A study conducted in Germany concluded that greenspace planning should be able to diminish these barriers to ensure park use opportunities for city dwellers (Kabisch et al., 2021). Further studies that presented similar results are (Addas, 2022; Kelly et al., 2022; Vaughan et al., 2018).

Resulting from the planting design findings, the native range of species can be considered positive results, since all nine UGSs presented a majority of native species representing an overall of 39% of the identified taxa. Apart from being more adapted to the local environmental conditions, require less maintenance, promote ecological balance and interactions with native wildlife, be more resilient to pests, diseases, and climate variations, native plant species serve as superior food sources for urban birds, and better accommodates both human and bird habitats(Mohamad et al., 2013). Nevertheless, amongst them only 10% were endemic, which gives us the opportunity to direct more focus on increasing this ratio with the plants from the Cerrado. Owing to that, a list of species to be avoided in the UGSs of Campo Grande was elaborated

and can be found on Appendix D, and a comprehensive list of suggested species to be used can be seen on Appendix E. A further list that resulted from the sites analysis comprises all the current planted species in each nine UGSs and could serve as literature reference for future research on the topic [Appendix G].

Regarding the learnings from the *intangible aspects* of analysis, including the findings from social surveys, it can be said that having the biophilic patterns help enrich the space, bringing it closer to the user and connecting to all the senses. Similar to other research projects where these aspects were evaluated using similar methods (Beatley et al., n.d.; M. R. Hunter & Luck, 2013; Naidoo & Fisher, 2011; Shanahan, Fuller, et al., 2015; Sustainable Cities Initiative, n.d.), since the UGSs in Budapest presented these patterns in their design, it can be speculated that they are a factor that created a better overall space experience, which can indicate increased physical and psychological benefits, as suggested by the literature as well.

Owing to this, it is viable to assume that proposing a landscape design project and inserting the missing biophilic patterns and enhancing the existing ones in the UGSs in Campo Grande could be a key element to improve the greenspaces and connect them further to the user. The UGSs that presented a higher level of design and presence of biophilic patterns, also presented higher park use. Similar studies also suggests that biophilic design and planning can be considered a useful paradigm, and can increase park use (Hami et al., 2014; Reeve et al., 2015; Totaforti, 2020).

Differing from the aforementioned projects that were applied in multiple cities, my research for this moment focuses only on Campo Grande, but with the potential to be replicated in other Brazilian cities as well, by adapting the needed factors. Nevertheless, my findings presented similarities to the other studies, since they all concluded that urban greenspaces that incorporate features of nature, such as vegetation, water bodies, and wildlife, have a positive impact on human well-being, social cohesion, and overall quality of life in cities; Well-maintained, easily accessible, visible UGSs, and connected to other parts of the city with features that encourage social interaction and physical activity, are more likely to be used and valued by residents; Community engagement and participation in the planning and management of urban greenspaces can ensure their long-term sustainability and effectiveness in enhancing the connection between cities and nature.

5. CONCLUSIONS AND RECOMMENDATIONS

"Every time you think of a city, you have to think green, green, green. Every time you see a concrete jungle, you must find open spaces. And when you find open spaces, make it so people can get to them." - Eduardo Paes, politician.

Initially, the sole focus of this research was on the greenspaces of the Brazilian case study of Campo Grande. However, with time and maturity the direction changed and included the Hungarian city of Budapest. Instead of doing a comparative analysis of both cities and UGSs, the case study of Budapest would englobe a perspective of best practices, whereas Campo Grande would be the place for applied strategies. Nevertheless, considering their differences and to acquire better results the same assessment criteria was applied to both cities. The two cities present different climate and weather conditions, have been through different scenarios of urban development and possess an overall different character. However, as presented in the previous chapters, they can be associated through some factors, such as social and socio-political facts, challenges and changes related to environmental constant mutations, similarities in temperature during summer, tolerance to certain species, among others. Regarding urban greenspaces, the differences between size, profile and space use between UGSs in Budapest and Campo Grande became evident throughout this research. Therefore, the strategies and approaches being utilised and applied in Budapest could be proposed in Campo Grande, by refining and selecting the relevant applicable aspects.

The examples from Budapest show that the city gives attention and importance to the matter of having more and better greenspaces in the city, always seeking to improve existing ones as well. For instance, all sites analysed have been redesign/rehabilitated in the past decade. As a result, the researched sites presented great landscape designs with appropriate planting design. Furthermore, by creating multifunctional places with a participatory approach, people help create optimal spaces and take ownership of the place, making use of it to the fullest, as was the case of UGS_2 and UGS_3. Another important factor is the need to rethink the urban spaces and connections, integrating greenspaces to the urban fabric in pursuit of more sustainable spaces and increased urban health. As presented, the 9th district of Budapest was a pioneer in the 80s by addressing these issues. Moreover, by seeing the space with the biophilic lenses as well and assessing the presence of the 14 biophilic

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patterns, we can measure the complexity and quality of a project, which will further attract users and provide the optimal benefits a greenspace should. Nevertheless, there is no perfect design or place as there will always be something to improve and make it better. The analysed sites in Budapest could benefit of a greater biodiversity as showed in the results.

In great contrast, the examples from Campo Grande suggest that the government is not investing much in urban greenspace creation and integration. Even though the city is considered one of the most vegetated in the country and it is praised by having a lot of trees, a green infrastructure and network approach is missing and/or is being neglected. The results presented that these 'neighbourhood' typology of greenspaces is often neglected and consists of mostly grass and trees, with the few places that are named 'squares' by the local government having usually only a partial design, which means that they have a few paved pathways and light poles, the bare minimum. The planting design lacks variety in levels and biodiversity. All these arguments could be confirmed by the heatmap and site use survey results. By not hiring professionals to create a proper landscape project, and if/when they do the community is not involved, the citizens are taking ownership of these public urban greenspaces and using them as an extension of their gardens, planting new species and taking care of the existing ones. Even though it is inspiring to see the population reacting, together with the lack of adequate levels of maintenance, gap in the local literature and information regarding appropriate plants for urban environments, this can be a hazard, hence the list of species to be used and to be avoided elaborated in this research [Appendix D and E]. Furthermore, the lack of water presence in all nine studied sites is extremely concerning, reflecting further on the negligence and need for action. On the other hand, the greenspaces examined accommodate abounding improvement possibilities. According to Gisseli Giraldelli, a biologist and superintendent of surveillance and environmental management of Campo Grande, the aim for the city is to be a biophilic and biodiverse city that can work similarly to a biodiversity corridor. Thereby, the city will offer better life conditions to all its habitants, human or not (Tucker, 2021). This is entirely aligned to the goals and objectives presented on this study, in addition to reassuring the importance of inserting a biophilic and interdisciplinary approach during planning, implementation and care to the current methods and tools.

From the data collected in the social survey, it can be said that the results corroborate the arguments posed in this research regarding the importance of urban greenspaces not only to urban health but to social well-being as

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well. By having a multicultural group of participants, it was proved that people's connection to nature is not bound by culture, although it can vary in some respects, the overall feelings and needs can be considered rather universal. Furthermore, even though the current literature focuses on the benefits of physical health, the results from the survey presented higher votes for mental health aspects, such as participants being more relaxed, calmer, happier, less anxious, and so on, thus reverberating the biophilia hypothesis. These, however, do not refute the need for deeper psychological and chemical analysis of the effects on human body, but it is an indication that is also present in multiple studies presented in the literature review chapter. Moreover, results also show that people do pay attention to their surroundings and to the vegetation, in addition to showing interest on learning more, having more and better greenspaces near them and getting involver in the decision making and design through community activities.

5.1 Recommendations for further research

Even though this research acknowledges that since landscape architecture, site analysis and social survey is not an exact science, results might be biased, the implications of this study are promising and of great significance to the urban environment. In seeking to understand the greenspaces from a planting design and biophilic perspective, the used method and strategy suggestions can be replicated in other urban greenspaces by making the necessary adjustments. In the case of Campo Grande, the aim is to provide the tools and knowledge that could be used and applied in further greenspaces, both compact and linear, therefore integrating them more to the urban fabric and strengthening the green infrastructure and network, in addition to integrating the community in the decision-making process as well.

As it is expected in academia, there were limitations to this study, such as time, budget, access to researched area and the extreme events of the COVID-19 pandemic, to cite a few. Nevertheless, this leave abounds opportunities for further research. A next step could be to further elaborate the analysis method based on the green system and biophilic design approaches. For the technical aspects it would be valuable to include a machine-based assessment of the trees, for an example, to deeper understand their current situation in order to propose more assertive strategies to improve urban health. On the other hand, related to the biophilia hypothesis and the benefits to social well-being, it would require

a higher interdisciplinary approach since it involves much of the psychological aspects. Creating a team to perform controlled experiments to understand how people use and perceive the space around them in more detail, as well as the level of biodiversity they can catch while in contact with nature, would provide invaluable data and insights.

Another important further step of this research and that relates to the goal of making information available for the population of Campo Grande, would be to design a book or a web-page, since it is much simpler to produce and disseminate, with a longer suggested plant species list, together with photographs and graphs that can easily show each plant's characteristics, such as native range, size, flowering season, fruit season, maintenance required, among other aspects. In connection to this, a bolder idea is to partner with front end developers and create an application to map out fruit trees within the city, where people could find their exact location and fruiting season, diminishing waste and especially helping those with less economic power to enjoy some fruits.

In conclusion, together with the master's study, this research was an attempt to better understand urban greenspaces in order to propose strategies that could enhance urban health and social well-being, reconnect these spaces to the urban fabric and local culture, involve and instruct the communities, focusing on the Brazilian city of Campo Grande as a case study, therefore moving towards a greener and more liveable city.

6. NEW SCIENTIFIC FINDINGS

"Research is creating new knowledge." - Neil Armstrong.

The most relevant new scientific results of the present dissertation can be summarized in the following 9 theses:

Thesis 1: *Literature gap on the Brazilian case study, and the hazards associated with it*

After researching more than two hundreds scholar works on both national and international literature, plans and directives from Campo Grande, I found a significant knowledge gap concerning planting design and vegetation use in the city. As a result, the use of some species is creating multiple issues and hazards.

For instance, *Ficus benjamina, Licania tomentosa* and *Delonix regia* were identified in, respectively, 7, 9 and 8 out of the nine UGSs, and due to their extremely aggressive roots presented damages to the sites. Furthermore, they were common street trees in the past, and are nowadays causing major damages to the roads and electrical system, therefore having to be removed or pruned drastically. Apart from the danger to human lives, these are causing significant economic impacts as well and has been recognized by the local government as one of the main problems of urban tree planting. Owing to this, I developed a list of species that should be avoided for urban use in Campo Grande and it can be found on Appendix D.

Thesis 2: *Appropriate vegetation awareness and use for a better urban environment*

Information can contribute to growth. Seeking to shorten the gap in the local literature of Campo Grande, I developed a comprehensive, detailed list of the current vegetation from all nine studied UGSs, which can be found on Appendix G.

Furthermore, as a result of this research I constructed a list of suggested plant species that can be safely introduced to the urban landscape of Campo Grande, focusing on native and endemic species of the Cerrado, which are resilient and adaptable to the urban environment. This list can be found on Appendix E.

Thesis 3: *Interdisciplinarity as a key factor in favour of urban health and social well-being*

By applying the analytical method I created (chapters 3.1 and 3.2), which entails both the physical and social factors of assessment, my findings indicates the interconnectivity of the whole, meaning that only having vegetation is not enough for an UGS to thrive and provide their optimal benefits. For that, the combination of factors should coexist in some level of harmony.

The UGSs from Budapest that presented positive overall results from all assessed categories, also showed a higher level of use and involvement by the community, that can be related to the landscape projects and participatory design strategies applied. The sites where participatory actions were used, such as the example of Bakáts tér and Kerekerdő park, presented outstanding results.. On the other hand, I found that the UGSs from Campo Grande were not in their optimal states, albeit the ones which presented better conditions in both the green system and biophilic criteria, indicated higher use and involvement by the local community. For instance, the sites with less use and satisfaction from the users were UGS_1, UGS_2, UGS_5, UGS_7 and UGS_9, where there are no functions or infrastructure such as benches, only vegetation. From this I can conclude that planning UGSs with an interdisciplinarity approach can greatly affect the positive benefits they can provide to urban health and social well-being.

Thesis 4: *The importance of functionality for space use*

The analysed greenspaces of Budapest, together with many other studied examples from different cities/countries, showed that multifunctionality is one of the most important aspects of a site. However, having at least two different activities can already represent an increased use. This finding became evident by the results I gathered from the case studies of both cities. To promote social well-being, people need to be able to use UGSs, and I found that the UGS in Campo Grande which presented only vegetation and no other attraction factors, such as functions, were not being used by people.

The majority of analysed UGSs in Campo Grande lack functionality, oftentimes not even providing the basic function of resting, due to the lack of infrastructure and urban furniture, as was the case of UGS_1, UGS_2, UGS_5, UGS_6, UGS_7 and UGS_9. The absence of use can lead to

vandalised, neglected and unsafe spaces, as it was the case for UGS_1. Furthermore, the results from the social and site use surveys reinforce this finding, where the majority of respondents wrote they would visit more urban greenspaces if 'they felt safer', 'had more activity options available there' and 'if the spaces were cleaner'. Moreover, participants said they were not completely satisfied with the recreational functions of the urban greenspaces in their cities, and would like to be involved in participatory actions for space improvement.

Thesis 5: *Aesthetical and biodiverse urban greenspace for increase in use and benefits*

In the literature chapter I presented studies which corroborate my argument that higher biodiversity and aesthetic values is directly relates to the increase in use of urban greenspaces, and the experienced benefits one can get from them.

I discovered that the UGSs from Campo Grande showed a lack of a proper landscape design project, functions, biodiversity and overall blend aesthetics can be related to the sites not being used much. For instance, only 3% of the interviewed people said they use UGS_1, 5% use UGS_2, 14% use UGS_5, 12% use UGS_7 and 8% use UGS_9 (% are related to each UGS and not an average of all nine sites). Additionally, in all nine UGS the users wrote that 'having better aesthetic' would encourage them to use these spaces. Regarding biodiversity, all nine greenspaces are biodiverse to some extent, except for UGS_4. Nevertheless, there are mainly two level of vegetation consisting of grass and trees, and according to the survey users assessed the overall landscape design quality of the sites as 'not enough', the amount of vegetation as 'enough', however the diversity of vegetation was rated as 'not enough'.

Thesis 6: *Only having vegetation is not enough for a good urban greenspace*

During this dissertation I argued that being a greenspace only is not enough, and many are the aspects that need to be taken into consideration for the site to be considered well suited and provide the optimal benefits they can.

Firstly, I confirmed that the quality of being green or having vegetation is not enough by finding that even though the UGSs in Campo Grande are far bigger in size, therefore having more green coverage than the UGSs

in Budapest, the population is not making much use of the sites. Secondly, the lack of an appropriate planting design is impeding the greenspaces to provide the optimal benefits a greenspace can. Even though the overall result regarding biodiversity showed that all nine UGSs in Campo Grande are somewhat biodiverse, based on my applied methodology and social survey data, there is no landscape design is most sites, and no planting design in all of them, where there are mainly two levels of vegetation: trees and grass. I discovered that this results in a boring and not diverse space according to the users, in addition to providing poor environmental biodiversity, whereas having more shrub species, perennials and groundcovers can greatly enhance these aspects. Finally, I found that the biophilia hypothesis can be also confirmed by this research, since in all nine UGS in Campo Grande I found the sense of stewardship/ownership by the local citizens, where by noticing this lack o biodiversity and planting design, they started treating the sites as an extension of their own gardens, planting a few perennials and shrub species by themselves, in addition to caring for the maintenance as well, as seen on UGS_1, UGS_2, UGS_7 and UGS_9.

Thesis 7: *Unique values as a part of local culture*

Based on the fruit tree species I found on the nine UGSs and data collected from personal interviews [Appendix B], I confirmed that this is a common and appreciated activity by the residents. My results showed that eating fruits from urban trees is embedded in the local culture of Campo Grande, since the vast majority of interviewees grew up eating/collecting fruits from public trees, still do so nowadays and affirm that they would greatly appreciate having more fruit trees in the urban environment. The species that were most cited are: mango (*Mangifera indica*), acerola (*Malpighia emarginata*), guava (*Psidium guajava*) and siriguela (*Spondias purpura*). Furthermore, fruit trees are a great source of food for birds, hence in order to maintain the urban bird population it is necessary to continue planting fruit-bearing taxa. Campo Grande is one of the few remaining cities where exotic native birds can be seen flying around freely and nesting on urban trees.

Owing to this, I decided to analyse the unique values of each identified species as well. My findings showed that in all nine UGSs the majority of species presented medicinal values, with the overall number between the nine being 41%. Moreover, in UGS_8 I found indications that the local residents were using the bark of *Stryphnodendron adstringens* for

medicinal purposes. The second highest rated value was having edible fruits, where between the nine UGSs 23% of the identified species presented this unique value. In addition to these, I further discovered that in all nine greenspaces the local population was planting and protecting seedlings/small trees from fruit species, with the most common being mango (*Mangifera indica*), acerola (*Malpighia emarginata*), guava (*Psidium guajava*), limão-taiti/tahiti-lime (*Citrus × latifolia*) and limão-rosa/mandarin-lime (*Citrus bigaradia*). Furthermore, the remaining unique values identified represent 18% of ornamental species, 4% aromatic, 4% condiment, 4% ecological restoration, 3% other edible parts, 2% cosmetics and 1% unknown.

Thesis 8: *The importance of prioritizing native and endemic species*

Then innumerable benefits of native species were already heavily discussed in this research. Therefore, my findings from the UGSs of Budapest, I discovered that only UGS_3 has the majority of species being native, with the other two sites having both established and non-native species as a majority. Overall, between the three UGSs 39% of the identified taxa were native, 31% non-native, 17% established, 7% unidentified and 6% unknown. Nevertheless, this can be due to the fact that the precise geographical endemism of European species can be biased.

On the other hand, the results from the UGSs of Campo Grande I found that all nine UGSs presented a majority of native species, representing an overall of 39% of the identified taxa [Appendix G]. Additionally, 23% represents non-native species, 18% established, 10% endemic, 6% unidentified, 3% unknown and 1% were invasive. Individually, UGS_1 presented the highest percentage of native taxa with 55%, and UGS_9 the higher rate of endemic taxa with 13%. These results can be considered positive, however further steps should go in the direction of inserting even more native and, especially, endemic species in future projects and/or interventions, enhancing the unique biome of the Cerrado.

Thesis 9: *Factoring users' opinions for better urban greenspace understanding and planning*

From the heatmaps and site surveys I conducted with 90 people in Campo Grande, I could discover if and how the citizens were using those greenspaces, what were their opinions, feelings, needs and suggestions. I

found that most UGSs did not have any functions or infrastructure, factors that were directly related to the use ratio obtained by the survey. The results regarding landscape design and vegetation were rated as 'not enough'. Additionally, my argument regarding the importance of participatory actions corroborated with the answers, since 75% participants said they would be interested in such actions for greenspace improvement.

Adding a more global perspective, my social survey performed with 290 people worldwide showed that the majority of people enjoy and do visit UGSs for multiple activities, in addition to experiencing positive and calming effects during and after this contact with nature. Moreover, 57% of people said they started visiting UGSs more often since/during the pandemic. When it comes to vegetation, 73% replied they do pay attention to the plants around them. An outstanding 99.31% o people believe greenspaces are essential in cities, and 57% of the participants would like to get involved in participatory actions, and 22% voted maybe.

7. LIST OF PUBLICATIONS

7.1 Articles in international journals

PEREIRA ROSA, C. A., DANTAS, G. S., & DELGADO DA SILVA, B. M. (2021). Urban Green Space Rehabilitation in Campo Grande, MS. An Overview of the Anhandui River Current Situation, Post Revitalization Project. *Journal of Biomedical Research & Environmental Sciences*, *2*(5), 399–405. https://doi.org/10.37871/jbres1248

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7.2 Peer reviewed conferences

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7.3 Abstract conference papers

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