

CHALLENGES FOR GREEN INFRASTRUCTURE FROM THE PERSPECTIVE OF BRAZILIAN RESEARCHERS

DESAFIOS PARA A INFRAESTRUTURA VERDE DA PERSPECTIVA DE PESQUISADORES BRASILEIROS

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ABSTRACT

The topic of Green Infrastructure (GI) has been debated with growing interest in Brazil as a tool to achieve more resilient cities, specially in terms of urban drainage and water supply. In Brazilian universities, the discussion was brought by professors influenced by the ideas of Ian McHarg expressed in his iconic work **Design with Nature**, which has recently had a new impulse after the publication of the studies from Mark Benedict and Edward McMahon. In 2019 there was a certain amount of Brazilian researches on the field of GI, but it is still difficult to apply and develop GI concepts in a tropical weather and with economically poor conditions. This article aims to bring advances and challenges GI studies are facing now in Brazil, from the perspective of the workshop entitled Rethinking the Green City, held in April 2019 in Brasilia, which promoted the meeting of 36 British and Brazilian researchers. The topics highlighted from the presentations and discussions from the workshop were: the weakness of the State to plan and provide solutions for water pollution, drainage and urban forms; the lack of awareness in general on the importance to incorporate the natural processes on planning strategies; and the need for strategies to change patterns (and thoughts) to incorporate GI concepts. Researchers have to figure out how to present GI in these conditions in the time to come.

Keywords: Green infrastructure. Rethinking the Green City Workshop. Brazil.

RESUMO

O debate sobre infraestrutura verde vem despertando o interesse de diferentes campos disciplinares: arquitetos paisagistas, urbanistas, engenheiros, geógrafos, biólogos, entre outras formações. A infraestrutura verde constitui-se em uma ferramenta de planejamento, projeto e gestão que visa não apenas conectar física e ecologicamente a rede de verde do território, como também articulá-la com as demais infraestruturas construídas. O conceito foi cunhado em contexto americano, ainda muito centrado em sua colaboração para a preservação das áreas de interesse ambiental, por meio do desenho de corredores verdes. O Reino Unido secunda ampliando sua abordagem para a escala da região e visando não apenas a promoção das unidades de conservação, como também o desenho de novos espaços livres. No Brasil, os estudos sobre o tema já vêm sendo desenvolvidos há algum tempo. Em abril de 2019, o seminário “Rethinking the Green City” reuniu 36 jovens doutores e doutorandos brasileiros, predominantemente da área de Paisagem e Ambiente das Faculdades de Arquitetura e Urbanismo, e ingleses, com formações mais diversas, a fim de definir o estado d’ arte da pesquisa e do ensino de planejamento da paisagem com a infraestrutura verde desenvolvida no Reino Unido e no Brasil. O objetivo desse artigo é apresentar sucintamente um panorama do que foi discutido no seminário, a partir do olhar de três professoras e pesquisadoras de Teoria e Prática em Arquitetura da Paisagem que participaram do workshop, a fim de discutir o estado da arte dos ensino de Arquitetura de Paisagem sobre Infraestrutura Verde no Brasil e na Inglaterra em 2019, seus avanços e limitações.

Palavras-chave: Infraestrutura verde; Rethinking the Green City Workshop; Paisagismo.



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I. INTRODUCTION

The Florida Green Corridors Commission coined the term Green Infrastructure (GI) in 1994. It is a broad concept that is still in development (AHERN, 2007) and is now understood as a process of planning in which the landscape integrates ecological and socioeconomic values in a holistic approach of preservation, design, and management (MELL, 2010). In the practice and disciplinary field of Landscape Architecture, Green Infrastructure has been debated for the past 15 years as a tool for planning greener and more resilient cities that are adapted to Climate Change. The concept bears, at its roots, the way of rethinking urban planning and its relation with the environment by landscape conformers, as Ian McHarg debates, especially in **Design with Nature** (1969), which celebrated its 50th anniversary in 2019. Green Infrastructure also brings, as its complement, issues related to urban ecology, human ecology, popular participation, and innovative partnerships between academia, government, private initiative, and community, in an attempt to rethink environmental practices in cities and find solutions for renaturing them.

2 Environmental practices have costs and benefits that can be unequally distributed. Therefore, GI and decision making are related subjects. The debate on Green Infrastructure emerges as a way of rethinking the teaching practices of Landscape Architecture to provide tools to landscape planning by promoting land occupation in line with the carrying capacity of the environment. It complements the application of the concept of ecosystem services, which can be understood as the benefits people receive from ecosystem processes and cycles, including food production, water, fuels, climate regulation services, flooding, nutrient cycles, aesthetic, leisure, and cultural and spiritual benefits (ASSOCIAÇÃO DE AVALIAÇÃO ECOSISTÊMICA DO MILÊNIO, 2005).

In the context of Great Britain, green infrastructure has already been incorporated into its urban and landscape planning and design strategies have become a standard practice, an emblematic example of which is the London Green Grid Plan, whereas, while Brazil has seen some advances in its urban and environmental legislations, the practice of developing green infrastructure plans remains only an option for city planning. The g-GAU Urban Environmental Management research group of the Faculty of Architecture and Urbanism of the University of Brasilia (UnB), coordinated by Prof. Maria do Carmo de Lima Bezerra; the LabVerde research

laboratory of the School of Architecture and Urbanism of the University of São Paulo, directed by Prof. Maria de Assunção Ribeiro Franco and Paulo Pellegrino; the Inverde, Instituto de Pesquisas em Infraestrutura Verde e Ecologia Urbana, conducted by Prof. Cecilia Herzog in Rio de Janeiro, as well as other Brazilian laboratories have been developing studies that discuss landscape design and the contribution of green infrastructure to create bases for collaboration with public agencies, non-governmental organizations, and other universities.

To bring together the research conducted in the University of Brasilia (UnB) and Manchester (UoM) and map the network of young researchers who develop studies on the subject in the Brazilian and English context, Dr. Ian Mell and Prof. Maria do Carmo de Lima Bezerra organized, in 2019, the workshop Rethinking the Green City. It was sponsored by the Newton Fund, the British Council, and the Federal District Foundation (FAP-DF). Other Brazilian laboratories did not join its organization but got eventually involved by the participation of their researchers.

For the organizers of the **Rethinking the Green City** workshop, its main goal was to gather researchers and their works. The discussion on the challenges faced by GI in Brazil was a consequence and it needs to be described, studied, and addressed in the future. The major challenge of landscape planning and design with green infrastructure is to promote sustainable land use/occupation management and governmental management that leads to social, economic, and ecological development. Thus, we sought to debate the British, Brazilian, and international teaching and research experiences on how nature could be incorporated into innovative city renaturalization solutions to address increased social and environmental impacts, especially under increasing climate change issues. The four main objectives of the workshop are as follows:

- foster academic discussions among engineers, planners, landscape architects, and urban planners to examine ways in which urban nature, green infrastructure, and the interpretation of the sociocultural conditions of urban landscapes can be used to solve the problems associated with constant changes;
- promote the exchange of knowledge in teaching and research on best practices and innovation in approach, methodologies, and solutions between multidisciplinary groups of experts;

- develop state-of-the-art scenarios that can be promoted to government decision-makers, developers, and designers by bringing environmental knowledge to the center of urban development;
- create dialogue between stakeholders to promote behavioral changes regarding how water, biodiversity, and green infrastructure are considered in urban planning (WORKSHOP ..., 2019).

The workshop was framed around a fundamental question: How can the lessons of nature be used to improve the sociocultural, economic, and ecological functionality of cities? Young Brazilian and English PhDs and doctoral students were gathered (most of whom already worked as professors and researchers in the field or related areas) to understand researchers' profiles and teaching and research practices. British researchers had different backgrounds: biology, geography, planning, architecture, among others. However, among Brazilian researchers predominated those from the Landscape and Environment area of the Faculties of Architecture and Urbanism. We developed this study based on the presentations of such Brazilian and British researchers to reflect on some challenges for research and practice in GI in Brazil. It also presents a brief Brazilian panorama regarding research and teaching on GI.

2. THE BRAZILIAN CONTEXT

Brazil has a long history of conflicts with its urban waters. At the same time as they were the basis of the initial development of its cities, they soon became a problem. In a tropical country first dominated by forests, river and stream floods greatly disrupted urban life. Soon, they began to be channeled into fast-growing cities. Today, few watercourses in the largest cities of the country are running in their natural beds. The situation is worsened by the construction of informal housing on the margins of these watercourses, which also suffer from the discharge of fresh sewage due to the lack of basic sanitation infrastructure. The Brazilian population seems to have learned to live with and has been trying to adapt to this constant situation of flooding and pollution of its waters.

This context and the large urban plans for river canalization to create large valley bottom avenues and the subsequent worsening of urban drainage problems gives rise to the debate on GI in Brazil. Brazilian

researchers have, as their theoretical reference, precursor approaches on Landscape Planning and Design, such as Frederick Law Olmsted and his project Emerald Necklace (1886), which adds ecological engineering concepts to landscape architecture, creating, in the Boston Park System, a complex flood containment and recreation area system (JELLICOE; JELLICOE, 1987); Ian McHarg, the forerunner of environmental design with **Design with Nature** (1969), which develops a landscape analysis system addressing geomorphological issues in a layered system that has become a reference as a method of analysis in the field of architecture and urbanism; Anne Whiston Spirn and her book **The Granite Garden** (1984), which emphasizes natural processes and their relation to urban and human processes; Eugene Odum and his **Foundations of Ecology** (1953), which synthesizes questions about ecology; Richard Forman and Michel Godron's (1986) concept of Landscape Ecology, which studies the relation between ecology and its impacts on the landscape; and, finally, Mark Benedict and Edward McMahon's book **Green Infrastructure, Linking Landscapes and Communities** (2006), which conceptualizes and outlines the principles and benefits of green infrastructure systems. (FRANCO, 1997; HANNES, 2018; JELLICOE, 1987).

The national production on environmental planning and GI is based on LabVerde at the School of Architecture and Urbanism of the University of São Paulo (FAUUSP) and its eponymous journal, which publishes scientific articles about this theme every six months. The Laboratory has several research projects, workshops, and practical applications based on environmental design. As an example, we can mention the Green Structure Plan for the University City Campus of USP. Its coordinators have published books on the subject that constitute an important national theoretical basis. Prof. Maria de Assunção Ribeiro Franco has authored **Environmental Design: An Introduction to Landscape Architecture with the Ecological Paradigm** (1996) and **Environmental Planning for a Sustainable City** (2001) and organized **São Paulo on Climate Change: Environmental Scenarios for Urban Resilience** (2019), co-authored by Evy Hannes and a multidisciplinary team of architects, engineers, and geographers. Paulo Renato Mesquita Pellegrino, in partnership with Newton Becker Moura, organized the recent **Strategies for a Green Infrastructure** (2017).

The very beginning of the GI debate in Brazil arose in 2005, in a scenario within the architecture training course at FAUUSP, in which Paulo Renato

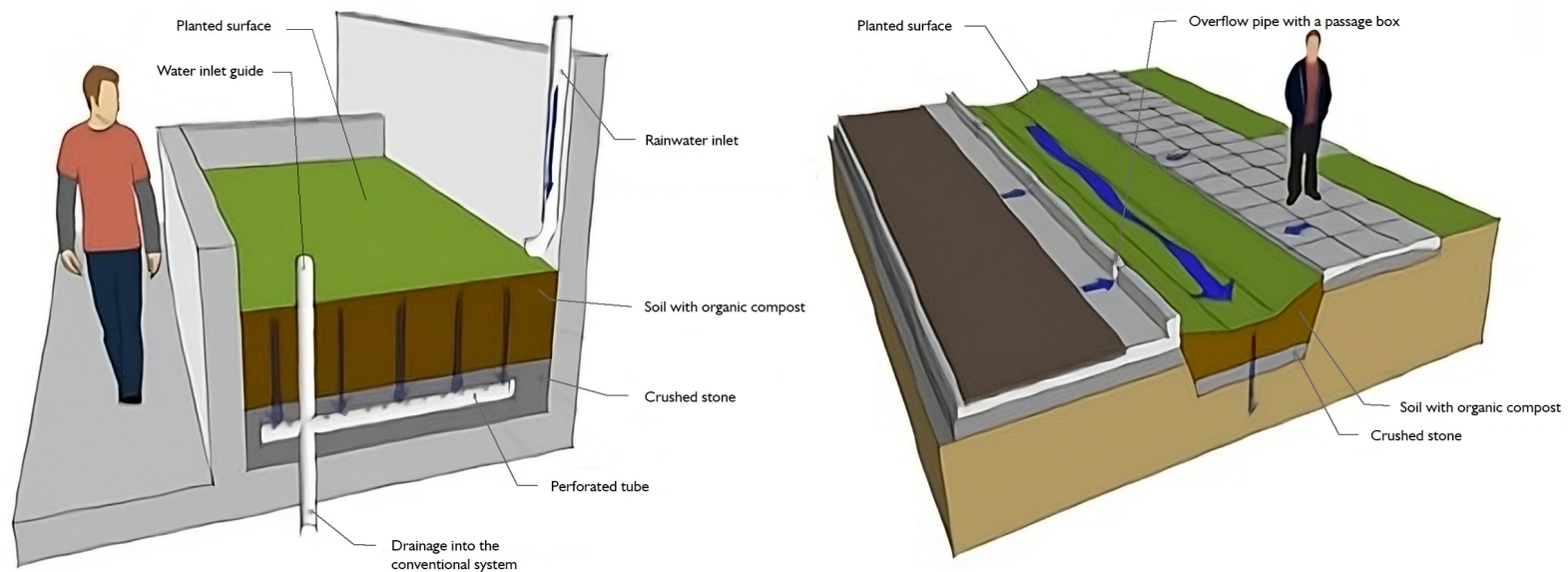
Pellegrino and Rosa Grena Kliass brought together foreign and Brazilian professionals and set up a program that introduced and disseminated new design practices for green infrastructure. A new group of research was also created. In 2006, at the Landscape Planning: Study for a Green Infrastructure workshop during the 8th Enepea — the Brazilian Landscape Architecture Education Meeting (also held at FAUUSP) — Nathaniel Cormier, from Seattle, USA, proposed applying green infrastructure techniques to the college building with actions to collect rainwater, filter it, and allow it to be resorbed from the ground (or reused for other purposes) to delay its return to the traditional urban drainage system and prevent flooding. Each GI technique or tool was defined by a name: rain garden, bioswale, retention pond, cistern, and green roof (Figure 1). The exercise demanded that the involved professionals used their creativity to design alternatives to these natural processes in some interesting way

and showed scenarios of how users of the building or city would perceive and collaborate with the proposals. Cormier’s class was reproduced throughout the country and its text version became one of the most respected bases in a national conceptual review (SAKATA, 2015).

On **Cities for All, Relearning to Live with Nature** (2013), Cecília Herzog, lecturer at Pontifical Catholic University of Rio de Janeiro, discusses the current models of global development and their implications for the transformation of natural and urban environments (HERZOG, 2013). She dedicates 70 pages of her book to ecological or “heavenly cities” (as Spirn ([1984]) calls them in **Granite Garden**) and green infrastructure. This was the first book published in Brazil that directly dealt with the theme of GI. It soon became a reference and complementary bibliography in Architecture and Urbanism courses throughout the country.

Figure 1 – Instructions to design a rain garden and a bioswales.

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Source: Cormier and Pelegrino (2008).

In 2019, Brazil had a certain amount of research on GI but still showed a lack of practice and successful cases to base new applications. In 2022, the scenario is more promising. In the municipality of São Paulo, the Urban Gentle Program at Sé Juriditican created, in 2020, small gentle spaces in downtown São Paulo to expand the possibilities of being, leisure, permeability, and biodiversity. The program includes several examples of Urban Green Infrastructure, ranging from urban conservation forests, rain gardens, bioswales, green staircases, sidewalks with infiltration wells, remodeling of squares, and land art to green spaces in streets and avenues with the objective of expanding the ecological urban references in the city landscape.

Even though the practice of green infrastructure is still beginning in Brazil, some colleges have been introducing undergraduate and graduate disciplines to develop experimental project studios that explore how landscapes perform multiple functions and the potential of existing natural and built systems at various scales. At the School of Architecture and Urbanism of the University of São Paulo (USP), this work was undertaken by the disciplines taught by Paulo Renato Pellegrino and Maria Assunção Franco (Labverde Research Group) and Alexandre Delijaicov, André Takiya, and Milton Braga (Fluvial Metropolis Research Group). To bring the debate to the School of Architecture and Urbanism of the University of Brasilia, in the first half of 2018, Profs. Bezerra, Giselle Chalub and Camila Gomes Sant'Anna (the latter as a teaching assistant) taught the graduate discipline Urban Planning Workshop: Green Infrastructure. In private universities such as Unip and MACKENZIE, the theme has been treated modestly — even camouflaged — within the disciplines and studies of Urban Design and Urban Design and Landscaping.

These experiences show that the necessary revision of the syllabus of the Landscape Architecture discipline (AHERN, 2007; AUSTIN, 2014; FIREHOCK, 2010; MELL, 2010; PELLEGRINO; MOURA, 2017) to promote greater integration with infrastructure, planning and urban design, economics and heritage studies and develop in students the ability to act in a multidisciplinary approach that starts with the appreciation of the natural, green, and blue systems that exist in their area of intervention.

From this perspective, according to Pellegrino e Moura (2017), the following contents would be approached: landscapes as flexible systems; ecological urbanism and multifunctional landscapes; the ecology of

landscapes: the management of water resources; flow permanences: use and appropriation of landscapes; cumulative ecosystem services: resilience to change; shaping a green infrastructure: deployment strategies; modes of representation; and development of integrated landscape projects, especially with the implementation of the GIS tool.

These issues are also present in the debates on the political and pedagogical plans of the most recent Architecture and Urbanism courses. On the 6th Conference of the Lusophone Network of Urban Morphology, PNUM 2017, in its thematic session Built Environment and Sustainability Design: Constructive Methods and Technological Interactions, Noêmia Oliveira Figueiredo, lecturer at the Federal Rural University of Rio de Janeiro, mentioned that the reformulation of the pedagogical plan at her university included a debate about incorporating the concepts, principles, and techniques of green infrastructure into landscape planning and design disciplines. The intention was to create an undergraduate course entitled Green Infrastructure, which would discuss, among other things, the morphological parameters for the urban tissue surrounding protected areas.

Although Ecosystem services and GI consist of more than dealing with water, the key to GI in Brazilian universities was, indeed, water: water resources and water management, biodiversity of fauna and flora, climate change, urban form and open spaces, health and well-being studies, as well as the economic value of nature are traditionally considered to be different topics; thus the importance of the opportunity to relate them to GI studies. One of the major challenges in incorporating green infrastructure as a planning and project tool into teaching and research activities is the difficulty of creating methodological strategies that address one of its main principles: multifunctionality, i.e., the ability of Green Infrastructure to play multiple functions.

THE RETHINKING THE GREEN CITY WORKSHOP

Workshop participants were divided into sessions. They presented papers with varied themes that covered different related issues, such as green infrastructure, sanitation, climate, and working with the population to recover degraded stream margins and public open spaces. Generally, these articles emphasized water.

This study highlights three common challenges in these presentations: the weakness of the State to plan and provide solutions for water pollution, drainage, and urban forms; the overall lack of awareness on the importance of incorporating natural processes on planning strategies; and the need for strategies to change patterns (and thoughts) to incorporate GI concepts.

Nate Millington presented his work on the water issues of the municipality of São Paulo: *Sao Paulo in Maintenance: Climate Change, Water Crisis and Peripheral Urbanization in a Contemporary Megacity*, in which he describes how the coexistence of floods and scarcity have been produced by the urban form of São Paulo, what the responses to flooding and scarcity have been, and what are the implications for residents of various regions. He briefly reviewed the technologies and practices to adapt to flood and scarcity challenges in Sao Paulo both in the neighborhood and municipal scale, the new forms and technologies of state practice and civil society, the commitment of the São Paulo governance after the 2014-2015 scarcity crisis and the centralized infrastructure of São Paulo to supply water and manage floods, especially in the interstitial, marginal, and peripheral areas of the municipality.

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Carme Marchí Castañer discusses her participation on the pilot program to revitalize the urban basin of São Paulo, in which she researched the Jaguaré Stream and its very polluted waters and degraded banks. This research is part of her PhD Dissertation, developed at the School of Architecture of the University of São Paulo. The author shows how, in the São Paulo Metropolitan Region, the local economy and the population's well-being have been affected by the impacts caused by the urbanization process and its effects on the degradation of urban water quality and the hydrological cycle. Such a process of urbanization transforms natural river ecosystems into piped systems that try to quickly clear water and the problems it causes through standard, high-cost, and centralized grey standard infrastructure systems. These infrastructures destroy the biodiversity and the natural processes of maintaining water quality that occur in riparian wetlands and marginal areas (MACHÍ CASTAÑER, 2018).

Luciana Schwandner Ferreira presented her research on Green areas and the local climate. She has been working on mapping the surfaces in satellite images (roofs, asphalt, vegetation cover, etc.) and their relation to temperature variations. Temperature and climate studies involve

many factors, and they will be reliable if they deal with this complexity. Measurements should be made at different times of the day and over the years. Many studies on the subject in Brazil have been based on a same source (which measured temperatures on a single occasion). Thus, the researcher pointed out the lack of data as a barrier to be overcome. Moreover, she commented that Brazil is yet to tackle climate change as a fact. Political leaders in the present government have endeavored to deny the environmental issue. Finally, she claimed that the most appropriated urban forms to deal with climate effects would be difficult to implement due to the lack of power to actually plan cities. Legislation, when followed, merely imposes numerical coefficients and indices that fail to translate into the shapes intended by planners.

Millington, Castañer, and Ferreira, among others, pointed out that the State has failed to deal with rivers, urban drainage, and the climate in a sustainable way. The lack of better patterns and the weakness of the State to coordinate the development of the cities are among the main causes.

Francine Sakata developed her presentation based on the cultural connection between people, gardens, parks, and natural environments in Brazilian cities. The maintenance of green urban space faces difficulties in peripheral areas, such as a lack of financial resources, social housing, and control of the soil; the feeling of insecurity around urban woods; and the perception by a part of the population that nature is an obstacle rather than an asset. She showed the great absence of vegetation in sidewalks, the excessively impermeable soil of the cities, and the great tolerance of the Brazilian society to water pollution (Figure 2).

Sakata showed that green recreational areas are often created in areas with an opportunity for land and funding to deploy public facilities, rather than where they are needed the most. Still, she showed cases in which previously empty areas that caused problems for neighbouring communities were transformed into spaces which transform lives around them, such as the Prosamim housing program in Manaus (Figure 3).

Patricia Sanchez, who has been studying the conversion of degraded and residual areas in cities, presented some of her research on urban forms that can reconcile Human Density and Green Spaces in Cities, evincing the lack of knowledge about the relation between housing density, built density, and sheltered population in both horizontal and vertical tissues



Figure 2 – Polluted stream in São Paulo, Brazil.
Source: Sakata (2020).



Figure 3 – Mestre Chico park in Manaus, Brazil.
Source: Queiroga (2015).

and detailing the possibilities of creating green and permeable areas and maintaining housing densities. Once again, her survey provides answers that will be difficult to implement.

Camila Gomes Sant'Anna presented her doctoral research, which analyzes GI as a new approach that can be used to respond to climate change. Green Infrastructure is a way for governments to develop comprehensive and inclusive urban planning to reach a balance between city and nature. She argued that the drafting of green infrastructure plans can help create a common urban development future for countries that are currently confronting the effects of Climate Change. Together, these countries can promote cross-disciplinary approaches to green infrastructure to develop landscape planning practices that can deal with climate changes, especially in cities with unequal and uneven urbanization.

Sakata, Sanchez, and Sant'Anna are among the researchers who have emphasized the need to connect people and nature in the cities in a healthier and more peaceful way. Green infrastructure is understood by decision makers (both public and private) and by society as a whole.

8 Evy Hannes' article, entitled Green Infrastructure as a Strategy for Ecological Communities: A Plan for Vila Amélia, for example, attempts to incorporate GI concepts on the plan of an existing neighborhood in the middle of a natural protected area. Her study describes green infrastructure as a tool capable of transforming the urban space and reconnecting people with the green spaces of the city, placing its natural elements and ecological processes as the main structure of a new thinking that uses river systems and green fragments as the backbone of the urban fabric.

her study explored the possibility of using green infrastructure as a tool for creating ecological communities and, through case studies of ecological neighbourhoods and ecovillages in the United States and Europe, shows the good practices already implemented in them. Her research focused on the northern region of São Paulo, the Índio stream watershed and Vila Amélia, a residential cluster set amidst the area around the Alberto Lofgren State Park, known as Horto Florestal. Her study proposes some guidelines that can contribute to the creation of an eco-community that respects local natural characteristics and the carrying capacity of its ecosystems (Figure 4). In this case, GI would have a double role: to actually qualify the

neighborhood and validate it as a "more acceptable" community close to the woods of Cantareira. Due to the need of a new pattern, she could observe a certain acceptability of GI by neighborhood residents and the tools they have to initiate the transformation of this space through their own interventions. Strategies were being created in the process.

Carme Castañer also evaluated the efficiency of alternative models for urban water management based on the use of green infrastructure technologies; green systems responsible for restoring the hydrological functions that control water contamination and mitigate the drastic effects of excessive waterproofing of urban land. She gave guidelines for Sustainable Urban Drainage (SUD) designs for the Jaguaré basin with the purpose of controlling the runoff in the sub-basin of the rotten water stream located further in the outskirts of the city, which conserves much of its course running in the open air. The construction of a wetland system supports the water filtration process and contributes to restore biodiversity (Figure 5).

In the design charrette of the workshop, the group who worked on the most local scale offered Ecosystem Services (ES) as a key to the design of the Brasilia Botanical Garden. The first discussion on this existing park was about the environmental services that are provided and their relations. After that, the program of activities and their spatialization and design would be developed. Thus, the authors showed that environmental services and their relations can and should be used as a conceptual basis for projects of parks in general. This is a strategy to approach the project unknown to Brazilian researchers and it may be developed for other cases and spread among teachers and planners. In these examples, Castañer, Hannes, and the charrette showed that their strategies are quite original and the existence of few references to use as models.

3. FINAL CONSIDERATIONS

The workshop **Rethinking the Green City** was structured to provide information exchange and partnership possibilities between researchers and professors. This was made possible by paper presentations, field visits, and its design charrette. Although it was impossible to fully discuss the issues regarding the next steps for green infrastructure research, the set of presentations and discussions made it clear that researchers and

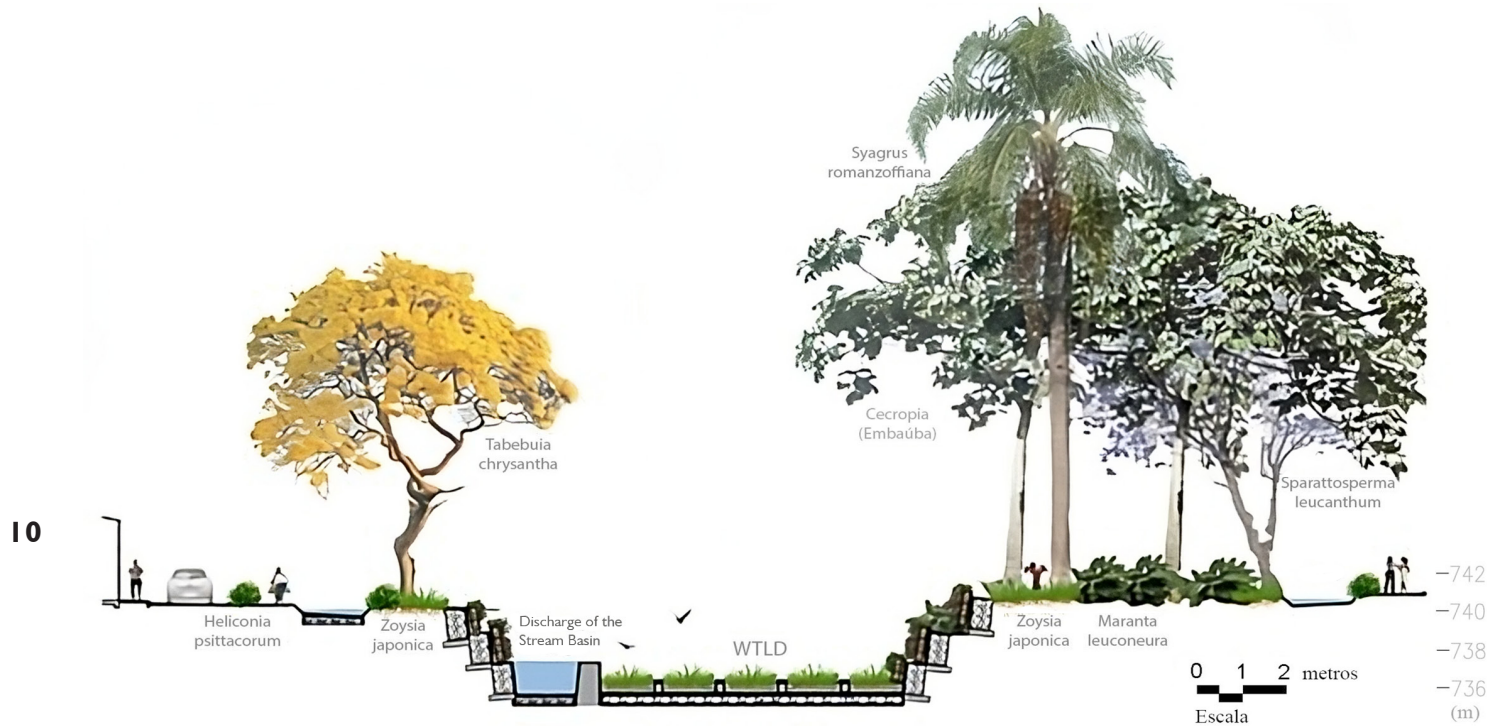
Figure 4 – Green infrastructure plan for the Indian Stream basin.



- Indian Stream hydrographic basin
 - Boundary of the Horto Florestal
 - Vila Amélia
 - Elevated trails along the waterways
- Figure 4 - Green infrastructure plan for the Indian Stream basin.
Source: Evy Hannes's work on Geosampa's VCartographic Base (2018).

Source: Evy Hannes's work on Geosampa's Cartographic Base (2018).

Figure 5 – Combination of Vertical Flow and Horizontal-Sub-Surface Flow Constructed Wetlands.



Source: Machí Castañer (2018).

society at large must address cultural and technical issues to enable the incorporation of the lessons of nature into urban planning.

In Brazil, the issue of housing provision and disbelief in the public power to manage this service must be faced as part of the equation. Overall, European research in GI and ES has been boosted by the discussion of climate change and the need to increase the resilience of cities. In 2019, the discussion of climate change was still incipient, possibly because Brazilians were discussing political issues and the environmental impact of

forest clearing, environmental pollution from mining, agriculture activities, and housing issues. Floods and water crises are major Brazilian problems, but the agenda has been broad. Even palliative solutions are based on traditional engineering tools and studies on these issues have failed to advance as needed.

In 2019, Brazil had a certain amount of research on GI but still lacked practice and successful cases on which to base new applications. Then, it has been difficult to teach GI to architects and urban planners due to

the lack of practice and successful case studies. Even more difficult is enhancing politicians and decision makers' awareness of the urgency this matter requires in Brazilian cities.

The economy of human civilization depends on the services provided for free by the ecosystem, which are valued annually at trillions of dollars. (DAILY et al., 1997). The lack of awareness of these values by human civilizations is increasingly transforming natural environments into human-dominated systems, in which ecosystems lose their ability to produce services (or have it drastically diminished), leading to the loss of human well-being and creating serious problems for the survival of life on the planet.

Green infrastructure and the provision of ecosystem services are tools for designing and planning cities, especially by promoting their environmental and cultural values. Landscape architecture encompasses GI and ES as a field of study. It can and should remain one of the main disciplines dealing with these topics. In the English context, they have already been incorporated into the political and pedagogical plan of most courses, but this process is still in development in Brazil. Progress requires society to recognize and support GI-based constructions and higher education, especially in the academic field. The technique of constructions and the rules governing infrastructure projects and works should evolve and incorporate green infrastructure solutions. In a country with abundant natural resources and low-quality patterns of urbanization, GI and ES can be important to improve urban settlements.

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