Periódico Eletrônico
Fórum Ambiental da Alta Paulista
ISSN 1980-0827 – Volume 18, número 3, 2022

Urban gardens: contribution of small green spaces to sustainable drainage

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ISSN 1980-0827 – Volume 18, número 3, 2022

ABSTRACT

With climate change increasingly imminent, populations living in urban areas are even more vulnerable to flooding, landslides and other socio-environmental problems caused by poor drainage and excessive soil sealing. Between skyscrapers and the excess of streets and impermeable pavements, urban gardens emerge as an ecological and functional alternative for the improvement of drainage and for the renewal of urban infrastructure. This article aimed to analyze the permeable areas of urban gardens, as well as characterize the infrastructure of these spaces. Six vegetable gardens of distinct neighborhoods of the city of São Paulo were selected for this analysis. These spaces were mapped, visited and measured their permeable and impermeable areas. The results show that these small green spaces analyzed have high permeability rate; most have rainwater capture for irrigation of the beds and two of them preserve their springs. It is concluded, therefore, that the urban gardens studied have the potential to reduce the impact and speed of rainwater, increase the absorption of rainwater by the soil and capture rainwater.

KEYWORDS: Green spaces. Agenda 2030. Sustainability.

1. INTRODUCTION

Due to the vulnerability of urban areas to weather events, the implementation of green infrastructure in cities becomes relevant to mitigate the impacts of soil sealing and lack of drainage. The waterproofing of cities, a result of civil construction that prioritizes automobiles and the circulation of vehicles, has caused serious social and environmental problems (HERZOG, 2010). Urban areas, planned and built based on gray and low-draining infrastructure that, not long ago, were treated exclusively in the technical field of engineering, are susceptible to climatic factors, which result in floods, landslides and great damage, not only material, but also to human, animal and plant life (HERZOG, ROSA, 2010; POMPÊO, 2010).

Climate change and inadequate infrastructure make most urban cities vulnerable to natural disasters, droughts and floods (IPCC, 2022). Rising temperatures lead to increased evaporation, which dries out the landscape, although this may be offset in some areas by reduced soil water uptake by plants in response to increased CO2 concentrations.

However, there are ecological and functional alternatives inspired by Nature-Based Solutions (NBS) that should and can be taken into account in the planning and execution of the urban environment (HERZOG, ROSA, 2010). Prioritizing urban drainage for the disposal and reuse of water, including environmental services, promoting access to leisure and the connection between the population and nature, are among the sustainable and intelligent ways of inserting green infrastructure in the context of urban centers (BENINI, 2018).

Spaces such as parks, gardens, vegetable gardens, green roofs, rain gardens and other ecological structures contribute to well-being in more sustainable, safe, multifunctional and resilient spaces. These benefits are the key to reducing the environmental impacts of urbanized regions that usually suffer from overflowing rivers, flooding, high temperatures and the loss of biodiversity (BENINI 2018; HERZOG, 2010).

There are countless environmental and socioeconomic advantages promoted by the implementation of urban green infrastructure: reduction of heat islands, adequate and sustainable rainwater drainage, rainwater buffering reservoirs and improved urban mobilization (MARUYAMA, FRANCO, 2017; NASCIMENTO et al, 2022).

It is certainly a great challenge to implement green infrastructure in large cities that, for the most part, suffer from the severe effects caused by occurrences of climate change (HERZOG; ROSA, 2010). This is the case of the municipality of São Paulo, the most populous city

in all of Latin America, according to IBGE (2016). The urbanized area of the municipality of São Paulo has 1,521,110 km² of territorial extension and an estimated 11,967,825 inhabitants (IBGE, 2016).

The growth model of the municipality of São Paulo and the occupation of the floodplains of the Pinheiro and Tietê rivers dates back to the 1920s with the visionary proposal of the sanitarian Saturnino de Brito to create a green belt with parks in the floodplains of these rivers. However, as we can see, the proposal was not adopted, and in the 1950s construction of the marginal roads began forming a ring road (LIMA, 2021). The result of poor urban drainage planning in the municipality of São Paulo is that a good part of the floodplain areas, streams and rivers are grounded, which results in numerous drainage problems and magnifies the effects of floods. (BROCANELI; STUERMER, 2008).

Against the grain of the great concrete metropolis, there is a tendency to create open green spaces, many of which are created and/or maintained by the community itself. They are backyards, urban gardens, squares, parks and other spaces for the cultivation of food plants, medicinal plants and non-conventional food plants (NCFP); in many cases, created on vacant sites used for garbage disposal and shelter for criminals. It is a new generation of farmers and urban gardeners who use domestic and collective spaces to grow plants for their own consumption, to feed the community and even for local commercialization.

Urban agriculture uses traditional knowledge (ALTIERI, 1995) and encourages people's connection with food, especially in vulnerable communities. In addition, the agricultural practices used in urban areas promote biodiversity, improve the microclimate, connect the landscape, reduce the risk of floods, overload the storm drainage network and diffuse water pollution (MESQUITA, 2019).

Certainly, urban vegetable gardens are a reality in São Paulo, with great potential for expansion. These green spaces are able to improve the urban environment, support the variety of vegetables, boost food security, encourage environmental education and the resilience of cities (COSTA, SAKURAI, 2021). Cormier and Pellegrino (2008) reinforce this concept when they say that urban landscaping needs to be multifunctional and must include the ecological management of urban waters, environmental comfort, biodiversity, alternatives for people's movement and accessibility. Promoting and expanding food production in urban areas is also a way to mitigate the emission of greenhouse gases concentrated in rural areas (SEEG, 2022).

Another advantage of urban vegetable gardens is that they contribute to improving soil in cities. Gardeners and farmers usually use live cover (*mulching*) for fertilization and land protection, that is, dry leaves, pruning residues, compost, sawdust or dead vegetation. Soil vegetated or covered by *mulching* is essential for soil health and for maintaining groundwater tables, as it protects the soil from the impact of rain and wind and retains moisture, which significantly improves soil quality in urbanized areas (SOLOMON, 2020).

The good drainage of cities, encouraged by urban gardens and other vegetated areas, becomes essential for planning based on NBS initiatives, where new proposals for controlling rainwater favor a harmonious coexistence between human beings and nature (BOTELHO, 2011). Botelho (2011) states that it is possible to develop new forms of occupation, new materials, new tools based on the principles of sustainability.

In this way, the present work sought to answer the following question: How can the infrastructure of six urban vegetable gardens in the Municipality of São Paulo contribute to the sustainable management of water resources?

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2. OBJETIVES

Characterize the infrastructure of six urban vegetable gardens in the municipality of São Paulo and analyze the permeable areas in these spaces, as well as the use of water.

3. ANALYSIS METHOD

The characterization study of urban vegetable gardens was conducted within the urban perimeter of the municipality of São Paulo. The gardens are distributed in different neighborhoods and registered on the Sampa+Rural website, a platform that gathers information on sustainable rural development, with 114 registered urban vegetable gardens, organic food fairs and tourist attractions linked to rural and environmental activities in the Municipality (SAMPA+RURAL, 2022). The platform connects the population with farmers and horticulturists in the capital. Among the 114 registered gardens, six were selected, heterogeneously, in six different neighborhoods of the capital (Figure 1). Visits to urban vegetable gardens were carried out between September and October 2022.

Figure 1- Community gardens characterized in the city of São Paulo

Source: Adapted from Google Earth, 2022

Data analysis in the vegetable gardens was carried out by collecting information on the Sampa + Rural platform. After contact with the managers of the urban vegetable gardens and their authorization for the study, a mapping of these locations was carried out with the measurement of permeable and impermeable areas. Subsequently, informal conversations took place following a script with questions addressed to the managers of these green spaces about the management and use of water in the irrigation of the beds. Informal research details and analyzes the gardens through the experiences established between spaces and their guardians (GODOY, 1995).

To measure the permeable and impermeable areas in meters, a 50-meter measuring tape and the Fields Area Measure (2022) application were used, which calculates areas covered in real time by the Global Positioning System (GPS). Data were tabulated in spreadsheets and presented in the form of tables and figures.

During the visits, systematic observation of the sites was also carried out using photographs to add information regarding the use of space, water and management of the construction sites. According to Becker (1972), the observation methodology and the collection of information can be obtained through photographs, when it is intended to carry out exploratory and descriptive research, so there is no room for susceptible generalizations (BECKER, 1972).

3.1 Study Areas

This study included the characterization of six urban gardens located in different regions of the municipality of São Paulo, as shown below.

3.1.1 Horta Viveiro Escola Mulheres do GAU

Horta Viveiro Escola Mulheres do GAU (Urban Agriculture Group) is located at Rua Papiro do Egito, 100, Bairro União de Vila Nova, in the eastern region of the municipality of São Paulo (Figure 2) with 1960 M². The green space was created in 2002 with the aim of revitalizing the place that was previously used as a place to dispose of industrial waste and burn waste. At that time there was no green spaces in the neighborhood. Currently, the garden relies on the work and management of women from that region, who cultivate, harvest and sell greens, vegetables and herbs, hold thematic workshops, organize lunches for the community and encourage the participation of residents in social and environmental projects.

Figure 2 – Horta Escola Viveiro Mulheres do GAU

Source: Horta Escola Viveiro Mulheres do GAU, 2022.

3.1.2 Horta Monte Alegre

Horta Monte Alegre located at Rua José Gomes da Silva, in the Jabaquara neighborhood, southern region of the city of São Paulo (figure 3) with 1600 M², started in 2020, shortly after the residents of the region got together to start the vegetable garden on the land belonging to the subsidiary energy company, (ENEL). Previously, the site was used as a garbage disposal and shelter for people in a state of social and economic vulnerability. The garden is currently cared for on a voluntary basis by some residents who use the crop for their own consumption.

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Figure 3 –Horta Monte Alegre

Source: Google Earth, 2022.

3.1.3 Horta Nossa Praça

Horta Nossa Praça located at Avenida Professor Alceu Maynard de Araújo, number 651, Santo Amaro, in the south region of the capital (Figure 4), with 250 M² has been in operation since 2018. The space was started by residents of the region who transformed an abandoned work into a green area with a square and vegetable garden. The garden still does not have rainwater harvesting. For this reason, residents buy water from a tanker truck to irrigate the beds. According to the managers of the space, there is no intention of selling the food grown in the garden. All production is intended for own consumption and small donations to the community.

Figure 4 – Horta Nossa Praça

Source: Sueli Rodrigues, 2020.

3.1.4 Horta Dona Sebastiana

Horta Dona Sebastiana is located at Rua Professor José Décio Machado Gaia, number 50, Bairro São Mateus, in the eastern region of the municipality of São Paulo (Figure 5) with 6000 M². The garden takes its name in honor of the founder of the space, the urban farmer Sebastiana, who in 2011 lost a productive garden due to flooding caused by heavy rains. Dona Sebastiana, as a way of rebuilding the garden, joined the East Zone Farmers Association and saw the space grow and prosper. Today, the garden has several participations in local social projects, hosts workshops, promotes cultural actions and even sells the cultivated species at affordable prices to the community.

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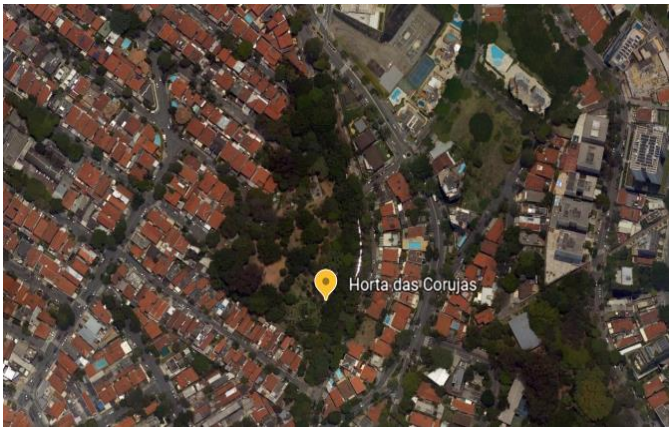
Figure 5 – Horta Dona Sebastiana

Source: Google Earth, 2022

3.1.5 Horta das Corujas

Horta das Corujas is located on Avenida das Corujas, in Vila Madalena, South Zone of the Municipality of São Paulo, with 800 M² the Horta das Corujas has been active since 2012, an initiative of urban gardeners who transformed the neighborhood square into a vegetable garden to put into practice the principles of horticulture and agroecology. The site has a fixed group of volunteers who are responsible for maintaining the urban green space. Vegetables, medicinal plants and NCFP are cultivated and collected by the community involved, in the right amount for individual consumption. Visits from residents and students for volunteer work and research are welcome on site.

Figure 6 – Horta das Corujas



Source: Google Earth, 2022

3.1.6 Horta das Flores

Horta das Flores is located in the Mooca neighborhood, in Praça Alfredo Di Cunto, in the eastern region of São Paulo. The garden was implemented by the City Hall through the Urban and Periurban Agriculture Program of the City of São Paulo (PROAURP), in 2004. The space offers free workshops and courses for the community on composting, NCFP organic fertilization and others. The garden is taken care of collectively and voluntarily by residents of Mooca and other neighborhoods. The space also has the support of undergraduate and graduate students in the maintenance of the construction sites and in the courses offered to the community. Currently, Horta das Flores has several education, environment and healthy food projects.

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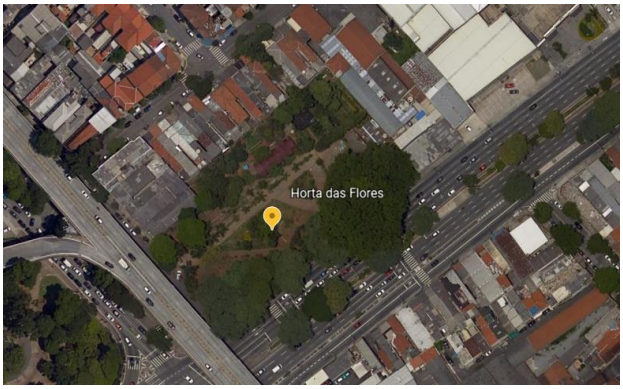
Figure 7 – Image of Horta das Flores, subprefecture of Mooca, São Paulo, SP

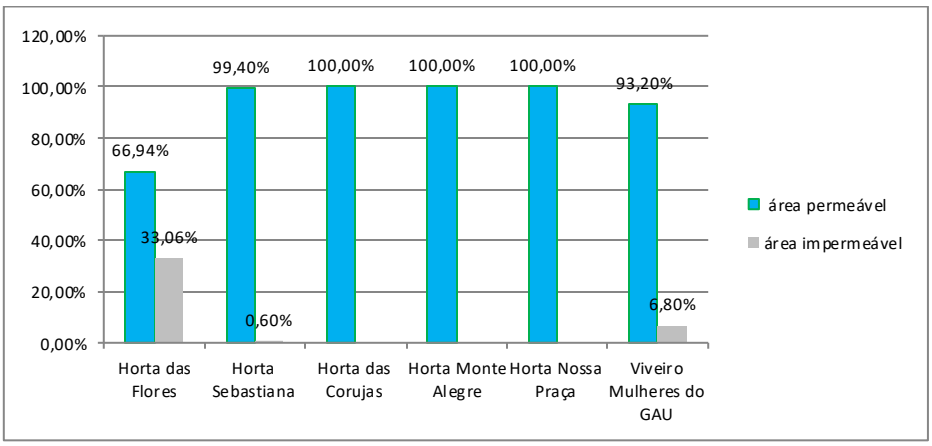


Source: Google Earth, 2022.

4. RESULTS

The evaluation of permeable and impermeable areas in the six urban vegetable gardens studied was positive (Figure 8), which demonstrates a large permeable space in urban gardens, which contributes to sustainable drainage. As expected, the gardens showed a low rate of impermeability, with impermeable spaces being found only in Horta das Flores and Horta Dona Sebastiana.

Figure 8: Permeable and impermeable areas in the urban vegetable gardens studied in the municipality of São Paulo



Source: Authors, 2022.

In Horta das Flores and Horta Viveiro Mulheres do GAU, the impermeable area consists of a bathroom, kitchen (used for preparing food in workshops and courses), storage of tools used in the maintenance of the beds and for other needs of visitors and volunteers in the space. In Horta das Flores, the site also has cobblestone paving that demarcates the access paths for vehicles and people entering the space. Horta Dona Sebastiana has a small waterproof space to store tools, for kitchens and to carry out the workshops offered there.

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Figure 9. Impermeable area of three urban gardens studied. In A: Horta das Flores, B: Horta Dona Sebastiana, C: Horta Viveiro Escola Mulheres do Gau.

Source: A. Authors, 2022, B. Horta Sebastiana and C. Horta Viveiro Escola Mulheres do GAU

Only in 2021, the municipality of São Paulo sanctioned the law that encourages the implementation of permeable areas through landscaping projects, removal of asphalt capping, construction of beds with the same level as the sidewalk to facilitate the flow of water; public policies that guarantee the importance of green areas in urban areas and the functional use of these previously idle spaces, for the production of food and other ecosystem services (CÂMARA MUNICIPAL DE SÃO PAULO, 2021).

As noted by the 2030 Agenda, urban drainage is a challenge due to climate change, being one of the goals of the UN Sustainable Development Goal (SDG) 6. Rescuing and conserving permeable areas in urban centers makes it possible to maintain the hydrological cycle and contributes to SDG 6: drinking water and sanitation (NASCIMENTO et al., 2022).

In the IPCC Report, it is mentioned that increased rainfall leads to flooding, causing deaths, injuries, damage to infrastructure, spread of diseases, interruptions in employment and education, psychological trauma and territorial displacement (IPCC, 2022). The expansion of urban gardens acts directly on the increase of permeable areas in cities, favoring sustainable drainage and mitigating one of the most serious consequences of climate change – floods.

Vegetable Garden managers reported that obtaining water is one of the biggest problems for vegetable garden management, in addition to labor. The irrigation of the vegetable gardens occurs in three ways regarding the origin of the water for irrigation. During the visits, three forms were observed: Rainwater harvesting; water and sewage network (private), and through the preservation of springs (Chart 1, Figure 8).

Chart 1: Source of water for irrigation of the six Urban Vegetable Gardens in the city of São Paulo

Rainwater harvesting	Private	Preservation of Springs
Horta das Flores	Horta das Flores	Mulheres do GAU
Horta Sebastiana	Horta Mulheres do G.A.U	Horta das Corujas
Horta das Corujas	Horta Nossa Praça	
Horta Sebastiana		
Horta Monte Alegre		

Source: Authors, 2022.

It is important to point out that of the four vegetable gardens that have a rainwater harvesting system, only Horta Monte Alegre is able to supply its water needs for the irrigation of the beds. However, the number of beds and productivity is lower in relation to the other vegetable gardens analyzed (Figure 10).

Horta das Corujas has its rainwater harvesting stored in a cistern and preserves a spring to complement the irrigation of the plants grown on site. Horta Mulheres do GAU preserves a spring and complements it with a private water network, Horta Dona Sebastiana has rainwater

harvesting system and uses the municipal water and sewage network for irrigation of cultivars, both are vegetable gardens that sell vegetables.

Horta Nossa Praça and Horta das Flores do not have rainwater harvesting systems. In Horta Nossa Praça, irrigation is acquired by means of a water truck, however the garden intends to install it in the future. In Horta das Flores, a project is starting in partnership with professors of the Master's Degree in Civil Engineering (PPGEC) at the São Judas Tadeu University (USJT). Rainwater will be collected and distributed to the food plant beds, but they still need piped water to meet the demands.

In view of this, it was found that most of the analyzed vegetable gardens still need to pay for water to irrigate the beds and, in the future, this financial cost may make it difficult or even unfeasible to maintain these urban green spaces. This scenario demonstrates that the initiatives and experience among the Urban Vegetable Gardens groups could help improve the water management of other urban gardens and green spaces, such as demonstrating the viability of capturing rainwater and less costly irrigation alternatives, such as takes place in Horta das Flores that use water storage in PET bottles and cords that carry the water to the ground. It should be remembered that each garden has its particularity regarding the structure to receive volunteers, their frequency or employees to contribute to the management of irrigation in the garden, which is still a problem among the studied gardens.

Figure 10. Irrigation methods for the six urban vegetable gardens studied: A. Spring - Horta Mulheres do GAU, B. Water tank stored with a Pipa Truck (water tank truck) – Horta Nossa Praça, C. Cistern – Horta das Corujas, D. Rainwater harvesting – Horta Sebastiana, E. Irrigation with pet bottles and cords – Horta das Flores, F. Rainwater harvesting - Horta Monte Alegre

Source: Authors, 2022.

The exchange of experiences between managers and volunteers can stimulate other gardens, as it could promote the optimization of more accessible technologies, optimization of

material and human resources in the maintenance of the gardens, and thus reduce financial costs. In addition, the preserved permeable area would increase the efficiency in capturing and storing rainwater, reducing the speed of runoff water and increasing the volume of water that penetrates the soil. All these actions would be collaborating with drainage and reducing the deleterious impact of rains.

Small spaces, with permeable areas dispersed throughout the city, can help balance groundwater recharge. According to Tucci (2000) impermeable areas such as sidewalks, streets and pavements prevent the passage of water into the soil and increase surface water runoff. The six characterized urban vegetable gardens have sidewalks and paved streets in their surroundings. It is important to encourage sustainable water drainage, creating and maintaining free spaces in cities, given the importance of preserving the hydrological cycle and reducing areas with flooding (BATTEMARCO et al., 2018). According to Barros et al. (2013), the use and occupation of the soil has consequences on water infiltration and control of rainwater.

Other aspects in relation to urban gardens deserve to be highlighted. Among them, of the six vegetable gardens analyzed, four of them (Horta das Flores, Horta Viveiro Escola Mulheres do GAU, Horta Dona Sebastiana and Horta das Corujas) contribute to cultural activities. These activities refer to workshops, lectures and courses, emphasizing that these spaces for learning and spreading knowledge are important social projects, which can be multiplied.

It should be noted that two of the studied gardens (Horta Viveiro Escola Mulheres do GAU and Horta Monte Alegre) used to be waste disposal areas, or used spaces reused by volunteers such as Horta Nossa Praça and Horta das Corujas. This feature demonstrates that spaces such as urban gardens have the potential to aggregate and mobilize the community, involving women, children and the elderly. These characteristics are in line with target 11.7 of the 2030 Agenda, which is to provide universal access to public, safe, inclusive, accessible and green spaces for all (AGENDA 2030, 2015).

And a last highlight is the income generation that urban vegetable gardens can promote for families in need. In addition, they contribute to the cultivation of unconventional foods promoting food security, where they collaborate with SDG 2 of the 2030 Agenda, which promotes access to food and fights hunger (AGENDA 2030, 2015). As an example, the spaces Horta Viveiro Mulheres do GAU and Horta Sebastiana sell organic food at affordable prices for the community.

5. CONCLUSION

The six urban gardens analyzed in this study have different ways of using urban space, offering permeable areas for most of their spaces. They are collective urban green spaces that contribute to mitigate the effects of rain and climate change, promoting more sustainable drainage in the regions where they are located in the municipality of São Paulo.

In the area of education, these urban gardens encourage environmental awareness among people of all ages. In food security, these spaces encourage knowledge and consumption of organic and biodiverse foods, such as NCFP and wild medicinal plants. In the community, the garden brings people together, it is a space for leisure, learning and knowledge exchange.

Urban gardens can serve as an example for students and the population in general, showing the importance of public policies for these spaces to be better used, as in addition to

feeding, they preserve water resources and contribute to increasing soil permeability and reducing the speed of rainwater.

Further studies are suggested on green spaces such as urban gardens, which contribute to improving drainage, preserving springs in urban areas, encouraging rainwater harvesting and mitigating the impact of rainwater on streets, sidewalks and establishments. These spaces promote well-being for the population in cities and have a positive effect on the environment.

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