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ORIGINAL ARTICLE

Urban Gardens and Soil Compaction: a Land Use Alternative for Runoff Decrease

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Abstract

After several landscape transformations caused by human activities, finding a suitable environment becomes increasingly challenging in urbanized regions. The predominance of non-permeable areas results in a low level of water infiltration. Notwithstanding, even green areas can have high runoff rates, since soil compaction has a decisive influence on the water movement. In places that have a natural predisposition to overflow, these problems are more significant. This study aimed to investigate causes of flooding, highlight the benefits of urban gardening and to propose urban gardening as an alternative to soil improvement in the Corujas Watershed, São Paulo, Brazil. The evaluation was based on: (a) the physical characteristics of the watershed, provided by morphometric analysis and land-use analysis; and (b) the soil compaction rates of an urban garden compared to a riparian forest and a grass area. The morphometric results indicated that the watershed has a significant flood tendency, and the land use map demonstrated that 29.55 % of the soil has some permeability. Nevertheless, this permeability currently varies according to soil management and cover. The grass area presented the highest compaction rates, the riparian forest a medium rate, and Corujas Garden the lowest rate. The garden also has green infrastructures and good management practices, which have led to the appearance and perpetuation of diffuse springs. These results showed that the urban garden activities could improve the physical characteristics of the soil and optimize water infiltration. Subsequent studies will investigate whether this characteristic also applies to other gardens located in different urban watersheds.

Keywords Green area · Soil compaction · Stormwater regulation · Community gardens · Watershed management

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Highlights

- The influence of the morphometric features in the urban drainage was evidenced.
- A relationship between land use and soil compaction was found.
- Urban garden showed lower soil compaction rates compared to other permeable areas.
- Urban riparian forest presented unexpected rates of soil compaction.

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1 Introduction

An environmental issue shared among world's major urban settlements is soil sealing, i.e., impervious cover, and cities in developing countries must face the consequences of soil sealing with urgency. The urban infrastructure that leads to soil sealing includes streets, houses, buildings and sidewalks. In these landscapes, only a small portion of stormwater can infiltrate into the soil (Umer et al. 2019). Hence, the flow to recharge the water table that should come from stormwater arrives mainly from sanitation leakage, which affects groundwater quantity and quality (Minnig et al. 2018; Tubau et al. 2017; Wakode et al. 2018).

Soil sealing increases runoff rates and aggravates floods (Alaoui et al. 2018; Redfern et al. 2016), causing damages that can affect population well-being and threaten the city economy (Haddad and Texeira 2015). Flood hazards grow daily with climatic changes, and its impacts affect mostly the low-income population (Al-Amin et al. 2019; Henrique and Tschakert 2019; Liao et al. 2019). As reported by Zambrano et al. (2017), water management strategies focuses mainly on control of floods and prevention of water supply crises. Nevertheless, a preventive approach can be more effective (Disse et al. 2020). Land use planning and management are essential to provide water regulation service. The decision-making process should consider urban infrastructure, water use (Mokarram and Hojati 2017), soil management (Rahaman et al. 2015), and selection of priority areas for conservation (Adhami and Sadeghi 2016; Shivhare et al. 2018).

Bae and Lee (2020) argued that it is desirable to restore the natural hydrological cycle and maximize permeability. In this context, the maintenance of green areas and trees in cities is essential for climate comfort (Rötzer et al. 2019) and water infiltration. Higher water infiltration rates mean less runoff and a decrease in damages caused by flood events (Berland et al. 2017; Bloorchian et al. 2016; Carter et al. 2018; Ren et al. 2020; Zambrano et al. 2017). Green areas can be a broad concept that includes parks, riparian forests, trees in sidewalks, and green infrastructure (Amato-Lourenço et al. 2016; Bloorchian et al. 2016; Di Marino et al. 2019; Zhang and Muñoz Ramírez 2019). The community gardens can also be a multifunctional green space (Russo et al. 2017) that provides several social and environmental benefits, such as biodiversity of plants and soil fauna, cooling effects, leisure and well-being, and water regulation (Anguluri and Narayanan 2017; Kabisch et al. 2016; Richards et al. 2017; Tresch et al. 2019). This activity is currently responsible for environmental activism, reframing of spaces, and bringing together community members (Carolan and Hale 2016; Egli et al. 2016; Hardman et al. 2018). However, there is a lack of studies on how urban gardens can play a role in improvement of soil physical characteristics. Soil compaction analysis studies, for instance, are more common in soils from forests and rural areas than urban gardens.

Soil compaction can affect primary production, as it limits root growth (Correa et al. 2019). Also, it is one of the main reasons for the increase in green areas impermeability, causing runoff peaks and subsequent socio-environmental impacts (Yang and Zhang 2011). In these scenarios, soil quality is one of the main factors that should be considered in public policies aimed at conservation and environmental balance (Sefati et al. 2019). The degree of compactness has a decisive influence on the water movement across the soil profile and the water content (Halecki and Stachura 2021). To evaluate this compaction, the Soil Penetration Resistance – SPR is a physical property that represents distinct behaviors according to density, moisture, and porosity (Hillel 2003). In addition to being a determinant for plant development, this index can also provide information on the soil's ability to act on water regulation (Martins and Santos 2017; Yang and Zhang 2011; Wang et al. 2019).

Among sealed areas and possibly compacted soils, regions with natural tendencies for flooding can face constant environmental disasters. Hence, this work has the following aims: (a) to identify the problems that lead to floods; and (b) to evaluate urban gardening as a possible solution related to soil compaction of an urban watershed. First, the main physical characteristics of the watershed were identified through a morphometric analysis and a land-use map. Then, compactness in green areas was evaluated by comparing urban gardens with riparian forest and grass in the same watershed to make the assessment as accurate as possible. The Corujas watershed in São Paulo-Brazil was selected for the study because of presenting a constant problem with floods and having one of the most successful community gardens in the city.

2 Methods

2.1 Study Area

São Paulo is the biggest and most important metropolis in Brazil and capital of São Paulo state. The city has an area of 1.521,11 km^2, a population of 12.106.920, and a demographic density of 7.959,27 hab/km^2 (United Nations 2018). According to the Köppen climatic classification, the climate is Cwa (Humid subtropical climate), with rainy summer and dry winter, an average temperature of the hottest month of more than 22 °C and rainfall of about 1376 mm per year (Center for Education and Research in Agriculture 2017).

The biome in the region is Atlantic Forest with some Savana islands. The remaining vegetation covers 30 % of the city area, and most of it is concentrated in the South. Polygons with native vegetation up to 0.5 ha are predominant and high rates of forest fragmentation in the region stands out (São Paulo 2016). São Paulo is within the Alto Tietê Watershed; the original landscape presents meandering rivers and vast alluvial plains associated with Tietê and Pinheiros Rivers. Currently, there are 287 water bodies distributed in 103 sub-basins that discharge in the Tietê River. Nevertheless, most of these rivers are channeled and rectified, becoming invisible to the population (São Paulo 2017).

The meadows in the urban area consist of flood-subject wetlands and are mostly occupied by highway and other civic structures. Furthermore, several streams were channelized and rectified for controlled-access roads and dam construction to explore the hydroelectric potential. All these interventions contribute to significant flooding in the area (Haddad and Teixeira 2015; Jacobi et al. 2015; Seabra 2015).

In 2009, the Municipal Policy of Climatic Change was instituted in São Paulo to provide strategies for adaptation and mitigation of environmental impacts related to the traffic, energy production, waste management, health care and land use (São Paulo 2009). The master plan that was reviewed in 2014 also refers to soil permeability. The rural zone expansion in Sao Paulo can be highlighted as an environmental improvement since the agricultural land use allows more water infiltration (Master Plan of São Paulo 2014). Both policies have achieved some goals, but there were differences between plan and implementation (Giulio et al. 2018). The watershed selected for this study is an example of this situation: Corujas stream has only two patches not channeled (Fig. 1).

2.2 Corujas Stream

The Pinheiros River started to be rectified in 1920, and the Corujas stream went through a channeling process twenty years later (Oliveira et al. 2012). Some green areas surround its

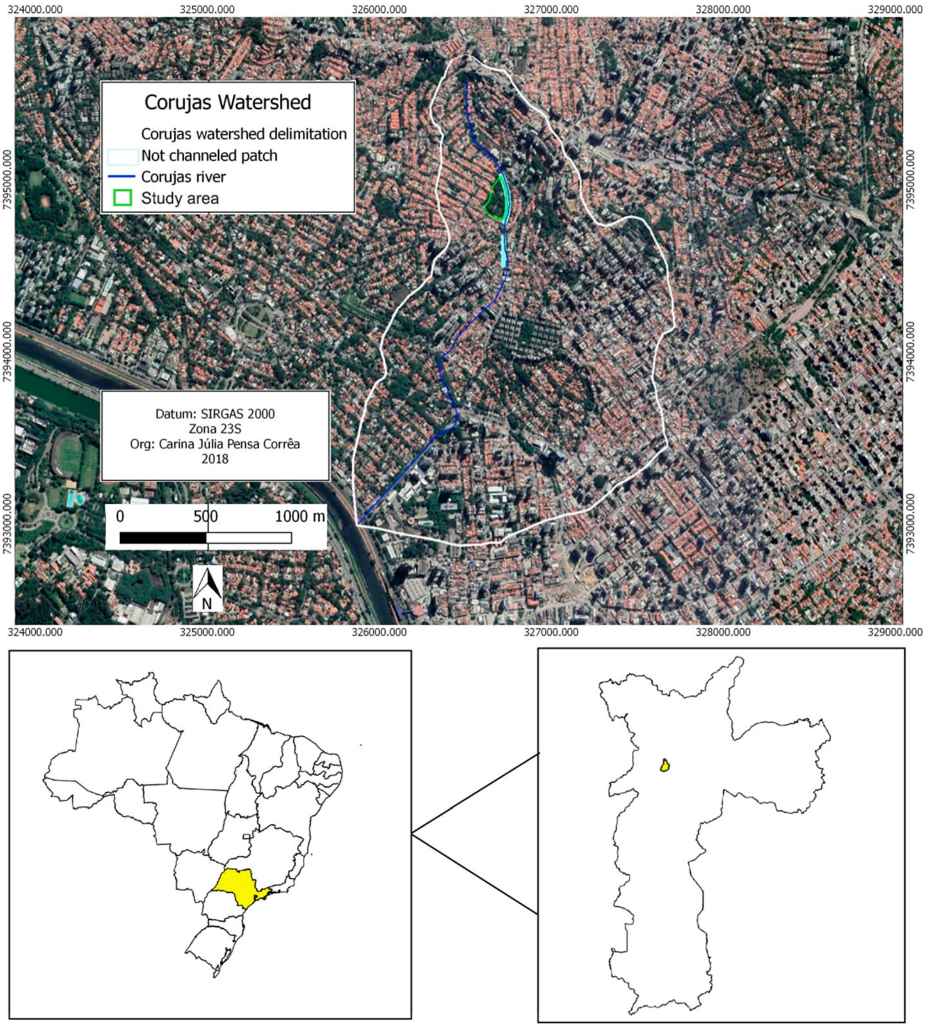

Fig. 1 Corujas watershed delimitation with the study area, main water course, and the non-channeled patches. Source: Image from Google Earth (2018)

open sections (Bartalini 2004), yet floods occur constantly in the region. Due to environmental hazards, initiatives in 2006–2009 resulted in several changes to improve water drainage in the Pinheiros neighborhood. The main park (Dolores Ibarruri) went through a revitalization process, with a landscape project that included several green infrastructures. However, not all the interventions were completed (Oliveira et al. 2012).

The project had good drainage strategies. The bioswale, a ditch with vegetation and a porous bottom responsible for reducing runoff speed, filtering rainwater, and controlling pollution that would go to the body of water (Berland et al. 2017; Li et al. 2016). Permeable pavements can also contribute to the reduction of runoff (Eaton 2018) and has potential for storage and reuse of water for irrigation (Nnadi et al. 2015). However, improper modifications or structures have increased the speed and volume of drained water in some regions, triggering erosion and soil accumulation on walking tracks after rain events. To better understand this

Table 1 Morphometric parameters analyzed and their formulas

Geometric character	
Area	Form factor
Perimeter	Circularity ratio
Compactness coefficient	Drainage pattern
Relief character	
Max slope	Max elevation
Min slope	Min elevation
Mean slope	Mean elevation
Relief ratio	Roughness index
Mean slope of the main stream	
Drainage character	
Main stream length	Drainage density
Total stream length	Watershed order
Sinuosity index	Maintenance coefficient
Strahler's stream ordering	
No tributaries, small channels	1st
Confluence between two first order channels (Only receive first order tributaries)	2nd
Confluence between two second-order channels (Receive first and second-order tributaries)	3rd
Confluence between two second-order channels (Receive first, second and third order tributaries)	4th
Index	Formula
Compactness coefficient (Kc)	$Kc = 0.28\frac{P}{\sqrt{A}}$ where: P=Perimeter (km) A=Watershed area (km^2)
Form factor (Kf)	$Kf = \frac{A}{L^2}$ where: A=Watershed area (km^2) L=Watershed length (from the outfall until the spring) (km)
Circularity ratio (Ic)	$Ic = \frac{A}{Ac}$ where: A=Circularity ratio (km^2) Ac=Circle area correspondent to the watershed perimeter (km^2)
Relief ratio (Rr)	$Rr = \frac{Hm}{Lc}$ where: Hm=Altimetric amplitude (m) Lc=Main stream length (km)
Roughness index (Ir)	$Ir = \frac{(Hm \times Dd)}{1000}$ where: Altimetric amplitude (m) Dd=Drainage density (m/m^2)
Mean slope of the main stream	$Gc = \frac{Amax}{Lc}$ where: Amax=Max elevation of the watershed (m) Lc=Main stream length (m)
Drainage density (Dd)	$Dd = \frac{Lt}{A}$ where: Lt=Total stream length (km) A=Watershed area (km^2)
Sinuosity index (Is)	$Is = \frac{Lc}{Lv}$ where: Lc=Main stream length (km) Lv=Vector main stream length (km)
Maintenance coefficient (Cm)	$Cm = \frac{1}{Dd}$ where: Dd=Drainage density (m/m^2)

Source: Adapted from Christofoletti (1969), Horton (1945), Strahler (1964) and Villela and Mattos (1975) trend to floods and soil erosion, an analysis of the morphometry was carried out in the Corujas Watershed.

2.3 Morphometric Analysis of Corujas Watershed

A key instrument to understand the dynamics of a watershed is morphometric analysis. The characteristics such as slope, geology, and drainage aspects can provide a holistic view of the physical environment (Christofoletti 1969). Focusing on these aspects, parameters were selected based on the works of Christofoletti (1969), Horton (1945), Strahler (1964), Villela and Mattos (1975), and they are summarized with their formulas in Table 1.

2.4 Geoprocessing

All the maps and the morphometric parameters of this work were developed with the QGIS 2.18 software and the GRASS 7.4.1 extension. Different charts were consulted for temporal comparison purposes: Society of Aerophotogrammetric Surveys chart from 1930 (1:5000) (São Paulo 2018); IBGE planialtimetric chart from 1984 (1:50,000) (São Paulo 2018); and EMPLASA planialtimetric chart from 1986 (1:25,000) (São Paulo 2018). The elevation and slope map that enabled the calculation were constructed from the IGC topographic chart from 1971 (1:10,000) (Geographic and Cartographic Institute 2018).

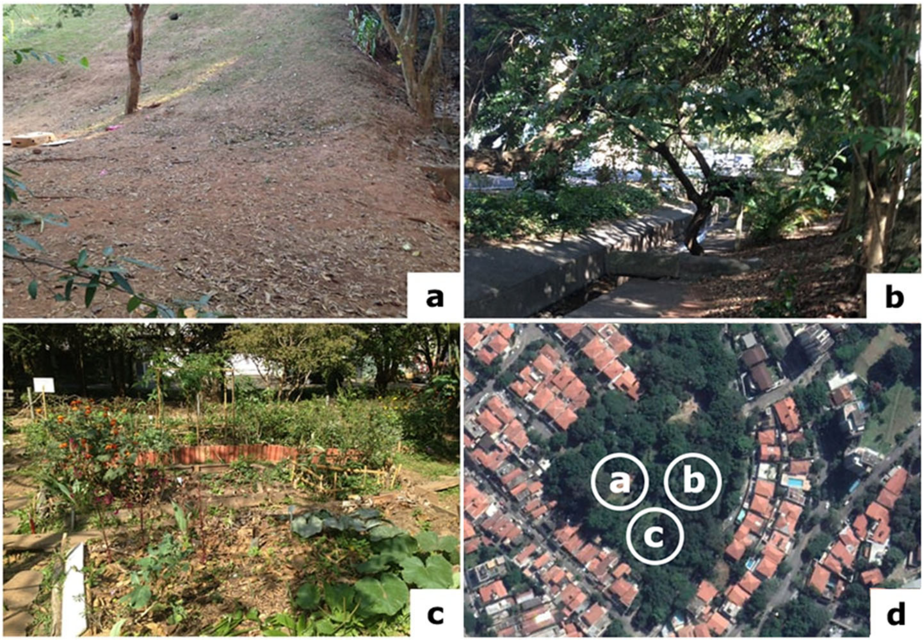

Fig. 2 Study areas characterization: a) Grass with exposed soil patches; a) Riparian forest; c) Corujas garden; d) Location in satellite images. Source: Image from Google Earth (2018). Photos by the lead author

2.5 Soil Compaction Study and Statistics Analysis

The soil penetration resistance (SPR) helps to understand the soil permeability. The compaction is superior when the resistance is higher, consequently, the water infiltration time into the soil will be longer. The areas selected for the compaction analysis are in the Dolores Ibarruri Park, Sumarezinho neighborhood. The selection was based on the proximity of distinct vegetation coverings so that the soil characteristic would be the same and the land use different: (1) Grass and exposed soil areas; (2) Tree area (riparian forest of the Corujas river); (3) Gardening area (Corujas garden). The garden has a high diversity of vegetables, fruits, medicinal plants, and unconventional food species (Fig. 2).

The equipment used was the Falker PenetroLOG Penetrograph – Electronic Meter of Soil Compaction, which measures SPR in pressure units (mPa) until 60 cm depth. Ten tests were made randomly in each area, totaling 30 repetitions. According to Filho and Ribon (2008), number of tests n = 10 in the 0–60 cm layer by soil management enables a high accuracy of the data and use of statistical parameters in SPR analysis. The fieldwork was accomplished in July 2018, and all SPR measurements were carried out on the same day to reduce the impacts of soil moisture variation (Esteban et al. 2019). The averages were analyzed through a Shapiro-Wilk normality test, a Variance Analysis (ANOVA), and a Tukey test. All analyses considered a level of significance of 95 % and were made using PAST 3.22 Software.

3 Results and Discussion

3.1 Morphometric Analyses

According to Strahler's (1964) classification, the Corujas Watershed has only one watercourse, classified as a first-order. Regarding the size, using García's (1982) classification, it can be considered a nano-watershed. The other morphometric indices were calculated and are summarized in Table 2.

Corujas has a circular tendency since the compactness coefficient is 1.231. A perfect circle would receive 1 for Kc, so proximity to unit means a nearly round shape (Villela and Mattos 1975). The circularity index (0.651) and form factor (0.5113) corroborate the result since values higher than 0.5 also indicate a trend to circularity (Christofolleti 1980). Compared to other studies (Abboud and Nofal 2017; Kaliraj et al. 2015; Rai et al. 2017; Shivhare et al. 2018), the watershed presents a high tendency to floods and significant surficial flows due to its low time of concentration (Tc).

The average relief is smoothly undulating (mean slope of 5.03 %). However, there is a significant variation, with rugged areas in the upstream region and plain regions near its downstream. In the study area, slope can reach 45 % and can contribute to land degradation (Santos et al. 2020). According to Didoné et al. (2021), sites with higher slopes are more predisposed to erosive processes. The digital elevation model presented a minimum altitude of 721 m, a maximum of 806 m, and an average of 765.11 m. The altimetric range represents the difference between the inlet and the highest altitude at a given point in the watershed area. The 85 m amplitude can be considered low compared to other morphometry studies (Almeida et al. 2016; Nardini et al. 2013; Santos and Morais 2012; Tonello et al. 2006) (Fig. 3).

Regarding the watercourse, the sinuosity index (1.183) indicates that the channel tends to be straight. Values close to 1 shows rectification, while values higher than 2.0 represent tortuous channels (Schumm 1963). Since there is only one stream, the watershed presents regular drainage parameters and a high maintenance coefficient. The value indicates the minimum area required for the maintenance of a watercourse. In this case, the watershed has a large recharge area (1.101 km/km^2) (Santos et al. 2012).

The drainage density can range from 0.5 km/km^2 (reduced drainage basins) to 3.5 km/km^2 or more (exceptionally well-drained basins) (Almeida et al. 2016; Tonello et al. 2006; Villela and Mattos 1975). The regular Dd found (0.987 km/km^2) may be due to low-intensity rain regimes, low precipitation concentration, porous rock formations, and low roughness index. When the rainfall of the last 20 years in the region was analyzed, rates remained close to the state average (1558 mm per year) and the national average (1430 mm per year) (National Institute of Meteorology 2018). In this context, rainfall is unlikely the answer for low drainage density.

Hence, the low roughness index (0.0838) (Kabite and Genesse 2018) and rock formations are the most likely explanation: the watershed presents sedimentary Cenozoic deposits with a porous domain. More precisely, sedimentary origin in the north portion is Conglomerate/Claystone/Siltstone, while the southern portion is Sand/Clay/Gravel (Brazilian Institute of Geography and Statistics, 2021).

According to the Brazilian Agricultural Research Corporation (2013), the watershed soil can be classified as Red-yellow argisol that can present high susceptibility to erosion and great cohesion (Agronomic Institute 2015). The clay composition can also delay water infiltration and decrease water retention (Jim 2019). Thus, the floods can be explained by the natural composition of the soil and an accentuated slope. Furthermore, soil sealing rates can contribute to stormwater runoff. The land use map (Fig. 4) demonstrated that 29.48 % of the soil has some permeability (6.98 % parks and green areas in residential building, and 22.5 % trees on sidewalks).

Table 2 Synthesis of the values found for the adopted parameters

Parameters	Values
Area	2.66501 km^2
Perimeter	7.168 km
Compactness coefficient	1.231
Form factor	0.511
Circularity ratio	0.651
Drainage pattern*	-
Min declivity	0 %
Max declivity	39.81 %
Mean declivity	5.03 %
Min elevation	721 m
Max elevation	806 m
Mean elevation	765.11 m
Relief ratio	31.516
Roughness index	0.083
Mean slopeof the main stream	0.031
Main stream length	2.697 km
Total stream length	2.697 km
Sinuosity index	1.183
Drainage density	0.987
Watershed order	1st
Maintenance coefficient	1.101

* Drainage pattern cannot be assigned as the basin has only one watercourse

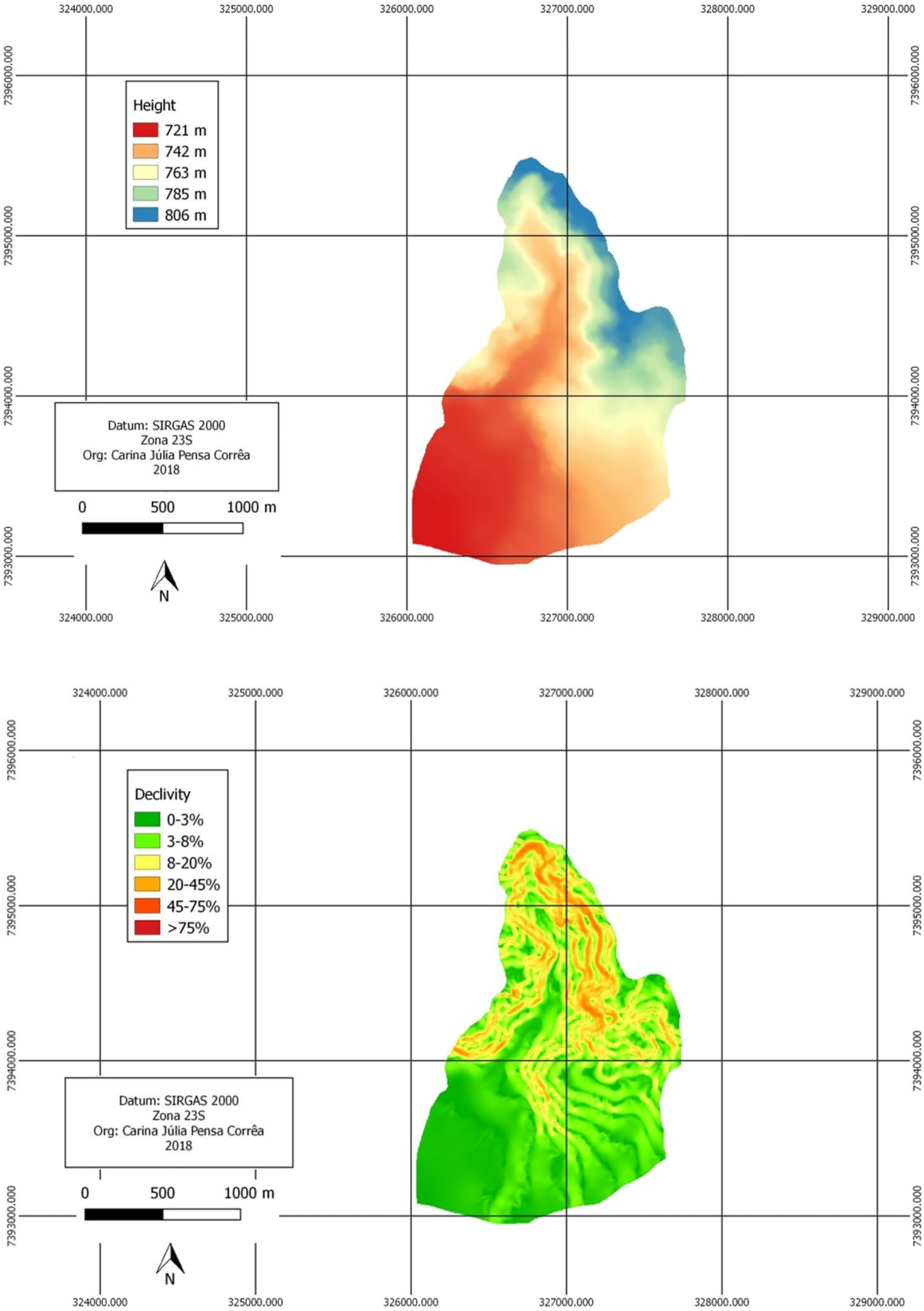

Fig. 3 Digital elevation and slope map of the Corujas watershed, São Paulo, Brazil. Source: Geographic and Cartographic Institute (2018)

The percentage found in this study corroborates the results by Amato-Lourenço et al. (2016) about the urban afforestation of São Paulo city. The authors found that the Pinheiros region has 28.4 % of vegetation cover, considering the trees in the streets and parks. Still, a

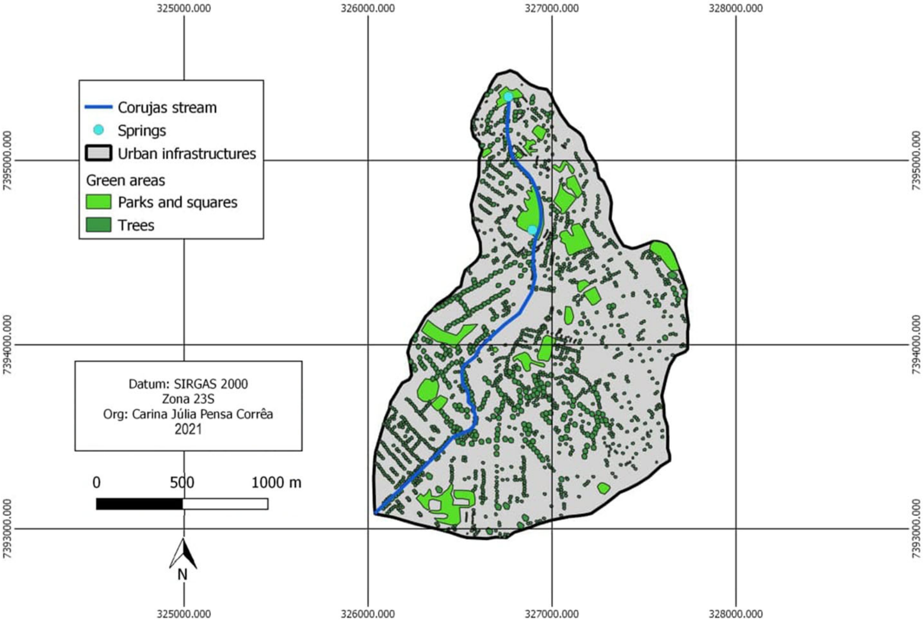

Fig. 4 Land use map of the Corujas watershed, São Paulo, Brazil

70 % waterproofing area can contribute to flooding. As stated by Eshtawi et al. (2016), small expansions of sealing can considerably increase runoff. In a quantitative analysis of watersheds, Walsh et al. (2012) noticed that 5-10 % of total impermeability and conventional drainage systems can increase the frequency and magnitude of the stormwater flow.

3.2 Soil Compaction in Different Permeable Areas

The degree of soil compaction was different according to soil management. In the grass area, the maximum measurement could be made up to 8 cm, and in the Riparian forest, the maximum value was reached of 21 cm. The garden was the only area where it was possible to measure to the end (60 cm) in 7 of the 10 collections. But the discrepancy between the areas can be observed from the first measured layer (0–9 cm) since the average strength in the garden was 0.28 MPa, in the riparian forest 0.85 MPa and in the park 1.12 MPa. In the next layers, the required strength continues to increase as expected (Betzek et al. 2018), but the vegetable garden continued to have lower values and, consequently, lower soil compaction rates (Fig. 5).

When the strength averages were analyzed statistically, it was verified that all areas differ from each other significantly. It is important to highlight that the areas are close to each other, with soil management being the only variation that can be pointed out among them. In this case, the soil organic matter index may be a factor for the lower compaction in the community garden (Jim 2019; Lima et al. 2015; Stock and Downes 2008).

Agroecological practices can improve soil physical characteristics including decompaction, as shown by Cherubin et al. (2019). The gardeners provide constant fertilization with organic compost produced locally and apply management techniques of soil cover. This cover consists of plant residues that provide a natural layer to retain moisture, prevent accentuated sunshine

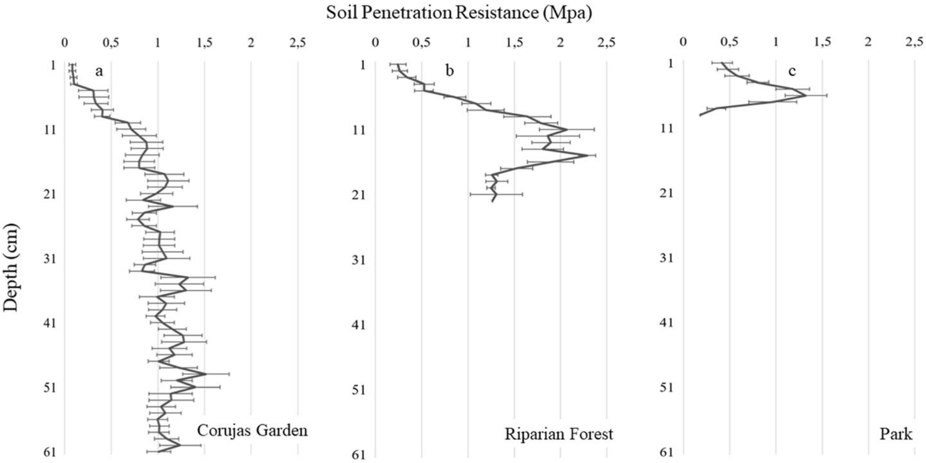

Fig. 5 Graph of the mean values and standard error of penetration resistance (mPa) up to 60 cm deep of the study areas: Corujas Garden, Riparian Forest, and Park. Different letters mean significant differences at $p < 0.05$ according to Tukey Test

exposure, and protect from rainfall impacts. According to Silva et al. (2018), soil cover techniques is effective to promote a decrease in temperature, increase of humidity, and reduction in compaction rates.

Another feature that favors the community garden is a higher vegetation cover. The roots of the plants are closely interrelated with porosity (Colombi et al. 2018; Paule-Mercado et al. 2017). As the garden has more vegetation growth than the park, it was expected that its result would be superior. However, a less compacted soil would be standard from the riparian forest, precisely because of the root's depth and volume (Almeida et al. 2018; Xie et al. 2020). In this case, the higher compaction rate could be explained by the channeling and imperviousness process. As proven by Jim and Ng (2018), areas around trees planted in urban areas may suffer from soil compaction and low porosity.

Pereira et al. (2021) demonstrated that average SPR (0–10 cm) in restored forests of Brazilian Savana range between 0.22 MPa and 0.42 MPa. These values indicate that the first soil layer of Corujas garden presents an average like a restored forest 46 years ago. On the other hand, the riparian forest area has a much higher rate. But this resistance varies in different forest formations. In Atlantic Forest, an average of 0.79 MPa was found (Martinkoski et al. 2017). As the study region is composed of Atlantic Forest, the comparison within this biome also demonstrates that the SPR in the upper layer of the soil of the riparian forest is high.

3.3 Stormwater Management

Green infrastructures can be described as engineering alternatives to establish spaces for stormwater management, to benefit the local microclimate and to create leisure spaces (Chenoweth et al. 2018; Mander et al. 2018). During the fieldwork, structures developed for the water infiltration were found in the garden. These are pits with a depth of approximately 60 cm, filled by boulders and covered by a cement structure. These structures can help in the maintenance of soil moisture, and therefore, in its decompaction. In addition, they reduce the amount of surface runoff by protecting herbaceous species from the garden (Fig. 6).

Another system implanted is a rain garden with the use of the biological activity of plants and microorganisms. This infrastructure can purify the stormwater, increase water infiltration in the water tables, and reduce the flow (Chaffin et al. 2016). The green drainage systems decrease flood hazards in urbanized areas (Walsh et al. 2012). The development of solutions to reduce runoff are crucial in the garden because of the inclination right above the area. To date, they appear to be helpful for soil conservation.

Soil management, fertilization techniques, vegetation planting, and green infrastructures generated another benefit: the appearance of diffuse springs. These springs do not appear in any official letter, and the water is used for irrigation purposes. The flow is stored in water tanks, which have small aquatic plants and tiny fish to control plagues and organic materials. Besides, they are responsible for keeping water moving, and thus, prevent the creation of disease-propagating mosquitoes.

4 Conclusions

The Corujas Watershed is an example of significant anthropic interventions in cities since it had a great part of its main water body channeled. Consequently, the region suffers from flood hazards and soil erosion. This situation could be explained by the geometric characteristics, which indicate a circular tendency and a low time of concentration. The slope of some regions, including the study area, may also favor environmental disasters. In this context, the maintenance of green areas is fundamental to mitigate the problem and increase soil permeability.

In Corujas watershed, 29.48 % of the area did not go through soil sealing. This portion is divided into parks, individual trees, riparian forest, and a vegetable garden. Since compaction

Fig. 6 Stormwater management in the Corujas garden: (a) Concrete infrastructure for stormwater infiltration; (b) Rain garden; (c) Water source in the middle of the garden; (d) Water tank used for water storage and irrigation

reduces the porosity and permeability of the upper layer of the soil, this parameter was evaluated in these distinct green areas. The results indicated that the grass and the riparian forest have high compaction, an adverse characteristic. Interventions for better soil management such as enrichment planting are valuable both for plant growth maintenance and soil capacity to water infiltration. On the other hand, the community garden has the lowest rates of soil compaction. Corujas garden promotes soil conservation practices, such as specific stormwater management infrastructures. The good practices had an unprecedented effect: the emergence of new springs that currently are protected by gardeners. Spring rising corroborates that the soil has good permeability and low rates of compaction. Subsequent studies on the extent of this potential in other urban watershed and other vegetable gardens need to be carried out. Still, the present findings are positive indicators that urban gardening can be a strategy for environmental and water conservation. These spaces can co-exist with other green areas and optimize water infiltration with green infrastructures, enhancing ecosystem services provision in cities. These benefits can be added to social and economic reasons for prioritizing the practice in public policies in Brazil and other densely urbanized regions.

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Author Contributions All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Carina Julia Pensa Corrêa, Kelly Cristina Tonello and Ernest Nnadi. The first draft of the manuscript was written by Carina Julia Pensa Corrêa and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data Availability The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflicts of Interest/Competing Interests The authors declare that they have no conflict of interest.

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