

An assessment of the ecosystem services content of green plans as an evaluation proxy for the delivery of urban green infrastructure

Abstract

To facilitate well-being and health amongst urban populations, there is a need for urban spatial plans to promote sustainable development, leading to considerable interest and practice related to the delivery of urban green infrastructure (UGI). One approach for delivering UGI is through the adoption of green plans. However, green plans vary considerably in their structure and content, and there is a pressing need to evaluate whether green plans incorporate the necessary range of ecosystem services (ES). In this paper, we adopt an existing evaluation method using coding to determine the extent to which ES are embedded explicitly and implicitly in green plans. We apply this to a unique situation of the Brazilian city of São Paulo which has four separate green plans (investigating each plan individually for potential ES delivery) and adapt the method to separate the rhetoric of plans from their tangible actions in order to get closer to an analysis of ES outcomes. The four green plans that make up the green area system present greater or lesser participation and intensity of the ES concept which can influence the UGI implementation. However, the analysis comparing the content and discursive representation of each green plan with its respective plan actions showed, except for one of the four plans, that the delivery of ES through the green plans focuses more on rhetoric than action. To deliver the desired UGI for ensuring urban sustainability, green plans must not only mention ES in their content but should embed ES in their plan actions.

Highlights

- UGI actions can be evaluated against the ecosystem services provided
- ecosystem services (ES) can be referenced implicitly and explicitly in green plans
- green planning must action delivery of ES to achieve sustainability
- green plans contain both rhetoric and concrete actions

1. Introduction

The continuous accelerated trend for urbanization has led to the emergence of concerns over the ability of urban planning to deliver sustainable development (Xu et al., 2019). Spatial planning and the patterns of land-use and land-cover change are directly interconnected and their interactions within socio-ecological systems can result in impacts on biodiversity and ecosystem services (Hersperger et al., 2018). As a consequence, the consideration of sustainable development is an important imperative

in land-use planning, leading to the development of greening strategies to address environmental problems in decision-making (Gazzola et al., 2019), including for built urban spaces (Artmann et al., 2019; Hansen et al., 2019; Naess, 2001).

Urban planners are aware of the need to effectively include green infrastructure (GI) in urban planning practice (Zardo et al., 2017). Therefore, municipalities are launching greening strategies to improve GI within city boundaries (Melero et al. 2020) that must be implemented through integration with spatial land-use planning (Goddard et al., 2010). Authors argue for a variety of categories of GI (e.g., Bartesaghi Koc et al., 2017; Badiu et al., 2019), with Pauleit et al. (2019, p. 4) identifying a typology of 44 classes of urban green infrastructure (UGI) distributed in eight groups: allotments and community gardens; blue spaces; natural, semi-natural and feral areas; building greens; private, commercial, industrial and institutional green spaces; parks and recreation; riverbank green; and agricultural land. Thus, understandings of UGI vary, and different greening strategies are being used to make urban planning greener or more sustainable. That is, there are many implementation approaches, ranging from inclusion of greening strategies in urban plans, through to the development of dedicated green plans. Kabisch (2015, p. 558) recognizes as green plans those planning documents that embrace “strategies which refer to the development and conservation of green spaces and biodiversity on a regional, city or specific green space level.”

Even where UGI strategies can be identified, recognizing the appropriate approach for determining their success is also contested (see, for example, Van Oijstaeijen et al., 2020; Teixeira et al., 2021; Chang et al., 2015; Rall et al., 2019; Meerow, 2020; Zhang and Ramírez, 2019). But despite the plethora of approaches for evaluating

UGI, with different assumed purposes for UGI, almost all the tools and frameworks described in the literature use ecosystem services (ES) as a proxy. ES as a concept recognizes the importance and value of ecosystems to humans (Costanza et al., 1997; de Groot et al., 2010), and they are understood as a bridge that links natural ecosystems with the human social system (Peng et al., 2020). The range of ES are expected to include provisioning (McPhearson et al., 2014; Russo et al., 2017), cultural (Dickinson and Hobbs, 2017; Ko and Son, 2018; Flausino and Gallardo, 2021); regulating (Larondelle et al., 2014; Cortinovis and Geneletti, 2019) and supporting (Haase et al., 2014), and to derive from a variety of types of green areas (de Groot et al., 2010).

Spatial planning has also frequently been evaluated using the concept of ES (Honrado et al., 2013; Mascarenhas et al., 2015; Kabisch, 2015; Cortinovis and Geneletti, 2018 and many others). ES frameworks (TEEB, 2011; Costanza, 1997) are often used as the basis for content analysis of tiered planning documents (at the regional, city and district levels) by searching for explicit or implicit references to the ES approach or specific services (Honrado et al., 2013; Kabisch, 2015; Rozas-Vásquez et al., 2018; Burgos-Ayala et al., 2022). For example, Rall et al. (2015) used an ES framework (TEEB, 2011) for analyzing 14 plans from New York and Berlin through a content analysis searching for explicit references for the benefits provided by different ES. A number of other authors have also developed, or adapted, criteria to analyze documents through content analysis using ES as the benchmark for evaluation purposes (for example, Woodruff and BenDor, 2016; Honrado et al., 2013; Mascarenhas et al., 2015; Hansen et al., 2015; Cortinovis and Geneletti, 2018). This content analysis approach has been shown to develop an understanding of the extent to which ES are embedded in plans but cannot examine the extent to which ES are ultimately delivered. Identifying the

outcomes of plan implementation is difficult to isolate from a range of overlapping plans and policies and therefore remains an exercise underpinned by untested assumptions that connect plan actions with outcomes. Nevertheless, as a further contribution to the evaluation of the greening of urban planning, and following the recommendations from Grunewald et al. (2021, p.12) that more integration is needed for embedding ES in more strategic spatial planning, especially, “in the context of larger urban areas where ecosystems are a part of even larger metropolitan surroundings” we chose the urban green planning of the city of São Paulo as a suitable case study to examine the embedding of ES actions in strategic planning.

São Paulo is the 8th most populous city on the planet, with the São Paulo Metropolitan Region including the City Green Belt Biosphere Reserve recognized by Unesco, in 1994, as an integral part of the Atlantic Forest Biosphere Reserve (Moraes Victor et al., 2004). Uniquely with respect to other cities (Chang et al., 2015; Cortinovis et al., 2018) the São Paulo Master Plan integrates four specific types of green plans. This context represents an opportunity to explore how the ES concept is presented in different types of green plans that are expected to deliver different UGI strategies and focus strictly on each plan separately, without inferring cumulative or synergistic effects. This is a modest contribution to the research gap identified whereby the ES concept as a measure of the relative success of different UGI strategies remains unknown.

Thus, this paper aims to explore whether and how the concept of ecosystem services is present in each green plan representing a way of delivering urban green infrastructure. It is unique in considering each of a set of adopted green plans, rather than the UG credentials of a single individual plan in a geographical location. It follows

the method developed by Hansen et al. (2015) to use content analysis constrained by a focus on ES but, in response to the criticism of analyses of plans not measuring outcomes, has a focus on plan actions in addition to the remainder of the plan text. Whilst still not measuring outcomes, this approach helps to separate the rhetoric of plans from tangible actions. The aim is addressed through two research questions:

1. How is the ES concept, in explicit and implicit terms, and within plan actions specifically, represented in each green plan?
2. What is the extent to which different types of urban ES are represented in each green plan, and its plan actions, as a way of assessing whether ES are comprehensively directed towards the delivery of UGI?

The paper is structured as follows: the next section (section 2) introduces the methods, including a brief explanation of the São Paulo case study and the evaluation framework. In section 3, we introduce and discuss the results based on the application of the evaluation framework to São Paulo. Section 4 presents the conclusions, highlighting the implications of the findings and potential future pathways to improving the greening of urban planning.

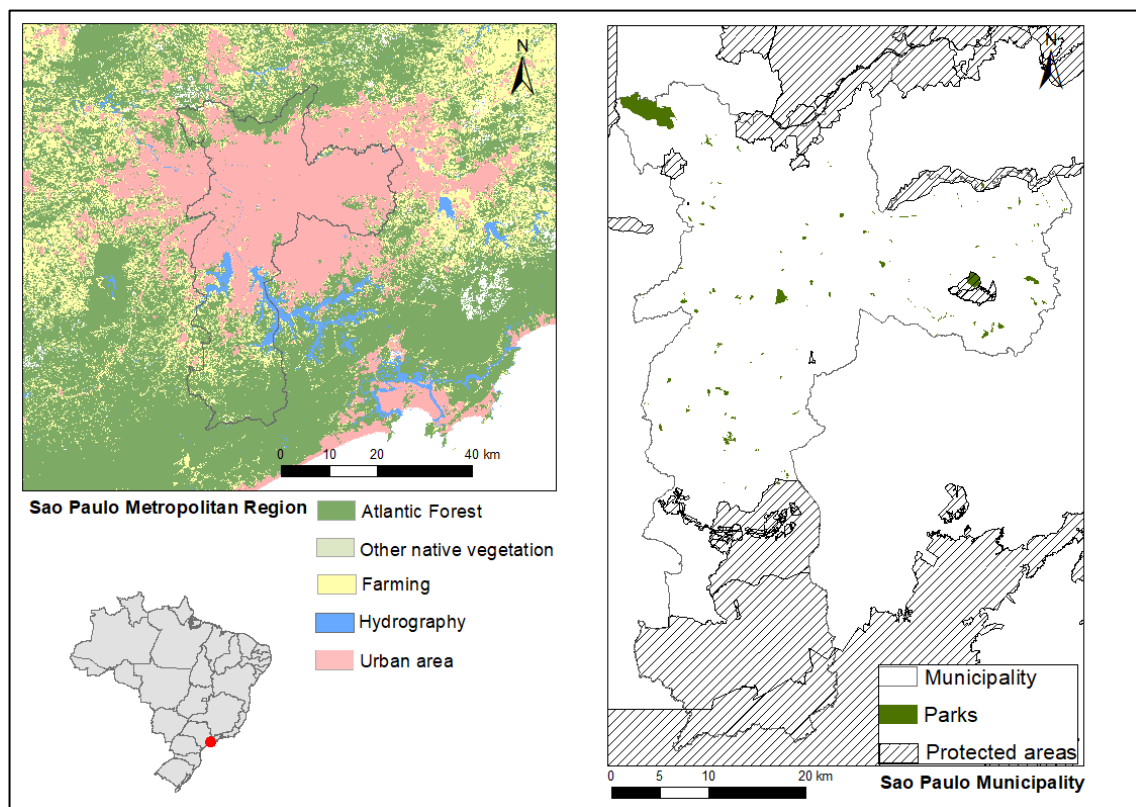
2. Methods

This section presents a brief explanation of the São Paulo case study, the rationale for analysis using the ES concept, and the way the evaluation framework is applied to our data set.

2.1. The role of the Master Plan and Green Plans of São Paulo city

São Paulo city is the most populous Brazilian megacity, being highly urbanized (at a rate of 99.1%) and encompassing important natural resources such as a dense drainage network (Fukasawa and Mierzwa, 2020) with 30.4% of its area covered by remnants of the Atlantic Forest and 31.4% comprising protection areas (Petroni et al., 2022), as shown in Figure 1. However, the distribution of green areas reveals a significant geographic disparity: from 32 boroughs only 5 have more than 15m² of green area per inhabitant (Moreira et al., 2020), an issue also reflected in the irregular distribution of squares in the city (Benchimol et al., 2017).

Figure 1 – São Paulo city and its green areas.



At the municipal level, the Master Plan is responsible for applying the instruments of the Statute of the City (Federal Law 10257/2001) (Ultramari et al., 2018). In São Paulo, the Master Plan is reviewed every 10 years and its latest version, the São

Paulo Master Plan PDE (Plano Diretor Estratégico in Portuguese) (2014) aims at establishing strategic guidelines for land-use and urban development harmonizing the distribution of goods and infrastructure, whilst recognising the importance of green areas (Siqueira-Gay et al., 2019).

The current Master Plan PDE (São Paulo, 2014) defined in its section ‘urban and environmental policy and system’, the System of Protected Areas, Green Areas and Free Spaces (*Sapavel*, in Portuguese) that covers a set of areas falling into several categories protected by environmental legislation, such as indigenous areas, areas providing environmental services (in Brazil, the terms ecosystem services and environmental services can be used as synonyms or with some conceptual differences – Souza et al., 2016, in the context of this article they are used as synonyms), public parks, areas with vegetation and spaces not occupied by covered buildings on public or private property. This Sapavel system has the following objectives to provide UGI in the city of São Paulo: a) protection of biodiversity; b) conservation of areas providing environmental services; c) protection and recovery of Atlantic Forest remnants; d) qualification of public green areas; e) encouraging the conservation of privately owned green areas; f) conservation and restoration of ecological corridors at the municipal and metropolitan scale; g) compliance with the provisions of the National System of Conservation Units (São Paulo, 2014).

To achieve the main objectives of the Sapavel system, the PDE (São Paulo, 2014) establishes four green plans: the Municipal Urban Afforestation Plan (PMAU in Portuguese) (São Paulo, 2020a); the Municipal Plan for Protected Areas, Green Areas and Free Spaces (Planpavel in Portuguese) (São Paulo, 2020b); the Municipal Plan for the

Conservation and Recovery of Areas Providing Environmental Services (PMSA in Portuguese) (São Paulo, 2019); and Atlantic Forest Municipal Plan (PMMA in Portuguese) (São Paulo, 2017); as presented in Figure 2 and Table 1 (Supplementary materials provides a more detailed description of the contents of the plans and for this section).

Figure 2 – The São Paulo Master Plan and its four green plans.

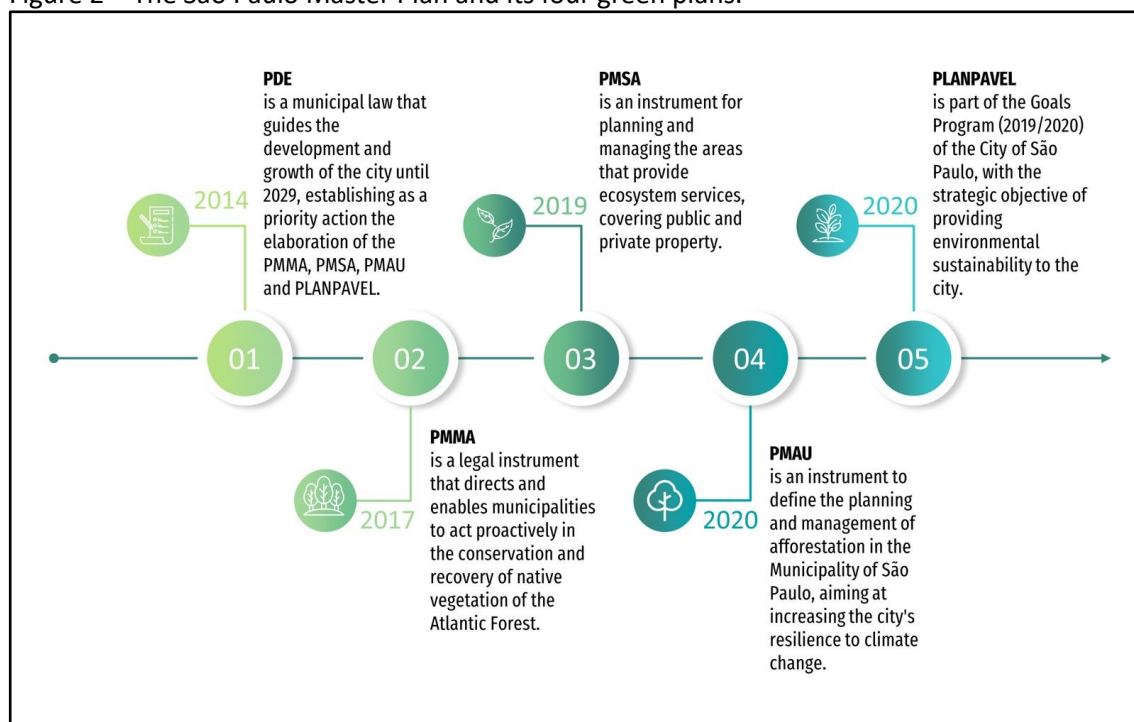


Table 1 – Brief description of the four green plans that comprise the Sapavel System.

Green Plans of Sapavel	Scope foreseen in the São Paulo Master Plan	The objectives established in the green plan	Plan Actions presented in the green plan
PMMA – 533 pages	The plan, which follows a federal law, aims to define priority actions and areas for the conservation and recovery of native vegetation and biodiversity of the Atlantic Forest, based on a mapping of its remnants. It should be in line with the guidelines of the São Paulo City Green Belt Biosphere Reserve.	The objective of the plan is to define priority areas for the conservation and recovery of the Atlantic Forest , based on the mapping of existing remnants in the Municipality of São Paulo. The plan will provide subsidies for other green plans and programs of the municipality proposed by the Master Plan.	Chapter 3, entitled Action Plan, presents guidelines in six main areas: 1.Structuring; 2.Environmental Education and Social Participation; 3.Licensing, Authorizations for - Vegetation Management and Environmental Compensation; 4.Protected Areas and Green Area Systems; 5.Environmental Monitoring and Inspection; 6.Adaptation to Climate Change.
Planpavel –	The plan must contain at least: the definition	The process of elaborating the Planpavel had a participatory	The green plan is structured around four main axes: protected areas, green

68 pages*	of typologies of green areas and open spaces; the creation of new categories of municipal parks and green areas, both public and private.	approach which aimed to identify areas for the creation and/or expansion of parks, squares, or other types of green areas, open spaces areas to be requalified. Many specific objectives are proposed for the protected areas, the green areas, the free spaces and the transversal axis.	areas, open, and transversal spaces in which 40 guidelines** for action plans are presented.
PMSA – 192 pages	The plan will be the instrument for planning and managing the areas providing environmental services, covering public and private properties.	The main objective of the PMSA is to promote and encourage public policies and initiatives for conservation and recovery of areas providing environmental services in the São Paulo city. Many specific objectives are also proposed to reach it.	The green plan has a chapter entitled strategic action lines, in which the action plans are presented in eight main lines of actions: 1.strengthening sustainable agriculture; 2.economic, financial and tax instruments and incentives; 3.review and adaptation of legislation; 4. strengthening the management of protected areas; 5.conservation and restoration of biodiversity; 6.strengthening sustainable management; 7.register of areas providing environmental services; 8.strengthening of actions provided for in the PMMA.
PMAU – 528 pages	The plan will be the instrument to define the planning, implementation and management of urban afforestation.	The main objective is to be an instrument to define the planning and management of afforestation in the Municipality of São Paulo, aiming at increasing the city's resilience to climate change, the qualification of the landscape, and the satisfaction of the population, considering the assumptions of ecology and smart cities. Some specific objectives are also proposed.	Chapter 6 of the green plan, entitled Action Plan, presents 5 themes with 170 planned actions entitled: Know – actions 1 to 30 (technical and scientific knowledge about the planning, implementation and management of urban forestry); Involve – actions 31 to 61 (population engagement in urban forestry management actions, as well as municipal employees in participatory processes); Plant – actions 62 to 94 (planting of tree seedlings in the Municipality of São Paulo); Care – actions 95 to 134 (diagnosis of tree management); Integrate – actions 135 to 170 (promote improvements and develop integrated, transparent and participatory forestry management).

* Although scheduled to be released in 2020, Planpavel has not yet been published. Thus, in this research, the advisory report on Planpavel was used in this work. As the action plans and guidelines are presented in this advisory document, it is considered that the main scope of the report, although not yet published, is contained in this technical document.

** presented in supplementary material.

2.2. Rationale

In this work we adopted the Hansen et al. (2015) framework because it facilitates understanding of how the ES approach has been taken up in planning discourses by capturing where the ES concept has been incorporated both explicitly and implicitly. We

modified its application by specifically applying it to plan actions separately, as well as applying it to the remainder of the plan text. This framework also facilitates assessment of the breadth of coverage of individual types of ES within the planning documents by expanding on the TEEB (2011) categories of ES. An explicit consideration refers to a specific mention of a TEEB (2011) ES category, whilst implicit refers to a connection with a TEEB (2011) ES category, without specifically mentioning the term (after Honrado et al., 2013; Mascarenhas et al., 2015; Hansen et al., 2015). Of the methods identified in the literature, it is the only approach to also identify implicit links to ES based on the discursive representation of the ES concept in the plan and, therefore, we consider that it provides the greatest depth of investigation as it is more comprehensive than simply counting the recurrence of key words derived from the TEEB (2011) categories.

Coding and thematic analysis is the part of qualitative research that investigates the occurrence and meaning of codes, i.e., specific terms and expressions, in several types of documents such as those resulting from interviews, official documents and legislation (Auerbach and Silverstein, 2002). In this research, the focus is on analyzing planning documents. The documents were downloaded and organized, the terms (keywords) properly coded and the qualitative analysis was conducted with the assistance of NVivo, a specialized software tool tailored for classifying and managing qualitative data (Richards, 1999). The analysis is divided into: (i) coding, (ii) classifying; (iii) reporting (Dhakal, 2022). Firstly, the software provided several options to sort, label, and organize the terms hierarchically through the node and classification. Then, categories are created, and representations of mapping tools are used to reporting the findings. The approach taken in this research relies entirely on deductive coding, using the subcategories of the four ES services categories (provisioning, regulating,

supporting, cultural) as themes, then these specific services are described under each theme as specific codes. These codes were used in the NVivo software package (see Supplementary Material) as a basis for recording, in the whole text and also in the plan actions outlined in each green plan, the explicit and implicit mentions of ES among the 21 types of individuals (subcategories of the four categories of) ES adopted by Hansen et al., 2015 (see Table 2).

Table 2 - The urban ecosystem service types (the deductive codes) adapted by Hansen et al. (2015).

Ecosystem services adapted by Hansen et. al (2015)
Provisioning services: related to material or energy outputs provided by ecosystems
Food
Raw materials
Fresh water
Medicinal resources
Regulating services: related to the regulation of environmental conditions through natural processes
Local climate regulation
Air quality regulation
Carbon sequestration and storage
Noise Reduction
Run-off Mitigation
Moderation of extreme events
Waste-water treatment
Erosion prevention and maintenance of soil fertility
Pollination
Biological control
Supporting services: natural processes that serve as a basis for other services
Habitats for species
Maintenance of genetic diversity
Cultural services: non-material benefits that the population acquires in contact with ecosystems
Recreation and mental and physical health
Tourism
Aesthetic appreciation and inspiration for culture, art and design
Spiritual experience and sense of place
Education and learning

Following Hansen et al. (2015), each mention of an ES was categorised manually and recorded in NVivo, based on the nature of the mention (among the 21 types of ES), or in terms of the level of elaboration found in each of the four analysed plans (i.e., we code using NVivo software into categories N, A, I, or E based on Table 3 as adopted by Hansen et al., 2015), to assess the level of consideration of the ES approach in each of the green plan contents. No formal inter-coder statistic was conducted; the ambiguous cases were re-examined in team meetings until consensus was reached. As the action plans are part of the content of the green plan, it was possible to distinguish the ESs related exclusively to them.

Table 3 – The coding categories to assess how ES are addressed in the plan.

Category	Code	Explanation	Examples from analysed green plans
Not mentioned	N	ES is not mentioned at all.	
Acknowledged	A	An ES is only mentioned. It links urban green/ecosystems/natural areas to specific services/function.	"A considerable part of the health benefits, mainly mental, promoted by afforestation come from the direct contact of the population with green areas, and from interactions between users of public places."
Indirectly elaborated	I	An ES is mentioned in the same way as "A" but loosely related to goals/activities/targets.	"Guideline - Stimulating the implementation, expansion and maintenance of vegetation cover in privately owned properties, with priority given to those located in districts with high surface temperature and high vulnerability to climate risk."
Elaborated	E	An ES is further elaborated. That means ES is directly linked to goals/targets/objectives. It can also be mapped or otherwise quantified.	"Articulate, through PMSP representatives in the Córrego Limpo Program, the prioritization of the depollution of watercourses with linear parks implemented and planned, considering the existing system of information shared by the program's management council."

Note: As our case is related to green plans, we eliminated the category “problem mentioned but not linked to ES” from Hansen’s criteria, because the four plans focus on green areas, and so everything in these plans is, by definition, related to urban green/ecosystems/natural areas.

Source: modified from Hansen et al. (2015).

3. Results and Discussion

Table 4 presents the ES coding categories (see Table 3) for each of the 21 ES types (see Table 2) in each green plan based on analysis of NVivo data. This Table 4 synthesizes all 337 coded text elements, while the complete set, including excerpts and classifications, is provided in the supplementary material.

Table 4 – Summary of the deductive coding results (following Hansen et al., 2015) in each green plan.

	PMMA				PMSA				PMAU				PLANPAVEL				Mentions of ES in each subcategory
Provisioning services	PMMA		plan actions		PMSA		plan actions		PMAU		plan actions		PLANPAVEL		plan actions		
Food	11	E	2	E	14	E	5	E	12	I	2	I	4	I	2	I	41
Raw materials	1	A	1	A	1	A	0	N	1	A	0	N	0	N	0	N	3
Fresh water	14	E	2	A	15	E	1	A	1	A	0	N	7	E	3	E	37
Medicinal resources	2	E	0	N	1	I	1	I	2	A	0	N	0	N	0	N	5
Regulating services	PMMA		plan actions		PMSA		plan actions		PMAU		plan actions		PLANPAVEL		plan actions		
Local climate regulation	9	I	0	N	13	I	0	N	9	I	0	N	3	I	1	I	34
Air quality regulation	4	I	0	N	3	A	0	N	6	A	0	N	0	N	0	N	13
Carbon sequestration ...	3	I	0	N	7	E	0	N	1	A	0	N	1	I	0	N	12
Noise Reduction	0	N	0	N	0	N	0	N	1	A	0	N	0	N	0	N	1
Run-off Mitigation	1	A	0	N	2	A	0	N	4	A	0	N	3	E	3	E	10
... extreme events	6	E	1	I	2	A	0	N	2	A	0	N	2	E	1	E	12
Waste-water treatment	0	N	0	N	1	A	0	N	0	N	0	N	3	E	3	E	4
Erosion prevention ...	4	I	0	N	3	I	0	N	2	A	1	A	0	N	0	N	9
Pollination	5	A	1	A	3	I	0	N	2	A	0	N	0	N	0	N	10
Biological control	2	A	0	N	0	N	0	N	0	N	0	N	0	N	0	N	2
Supporting services	PMMA		plan actions		PMSA		plan actions		PMAU		plan actions		PLANPAVEL		plan actions		
Habitats for species	19	E	5	I	7	E	3	I	3	A	1	A	6	I	5	I	35
... genetic diversity	10	E	0	N	3	I	0	N	0	N	0	N	2	A	0	N	15
Cultural services	PMMA		plan actions		PMSA		plan actions		PMAU		plan actions		PLANPAVEL		plan actions		

Recreation ... health	8	I	2	I	4	I	0	N	4	A	0	N	12	E	4	E	28
Tourism	7	E	3	E	7	I	4	I	2	A	0	N	3	E	3	E	19
Aesthetic ... for culture..	4	I	0	N	3	A	0	N	2	A	0	N	7	I	5	I	16
Spiritual experience ...	1	A	0	N	1	A	1	A	0	N	0	N	0	N	0	N	2
Education and learning	9	E	2	E	5	I	4	I	6	E	0	N	9	E	5	E	29
Total	120		19		95		19		60		4		62		35		337

N – not mentioned (white); A – acknowledged (orange); I – indirectly elaborated (yellow); E – elaborated (blue) (see Table 3 for details).

Note: to summarize the data for each ES in Table 4, following Table 3, the most elaborate mention (that is, assuming a hierarchy from most elaborated to least elaborated as: E – A – I – N) was always considered to be representative of each ES in each plan, regardless of its frequency. However, individual analyses of the different levels of elaboration will be presented in section 3.2.

In quantitative terms only, comparing the number of ES citations (337 quotes (120; 95; 60 and 62 for each plan, respectively, see Table 4) in each green plan (Table 4) with the number of pages in each plan, there is no direct relationship between the number of citations and the number of pages. Thus, the frequency of ES mentions in each green plan is independent of the volume of the plan.

It is also clear that for all green plans, except for Planpavel (56.4%), the mention of ES in the action plans is very low compared to the total content of the plan (PMMA - 15.8%, PMSA - 20% and PMAU - 6.7%)

Qualitative analysis of the integration of ES in green plans and in their plan actions will be provided in the following two sections that present the results and discussion for each of the two research questions respectively.

3.1 How is the ES concept represented in each green plan – as a measure of recognition of the ES concept in the UGI offering?

To answer this research question, by following Hansen et al. (2015), we initially analysed the discursive representation of the ES concept, or related concepts, by identifying if the terms: “ES”, “landscape” or “ecological function”, or “benefits” derived

by humans from nature, are explicitly mentioned either individually, or in combination anywhere in each green plan based on documentary analysis. For undertaking this, the 337 quotes (120; 95; 60 and 62 for each plan, respectively – see Table 4) identified by the NVivo analysis (Table 4) were then analyzed again, manually (by reading and analysing each quote expanded to a text buffer that allowed its understanding for authors) to identify the presence or absence of these terms and how they are addressed related to ES in the discursive representations of the ES concept. Additionally, these terms were searched again in each green plan by using a word engine to complement and confirm this analysis of discursive representation of ES concept (all analysed data are presented in Supplementary Material).

Table 5 presents the analysis of the discursive representation of the ES concept in the four green plans and their plan actions.

Table 5 – Discursive representation of the ES concept in each green plan.

ES concept	Green plan	Main findings of plan's contents	Main findings of plan's actions
Is the term ES mentioned?	Planpavel	the term is mentioned explicitly several times (47 times) in the document.	the term is mentioned explicitly several times (22 times) in the plan actions.
	PMAU	the term is mentioned explicitly 12 times in the document.	the term is mentioned explicitly once in the plan actions.
	PMSA	the term is mentioned explicitly several times (30 times) in the document and distinguished with the concept of environmental services (35 times).	the term is mentioned explicitly (12 times) in the plan actions.
	PMMA	the term is mentioned explicitly several times (30 times) in the document.	the term is mentioned explicitly (6 times) in the plan actions.
Is the term landscape or ecological functions mentioned?	Planpavel	the plan cites the term and relates diversified ecological functions to the protected areas, the green areas and the free spaces such as biodiversity, carbon sequestration, water regulation, microclimate, temperature control, water regulation and others.	the plan actions cite the term and relates diversified ecological functions to the protected areas, the green areas and the free spaces such as biodiversity, carbon sequestration, water regulation, microclimate, temperature control, water regulation and others.
	PMAU	the plan cites the term and mentions some ecological functions (erosion control, air quality, biodiversity, temperature and humidity control and biodiversity) of urban afforestation.	the term landscape is mentioned explicitly one time in association with ecological corridors, only 3 explicit mentions of biodiversity are found in the plan actions.
	PMSA	the plan cites the term and mentions the importance of ecological functions for its objectives, such as the role of some types of green areas as ecological stepping stones.	there are explicit and detailed mentions between landscape and its ecological functions described as priority areas for the provision of ecosystem services in the plan actions.
	PMMA	the plan mentions the term and highlights that landscape ecology is the conceptual and methodological basis for biodiversity conservation actions in the plan for defining	there are only some specific and localized mentions between the landscape and its value for the function of restoring biodiversity in the plan actions.

		priority areas, applying public policies, and resolving environmental conflicts.	
Are benefits humans derived from nature mentioned?	Planpavel	benefits are mentioned and often directly related to ecosystem services both for nature and people.	benefits are mentioned and often directly related to ecosystem services both for nature and people for example life quality, human well-being, protection of landscape and cultural heritage in the plan actions.
	PMAU	benefits are mentioned related both for nature and for people.	there are no mentions of human benefits derived from nature in the plan actions.
	PMSA	benefits are mentioned and directly related to ecosystem services emphasized for people but also related for nature.	there are explicit mentions to benefits derived from the nature related to tourism, sustainable agriculture, water and others.
	PMMA	benefits are mentioned and often directly related to ecosystem services both for nature and people.	there are explicit mentions to benefits derived from the nature for family farmers and traditional communities and others in forest restoration activities in the plan actions.
In which way are humans and nature, ecosystems and landscape seen as related?	Planpavel	the plan recognizes and describes this interconnection and recommends that this perspective be adopted, for example, using nature-based solutions.	the plan actions recognize and describe this interconnection and recommends that this perspective be adopted for example, using nature-based solutions and for creation of parks in geosites, in order to foster geoconservation and the dissemination of information related to the geological, biological, historical and cultural aspects of these places.
	PMAU	the plan recognizes and describes this interconnection, but with a more limited landscape perspective, and does not explore the terms integrated into the recommended actions, nor measure them by the proposed indicators.	there are no connections between humans and nature, ecosystems and landscape in the plan actions.
	PMSA	the plan recognizes and describes this interconnection and explores this importance with different scales of approach in which the spatial dimension of the landscape, provision of services, and benefits are related, and recommends that this perspective be adopted, for example, using agroecology.	the plan actions also recognize and describe this interconnection and explores this importance with different scales of approach in which the spatial dimension of the landscape, provision of services, and benefits are related, and recommends that this perspective be adopted, for example, using agroecology, ecotourism, environmental education.
	PMMA	the plan recognizes and describes this interconnection but the spatial dimension of the landscape is presented in protecting ecological corridors and others that strengthen the preservation of biodiversity.	in the priority actions the perspective of human integration is limited, when mentioned it refers more to impacts than human dependence, but in the context of the discussion of urban parks and conservation units in possible privatization actions, this association is slightly demonstrated in the plan actions.

Note: Supplementary material contains the full analysis of the discursive representation of the ES concept in all plans.

From Table 5 we could verify that the ES concept is explicitly mentioned many times in each green plan. This result differs from analyses carried out on 136 Italian urban plans (La Rosa, 2019) and 19 Canadian municipal plans (Thompson et al., 2019) that found predominantly implicit mentions of ES. Also, the terms landscape and ecological functions and the understanding of ES concept as resulting human benefits are presented in all four green plans. Regarding the relationships between humans and nature, ecosystems and landscape the discursive analysis results present some

differences among these green plans. Planpavel and PMSA present a better integration between these terms, including recommending integrated actions, such as nature-based solutions and agroecology, respectively; unlike the other two green plans in which the relationship between the terms is more incipient or fragmented. However, only three green plans (Planpavel, PMSA and PMMA) present an explicit connection of the benefit deriving from the ES in most of the contents of each green plan. In Planpavel, the approach of ES is considered to be a planning tool to face the situation of inequality in the distribution and quality of public green areas and social vulnerability. The PMMA considers that assessing the connections between urbanization, biodiversity and ES are the guiding thread for the construction of this planning. According to the PMSA, it is essential to combine the traditional instruments of urban and environmental planning with new concepts and instruments, based on the understanding of the close relationship between ecosystems (natural, rural, and urban), ecosystem/environmental services and the notion of provider-receiver. The connections between elements of nature and ES are well developed, it is worth noting that the PMSA presents a spatial discussion of the provision of services.

Only Planpavel, whose action plan reveals the highest number of explicit mentions of the term ES, and PMSA, present a balance in the discursive representation of the entire content of the plan in relation to their respective action plan. The extensive action plan of PMAU is very detailed in its actions but is very focused on managerial and legal actions regarding urban afforestation, not exploring its connections with the landscape and its benefits to society in a more integrated way. Although it has a more elaborate action plan in its discursive representation than PMAU, PMMA explores in a

limited way the relationship between human, nature, ecosystem and landscape that would demonstrate an approach centered on the provision of ecosystem services.

The first part of the analysis based on the discursive representation supported by Hansen et al. (2015) explores to what extent the concept of ES was present in the development of the four green plans analyzed. However, to complete the answer to the first research question, an additional analysis was carried out focused on analysing the explicit mentions of ES terms into the objectives and action plans of each plan (presented in Table 1). This analysis aims to confirm whether the ES concept intentionally guides the plan development and in its consequent actions to offer UGI.

Table 6 complements Table 5 by presenting an analysis of the ES mentions in the plans' actions and the plans' objectives.

Table 6 – Brief analysis of the ES mentions in the four green plans' objectives, and actions.

Green Plans of Sapavel	ES mentions in the plans' objectives and the main UGI type		Analysis of ES mentions in the Plans' Actions	
	main plan's objective (see Table 1)	ES mentions; the main UGI type	ES mentions in the Plan Actions (see Table 1)	Analysis
PMMA	define priority areas for the conservation and recovery of the Atlantic Forest, and provide subsidies for other green plans	no ES mentions; Atlantic Forest conservation	Of the six axes for action plans, two (4. Protected Areas and Green Area Systems and 6. Adaptation to Climate Change – see Table 1) explicitly mention ES - to create a payment for environmental services; to design and implement the PPSA (axis 4) and to increase biodiversity through the use of ecosystem-based adaptation measures (axis 6).	The actions that explicitly mentioned ES are not directly related to the objectives of the green plan, although they may have an indirect influence.
Planpavel	identify areas for the creation and/or expansion of parks, squares, or other types of green areas, open spaces areas to be requalified	no ES mentions; parks, squares other types of UGI, Nature-based Solutions; rivers and streams; open spaces	Of the 40 guidelines for action plans, four explicitly mention ES (8 - connecting with PMMA, 21 with PMSA, 22 and 27 – see Table 1) and are directly aimed at maximizing ES in protected areas, and private green areas, public and private open spaces	There are action plans in the green plan that highlight ES explicitly, covering the scope of the plan and its main objective and its UGI
PMSA	promote public policies and initiatives for	ES term is mentioned; conservation and	Of the 8 main lines of action planned, one (7 – see Table 1) mentions the creation of	There is an action plan foreseen in the green plan that explicitly

	conservation and recovery of areas providing environmental services	afforestation of selected green areas	a register of areas that provide ES	mentions the ES and is directed to the main objective of the plan and its UGI
PMAU	define the planning and management of (tree) afforestation in the Municipality of São Paulo	no ES mentions; tree planting	Of the 6 themes and 170 planned actions (see Table 1), one explicitly mentions the need to carry out studies regarding the ES provided by trees (theme named “Know”, plan actions number 6)	Only one of the many actions proposed in the green plan explicitly mention ES, only partially covering the broad objective of the plan

Although Table 5 shows that the discourse represented by the narrative of the four green plans reveals the presence of the ES concept, its analysis in two relevant elements of the structure of these plans – the objectives and action plan – reveals different results (see Table 6). No green plan explicitly mentioned the term ES in its objectives. Only in Planpavel and PMSA do the action plans mention ES directly related to the objectives and the UGI expected in each plan. In PMAU, only 1 of 170 proposed actions present an explicit mention of ES, but with a partial association with the objectives and the expected UGI of the plan. And in PMMA, the action plans that explicitly mention the term ES are not directly related to the objectives and the UGI to be offered in this green plan.

Table 6 confirms that the ES concept in the PMAU, although frequently mentioned, has less prominence in stipulated actions to implement the plan. While the PMMA bases its development on the valorisation of ES in areas covered with Atlantic Forest, it misses the opportunity to address this importance in actions to implement the plan. On the other hand, both PMSA and Planpavel reinforce that they were supported by the ES concept.

Two of four green plans – Planpavel and PMSA – present a broad discursive representation of the ES concept, confirmed by both plans’ objectives and actions,

which suggests some consciousness of the cascade model as proposed by Haines-Young and Potschin (2010) in delivering UGI through these plans. And thus, these two green plans project the need for a socioecological system perspective in urban planning in the city of São Paulo (Rozas-Vasquez et al., 2018).

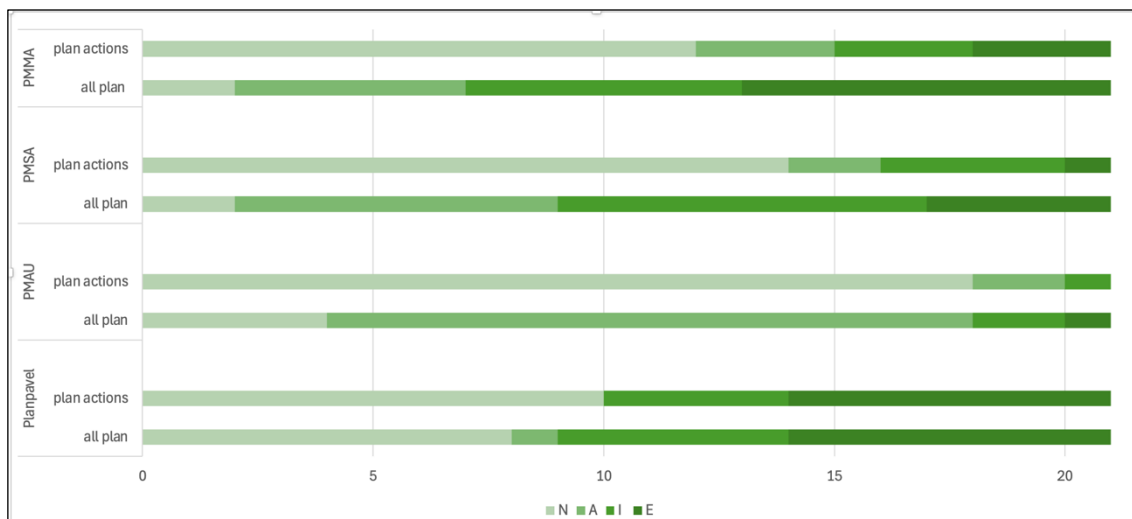
In terms of the human-nature perspective, the four green plans bring some insights beyond the more obvious role assumed by ES such as the benefit, dependence, and interdependence perspectives that reinforce nature's intrinsic value for humans as highlighted by Thompson et al. (2019), Cortinovis and Geneletti (2019), McPhearson et al. (2014); Larondelle et al. (2014) and Haase et al. (2014).

3.2 What is the extent to which different types of ES are represented in each green plan – as a way of assessing whether implicit or explicit ES are directed towards the delivering UGI?

To answer this research question, by following the Hansen et al. (2015) framework, we explore the depth and the distribution of ES types in each green plan to understand UGI delivery.

To build Figure 3 we focused on recognizing the depth (measured by the level of mention) of the consideration of the 21 ES (as adopted by Hansen et al., 2015 – Table 2) in each of the four green plans by using the data presented in Table 4. Figure 3 reflects only the highest level of mentions of ES in the plans observed for synthesis purposes, without implying comprehensive coverage, and the detailed assessment is provided in Figure 8.

Figure 3 – ES coding categories observed in the four green plans.



Categories: N – absent; A – acknowledged; I – indirectly elaborated; E – elaborated (see Table 3 for details). Note: to summarize the data for each ES in Table 4, following Table 3, the most elaborate mention (that is, assuming a hierarchy from most elaborated to least elaborated as: E – A – I – N) was always considered to be representative of each ES in each plan, regardless of its frequency.

Figure 3 reveals that no green plan includes consideration of all 21 ES (see Table 2) and the number of ES not mentioned, and the level of ES elaboration varies between the plans. Considering the categories of ES representing the most comprehensive inclusion together (E plus I), Planpavel stands out (12 elaborated and indirectly-elaborated ES out of 13 mentioned) followed by PMMA and PMSA (14 elaborated and indirect-elaborated ES out of 19 mentioned, and 12 elaborated and indirectly-elaborated ES out of 19 mentioned, respectively) and finally PMAU (3 elaborated and indirectly-elaborated ES out of 17 mentioned).

Planpavel is the green plan in which the plan actions present the highest number of mentions of ES and with the highest level of elaboration, denoting the protagonism of the ES concept not only in its content, but also in its actions.

Figures 4 to 7 detail the data presented in Figure 3 and show the distribution charts of ES presented in each of the four green plans and associate both the number of

any ES mentions and the most representative code for each ES. These distribution charts, named tree maps (set of nested rectangles with different size), were obtained using NVivo. They help to verify patterns in the adopted coding and compare the predominance between them, denoting the prevalence of patterns. Here these figures are mainly intended to visually illustrate the predominance of ES types in the 4 main ES classes.

Figure 4 – The Planpavel code distribution chart.

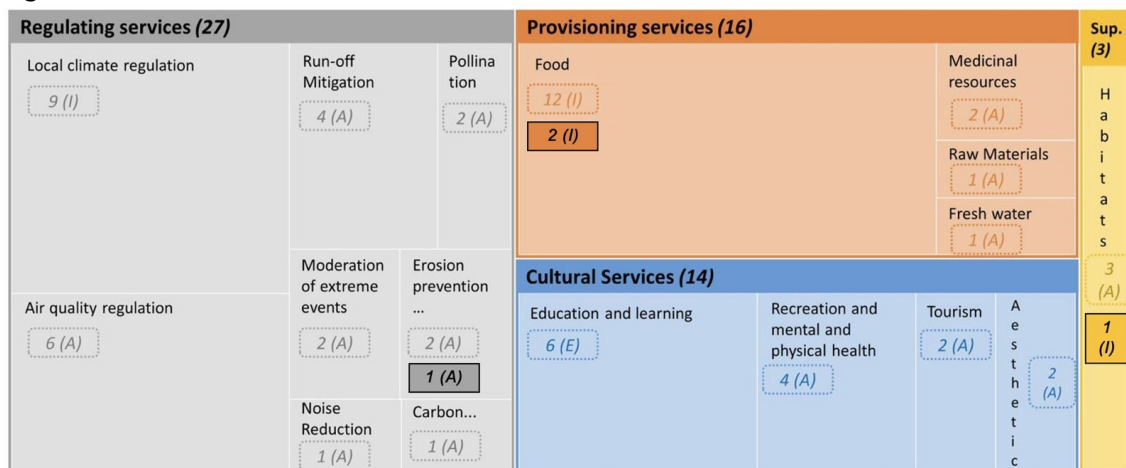


A – acknowledged; I – indirectly elaborated; E – elaborated (see Table 2 for details).

Note: 12 (E): the number represents the number of citations for this ES, and the letter represents the highest-ranking elaboration category across the number of citations and the numbers presented in rectangles in a darker shading than the corresponding ES represent the number and level of elaboration of the ES in the plan actions.

The analysis of Figure 4 reveals that cultural ES predominate in Planpavel, followed by regulation and provisioning ES and, to a lesser extent, supporting ES. Planpavel is the green plan that has the most diversified delivery of UGI (parks, squares, other types of UGI, Nature-based Solutions; rivers and streams; open spaces), thus demonstrating coherence in the focus of cultural ES, but also balancing regulation and provisioning ES, with less focus on supporting ES. The analysis of the mentions of the ES in the Planpavel action plans shows a balance in relation to the coverage of the ES categories and subcategories.

Figure 5 – The PMAU code distribution chart.

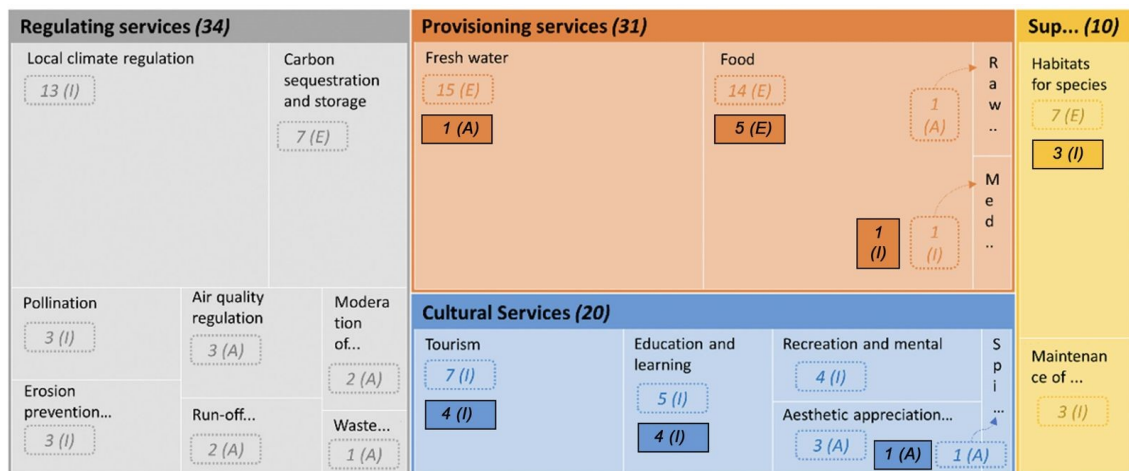


A – acknowledged; I – indirectly elaborated; E – elaborated (see Table 2 for details).

Note: 2 (A): the number represents the number of citations for this ES, and the letter represents the highest-ranking elaboration category across the number of citations and the numbers presented in rectangles in a darker shading than the corresponding ES represent the number and level of elaboration of the ES in the plan actions.

The analysis of Figure 5 reveals that the PMAU is dominated by regulating ES, followed by provisioning ES and cultural ES, and to a lesser extent, supporting ES. The PMAU is the green plan that has a very specific focus on UGI (mainly urban afforestation through tree planting). Thus, although regulating ES are relevant to the promotion of this UGI, it is considered that the cultural ES category is somewhat disproportionate, as well as the reduced emphasis on supporting ES. The mentions of the ES in the PMAU action plans can be considered negligible.

Figure 6 – The PMSA code distribution chart.

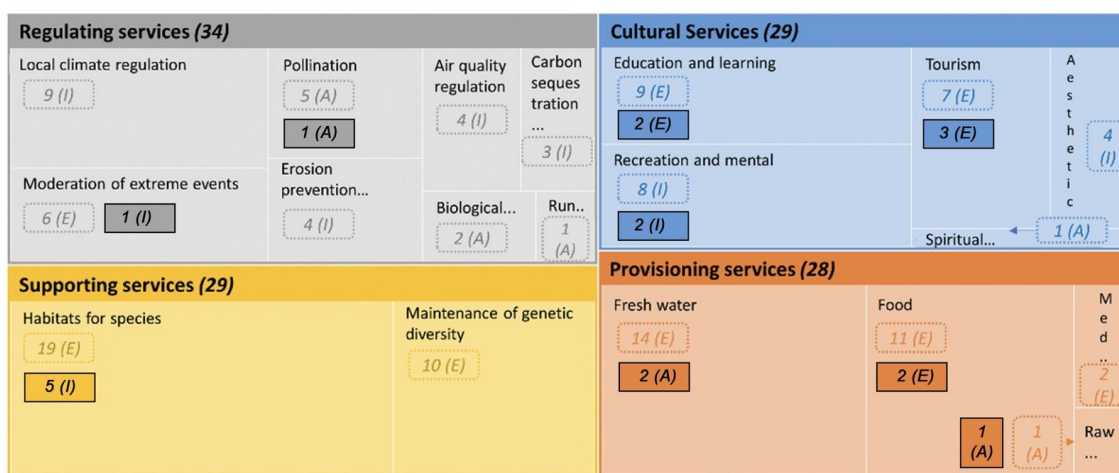


A – acknowledged; I – indirectly elaborated; E – elaborated (see Table 2 for details).

Note: 4 (I): the number represents the number of citations for this ES, and the letter represents the highest-ranking elaboration category across the number of citations and the numbers presented in rectangles in a darker shading than the corresponding ES represent the number and level of elaboration of the ES in the plan actions.

The analysis of Figure 6 reveals that the PMSA is dominated by regulating ES, followed by provisioning ES and cultural ES, to a lesser extent, by supporting ES. The PMSA is the green plan that has a UGI focus on conservation and afforestation of selected green areas for a purpose to feed future schemes of payment of ES. In this sense, maybe supporting ES would be expected to have a greater predominance in the scope of the plan. However, surprisingly, the PMSA plan actions do not mention even one regulating ES, mentioning mainly cultural and provisioning ES, but largely ignoring the water provision ES, one of the most recurrent in PSA in Brazil (Souza et al., 2018).

Figure 7 – The PMMA code distribution chart.



A – acknowledged; I – indirectly elaborated; E – elaborated (see Table 2 for details).

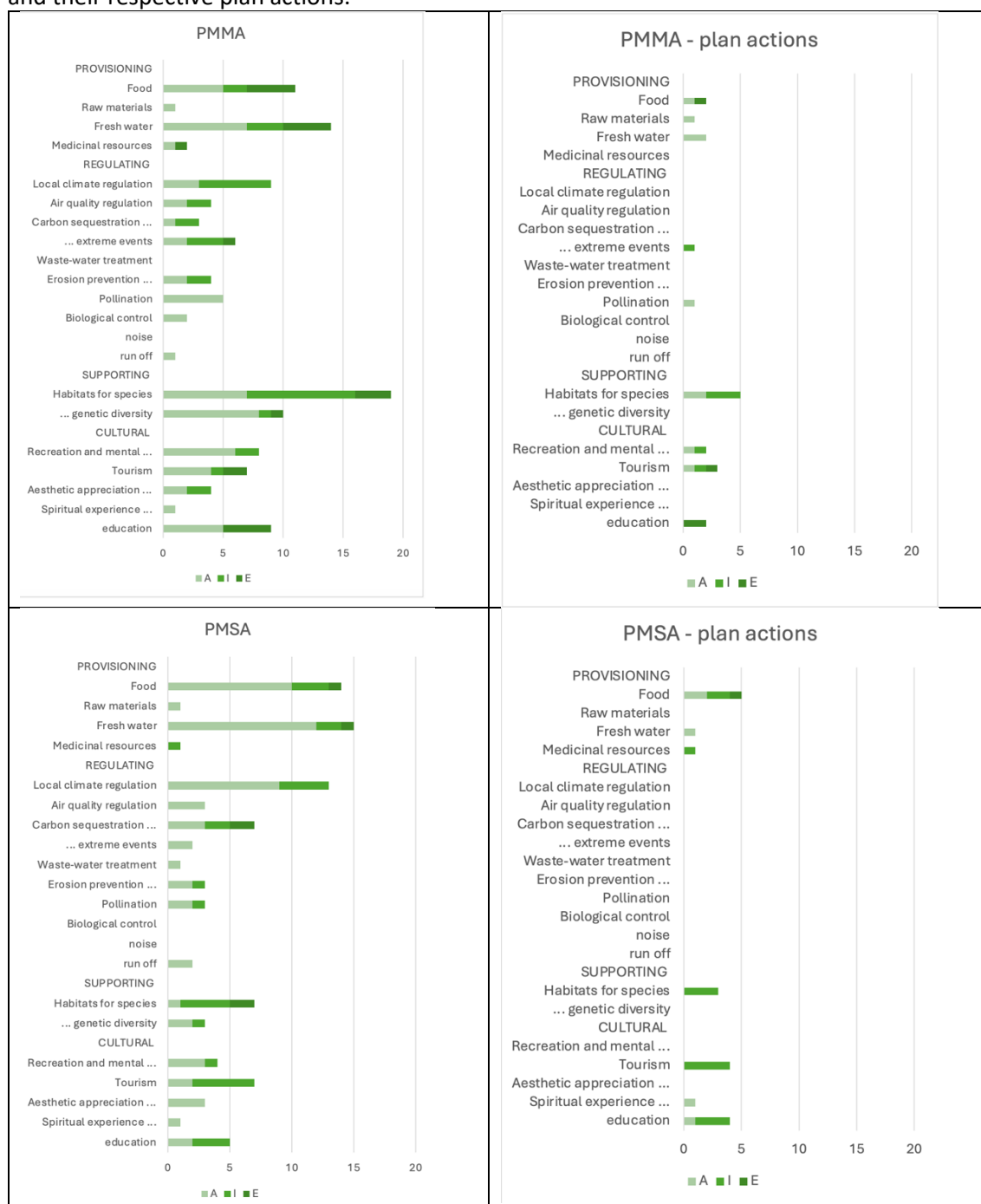
Note: 19 (E): the number represents the number of citations for this ES, and the letter represents the highest-ranking elaboration category across the number of citations and the numbers presented in rectangles in a darker shading than the corresponding ES represent the number and level of elaboration of the ES in the plan actions.

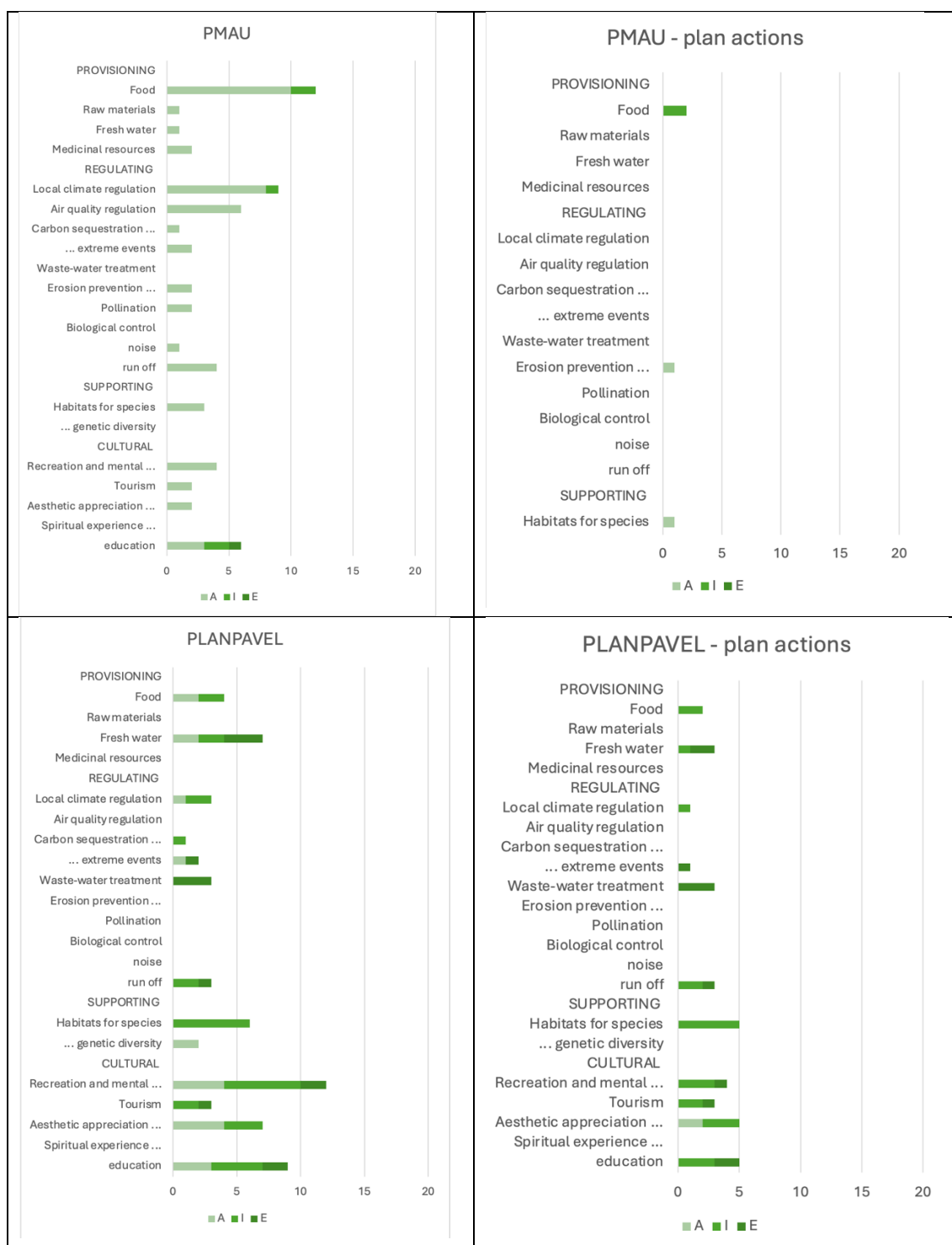
The analysis of Figure 7 reveals that in the PMMA there is a relative balance between the presence of the four classes of ES, with a slight predominance of regulating ES. The PMMA is the green plan that has a UGI Atlantic Forest conservation focus. Thus, it is interesting to note the space in this green plan for supporting ES that is in line with the mission of ensuring the protection of one of the biomes, which is a global hotspot and is among the most threatened in the country. ES mentions in the PMMA plan actions are much less frequent than in the plan's content but covering all the four ES categories to a limited extent. However, this may be a result of the biome influence on revealing ES in which the green plan is inserted, confirming that the ES approach does not actively participate in the green plan's actions.

Figure 8 details the analysis presented in Figure 3 for each type of ES coding category considering each green plan and its plan actions presented in Figure 4 to Figure 7. Here the analysis sought to better explore and understand all the types of ES (see Table 2) mentioned in each green plan and their level of mention by following the Hansen et al. (2015) framework. In Figure 8, each graph referring to the green plan

presents the mentions of the SE individually and not aggregated as in Figure 3 to Figure 7, to allow a detailed analysis of the different levels of elaboration of each ES in each plan. It is important to highlight that no statistical tests were conducted to assess associations between the frequency of mention of ES and the level of elaboration, and all analyses are descriptive.

Figure 8 – Total number of times each type of ES is mentioned in each of the four green plans and their respective plan actions.





Categories: A – acknowledged; I – indirectly elaborated; E – elaborated (see Table 3 for details).

The analysis of Figure 8 allows us to consider that the PMAU largely acknowledges the ES (17 types out of 21), with only one mention of cultural ES (education) being elaborated. On the other hand, the Planpavel presents the ES (13

types out of 21) as much better elaborated, but only the supporting ES (genetic diversity) is acknowledged. The PMSA presents only 7 ES as acknowledged out of the 18 ES (out of 21) mentioned, while the PMMA presents the same number of ES (18 out of 21), of which 5 ES are only acknowledged. Considering only the ES presented in plan actions of each green plan this figure clearly demonstrates and confirms that only in Planpavel were the plans actions actually constructed and can be developed supported by the ES approach.

Comparing Figures 4 to 7 with Figure 8, we can consider among the strategies to offer UGI towards sustainability, Planpavel and PMMA stand out and represent the best ES delivery strategies. PMMA stands out for the greater coverage of ES and Planpavel for the greater depth of their consideration in the plan. The PMMA is a plan guided by public policy devoted to conservation, and the Planpavel has the goal to cover a broad spectrum of UGI typologies. However, it can be considered that in the green plans, with the exception of Planpavel, the absence of the ES approach in the action plans may compromise the delivery of the intended UGI.

A detailed assessment of the ES presented in Figure 8 for Planpavel highlights some gaps in the consideration of some relevant regulating ES, such as pollination, erosion prevention and noise, for the UGI to be offered. However, the level of elaboration of the mentioned ES allows us to infer that the ES concept was indeed aligned with the scope of this green plan. The role of cultural services, also considered in this plan, in addressing urban sustainability is emphasized by Andersson et al. (2015) even for increasing the awareness for urban population on the importance of ES.

Regarding the PMMA, Figure 8 confirms the importance given to the supporting ES, habitats for species and genetic diversity, both of which are extremely important for the provision of the UGI. The emphasis on detailing supporting services is in line with their importance as measured by Almeida et al. (2018) that this category of ES underlies the relevant regulating services provided by some São Paulo urban parks. The ES provision fresh water is also highlighted, since this forest is a recognized water source, as well as providing other regulating ES. Regarding the three missing ES, they are of lesser importance for the UGI. However, pollination ES is one of the regulating ES that could be better addressed in the plan for its importance even for maintaining diversity in the Atlantic rainforest.

In the opposite direction to these well evaluated two green plans, the PMAU represents the plan with the most reductionist approach regarding the supply of ES and consequently regarding the delivery of UGI. By analyzing Figure 8, the PMAU confirms that the consideration of ES in the plan, in addition to being unbalanced in terms of ES distribution, is also quite superficial in terms of adding value to the intended UGI focus. The most cited provision ES, food, and the cultural ES, education and learning, corroborate that ES were definitely not consciously part of the scope of this plan. Despite the lower level of elaboration of ES, this emphasis on regulating ES in this green plan meets the call of Sutherland et al (2018) to pay attention to this ES category but it remains overlooked in the decision-process as highlighted by Cortinovis and Geneletti (2019).

By analyzing Figure 8, the PMSA, the provisioning ES - food and freshwater - stand out as the most cited, and some with a high level of elaboration, as well as the regulating

ES, climate, and carbon sequestration. These ES are strongly consistent with the UGI offered by the plan. The connections with provisioning services in the Global South in terms of quality of urban livelihoods and UGI is emphasized for Shackleton (2021) as found in this green plan. The omissions of ES do not indicate gaps in the provision of UGI, however, the supporting ES should have been better considered because of their importance for the conservation and restoration of biodiversity. The PMSA case confirms this by reinforcing the ES most valued in Brazil in PES schemes, as highlighted in Souza et al. (2016) and in the strong discourse of a utilitarian vision of ES for the population.

The clarity of the linkages between UGI and ES is a surprise given that low levels of awareness regarding the engagement of the ES concept in urban planning processes are still perceived in Brazil. For example, Juntti et al. (2021) revealed that despite being claimed by residents, the ES benefits are neglected in formal urban planning. For Gallardo et al. (2022) although the implicit ES concept is found in planning, there is little evidence that it is considered in an organized and conscious way in planning. For Rolo et al. (2021) even when there is the provision of public policies to incorporate the ES concept into urban planning, this still needs to be strengthened at the local level.

From the perspective that the UGI is seen as a portal to urban sustainability (Pauleit et al., 2019) and considering that its multifunctionality also represents an approach for urban spatial planning (Wang and Banzhaf, 2018) we explored how each green plan covered a set of ES with different levels of elaboration in these plans. As the four green plans that comprise the Sapavel system have different purposes and strategies for UGI delivery, the set of ES presented in each plan is not the same as

expected, as not all types of green areas offer all types of ES and/or the same types (Geneletti et al., 2020; Cheng et al., 2021; Amorim et al., 2021; de Manuel et al., 2021).

But the differences observed in the breadth and quality of ES inclusion in these four green plans suggest the need to mature this approach especially in PMAU to promote sustainable urban development as recommended by Cortinovis and Geneletti (2018); Woodruff and BenDor (2016) beyond its status as an uptake concept (Rall et al., 2015). For Hansen and Pauleit (2014) the coverage and quality of ES types and the means to deliver UGI are closely related and may strengthen each other, revealing the priorities assumed for the UGI in urban planning.

The perceived intention of including the ES concept is verified in the four green plans. This result is aligned with the view that ES emerge in plans that better link community goals and the protection of natural resources, as discussed by Woodruff and BenDor (2016). As verified by Cortinovis and Geneletti (2018) in Italian plans, some actions to address urban ES and a variety of tools for implementation and differences in the level of embeddedness of ES are also found in the four green plans.

However, it is in contrast to the lower degree of ES concept inclusion observed in Berlin and New York urban planning (Rall et al., 2015), in the UGI in cities from Latin America and the Caribbean (Romero-Duque et al., 2020), in 136 Italian urban plans (La Rosa, 2019) and in 19 Canadian municipality plans (Thompson et al., 2019).

5. Conclusions

The analysis of the four green area plans that make up the green area system (Sapavel) in the city of São Paulo, linked to the master plan, revealed that with greater

or lesser participation and intensity, the ES concept is present in each plan contributing to the provision of UGI. This finding confirms and adds to those of previous studies on the leading role of ES in evaluating UGI in urban planning.

The detailed documentary analysis (ex-ante) of the four green plans reveals that the measurement by the amplitude and the quality of the ES can be an efficient tool for evaluating the likely success of the UGI strategy to achieve strong urban sustainability. With different frequencies of presence and level of elaboration of the ES, the green plans corroborate this finding.

However, the comparative analysis between the content of each green plan in comparison with its respective plan actions, showed, with the exception of one plan (Planpavel), that the ES approach is more present in a rhetorical way than in a concrete way that delivers effective mechanisms for the provision of ES.

The analysis of the Planpavel green plan, the best of those evaluated, revealed that the ES were very present in the discursive representation of the green plan. Although not explicitly mentioned in the plan's objective, ES are explicit in some action plans, covering the scope of the plan and its main objectives and UGI. A detailed analysis of the ES in this plan also reveals coherence between the intended UGI and the types of ES mentioned, although some ES not mentioned are absences that should not be overlooked. The greater level of elaboration of the ES in this green plan for almost all of those mentioned demonstrates that the concept of ES was really present in the core of the plan's construction.

By contrast, the PMAU green plan, the worst of those evaluated, demonstrated that since the analysis of the discursive representation, the concept of ES has not been

widely considered, nor embedded in its objective or action plans. This limitation in the scope of the concept of ES is proven both by the level of depth (the majority of ES are only acknowledged in the plan), and by the disproportionality between the classes and types of ES to deliver the intended UGI.

Concerning the two plans evaluated as intermediate in terms of the concept in ES in their scope, there is relevant evidence to highlight. The PMSA presents the ES concept as well-founded in its discursive representation. However, a more detailed look at the depth and distribution of ES reveals that in order to deliver the intended UGI, the category of supporting ES could be expanded, and the level of elaboration of some ES, especially provisioning and regulation, could be increased too. The PMMA discursive representation of the ES concept is almost as well integrated as the PMSA. Regarding the presence of ES in the PMMA, the main supporting ES related to the UGI offer are represented in this plan; however, some important ES for the delivery of UGI, such as pollination, are absent from the plan.

An imbalance in the scope and depth of ES in each green plans allows identifying problems and limitations in each proposition of UGI strategies in urban planning. Each green plan analyzed addresses a well-founded UGI typology for achieving urban sustainability when different aspects of sustainability can be delivered by the ES concept and integrated into the plan content.

Some lessons learned from this study case can be useful for plan-makers. Explicit and implicit mentions of ES in green plans are important to strengthen urban planning aimed at sustainability but are insufficient for its operationalization if the level of depth

of the ES concept is superficial. One studied green plan (PMAU) confirms this where only limited action regarding ES concept is presented in a comprehensive action plan.

A smaller number of ES in green plans does not necessarily represent a reduced approach to urban sustainability, if the chosen ES represent the UGI that is intended to be offered and are elaborated in depth, allowing it to be evaluated. Two studied plans (Planpavel and PMMA) confirm this through the analysis of the ES concept discourse used in both plans. However, not mentioning specific action aimed at the ES concept may reveal a weakness in the implementation of the plan, as can be seen in the PMMA.

Green plans may have specific UGI deliverables, but to ensure that urban sustainability has been promoted, these plans must provide an appropriate set of in-depth ES considerations, not only in their content, but mainly in their plan actions. This seems to be a strategy that strengthens the elements of different types of UGI within urban spatial planning, considering the premises of sustainable development. Our findings are based solely on qualitative documentary analysis of plan content, without empirical measurement of impact or implementation outcomes. However, urban sustainability can be prompted by UGI, and ES can be considered a way both to deliver and evaluate this connection.

This research provided several insights to urban spatial planning considering expanding UGI strategies founded in ES concept. Some recommendations for future research may consider: other methods such interviews, survey and focus group to deeply explore the ES concept in providing UGI in spatial planning; ex-post analysis to test how coherently and effectively the results of ES mentioned in the plans; and the

discussion between adopting one green plan and multiple green plans to deliver UGI towards sustainability.

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After revision.

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