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Review

Urban Green Infrastructure: Does Species' Origin Impair Ecosystem Services Provision?

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Abstract: The adverse effects of urbanized areas' growth might be mitigated by the multiple ecosystem services that urban green infrastructure provides. However, the design and composition of such infrastructure is still a hotly debated issue, mainly considering the challenges associated with the use of exotic plant species. To assess if there is a clear association between the species' origin and ecosystem services or ecosystem disservices, an in-depth systematic literature review was carried out based on a bibliometric approach to assess the panorama of the scientific perspective. Based on the results, a detailed analysis was performed for the urban green infrastructure of five European Mediterranean cities, where management and expansion of the urban green infrastructure might act as tools to mitigate climate change and biodiversity loss. Urban green infrastructure benefits to urban areas and its composition must consider the balance between services and disservices provided by plant species. Data analysis shows that disservices are not exclusively related to exotic species, revealing that plant species selection based on their origin represents a biased approach, as it often disregards the higher capacity of some exotic species to thrive under continuous pressure and disturbance, along with relevant and highly valued cultural services provided. Since exotic species are commonly used, ecosystems formed can be seen as experiments to support decisions, allowing new approaches to planning, designing, and maintaining urban green infrastructure.

Keywords: plant species; native; exotic; ecosystem services; ecosystem disservices

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1. Introduction

Urban green infrastructure (UGI) and ecosystem services (ES) are relevant topics in current research related to urban areas. UGI is now recognized as an essential tool to reduce the impacts associated with urban expansion [1–3] and, more recently, to support adaptation measures to projected climate change [4,5], showing multifunctionality [6] and multiple benefits for city dwellers [7]. Despite the indisputable benefits, UGI can also be analyzed considering potential ecosystem disservices (ED) [8] related to the costs or negative consequences of their implementation and management.

The floristic composition of the UGI is a frequent trigger of the disservices debate as the choice of plant species is still much grounded on aesthetic values, prioritizing exotic species over native ones [9], and frequently dismissing the risks such as the invasive trait of some species [10], allelopathy phenomena [11], allergenic potential [12], among others [13]. Thus, species origin turned into a concept surrounded by a generalized prejudice against non-native species, adopted by conservationists, land managers, policymakers, and by countless scientists worldwide [14].

The concept of nativeness was first defined in 1835 by the English botanist Jonh Henslow, and one century later, in the late 1940s, several botanists used native and alien

terms to distinguish real British plants [15]. However, the concept of biological invasion only gains emphasis after the launch of Charles Elton's book, *The Ecology of Invasions by Animals and Plants*, in 1958. Elton's publication is seen as the starting point of increasing awareness regarding potential disservices associated with exotic plants. Since then, an anti-exotic movement has been conveying that introduced species are enemies of Man and Nature [14], and misleading concepts helped such a trend [16]. Several terms exist for the same concept (e.g., exotic species can also be called alien, introduced, and non-native species). Although the definition of such concepts related to species invasiveness is scientifically well-defined [17,18], some studies argue that there is a lack of clarification between scientists, policymakers, and citizens [19,20]. Consequently, prejudice against exotic species in public spaces may occur since this concept is automatically and erroneously associated with the concept of invasive species. There is no questioning that invasive species significantly impact the invaded habitats and that species not causing harm now may cause harm shortly, [14] as the adverse effects can vary over time. However, studies have also demonstrated that the percentage of introduced species that have revealed invasion potential is reduced [21].

Moreover, according to Lyytimäki et al. [8], the perception of services and disservices is an issue of subjective evaluation, and what is perceived as a disservice varies over time. In ES evaluations, careful cost–benefit analyses are needed to support multiple decision-making that consider regional differences, and to ensure that disservices do not outperform services. Current approaches to the management of the UGI must recognize that changes in natural systems are taking place and adopt new strategies that are more appropriate for our rapidly changing planet, especially considering changes in the suitability of native species related to climate change [14]. For instance, novel urban ecosystems (NUE) can be integrated into urban planning and designing, supported by multicriteria species selection, to play a key role in creating cities that are more resilient and better adapted to future climates [22–25].

Recently, a trend to reduce the use of exotic plants in the UGI is gaining relevance, in parallel with an increase in the use of native plants, aiming to promote conservation and connectivity between urban landscapes and the surroundings [26]. Is this a consequence of the pressure associated with more information about invasion impacts and a decision based on the species' origin, or a strategy to improve the resilience of the UGI and urban areas considering disservices associated with exotic plants? A systematic literature review exploring this link between plant species' origin and the UGI ES and disservices will undoubtedly inform future research and decision-support initiatives. In this context, the goals of this research were: (i) identify the ES and disservices associated with UGI performance; (ii) search for relations between the ES and disservices and plants' origin (native/exotic dichotomy); (iii) summarize the geographic distribution of studies; (iv) asses the correspondence between published scientific results and data available for UGI conditions of target cities.

2. Materials and Methods

To achieve the goals of this work, the research was developed in two stages: (1) a systematic literature review to respond to goals (i), (ii) and (iii), and (2) a case study analysis to respond to the goal (iv).

2.1. Systematic Literature Review

The systematic literature review for data collection was conducted in June 2023, using the Scopus database. Two searches were done based on two distinct word combinations: (a) ecosystem services, urban and plant species; (b) ecosystem disservices, urban and plant species. The following search terms were included in Boolean search strategies: 1. (TITLE (ecosystem services AND urban AND plant species)) OR (ABS (ecosystem services AND urban AND plant species)) OR (KEY (ecosystem services AND urban AND plant species)); 2. (TITLE (ecosystem disservices AND urban AND plant species)) OR (ABS (ecosystem

disservices AND urban AND plant species)) OR (KEY (ecosystem disservices AND urban AND plant species)). The search was limited to peer-reviewed, published, English-language articles. The PRISMA flow chart of the study is shown in Figure 1.

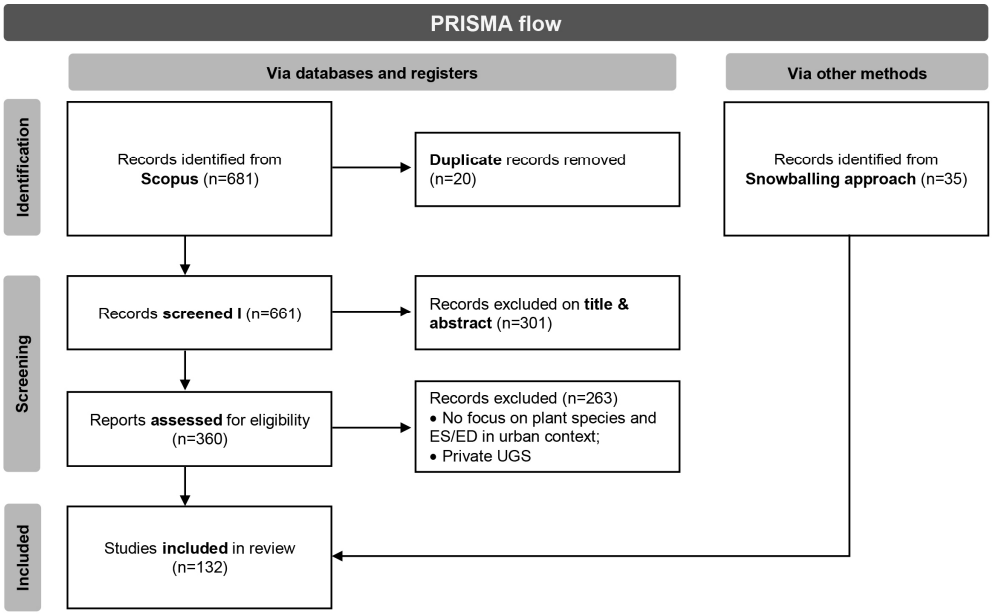


Figure 1. Systematic review flow diagram based on PRISMA.

These searches provided 661 manuscripts. All information was imported into a free data management software—*Zotero 6.0.30*. Through reading the titles and abstracts, 360 manuscripts that address the topics of green spaces in urban contexts were selected to be analyzed in detail. Articles that addressed the topics of green roofs, private or residential gardens, and green walls were excluded as only public urban green spaces (UGS) were considered in the current research. A snowballing approach in the systematic review was also used to collect as many articles as possible. For this, the search platforms Google Scholar and Science Direct were also used in addition to previously identified lists of manuscript references.

This strategy yielded a total of 132 articles that explore, directly or indirectly, the link between plant species origin and potential services and disservices. Although there is a new classification of ES provided to UGI—CICES classification (see https://www.biodiversity.fi/ext/en/data-pages/cices.html (accessed on 1 October 2023)), in this analysis, we have as reference the classification that has already been recurrently used from the Millennium Ecosystem Assessment [27] and the Economics of Ecosystems and Biodiversity [28], since it is the classification used in all articles consulted. All the information found is compiled in a table format (see Table S1 in Supplementary Material), with a list of the references obtained, the plant species identified, their origin (validated based on information from Kew Gardens—https://powo.science.kew.org/ (accessed on 1 September 2023)), the life form (according to Raunkiaer [29]), and listed services and disservices described.

2.2. Case Study Analysis

The results from the systematic literature review carried out in the previous Section 2.1 supported the identification of the European Mediterranean area as highly productive regarding the number of articles focused on the association between native/exotic plants and ES/ED. To assess if the results from the literature review match the reality of the UGI, six cities were selected for the countries with a higher number of studies in the European Mediterranean (Spain, Italy, Portugal), where a higher number of articles were published considering the topic of interest. Information for the two cities with a higher number of inhabitants for each country was collected, namely for Madrid, Barcelona, Lisbon, Oporto,

Rome and Milan. For Italy, information for the biggest cities is not available (e.g., Milan) or is insufficient (e.g., Rome), limiting the ability to produce a comparison or proceed with a deeper analysis, which is why it was decided to remove these Italian cities from this cases study analysis. The analysis and characterization of the selected cities was conducted based on the information available on official municipal websites, compiled in Table S2 in Supplementary Material.

The collected data, namely plant species identified, their origin (validated based on information from Kew Gardens—https://powo.science.kew.org/ (accessed on 1 September 2023)), their life form (according to Raunkiaer [29]), the associated services and disservices, was compiled in Tables S3 and S4 in Supplementary Material.

3. Results

3.1. Systematic Literature Review: A Panorama of the Scientific Perspective

3.1.1. Ecosystem Services

Ecosystems are the bases that sustains life [30], providing a series of benefits to the population [31]. In recent years, scientific studies have developed quantification [32,33] and evaluation methods [34,35] focused on ES. Most of these studies focus on patches or forest areas, land use mosaics, or in UGS, like parks and leisure areas [36], describing the benefits of the most representative UGS [37,38]. Our results show that the most commonly valued ES provided by UGI are regulation ES, especially particle removal, carbon dioxide (CO^2) sequestration, microclimate regulation, and those of cultural nature, mainly aesthetic values (Figure 2). Such findings show that the most frequently studied ES are those that influence or have direct benefits to humans [31]. Those with indirect benefits [31,37], such as pollination [39], symbiotic associations between plants and fungi [40], among many others which ensure the sustainability of the ecosystems themselves [31,37], are scarcely considered. In addition to the fact that some of them are difficult to evaluate, the population is unaware of this indirect ES because, in most cases, they are not economically subject to valuation or accounting [31].

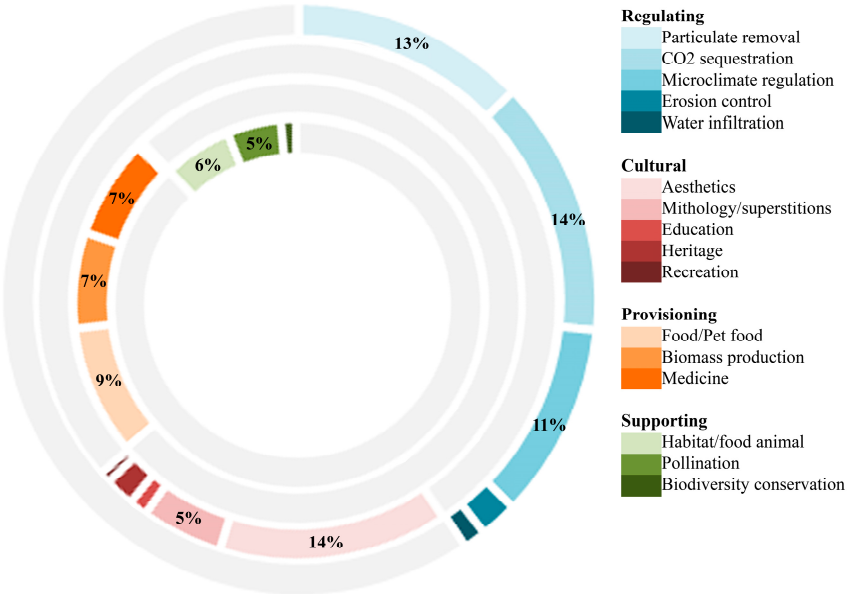


Figure 2. Studies by ES type. Showing 95 studies from the total of 132 screened—data available in Table S1 in Supplementary Material. In this table, the symbol * corresponds to studies that establish the species origin, which is maintained in the processing of the data.

A growing body of literature has come to associate UGI with ES potentials [37,41–43]. However, the rapid and intense urbanization processes introduce changes in ecosystems and their functions, generated by the rapid rhythm of modifications related to city lifestyle

and urban sprawl, create or promote disservices like allergens, biological invasions, increased prevalence of pathogens or pests, limitations to mobility and security, and increase in greenhouse gas emissions [8]. In this context, a growing awareness about maximizing the benefits of UGI emerged, pointing to the need to have coherent and specific planning adapted to each location, namely to its physio-geographic, demographic, and cultural factors [10,44,45].

3.1.2. Ecosystem Disservices

According to Lyytimäki and Sipilä [13], three main categories of ED should be considered in the study of urban ecosystems: (1) public health-related disservices, (2) economic disservices, and (3) ecological disservices. In urban areas, ecological disservices, mainly invasive species, and public health disservices, especially allergenic issues, are the ones that have raised the most significant concern in the scientific community (Figure 3). In terms of ecological disservices, it is considered that species' invasiveness, an issue directly associated with some exotic plants, is an ED that occurs associated with UGI, which also has economic impacts since the uncontrolled propagation of a few species increases costs with UGI management. Considering public health-related disservices, the allergenicity of some plant species is the most relevant issue. There are some families (e.g., Betulaceae, Cupressaceae, Fagaceae, Oleaceae, Poaceae, Ulmaceae) that are identified as problematic, concerning allergenic problems, including those that also have the highest cross-reactivity index [46] and reaction to urban environmental pollution [47], showing that some potential ED are not related to species' origin.

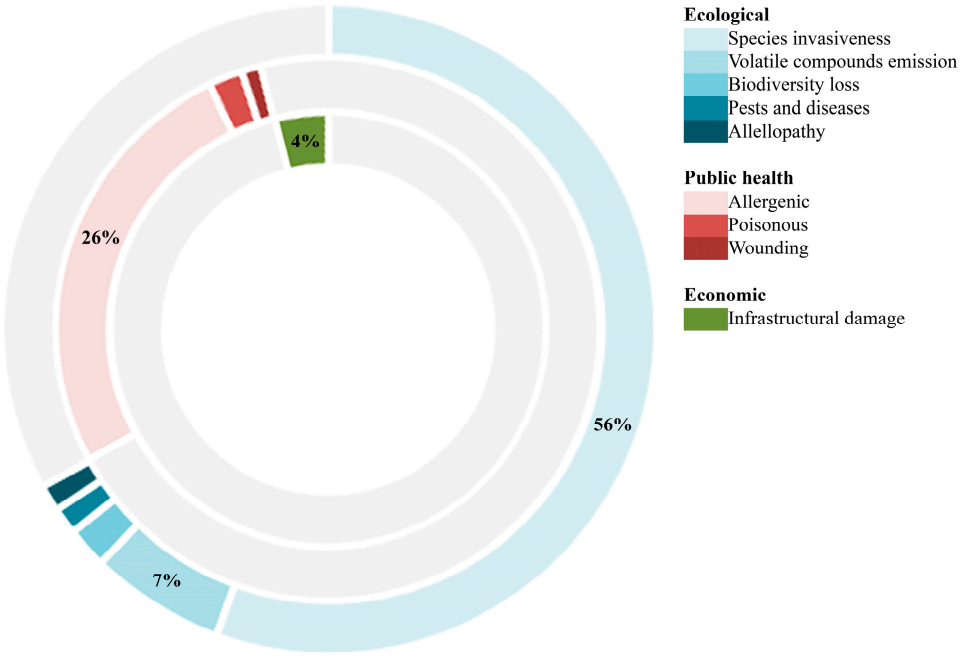


Figure 3. Studies by ED type. Showing 72 studies from the total of 132 screened—data available in Table S1 in Supplementary Material. In this table, the symbol * corresponds to studies that establish the species origin, which is maintained in the processing of the data.

3.1.3. Geographical Distribution

At a global level, around 53% of the articles refer to plant species' origin and are focused on the Mediterranean (17%), Temperate (15%) and Tropical (16%) climatic contexts (Figure 4). When it comes to associate plant species' origin with the services and disservices, the Mediterranean (39%) and Temperate (33%) regions have the highest percentage of produced literature (Figure 5). Regarding the Mediterranean climatic context, plant species present the greatest correspondence with ES or ED in the countries of South Africa (20%) and South Europe (41%), particularly Spain (22%), Italy (17%), and Portugal (11%).

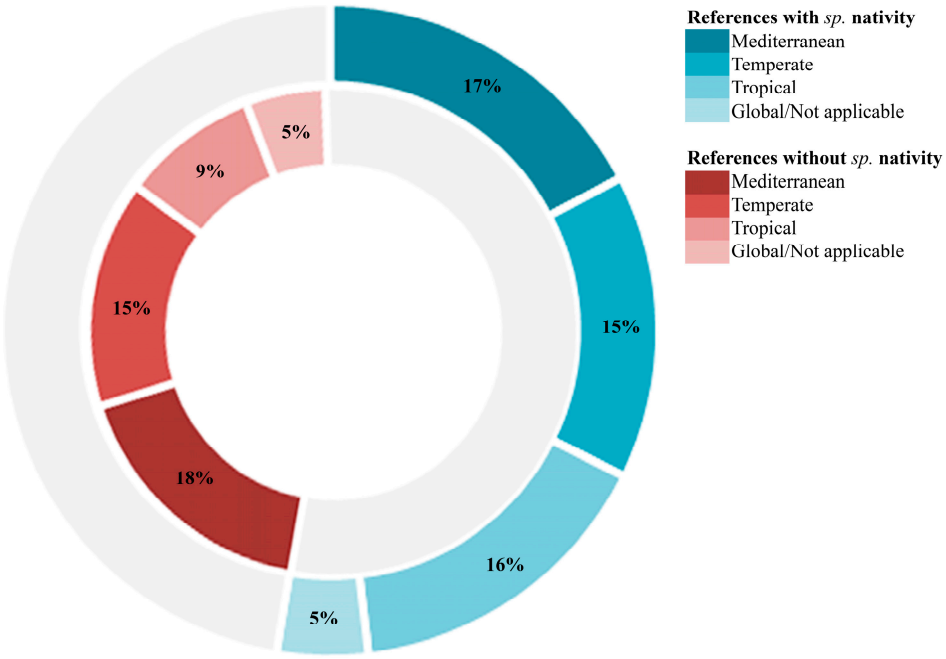


Figure 4. Studies citing species origin by climatic regions. Showing 62 studies from the total of 132 screened—data available in Table S1 in Supplementary Material. In this table, the symbol * corresponds to studies that establish the species origin, which is maintained in the processing of the data.

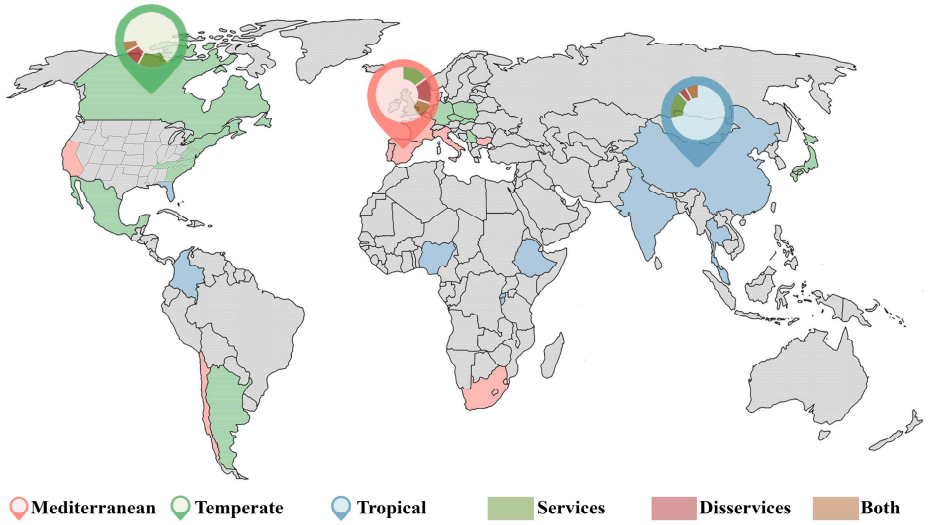


Figure 5. Geographical distribution of the studies considering ES and ED. Showing 119 studies from the total of 132 screened—data available in Table S1 in Supplementary Material. Excluded studies: those with unknown location or literature reviews. In this table, the symbol * corresponds to studies that establish the species origin, which is maintained in the processing of the data.

In the Mediterranean context, the high percentage of papers that referred to ED (70%) (Figure 6) is unsurprising, considering the high number of species introduced and the high susceptibly to invasion by exotic plants. However, in contrast to the conclusions of similar studies [48], there was a significant percentage of native species with ED associated (30%). This result can be related to the high number of studies carried out within the scope of the ED in the area of public health, and specifically to the allergenicity of the human population to some native species, such as *Betula* sp., *Fraxinus* sp., and *Olea europaea*, in the case of the European Mediterranean. In addition, the reported ED related to exotic plants is more

common for natural and semi-natural habitats, which are generally scarce in the urban context. Though, especially for the European Mediterranean cities, the UGI exhibits a very high percentage of exotic plant species, a pattern very much influenced by the historical legacy, which explains the considerable amount of introductions across centuries.

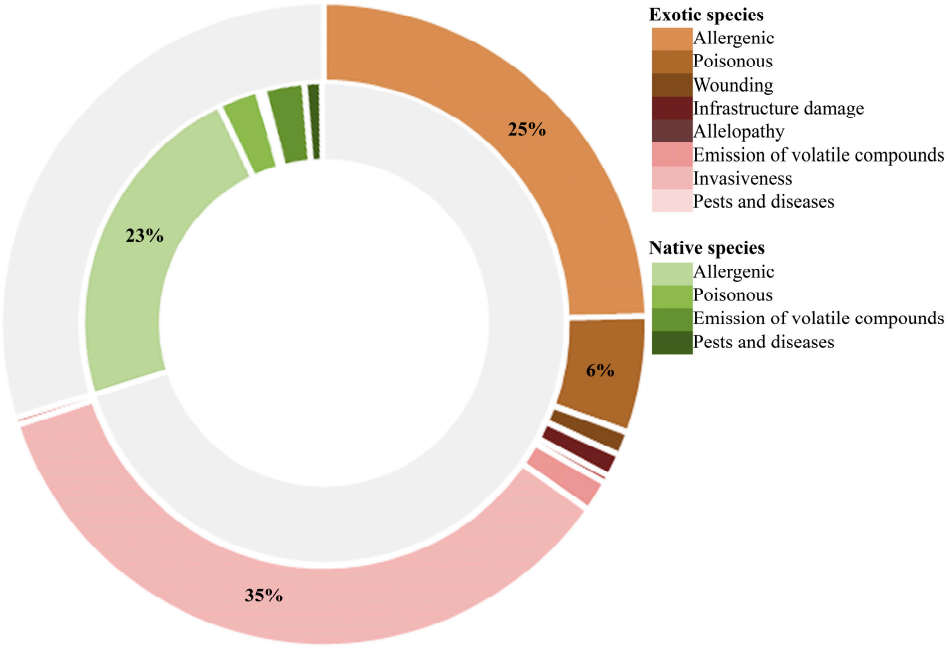


Figure 6. Studies relating ED and origin of the plant species in the Mediterranean climatic context (46 studies from the total of 132 screened—data available in Table S1 in Supplementary Material).

3.2. Case Study Analysis: The Mediterranean Region

3.2.1. The Historical Legacy

The distribution of cultivated plants is strongly influenced by historical patterns [49–51], such as land use options (gardens, parks, or streets) [50,52,53], and lifestyle [53–58]. On one hand, there are urban landscapes that mimic the settler's homelands [59], suggesting that places with different cultures will also have the cultivation of different plant species [60]. One the other hand, societies are open to the introduction of plants. Both processes benefited from the increasing transference of valuable plants associated to stronger fluxes of people and trade around the world [17], an exchange that had great impacts on UGI composition.

The introduction of species outside their natural context has occurred since antiquity, mostly due to the expansion of agriculture, but it was also highly promoted by the discovery and intensification of commercial maritime routes betweenAmerica and Asia [17]. Such movements generate a flow of propagules with Europe, particularly the European Mediterranean Region, which initiated and fueled these processes, and where the introduction of exotic species gained volume, speed, and area across time. Today, the high volume of propagules transferred worldwide is promoted by the increasing availability of transfer options that guarantee high speed and reach wider areas.

In the urban context, the aesthetics and ornamental characteristics prevail as an argument for introducing exotic plants. Ignatieva [61] relates the preference for exotic plant species in landscaping on a global scale with the creation of botanical gardens, promoting the emergence of the tropical landscaping concept. With the emergence of this trend, a homogeneous group of tropical species would have been selected and replicated extensively by horticulturists for cultivation in geographically distant cities [61]. In turn, this resulted in a widespread supply of a preselected group of cultivated ornamental species out of the context of the original ecosystems. Consequently, several cities ignored the local biodiversity to cultivate this group of standardized species offered as models by the botanical gardens.

The preference for using exotic species in landscaping in the 16th century is also related to the social value attributed to introduced plants. New plants from distant territories, with peculiar flowers, leaves, or fruits, captured the interest of a society that attributed great value to the "exotic" element often associated with exclusivity and social status [62]. Such interest represents a significant cultural ES, having influenced landscape professionals regarding the choice of species for the UGI.

The first botanical gardens appeared in the Mediterranean region, spreading through European regions and generating a great exchange of seeds and propagules. For this reason, it is expected that the Mediterranean region presents a wide variety of cultivated species, mainly for ornamental purposes [60], from tropical or subtropical areascapable of growing in the mild climate of this region [63]. This region has also been pointed out as the origin of the introduction of plants cultivated in other areas of the world [64].

In this context of growing introductions, urbanized areas, very different from natural and semi-natural areas in terms of abiotic conditions [65,66], are identified as highly susceptible to the entry and establishment of exotic species [67,68], either due to the fragmented and highly disturbed habitats [67,69], the intense flow of products and people [17], or even the differentiation of land use and microclimatic changes induced by the daily life of the human population [23,70], promoting the emergence of NUE [71].

The assumption of novelty in urban ecosystems [72] has caused some concerns among decision-makers about the correct course of action regarding UGS. In this regard, the European Commission recently launched two key reports to help decision-makers in the planning and management of UGS towards maximizing the provision of ES: the *EU Guidance on Integrating Ecosystems and their Services into Decision-Making* (2020) and the *EU Ecosystem Assessment* (2021) (see Table S2 in Supplementary Material). Consequently, at the national level, some countries have adopted measures in an attempt to increase the ES produced by the UGI, or at least to minimize some of the ED, such as Spain, Portugal, and Italy, countries that decree or list invasive exotic species (see Table S2 in Supplementary Material). Thus, at the local level, several European Mediterranean cities have analyzed their UGI to determine the best form of intervention in their UGS.

3.2.2. The European Mediterranean UGI

Considering the higher reference to the UGI in the Mediterranean context in the previous systematic literature review, five cities were selected to analyze their UGI composition in this specific climatic context. All the selected four cities (Madrid, Barcelona, Lisbon and Porto) have official municipal websites with relevant data regarding UGS's characterization, planning, implementation strategies, management, and guidelines to optimize the UGI ES (see Table S2 in Supplementary Material).

According to the available data, the cities with higher values of green area per inhabitant are, respectively, Porto (54.8 m^2), Lisbon (27.8 m^2), Madrid (18.26 m^2) and Barcelona (17.72 m^2). These values are influenced by the criteria used to assume an urban area as green, and by the type of UGS considered in the assessment. Lisbon, Madrid and Barcelona count only public green areas in their data, unlike the Porto municipality which considers all UGS in the city, whether public or private. Regarding the latter, if only the public green areas per inhabitant are considered, the number reduces to 7.8 m^2/inhabitant. Also, municipalities such as Porto and Barcelona account for plant specimens at the urban area level, covering large parks and central public forest areas. On the other hand, Madrid only counts the street trees, parks, and central gardens and does not include other types of UGS, which are also relevant. The variables used in the analysis and characterization of the UGI vary between cities, which means that values that would be comparable at the outset should only be regarding some variables, such as the area covered/scale, spaces typologies, and the population.

The joint analyses of these four European Mediterranean cities (see Table S3 in Supplementary Material) shows a greater prevalence of native species in the UGI of such cities, contradicting some of the consulted literature [62,73]. This result can be explained by

the fact that large UGS are very often not contemplated in scientific studies, such as, for example, forest areas, where native species from different genera (*Pinus*, *Populus*, *Quercus*, among others) are sometimes strongly represented. Moreover, the fact that the typologies of private green spaces, whether residential or institutional, are omitted also influences these values [74]. For example, botanical gardens that accommodate mainly exotic species are not included in the consulted studies. In addition, the type of data provided also varies between cities. Madrid, Barcelona, and Porto, beyond citing the most common species, refer quantitatively to the representativeness of each one. Lisbon only lists the species present in the UGI without any information on the species' representativeness.

As expected, closer attention is dedicated to phanerophytes, possibly due to the perennial nature of this life-form type but also because of the broader contribution to ES provision. However, ED could also be more important in such cases (Figure 7), namely damages by roots, higher costs associated with collecting organic debris, or even removal in case of risk. Examples of ED associated with herbaceous plants include the invasive *Oxalis pes-caprae* or the allergenicity of *Amaranthus* sp., *Chenopodium* sp., *Parietaria judaica*, *Plantago* sp., and *Urtica dioica*.

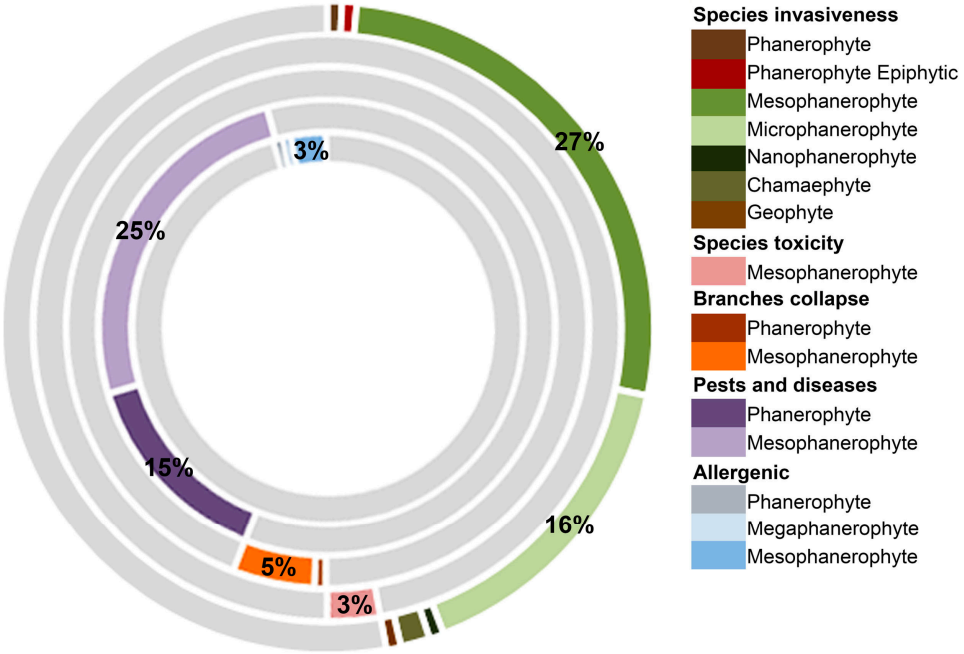


Figure 7. Life forms and species ED association (Table S4 in Supplementary Material, the symbol * corresponds to species native to the Mediterranean Region).

As suggested by the European Commission, cities must list the species integrated into the UGI with identified ED. In this sense, the results of this stage match the results of the systematic literature review, once a large part of the ED is associated with exotic species (64%), where invasion is the most worrisome and inconvenient aspect (51%), followed by species that have been associated with branch collapse (7%) and pests and diseases (5%) (Figure 8), determining higher costs with maintenance, prevention and treatment. Considering that, based on the ecological ES that UGS can provide in urban areas, and highlighting the native species' adaptability to existing urban conditions, the Madrid and Barcelona municipalities aim to increase the use of native species in their UGI.

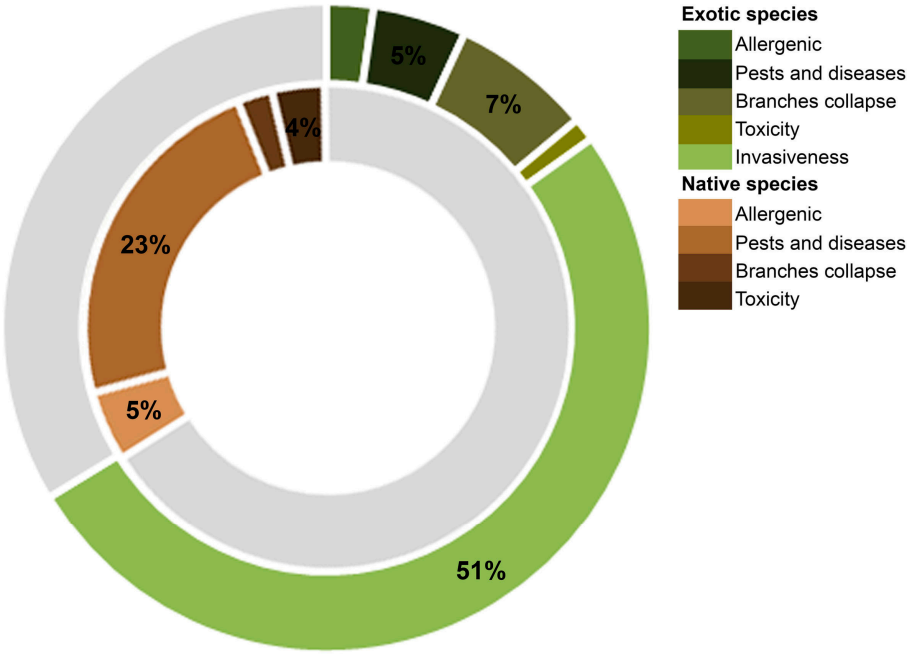


Figure 8. ED and species origin association (Table S4 in Supplementary Material, the symbol * corresponds to species native to the Mediterranean Region).

4. Discussion

The complexity of the UGI, as a multifunctional network providing various ES, justifies investing deeply in its study, aiming to promote interventions in the UGI that maximize the benefits (ES) and minimize potential risks (ED). The study of the services provided by the UGI has been mostly directed towards ES which is highly valued by human societies (e.g., food, CO^2 sequestration, aesthetic effect, among others). But the potential disservices that UGI can generate are also catching the interest and concern of science and decision-makers (e.g., allergies, emission of volatile compounds, and invasive species, among others), promoting a better understanding of the pros and cons.

Although the composition of the UGI plays a significant role, the association between ES or ED with plant species, and their origin, is a topic that has not received full attention, as the analysis is often focused on plant communities or parts from the UGI. Studies based on a taxonomic perspective are often disregarded, which justifies the restricted selection of 132 in the literature search. Thus, the present manuscript reaches the scale of plant species, and their origin, with potential associated services and disservices, but it also verifies the match between published scientific results and data available for the UGI for five Mediterranean cities.

Considering the literature review, results show that ED can be identified for both native and exotic species. While invasion is the most cited ED for exotics, for native plants, allergenicity is the ED with the highest reference in the literature. A pattern also drawn from the analysis of the UGI of the selected European Mediterranean cities mostly focused on phanerophytes. Considering the high prevalence of exotic species in the UGI of the selected cities, a pattern very much influenced by the historical legacy, and the diversity of ES associated with natives and exotics, it seems unjustifiable to set the UGI composition based on species origin. That would neglect the ES provided by exotic species and the region's historical legacy, restricting the action of designers, planners, and policymakers to a conceptual assumption.

The historical interest in the exotic species relegated the vast majority of native species to second place when setting the compositions of the UGI. But the use of natives is not always a second option. For different reasons, the use of natives fluctuates. It follows trends in the design and planning of the UGI, working like a pendulum that oscillates between the choice of native and exotic species, a condition that cannot be detached from

the evolution that the design and function of UGS experienced over the last centuries [75]. The lower interest on natives is very much related to specific traits, particularly in the case of comparing trees. Let us compare, for example, a *Quercus faginea*, from the Mediterranean region, with a *Jacaranda mimosifolia*, from tropical climates, two robust and deciduous phanerophytes. Most likely, the *Jacaranda mimosifolia* will be pointed out as more attractive due to the extravagant purple flowering in spring and summer and the unusual shape of its foliage. The aesthetic value prevailed in choosing plant species for use in UGI [76,77], considering size, crown shape, types and colors of flowering, fruiting attributes, and growth speed, among others, criteria associated mostly with cultural ES. Also, some species have assumed a significant role in cultural services delivery despite related disservices, as in the case of some invasive *Acacia* species, with high associated cultural value, namely in Portugal, France, or Italy [78]. Perhaps, for this reason, efforts are beginning to emerge dedicated to demystifying the use of exotic species [79–82].

The use of native species is gaining relevance today, as demonstrated by data analysis from the selected European Mediterranean urban areas. But this is not a new phenomenon or exclusive to the Mediterranean region. Through his inspirational work, Burle Marx proved that it was possible to carry out landscape architecture projects with an extraordinary artistic quality using native plants, bringing this debate about the origin of species to the fore in the garden's design. Is this representing the emergence of a new paradigm among landscape architects and designers of public spaces due to new arguments, or is it a momentum of the pendulum movement?

Ecological designers and conservationists put higher pressure to defend the use of native species in the UGI, instead of exotics, as a way of preserving biodiversity and endemic resources [83,84], benefiting from their adaptation to climatic conditions [85], ensuring higher fitness of the plants, reducing susceptibility to pests and diseases [86], and reducing maintenance efforts and costs [87]. It is this argument that some authors challenge when considering climate change impacts and the resilience of urban areas. Some studies indicate that natives are better prepared to cope with climate change [88], while others assume that exotics will outperform natives [89], reinforcing the resilience of urban areas by maintaining ES provision [90].

For some authors, the use of native plants is also assumed as a strategy to reduce susceptibility to invasion by exotic species [62,91–93], but even in areas where the composition is projected only for natives, and despite the higher maintenance rates, the establishment of invasive plants might occur, especially with herbaceous plants (*Bidens pilosa*, *Digitaria sanguinalis*, *Soliva sessilis*, etc.). Studies that correlate invasive species with ES and ED in the urban environment are beginning to emerge [77], showing that although these species generally have numerous consequences in the ecosystems [94–96], due to their good adaptability, they can serve, in an initial phase, as a vehicle for the recovery of degraded lands [97].

These arguments led to the emergence of new paradigms and concepts that try to find a middle ground, such as the concept of NUE. The NUE concept assumes that since exotic species are already commonly used in UGI, ecosystems already formed can be seen as experiments, producing new types of communities and new ES or ED, still to be explored and demanding further studies. The concept of NUE embraces the establishment of species, or their communities, which are generally considered for eradication [98], but acknowledging their existence and possible ES does not imply that managers no longer control invasive species or that traditional conservation and restoration practices are completely replaced [22,99,100].

There is a mismatch between ecological processes' spatial and temporal scales and the social scales of monitoring and decision-making, which limits human understanding of ED and the integration of this knowledge into planning [101]. In this sense, UGI composition, considering changes or the creation of new UGS, must always be based on a multifactorial analysis that includes ES and ED. For that, it is increasingly evident that urban management

and planning need to go beyond the traditional boundaries of the urbanized area and operate at the scale level of ecosystems [101].

5. Conclusions

UGI plays a significant role in urban areas, including mitigating the effects of climate change and adding several benefits to populations. However, the selection of plant species to be included in the UGI has generated debate. On the one hand, ecologists and conservationists advocate for the exclusive use of native species in urban environments to minimize biodiversity loss and ecosystem degradation; on the other hand, some exotic species perform important cultural ES, and emerging concepts even reveal unexpected services provided by invasive species, balancing the scales between services and disservices of this species.

Disservices in urban ecosystems are not exclusive to exotic species. The results of the literature review show that invasion is an ED related to some exotic species, while the bibliography also points out that some native species are responsible for high rates of allergenicity in urban populations. The analysis of the European Mediterranean cities also reinforces these results. Likewise, those ED are considered the most prevalent in this region.

UGI plays a critical role in urban areas, providing a wide array of ES, from regulation to cultural services. However, designers and planners should also consider related ED regarding new information available. In light of the literature analyzed and current knowledge, it makes less and less sense for the choice of species to be influenced by their origin. Furthermore, understanding the complexity of UGI composition and dynamics can contribute to more conscious and relevant decision-making based on the balance between species ES and ED, regardless of their origins. In addition, it is important to consider the high heterogeneity of the UGS, and that most of them are subject to intense maintenance regimes or impose limitations on plants, performing a new combination of factors that are absent in natural habitats.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/land13010023/s1, Table S1: Results of the systematic literature review. Information based on screened studies correlating ES or ED with plant species in urban areas [102–229]; Table S2: Official municipal websites of selected cities; Table S3: Prevalence of plant species in the selected cities; Table S4: ED of the plant species pointed out on the official reports of selected cities.

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