Urban green management plan: Guidelines for European cities

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Urban green areas are essential components of a city. They guarantee an adequate quality of life by providing several ecosystem services. Green areas must be designed and managed appropriately with a long-term approach ensuring a healthy urban ecosystem. It is possible to observe how especially in the USA and Canada there is a useful tool for this purpose, the Urban Forest Management Plan. The aim of this study is to understand which practical and effective plans were available for manage public urban green spaces in Europe, before COVID-19 (non-routine period), in order to carefully set up management plans. In order to reach the goal a bibliographic review was performed and reported following the PRISMA Statement. Furthermore, a research was carried out on the main management plans adopted by the municipalities in European capitals. In this regard, the research tries to investigate the knowledge base that European municipalities can use to set up an urban green management plan. The narration of the outcomes was designed as an initial guide aimed primarily at public administrators by providing them with a path and a scheme on how to structure a long-term green management plan in European cities. In the hope that even European municipalities can adopt a long-term green management plan, we propose a scheme to be followed to achieve this goal, with the indication of five essential points to be taken into account.

KEYWORDS

green infrastructures, urban forest, ecosystem services, maintenance, public spaces, COVID - 19

1 Introduction

Cities are a set of strongly interacting systems dominated by humans and where understanding the relationships between human and ecological processes is essential for living in sustainable cities (Marzluff, 2008). Natural environment is vital for cities as it provides a series of benefits known as ecosystem services (ES) (TEEB, 2011). The uncertainty of ecological responses and the social and political complexity of managing ecological resources in an urban context in order to maximize the supply of ES, are interesting challenges (Green et al., 2016; Battisti et al., 2019; Battisti et al., 2022). Although the topic of ES is important as shown by several studies (TEEB, 2011; Costanza et al., 2017), the ES

provided by the urban green areas are not yet well integrated in the management process (Young, 2010). The ES are provided by the whole urban ecosystem, in a greater or lesser way according to specific areas. Many of these ES are provided by green areas. It is therefore necessary to plan all the management and design activities, with a long-term vision. The challenge of the managers of the green areas is to guarantee an effective demonstration of "good green space" under constraints of resources, weak political support and increasing requests from various user groups (Lindholst et al., 2016).

The conception of the garden and the urban park has evolved over time, currently there seems to be a tendency to conceive the green areas as an area that must provide ES, which is attentive to ecological aspects and which guarantees human well-being. The tendency to build new buildings is decreasing in favor of re-use of existing ones and many industrial areas around the world are being transformed into urban parks (e.g. Dora Park in Turin, Landschaftspark Duisburg-North in Germany or Freshkills Park in New York).

Several types of urban green areas, such as urban agricultural areas or the ecological park, have different characteristics and management needs. As an example, Figure 1 shows the types of public urban green areas that are generally maintained by European municipalities. We cannot neglect the management of green areas, because we risk shifting it and potentially increase costs over time, for future generations (Vogt et al., 2015). This is why a global planning of management is essential. In order to achieve this goal, a practical and concrete management plan is needed. There is a need to design green areas so that management costs are as low as possible, without forgetting all the functions that must be performed.

It is therefore evident that each category highlighted in Figure 1 presents different characteristics with different maintenance requirements. It is necessary to monitor maintenance operations in order to guarantee over time the ES supply of green areas, based on economic availability and new scientific discoveries and cultural needs. On this basis, the new green areas should be designed, which will take into account the environmental needs and citizen demands.

The goal is to ensure a healthy urban ecosystem. Urban Forest Management Plans (UFMP) have been developed in order to achieve this goal in the USA and Canada, which are also raising interest in other parts of the world.

The UFMP is based on the Urban Forest concept. UFMP is a management plan, generally lasting 20 years, where there are ambitious final goals to be achieved. These goals must be pursued through functional sub-aims that are both five-year and yearly (van

Wassenaer et al., 2012). It is a management plan that specifically indicates where and what to do in order to achieve the goals. Concrete examples of these UMFPs can be found in the following cities: City of Portland, (2004); Town of Oakville, (2008); City of Tampa, (2013). Many of these UFMP Americans (USA) and Canadians use criteria and indicators that can be found within the work done by Kenney et al. (2011) who have implemented the work done by Clark and his colleagues in 1997. These indicators range from the canopy cover, to the public agency cooperation, to the visual assessment and to the Publicy owned natural areas management, planning and implementation. An interesting paper by Ordóñez and Duinker (2013) compared 14 different Canadian UFMP, highlighting which criteria and indicators were used or not. In addition, some examples of this type of management have also been found in Australia, one example being the Urban Forest Plan of Perth (City of Perth, 2016).The research question is placed in the debate of urban green management, through a reading of the literature in a multidisciplinary way, considering the concept of place-keeping (Dempsey and Smith, 2014) addressed in this case to European public urban green spaces, useful to ensure healthy and well-managed green spaces that provide multiple ES. The debate thus stems from the need to understand how to manage such urban spaces, knowing that managers and municipalities face economic-financial difficulties as well as a lack of data and specific municipal strategies (Feltynowski et al., 2018; Fongar et al., 2019). Some research proposes the application of mathematical models aimed at managing green spaces according to specific ecosystem services, such as CO_2 absorption (Daniele and Sciacca, 2021). Still other research focuses on the importance of urban green space management from the perspective of biodiversity conservation (Aronson et al., 2017; Aguilera et al., 2019). In general, there is a growing interest and demand for urban green strategies and management plans aimed at ensuring an adequate quality of life for city dwellers (Randrup et al., 2017; Raparthi, 2020).

Stressing again the role of greenery in the well-being of citizens, a strong need has been pointed out regarding the increase of green areas, during the lockdown period due to COVID-19 (Larcher et al., 2021). However, the hope is to consider this historical moment not as a routine period, and therefore not comparable with previous years. Therefore, the research analysed the literature on urban green management plans prior to the pandemic, in particular focusing on European realities, considering the demand for new green areas, and thus further highlighting the need to analyse the existing literature on the subject, in order to create a starting point for setting up urban green management plans tailored to each urban reality.

In this regard, the research tries to investigate the following question: What knowledge base can European cities use to set up an Urban Green Management Plan?

The narration of the outcomes was designed as an initial guide aimed primarily at public administrators by providing them with a path and a scheme on how to structure a long-term green management plan in European cities.

FIGURE 1
Types of public Urban green areas in Europe (modified by Swanwick et al., 2003).

2 Materials and methods

In order to understand which plans are available for manage urban green areas with a long-term perspectives in Europe, a
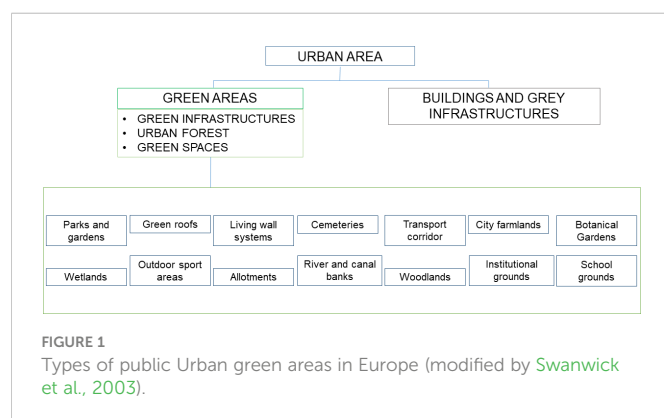
bibliographic research was performed. The reporting of this scoping review was guided by the standards of the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) Statement (PRISMA, 2021), using Scopus and Web of Science databases, analyzing papers written from 2010 to 2018. The flow diagram of the review process is shown in Figure 2. The keywords used were: 'urban AND green management AND Europe',' ecosystem services AND green management AND Europe'. This research was refined by choosing only those researches in which at least one of the authors worked in a European university or research organization. Finally, articles on the management of public urban green space were selected.

Figure 2 shows the method applied to review the literature body.

This research was subsequently extended by selecting directly on the websites of the European Union capitals if a methodology similar to UFMP was applied at the management level. Specifically, the documents founded on the websites of the European capitals contained: goals aimed to maintaining and improving green areas (lasting no less than 5 years) and/or presenting wider goals, reachable through concrete actions to be carried out in green areas (lasting no less than 10 years).

In total, 8 city plans document regarding long-term urban management plan were added to the literature body. The addition of data from other sources is also provided for in the PRISMA methodology.

3 Results and discussion

Following the bibliographic research on the situation in Europe, 44 papers have been identified that dealt with green management. Unfortunately, few information concerning a practical and long-term plan similar or applicable as UFMP was found.

The search for information on the websites of the European Union capitals highlighted a different approach, based more on the concept of Green Infrastructures, as can also be seen from the policies promoted by the European Commission. Also in this case little information was found about long-term management plans, except for a few lucky cases. However, it is noteworthy that the approach to the management issue is broader and less articulated compared to UFMP. Worthy of note are certainly the plans of Helsinki, London, Dublin and Berlin and interesting visions are held in the cities of Budapest, Stockholm, Tallinn and Vienna (Table 1).

The tendency to approach a type of instrument well-structured and with a long term vision therefore begins to be evident. For this purpose, we present the information found in some articles selected from the bibliographic research, which in turn present an interesting bibliography

FIGURE 2
The flow diagram of the review process.

worthy of reading, in the hope that many European municipalities can implement their long-term green management program.

This section will be divided into six sub-sections in order to suggest a path for European city administrators on how to establish a long-term green management plan: Definition of the term management; Goals and fund research; Available technical tools; Green areas and ecosystem services; The role of citizens; Proposal on how to implement a long-term green management plan in European cities.

3.1 Definition of term management

In order to deal with the issue of managing green areas, it is necessary to define the term management. In the literature a lack of an effective theoretical basis and common models concerning the management of urban green space is highlighted. We agree with Jansson and Lindgren (2012) that explain that a long-term management must take into account both the maintenance and design aspects. This definition is fundamental because too often design and maintenance are not coordinated and therefore maintenance is not considered in the design process with the risk of not achieving the goals set (Dempsey et al., 2016).

3.2 Goals and fund research

When long-term planning is needed, it becomes necessary to decide which goals are to be achieved over time. A good example can be found in Finland. In order to mitigate climate change, analyzing all the carbon flows, there is the need to develop models and tools to make 'carbon neutral' all the municipalities (Niemelä et al., 2010). The achievement of this goal is set for 2030. In this context, the vegetation of urban regions, with the provision of multiple ES, can have a role in climate change mitigation. From our point of view the goal must be associated with the idea that human well-being depends on a healthy ecosystem.

When setting one or more goals to be achieved, it is necessary to evaluate the financing possibilities. In this case the collaboration between local planning authorities, working and business sectors, developers and communities can lead to identification of sustainable funding for green infrastructures (Mell, 2017). Group work can certainly lead to the achievement of a healthy urban ecosystem.

3.3 Available technical tools

In order to achieve the goals, it is often necessary to use specific technical tools, which allow to evaluate and monitor the actions undertaken over time. These tools have long been used by the various municipalities and professionals and become useful in the long-term management of green areas. As an example the use of CAD and GIS software makes it possible to use spatial data. Specifically, GIS software can be applied effectively in the study of large habitats, and is useful for assessing the provision of ES in these contexts. (Vihervaara et al., 2010). Moreover the radio frequency identification devices can be used in urban green monitoring such as tree tomography and could
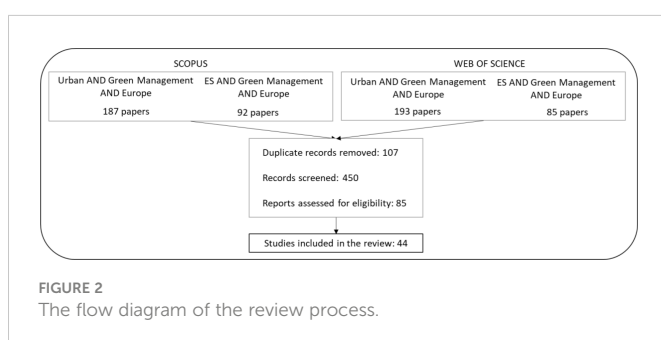
TABLE 1 European city plans with a long-term vision.

City	Document Types	Period	Main goals
Berlin	Berlin Strategy - Urban Development Concept[a]	2013-2030	Improving citizen' education and minimize environmental pollution
Budapest	Long-term Urban Development Concept[b]	Up to 2030	Ensuring a better community life and environmental development
Dublin	City Tree Strategy[c]	2016-2020	Protect existing trees and planting more trees to improve urban tree canopy
Helsinki	Helsinki City Plan[d]	2013-2050	Improving greenways and mobility networks
London	City Gardens Draft Management Plan[e]	2017-2022	Improving air quality and biodiversity
Stockholm	Stockholm City Plan – Summary[f]	2009-2030	Increasing mobility and minimize harmful environmental effects
Tallinn	Tallinn Environmental Strategy[g]	Up to 2030	Natural diversity conservation and improving environmental awareness
Vienna	STEP 2025 Urban Development Plan Vienna[h]	Up to 2025	Improving green and open spaces network and protect existing ones

[a]http://www.stadtentwicklung.berlin.de/planen/stadtentwicklungskonzept/download/strategie/BerlinStrategie_Broschuere_en.pdf
[b]http://budapest.hu/Documents/V%C3%A1ros%C3%A9p%C3%ADt%C3%A9si%20F%C5%91oszt%C3%A1ly/Budapest2030_ENG_summary.pdf
[c]https://www.dublincity.ie/sites/default/files/content/RecreationandCulture/DublinCityParks/Documents/Dublin%20City%20Tree%20Strategy%202016.pdf
[d]https://www.hel.fi/hel2/ksv/julkaisut/yos_2013-23_en.pdf
[e]https://www.cityoflondon.gov.uk/things-to-do/green-spaces/city-gardens/about-us/Documents/city-gardens-draft-management-plan-2017-2022.pdf
[f]http://www.stockholm.se/PageFiles/146069/Kortversion_ENG_l%C3%A5guppl%C3%B6st.pdf
[g]https://www.tallinn.ee/strateegia_ingl
[h]https://www.wien.gv.at/stadtentwicklung/studien/pdf/b008379b.pdf

therefore represent a future perspective for the management of urban forest (Luvisi and Lorenzini, 2014). A tool that can be used to identify and manage green areas is Hellwig's method. This method depends a lot on the quality of the data entered, does not require the use of GIS software or cartographic analysis, but allows to identify possible options to develop the city with the minimum environmental impact (Łopucki and Kiersztyn, 2015). For a targeted ES study there are software dedicated to this purpose, such as the i-Tree software (i-Tree, 2018) (https://www.itreetools.org/), ARIES (ARIES, 2018) (http://aries.integratedmodelling.org/) and InVEST (InVest, 2018) (https://www.naturalcapitalproject.org/invest/). As with any tool used, it must always be accompanied by an expert evaluation.

3.4 Green areas and ecosystem services

Hansen et al. (2015) who studied the relationship between the ES concept and planning in the planning documents of some european cities, the word 'ecosystem services' is not covered. In order to improve the design of sustainable cities it is necessary to incorporate the theme of ES that can be used as a key concept for integrating ecological sciences and social sciences (Niemelä, 2014). It is necessary that the issue of ES, and its assessment, will be included in the management process as well as the ecosystem disservices topics, even if perceived as negative elements, are essential to prevent unwanted effects in environmental management (Lyytimäki, 2014). As anticipated, the management also includes the topic of maintenance. The maintenance of urban green areas is strictly correlated with the provision of ES. Over time the green areas in the cities have been maintained to obtain mainly a pleasant aesthetic effect or to avoid accidental damage due for example to the fall of branches in the road. The maintenance of green areas is based on the size of the area, on its use by citizens and on the plant species and other elements that compose it.

These maintenance operations must be carried out, and if necessary modified, in order to maximize the provision of ES in cities. To achieve this goal, it is first necessary to identify which services are mainly provided in the urban area and if possible which indicators can be used for their monitoring.

In order to start correctly managing urban spaces, it is necessary to pay attention to the different types of soil in the city, trying to preserve them and improve their conditions so that they can provide important ecosystem services. The goal to pursue is to have sustainable cities that guarantee human well-being and preserve the soil capital, with the aim to have multi-functional soils in the city (Morel et al., 2015). In addition to the importance of the soil, the problem of air quality and climate change is strongly felt. Fortunately, there are environmental indicators that are useful for monitoring the current situation in the city and preventing future problems, lichens. These indicators can also be useful for managing green areas. The air purification service is closely related to the type of vegetation present in the area and is provided in a greater way by forest areas with a complex vegetation structure, furthermore managed and less complex vegetation types like lawns and planted trees appear to be less effective in mitigating climate regulation and improving air purification (Vieira et al., 2018).

The topic of habitat quality is one of the aims to be guaranteed through the correct management of urban green areas. In this case birds can be chosen as indicators of habitat quality, especially in the city, because their ecology is well known. Only a few species of birds benefit from buildings as substitutes for rock habitats and because food is abundant, moreover the woody plant composition is important for bird richness, which seems to reach its maximum value when there is an equal representation of coniferous and deciduous plants (Fontana et al., 2011). Mexia et al. (2018) shown that in urban parks a high species diversity and a heterogeneous spatial distribution of planted species, can create a multiplicity of niche and therefore increase an abundance of birds.

Another element present in urban spaces is represented by the water and the vegetation that hosts this environment. Often in parks and urban gardens there are ponds and other small water bodies that turn out to be important components in these areas. Furthermore these water bodies are useful for water purification, flood control or for particular aesthetic characteristics. Specific design of the ponds

could be useful in guaranteeing a good level of species diversity, making ponds of different sizes, some with an intermediate level of vegetation cover and others with other vegetation levels to support species that have other requirements and characteristics (Blicharska et al., 2016). The same authors indicated how maintenance should be targeted both to particular taxa and for overall richness.

Moving from the vegetation closer to water to the vegetation present in the lawns, it is possible to make considerations aimed at increasing the environmental quality and biodiversity. There are four green management practices that have a major influence on biodiversity: turfgrass lawns maintenance; removal of habitat; habitat simplification; use of pesticide and herbicide (Aronson et al., 2017). In some areas wildflowers could be useful in order to increase biodiversity especially those in a state of degradation such as roadsides. The realization of areas with meadow-like vegetation contributes to increase plant and animal diversity, making them aesthetically pleasing with low cost involved in their maintenance (Bretzel et al., 2016).

Generally around the lawns there are some woody areas that must be managed according to the rules of arboriculture, which must however be aimed at maintaining or increasing the biodiversity of the area and the needs and wishes of the citizens. However, often within these areas that have tree species, there may be alien species, sometimes invasive, sometimes less. In the management of urban green areas, it is important to take into account the presence of non-native species and set up a control or removal plan for these species. However, this problem must be tackled in a scientific and conscientious way, also because it is a high cost for local administrations. As explained by Dickie et al. (2014), often native trees that are removed are not necessarily highly invasive. Furthermore, the ecological services concerned must always be assessed objectively.

There are some cases where cities host at least part of the forests, which provide important ecosystem services, so it is necessary to manage them and to preserve them over time. This management must be aimed at mitigating climate change. A lot of information is becoming available on how to manage forests to climate change and that some forest owners associations are presenting policies to achieve this goal (Blennow, 2012). At the municipal level it would be necessary for the forests to be managed following specific guidelines based on environmental protection. However, only municipalities with larger woodland properties are certified by the Pan-European Forest Certification scheme, the Forest Steward Council scheme or similar (Nielsen et al., 2013).

Following the analysis of the main ecosystem services provided in urban areas, A preliminary assessment of the provision of ES is provided in Table 2. It is emphasized that Table 2 should be considered an initial basis from which subsequent assessment and reasoning can be derived, based on a specific territory.

3.5 The role of citizens

Citizens with their way of life influence and are strongly influenced by the green area. It is for this reason that prudent management relies heavily on the human component. If the inhabitants understand the value of nature and participate reasonably, the management will have a greater result. Therefore we must start seriously planning actions aimed at training citizens, in order then to achieve interesting results in the long term. People attribute a high aesthetic value to the green areas designed and maintained with a high contribution of resources even if many some maintenance operations can lead to a decrease in biodiversity, often because people perceive ecological quality as something messy (Filibeck et al., 2016).

There is a lack of communication among institutional actors while the transfer of scientific knowledge, training and the creation of a simple and common language are the essential tools to correctly

TABLE 2   Linking public green areas and main ecosystem services (modified by Gómez-Baggethun et al., 2013).

Types of public green areas	Main Ecosystem Services
Parks and gardens	Recreation, Aesthetic benefits, Pollination and seed dispersal
Outdoor sport areas	Recreation benefits
City farmlands	Food supply, Cognitive development
Allotments	Food supply, Cognitive development
Cemeteries	Spiritual and religious benefits
School grounds	Recreation, Cognitive development
Institutional grounds	Aesthetic benefits
Transport corridor	Noise reduction, Air purification, Urban temperature regulation
Wetlands	Waste treatment, Habitat for biodiversity, Moderation of environmental extremes
Woodlands	Habitat for biodiversity, Global climate regulation, Moderation of environmental extremes
River and canal banks	Runoff mitigation, Habitat for biodiversity
Green roofs	Runoff mitigation, Urban temperature regulation
Living wall systems	Urban temperature regulation, Aesthetic benefits
Botanical Gardens	Cognitive development, Habitat for biodiversity

maintain and design the green areas (Ugolini et al., 2015). An absence of a proper comprehensive analysis of existing situations could imply a barrier to planning and management for the development of some countries, as an example Macedonia (Hristovski et al., 2010). Furthermore, the relationship between citizens and green areas is often different in the various european countries. This is also due to the management of green areas and the citizen' perception. The vision of green areas management seems to be more inclusive in Berlin and less in Paris (Skandrani and Prévot, 2015). Moreover, the point of view of some citizens, such as the disabled people and children, turns out to be a precious resource, because sometimes some aspects that allow everyone to benefit from the green areas are not kept in mind. The interest and attention of children towards management issues are therefore only to be increased, because they are intrinsically already present, especially with the maintenance of their playgrounds. (Jansson et al., 2016). Their knowledge and awareness about environmental issues can increase through environmental education programs. Adult education is also of important, as they must contribute with their work to safeguarding and improving the environment but, more importantly, to support the educational activities for the children, motivating them to learn. Furthermore, adults should take part in political decisions.

The actors participating in environmental policy initiatives are motivated by the satisfaction of social norms and personal values because when individuals feel included in taking part in important decisions, they increase their perception of the legitimacy of institutional situations and their intrinsic motivation as well (Dedeurwaerdere et al., 2016). When citizens have been trained and involved, it is possible to leave them spaces for operational and common management of some green areas.

A form of green area managed collectively is represented by public-access community gardens. The various forms of collective green spaces are useful for creating a scientifically educated population, which manages resources and is involved in civic life, promoting ecologically responsible behavior (Colding and Barthel, 2013). If these behaviors were also reported in private areas, such as domestic gardens, we could achieve a global management of the environment in which we live. Domestic gardens provide multiple ES and small changes in garden management could benefit the environment and society (Dewaelheyns et al., 2016).

3.6 Proposal of how to implement a long-term green management plan in European cities

After a thorough literature review, we would like to propose a scheme that could be followed for the implementation of a long-term green management plan in Europe (Figure 3).

The scheme illustrates how a concerted work between municipalities and citizens can lead to the creation of a long-term green management plan. It is necessary that the plan is continuously monitored in order to verify that the settled goals can be achieved and allow any changes during time. The ultimate goal is to ensure a human well-being through a healthy urban ecosystem. This strongly anthropocentric assertion must, however, take into account that ES are provided more by healthy ecosystems, and therefore that the

FIGURE 3
Proposal of how to implement a long-term green management plan in European cities.
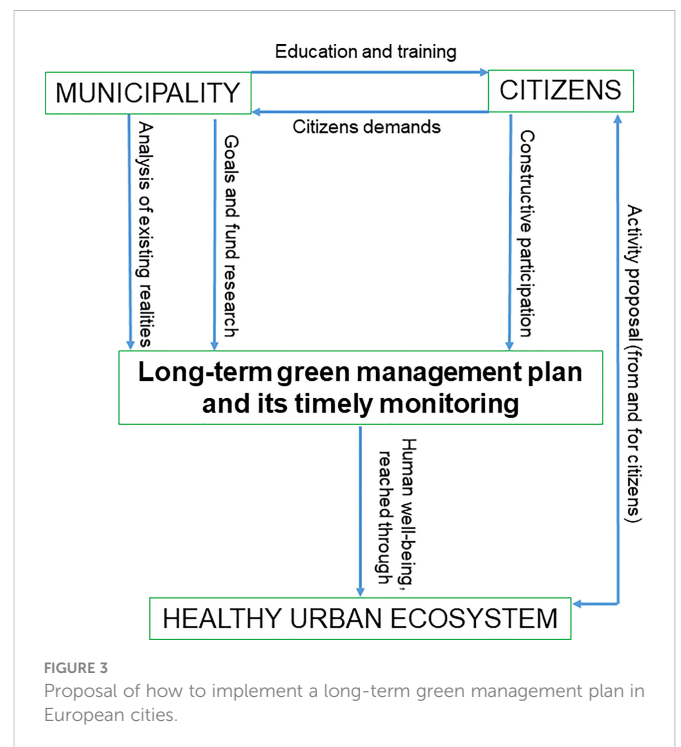
management of urban spaces must consider the needs of other living beings as well as the judicious use of present materials.

Finally, it should be emphasized that the drafting of an urban green management plan should include a comparison with the other management plans, so as to create a dialogue between the various city departments and also between plans, in order to manage urban space in a holistic manner.

4 Conclusion

The present review analyses the management plans of urban green spaces, prior to the pandemic, a period that greatly influenced people's perceptions of urban green spaces by highlighting the need for additional green areas (Larcher et al., 2021). However, such spaces must be designed, and above all managed over time, in a way that ensures the provision of several ES to the inhabitants of urban areas.

The results of the review and the proposed scheme for the drawing up of an UFMP, are to be read as an initial guide for local administrators, adapted to the needs of individual European realities.

In our opinion, the first step in the realisation of an UFMP is certainly the census of the green areas to be managed and possibly also their health status. Then, the formation of an inter-departmental and interdisciplinary group can set up a long-term management plan, making the plan dialogue with the other plans in the area. The reason for this is that such a heterogeneous group could bring in experiences gained during participation in projects and research, analyse aspects from different perspectives and share useful data, such as climate data. Finally, activities to raise awareness and educate citizens about these issues, as well as constant dialogue and discussion with them, can be the key to successful urban green management and health.

Finally, we would like to conclude the review by highlighting 5 points:

1. A long-term vision is particularly required, given that some European municipalities are moving in that direction.
2. The management becomes a necessary operation, which must be collective in order to guarantee the fruition of the areas over time. For this reason it is emphasized that maintenance is a fundamental aspect in the design phase too often not taken into consideration, even from an economic point of view. This is one of the reasons why the constant presence of professionals such as agronomists, geographers, biologists, geologists and experts in natural sciences should always be present in the design phase.
3. Fund research is essential. It must be a common goal and must allow the results to be achieved over time.
4. An active and constructive participation of citizens in decision-making and management processes is essential to be able to live in cities sustainable and usable over time.
5. The management plan must take into account the issue of ecosystem services and the socio-economic needs of the city.

Furthermore, it is hoped that there may be shared intercommunal plans over time as administrative boundaries often do not coincide with those of nature.

Author contributions

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Aguilera, G., Ekroos, J., Persson, A. S., Pettersson, L. B., and Öckinger, E. (2019). Intensive management reduces butterfly diversity over time in urban green spaces. *Urban Ecosyst.* 22 (2), 335–344. doi: 10.1007/s11252-018-0818-y

ARIES. (2018). *ARtificial intelligence for ecosystem services*. Available at: http://aries.integratedmodelling.org/.

Aronson, M. F., Lepczyk, C. A., Evans, K. L., Goddard, M. A., Lerman, S. B., MacIvor, J. S., et al. (2017). Biodiversity in the city: key challenges for urban green space management. *Front. Ecol. Environ.* 15 (4), 189–196. doi: 10.1002/fee.1480

Battisti, L., Larcher, F., Grella, S., Di Bartolo, N., and Devecchi, M. (2022). Management and mapping ecosystem services in a privately owned natura 2000 site: An insight into the stellantis–la mandria site (Italy). *Sustainability* 14 (5), 3134. doi: 10.3390/su14053134

Battisti, L., Pille, L., Wachtel, T., Larcher, F., and Säumel, I. (2019). Residential greenery: State of the art and health-related ecosystem services and disservices in the city of Berlin. *Sustainability* 11 (6), 1815. doi: 10.3390/su11061815

Blennow, K. (2012). Adaptation of forest management to climate change among private individual forest owners in Sweden. *For. Policy Economics* 24, 41–47. doi: 10.1016/j.forpol.2011.04.005

Blicharska, M., Andersson, J., Bergsten, J., Bjelke, U., Hilding-Rydevik, T., and Johansson, F. (2016). Effects of management intensity, function and vegetation on the biodiversity in urban ponds. *Urban Forestry Urban Greening* 20, 103–112. doi: 10.1016/j.ufug.2016.08.012

Bretzel, F., Vannucchi, F., Romano, D., Malorgio, F., Benvenuti, S., and Pezzarossa, B. (2016). Wildflowers: From conserving biodiversity to urban greening–a review. *Urban Forestry Urban Greening* 20, 428–436. doi: 10.1016/j.ufug.2016.10.008

City of Perth. (2016). *Urban forest plan*. Available at: https://www.perth.wa.gov.au/planning-development/city-initiatives/urban-forest-plan.

City of Portland. (2004). *Urban forest management plan*. Available at: https://www.portlandoregon.gov/parks/60402.

City of Tampa. (2013). *Urban forest management plan*. Available at: http://docplayer.net/35177724-City-of-tampa-urban-forest-management-plan-november-2013.html.

Clark, J. R., Matheny, N., Cross, G., and Wake, V. (1997). A model of urban forest sustainability. *J. Arboric.* 23 (1), 17–30. doi: 10.48044/jauf.1997.003

Colding, J., and Barthel, S. (2013). The potential of 'Urban green commons' in the resilience building of cities. *Ecol. Economics* 86, 156–166. doi: 10.1016/j.ecolecon.2012.10.016

Costanza, R., de Groot, R., Braat, L., Kubiszewski, I., Fioramonti, L., Sutton, P., et al. (2017). Twenty years of ecosystem services: How far have we come and how far do we still need to go? *Ecosystem Serv.* 28, 1–16. doi: 10.1016/j.ecoser.2017.09.008

Daniele, P., and Sciacca, D. (2021). An optimization model for the management of green areas. *Int. Trans. Operational Res.* 28 (6), 3094–3116. doi: 10.1111/itor.12987

Dedeurwaerdere, T., Admiraal, J., Beringer, A., Bonaiuto, F., Cicero, L., Fernandez-Wulff, P., et al. (2016). Combining internal and external motivations in multi-actor governance arrangements for biodiversity and ecosystem services. *Environ. Sci. Policy* 58, 1–10. doi: 10.1016/j.envsci.2015.12.003

Dempsey, N., Burton, M., and Duncan, R. (2016). Evaluating the effectiveness of a cross-sector partnership for green space management: The case of Southey owlerton, Sheffield, UK. *Urban Forestry Urban Greening* 15, 155–164. doi: 10.1016/j.ufug.2015.12.002

Dempsey, N., and Smith, H. (2014). "Understanding place-keeping of open space," in *Place-keeping* (Abingdon: Routledge), 33–49.

Dewaelheyns, V., Kerselaers, E., and Rogge, E. (2016). A toolbox for garden governance. *Land Use Policy* 51, 191–205. doi: 10.1016/j.landusepol.2015.11.016

Dickie, I. A., Bennett, B. M., Burrows, L. E., Nuñez, M. A., Peltzer, D. A., Porté, A., et al. (2014). Conflicting values: ecosystem services and invasive tree management. *Biol. Invasions* 16, 705–719. doi: 10.1007/s10530-013-0609-6

Feltynowski, M., Kronenberg, J., Bergier, T., Kabisch, N., Łaszkiewicz, E., and Strohbach, M. W. (2018). Challenges of urban green space management in the face of using inadequate data. *Urban forestry Urban greening* 31, 56–66. doi: 10.1016/j.ufug.2017.12.003

Filibeck, G., Petrella, P., and Cornelini, P. (2016). All ecosystems look messy, but some more so than others: A case-study on the management and acceptance of Mediterranean urban grasslands. *Urban Forestry Urban Greening* 15, 32–39. doi: 10.1016/j.ufug.2015.11.005

Fongar, C., Randrup, T. B., Wiström, B., and Solfjeld, I. (2019). Public urban green space management in Norwegian municipalities: A managers' perspective on place-keeping. *Urban Forestry Urban Greening* 44, 126438. doi: 10.1016/j.ufug.2019.126438

Fontana, S., Sattler, T., Bontadina, F., and Moretti, M. (2011). How to manage the urban green to improve bird diversity and community structure. *Landscape Urban Plann.* 101, 278–285. doi: 10.1016/j.landurbplan.2011.02.033

Gómez-Baggethun, E., Gren, Å., Barton, D. N., Langemeyer, J., McPhearson, T., O'Farrell, P., et al. (2013). "Urban ecosystem services," in *Urbanization, biodiversity and ecosystem services: Challenges and opportunities: A global assessment*. Eds. T. Elmqvist, M. Fragkias, J. Goodness, B. Güneralp, P. J. Marcotullio, R. I. McDonald, S. Parnell, M. Schewenius, M. Sendstad, K. C. Seto and C. Wilkinson (Dordrecht: Springer Netherlands), 175–251. doi: 10.1007/978-94-007-7088-1_11

Green, O. O., Garmestani, A. S., Albro, S., Ban, N. C., Berland, A., Burkman, C. E., et al. (2016). Adaptive governance to promote ecosystem services in urban green spaces. *Urban Ecosyst.* 19, 77–93. doi: 10.1007/s11252-015-0476-2

Hansen, R., Frantzeskaki, N., McPhearson, T., Rall, E., Kabisch, N., Kaczorowska, A., et al. (2015). The uptake of the ecosystem services concept in planning discourses of European and American cities. *Ecosystem Serv.* 12, 228–246. doi: 10.1016/j.ecoser.2014.11.013

Hristovski, K. D., Hild, N. R., and Young-Hristovski, J. E. (2010). The environmental management system in the republic of Macedonia – problems, issues and challenges. *Communist Post-Communist Stud.* 43, 115–124. doi: 10.1016/j.postcomstud.2010.01.003

InVEST. (2018). *Integrated valuation of ecosystem services and tradeoffs.* Available at: https://www.naturalcapitalproject.org/invest/.

i-Tree. (2018). *I-tree tools for assessing and managing forests & community trees.* Available at: https://www.itreetools.org/.

Jansson, M., and Lindgren, T. (2012). A review of the concept 'management' in relation to urban landscapes and green spaces: Toward a holistic understanding. *Urban Forestry Urban Greening* 11, 139–145. doi: 10.1016/j.ufug.2012.01.004

Jansson, M., Sundevall, E., and Wales, M. (2016). The role of green spaces and their management in a child-friendly urban village. *Urban Forestry Urban Greening* 18, 228–236. doi: 10.1016/j.ufug.2016.06.014

Kenney, W. A., Van Wassenaer, P. J., and Satel, A. L. (2011). Criteria and indicators for strategic urban forest planning and management. *Arboriculture Urban Forestry* 37, 108–117. doi: 10.48044/jauf.2011.015

Larcher, F., Pomatto, E., Battisti, L., Gullino, P., and Devecchi, M. (2021). Perceptions of urban green areas during the social distancing period for COVID-19 containment in Italy. *Horticulturae* 7 (3), 55. doi: 10.3390/horticulturae7030055

Lindholst, A. C., Konijnendijk van den Bosch, C. C., Kjøller, C. P., Sullivan, S., Kristoffersson, A., Fors, H., et al. (2016). Urban green space qualities reframed toward a public value management paradigm: The case of the Nordic green space award. *Urban Forestry Urban Greening* 17, 166–176. doi: 10.1016/j.ufug.2016.04.007

Łopucki, R., and Kiersztyn, A. (2015). Urban green space conservation and management based on biodiversity of terrestrial fauna – a decision support tool. *Urban Forestry Urban Greening* 14, 508–518. doi: 10.1016/j.ufug.2015.05.001

Luvisi, A., and Lorenzini, G. (2014). RFID-plants in the smart city: Applications and outlook for urban green management. *Urban Forestry Urban Greening* 13, 630–637. doi: 10.1016/j.ufug.2014.07.003

Lyytimäki, J. (2014). Bad nature: Newspaper representations of ecosystem disservices. *Urban Forestry Urban Greening* 13, 418–424. doi: 10.1016/j.ufug.2014.04.005

Marzluff, J. M. (2008). *Urban ecology: an international perspective on the interaction between humans and nature* (New York: Springer).

Mell, I. (2017). Financing the future of green infrastructure planning: alternatives and opportunities in the UK. *Landscape Res.*, 1–18. doi: 10.1080/01426397.2017.1390079

Mexia, T., Vieira, J., Príncipe, A., Anjos, A., Silva, P., Lopes, N., et al. (2018). Ecosystem services: Urban parks under a magnifying glass. *Environ. Res.* 160, 469–478. doi: 10.1016/j.envres.2017.10.023

Morel, J. L., Chenu, C., and Lorenz, K. (2015). Ecosystem services provided by soils of urban, industrial, traffic, mining, and military areas (SUITMAs). *J. Soils Sediments* 15, 1659–1666. doi: 10.1007/s11368-014-0926-0

Nielsen, A. B., Konijnendijk, C. C., Wiström, B., and Jensen, R. B. (2013). Municipal woodland in Denmark: resources, governance and management. *Scandinavian J. For. Res.* 28, 49–63. doi: 10.1080/02827581.2012.693193

Niemelä, J. (2014). Ecology of urban green spaces: The way forward in answering major research questions. *Landscape Urban Plann.* 125, 298–303. doi: 10.1016/j.landurbplan.2013.07.014

Niemelä, J., Saarela, S.-R., Söderman, T., Kopperoinen, L., Yli-Pelkonen, V., Väre, S., et al. (2010). Using the ecosystem services approach for better planning and conservation of urban green spaces: a Finland case study. *Biodiversity Conserv.* 19, 3225–3243. doi: 10.1007/s10531-010-9888-8

Ordóñez, C., and Duinker, P. N. (2013). An analysis of urban forest management plans in Canada: Implications for urban forest management. *Landscape Urban Plann.* 116, 36–47. doi: 10.1016/j.landurbplan.2013.04.007

Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA). (2021). Available at: https://prisma-statement.org/.

Randrup, T. B., Östberg, J., and Wiström, B. (2017). Swedish Green space management–the managers perspective. *Urban forestry urban greening* 28, 103–109. doi: 10.1016/j.ufug.2017.10.001

Raparthi, K. (2020). Ability of nature based solutions through urban green space management in building urban resilience. *Int. J. Urban Design* 3 (2), 46–56. doi: 10.37628/.v3i2.685

Skandrani, Z., and Prévot, A.-C. (2015). Beyond green-planning political orientations: Contrasted public policies and their relevance to nature perceptions in two European capitals. *Environ. Sci. Policy* 52, 140–149. doi: 10.1016/j.envsci.2015.04.015

Swanwick, C., Dunnett, N., and Woolley, H. (2003). Nature, role and value of green spaces in towns and cities: an overview. *Built Environ.* 29 (2), 94–106. doi: 10.2148/benv.29.2.94.54467

TEEB – The Economics of Ecosystems and Biodiversity (2011). *TEEB manual for cities: Ecosystem services in urban management, united nations environment program* Edited by Patrick ten Brink. (London and Washington: Earthscan). Available at: https://teebweb.org/publications/teeb-for-national-and-international-policymakers/

Town of Oakville. (2008). *Urban forest strategic management plan.* Available at: https://www.oakville.ca/residents/urban-forest-strategic-management-plan.html.

Ugolini, F., Massetti, L., Sanesi, G., and Pearlmutter, D. (2015). Knowledge transfer between stakeholders in the field of urban forestry and green infrastructure: Results of a European survey. *Land Use Policy* 49, 365–381. doi: 10.1016/j.landusepol.2015.08.019

van Wassenaer, P. J., Satel, A. L., Kenney, W. A., and Ursic, M. (2012). "A framework for strategic urban forest management planning and monitoring. trees, people, and the built environment," in *Paper presented at the urban trees research conference* (Birmingham, UK, Edinburg: Forestry Commission), 22–38.

Vieira, J., Matos, P., Mexia, T., Silva, P., Lopes, N., Freitas, C., et al. (2018). Green spaces are not all the same for the provision of air purification and climate regulation services: The case of urban parks. *Environ. Res.* 160, 306–313. doi: 10.1016/j.envres.2017.10.006

Vihervaara, P., Kumpula, T., Tanskanen, A., and Burkhard, B. (2010). Ecosystem services–a tool for sustainable management of human–environment systems. case study Finnish forest Lapland. *Ecol. Complexity* 7, 410–420. doi: 10.1016/j.ecocom.2009.12.002

Vogt, J., Hauer, R. J., and Fischer, B. C. (2015). The costs of maintaining and not maintaining the urban forest: a review of the urban forestry and arboriculture literature. *Arboriculture Urban Forestry* 41, 293–323. doi: 10.48044/jauf.2015.027

Young, R. F. (2010). Managing municipal green space for ecosystem services. *Urban Forestry Urban Greening* 9, 313–321. doi: 10.1016/j.ufug.2010.06.007