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Disservices of urban trees

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Abstract

Urban trees provide various benefits but they are also a source of various types of harm and nuisance. This chapter argues for the recognition of these ecosystem disservices and discusses ways to assess them. It presents a review highlighting the wide scope of disservices, including health effects, physical damage to infrastructure, emissions influencing air quality, unexpected economic costs, and social and psychological factors related to urban forests as places of fear or inconvenience. Different kinds of disservice may be produced by urban trees depending on their location, growth phase and the intensity of maintenance. Moreover, different disservices may be perceived as relevant depending on the knowledge base, attitudes and expectations of the people making the valuation. In some cases, concerns related to disservices may be amplified and exaggerated by the news media and social media debates. In turn, this may increase the risk of misplaced management actions. A balanced and comprehensive assessment of both ecosystem services and disservices provided by urban trees is needed for successful urban green management.

Introduction

Ecosystem services provided by urban green areas have been recognised to an increasing degree following the turn of the millennium (MEA, 2003; Gómez-Baggethun and Barton, 2013). Urban trees in particular provide urban dwellers with a variety of ecosystem services (see e.g., Chapter 4). However, urban trees are also the source of various types of harm, nuisance and costs. These 'bad' aspects may be labelled as ecosystem disservices. The concept of ecosystem disservice is a recent one and there is no widely agreed definition for it. On a general level, ecosystem disservices can be defined as the functions, processes and attributes generated by the ecosystem that result in perceived or actual negative impacts on human wellbeing (Shackleton et al., 2016). Both ecosystem services and disservices are inherently anthropogenic concepts, putting emphasis on the human valuation of ecosystem properties and functions. What is perceived as beautiful and beneficial by one person may be considered ugly, useless, unpleasant or unsafe by another. For example, biodiversity-rich, semi-natural areas inside city limits are often experienced as suffering from a lack of maintenance, as opposed to intensively maintained but biodiversity-poor urban parks.

Relatively few studies have focused on ecosystem disservices in urban areas. However, this paucity of research does not mean there is an absolute absence of knowledge. On the contrary, various disciplines have long traditions of describing different types of harm caused by natural forces – without mentioning the term ecosystem disservice. Other labels have been used to highlight the fact that nature can be scary, disgusting, or uncomfortable (Bixler and Floyd, 1997). Scholarly contributions include management studies focusing on the effects of natural disasters, botanical research focusing on pests and parasites, medical research analysing ecosystem-based health risks or socio-psychological studies scrutinising different fears and risk perceptions related to natural elements. Many of these studies describe single and isolated disservices, such as the inconvenience caused by a certain nuisance animal or an illness caused by a vector-borne pathogen.

This chapter argues for the recognition of both the ecosystem services and disservices of urban trees. A balanced assessment resulting in the net ecosystem services is required in order to guide urban green planning and management. It is also required as a basis for attempts to resolve unavoidable social controversies and conflicts related to urban green management. Urban areas are characterised by different lifestyles, values and attitudes with different levels of tolerance towards nuisances related to urban green areas. In some cases, concerns related to urban ecosystem disservices may be exaggerated by the news media and social media debates (Lyytimäki, 2014). This social amplification of risks is especially likely if overly optimistic public expectations are created about the benefits of urban greening, without paying proper attention to the possible nuisances. In such cases, the disservice may come as a surprise to the public. This, in turn, is likely to create frustrated or angry public responses, and demands for swift and effective countermeasures. Such critique may be avoided altogether if potential ecosystem disservices are taken into account during the early phases of the urban green management. Identification of disservices is also important as in some cases benefits to human well-being may be cost-effectively achieved through the reduction or mitigation of ecosystem disservices, rather than promoting ecosystem services.

As discussed in this chapter, various kinds of disservice can be produced by urban trees. The chapter starts with concrete cases of disservices and proceeds towards more abstract methodological issues. First, a typology of disservices based on available examples is presented. Second, different methods and data sources used to identify and analyse disservices are outlined. Third, criteria for frameworks aimed at aiding the assessment of the disservices are discussed. It is argued that in the long term, successful urban planning and management should be based on integrated knowledge of services and disservices as well as continuous communication and interaction aimed at increasing public acceptance and policy awareness of different aspects of urban trees and urban biodiversity.

The many faces of disservices

Ecosystem disservices represent a relatively novel research area. Only a few studies focusing on the relationship between urban trees and ecosystem disservices have been published (e.g. Camacho-Cervantes et al., 2014; Delshammar et al., 2015), whilst some reviews have focused on ecosystem disservices more generally (von Döhren and Haase, 2015; Shackleton et al., 2016). Ecosystem disservices have also been discussed as a side topic in review papers focusing on urban trees or urban ecosystem services (e.g. Dobbs et al., 2011; Roy et al., 2012). However, the most comprehensive pieces of literature comprises case studies focusing on urban ecosystem services and addressing the actual or potential negative effects or costs of urban trees as a side-topic.

Together, these studies show that a wide variety of disservices may be produced by urban trees depending on different factors, such as species composition, location of the tree in relation to other trees and built structures, the growth patterns and life phase of the tree, stress caused by external conditions and the intensity of maintenance activities. Many of the disservices are dependent on the particular qualities of the built infrastructure and specific characteristics of the urban ecosystem, as well as socio-cultural aspects influencing how people value trees. Table 1 presents examples of different types of disservice. The table does not aim to provide a complete and comprehensive overall picture, instead, it intends to illustrate the different but intertwined categories of ecosystem disservices.

Table 1. Examples of ecosystem disservices related to urban trees.

Type of disservice	**Examples**
Aesthetic issues	• Trees perceived as ugly (e.g., unmanaged trees with dead branches, trees suffering pest invasions). • Trees growing in unsuitable places (e.g., trees blocking views from windows or trees distorting architectonic ensembles). • Indirect effects of tree growth decreasing the aesthetic value of built structures (e.g., moisture damaging painted walls, debris, leaves or pollen littering the environment). • Trees hosting species producing aesthetic discomfort (e.g., bird excrement and unwanted birdsong or other aural behaviour).
Safety and security issues	• Direct physical risks related to trees and tree growth (e.g. roots causing tripping, leaves making surfaces slippery or blocking storm water drainage, trees falling, branches dropping, vegetation blocking visibility). • Safety and security issues related to other natural or semi-natural species (e.g. fears related to bats, rodents or urban carnivores). • Urban parks as places of fear related to human misconduct (e.g. perceived risk of night-time crime, uncontrolled pet dogs).
Health issues	• Trees causing direct health effects (e.g., pollen causing allergic reactions). • Trees producing air pollutants or precursors of air pollutants affecting health (e.g., volatile organic compounds). • Trees providing habitats for other species causing health effects (vectors of diseases).

Type of disservice	**Examples**
Economic issues	• Direct costs caused by planting, maintaining and removing plant coverage. • Direct costs caused by attempts to remove unwanted species (e.g., weeds, birds nesting in inappropriate places, invasive species). • Indirect costs caused by land use restrictions (especially if a green area or certain species is protected).
Mobility and infrastructure issues	• Urban trees and parks forestalling fast and comfortable transportation and movement, especially the use of motorised transportation or the movement of people with disabilities or elderly people. • Roots causing blockages of sewer pipes, branches causing electric and other wires to short circuit.
Environmental and energy issues	• Biogenic volatile organic compounds and secondary aerosol emissions from trees, carbon and methane emissions from decomposition affecting air quality and climate change. • Increased pollution levels due to reduced air exchange (blocking wind). • Displacement of native species and introduction of invasive species. • Decreased possibilities for utilisation of sunlight because of shade. • Energy consumption, resource use and pollution from maintenance activities.

(Compiled from: Lyytimäki et al., 2008; Escobedo et al., 2011; Gómez-Baggethun and Barton, 2013; Delshammar et al., 2015; von Döhren and Haase, 2015; Säumel et al., 2016)

Ecosystem disservices operate on various spatial, temporal and functional scales. The frequency at which they occur may be highly irregular or they may be permanently present, at low or high background levels. They can be direct impacts of ecosystem properties and processes on human wellbeing, such as pollen allergens. They can also be present as the diminished flow of an ecosystem service, such as pests decreasing the recreational value of a tree and leading to the loss of a cultural ecosystem service.

Ecosystem disservices originate, by definition, in or from an ecosystem and are manifest in social-ecological systems. Abiotic phenomena such as earthquakes or volcanic eruptions cannot be counted as ecosystem disservices. However, the boundaries between abiotic and biotic – as well as ecological and social – systems are blurred. As noted by Shackleton et al. (2016) the dropping of litter in urban park should not be considered an ecosystem disservice since this act falls clearly under the social domain, with no direct origin in the ecosystem. However, organic litter such as paper tissue decomposing as a result of the functioning of microbiota can be considered an ecosystem disservice if it causes aesthetic discomfort for

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park users. This example illustrates the importance of the temporal scale of the assessment. Other problems associated with urban forests that should not necessarily be counted as ecosystem disservices include parks as places for people to loiter or sources of neighbourhood conflict (Baur et al., 2014). For example, litigation costs related to conflicts over vegetation damage to buildings or urban infrastructure may sometimes exceed the direct costs caused by vegetation.

Many of the disservices can be classified as *social issues* or *health risks*. Some of them may be considered minor and temporary nuisances while others are long-lasting health hazards (Dunn, 2010). These issues, ranging from psychological to physical problems, overlap in many cases. For example, certain animal species such as bats or stray dogs occupying urban green areas can be vectors of diseases such as rabies. Fear related to such areas, species and diseases may create wellbeing losses exceeding the direct health effects of the disease itself. Avoiding such unnecessary well-being losses requires successful implementation of carefully tailored communication and interaction strategies (Decker et al., 2012). Active communication is also important in cases where urban trees pose health risks that remain unnoticed by susceptible groups of people.

Ecosystem disservices have occasionally been referred as *missed opportunities* to enjoy ecosystem services. Examples of missed opportunities include water retention, urban air cooling and resilience against pests. A lack of urban parks can increase the intensity of urban flooding, a lack of trees or green roofs can make urban heath island effects worse and monocultures of decorative plants can increase the risk of pest attacks. Some species that increase urban biodiversity may cause damage to those species that are cared for (e.g. herbivores using ornamental plants as food). Factors preventing the production or use of certain ecosystem service may include both natural variability in ecosystems and anthropogenic environmental deterioration (Power, 2010). Access to green areas providing the services may be also restricted or denied. However, some authors argue that such cases should be understood in terms of constrained supply of ecosystem services, rather than as disservices (Shackleton et al., 2016). In other words, some ecosystem services may be missing because of trade-offs between different services provided by urban trees, rather than disservices related to trees.

Another line of reasoning focuses on disservices as *increased costs.* Besides the costs of lost opportunities, disservices can be understood as management costs, such as the costs related to monitoring and restoration of damaged ecosystems. A well-known example of this kind of management cost is the resources used for management of invasive species, such as the fungus causing the Dutch Elm Disease (*Ophiostoma ulmi and O. novo-ulmi*) (Delshammar et al., 2015). Considerable costs can be caused by maintenance aimed at forestalling or removing urban ecosystem disservices such as bird excrement accelerating corrosion, tree roots damaging pavements, or animals digging nesting holes. Costs can result from recurring management actions, such as the removal of fallen leaves and debris or repairs to one-off damages such as the decomposition of construction wood due to microbial activity.

It should be noted that such direct costs are relatively easy to assess, whereas economic benefits originating from urban biodiversity are more difficult to assess since they are more often externalities not captured by current market mechanisms. Costs are also generated indirectly as maintaining urban biodiversity and green areas often restricts or prevents other land uses. Despite being highly relevant for urban planning, it is not clear whether these indirect costs should be accounted as ecosystem disservices.

The activities aimed at curbing ecosystem disservices may themselves be an additional source of disturbance or pollution. Therefore, they can be categorised as part of a larger class of *environmental effects* of urban tree management. Stressful urban environments typically require intensive maintenance measures, such as irrigation, use of fertilisers, pest-disease control, pruning and removal and replacement of damaged or old trees. These activities may lead to increased use of natural resources, air and soil pollution, nutrient runoff or increased traffic and noise, but again, careful consideration is needed in order to judge whether these should be considered ecosystem disservices. A clearer case of disservice can be seen in the trees themselves as sources of air emissions such as volatile organic compounds or precursors of particles and tropospheric ozone.

Methods and data sources for assessing ecosystem disservices

Comparing the importance of various ecosystem disservices with each other and with other issues is often complicated. In order to identify and assess different types of disservices, various research methods and data sources are needed. The temporal and spatial focus of the assessment strongly influences the selection of a suitable research method. Different methods are likely to be needed in order to study the generation of disservices, human exposure and effects of disservices, as well as possible management options. Overreliance on any single method or data source should be avoided in order to maintain the capability to provide a rich picture with all the relevant nuances.

Assessments based on natural sciences approaches are essential in order to produce reliable information on the ecosystem properties and functions that result in ecosystem services or disservices (see also Chapters 7 and 8). A lack of resources and readily available data often limits the assessment of disservices. Much of the existing information is based on case studies covering relatively small areas and giving anecdotal evidence focusing on disservices related to single species (von Döhren and Haase, 2015; Shackleton et al., 2016).

Many of the assessments have focused on present disservices and few have aimed to describe the long-term past trends or future scenarios. Long-term data on disservices is typically scarce, therefore methods based on the use of proxy indicators indirectly illustrating the historical development of certain ecosystem disservices can be highly useful. For example, complaints found in municipal records may be used to illustrate what kind of disservices are produced by urban parks (Delshammar et al., 2015), or newspaper archives may be used to identify what kind of issues have been publicly raised as disservices related to urban nature (Lyytimäki, 2014). Using such data sources involves various caveats: archived information may be incomplete, the collection and storage of data may be inconsistent, and recorded cases may reflect the level of civic activity or public interest rather than actual level of disservice.

Identifying future disservices presents considerable methodological challenges. Some disservices are characterised by ecological thresholds, hysteresis, and points of no return. The concept of an ecological threshold refers to the level of a stressor that triggers an abrupt change in ecosystem quality, property, or phenomenon. It highlights that even small changes in stressors can produce large responses in ecosystems. The occurrence of many ecosystem disservices (such as outbreaks of pests) may be dependent on particular threshold conditions that need to be met (Escobedo et al., 2011). Hysteresis refers to processes with significant time lags between a driving force and a corresponding change in an ecosystem. Points of no return refer to permanent regime shifts between different alternative stable states, characterised by modified feedbacks in the system. The unpredictability in the timing or magnitude of such nonlinear changes presents substantial monitoring, modelling and management challenges.

In addition to natural sciences based assessments, social sciences and humanities methods are required in order to understand what ecosystem functions have been or may be considered disservices. Depending on the context of the valuation, different values, norms and attitudes can be involved and different ecosystem services and disservices can be highlighted as the relevant ones. Therefore, it is of utmost importance to be aware of the wide scope of different methods and materials complementing the natural scientific ones (Table 2).

Table 2. Examples of methods and materials related to ecosystem disservices

Type of disservice	**Examples of research methods**	**Examples of data sources**
Aesthetic issues	Interviews, surveys, media and document analysis.	Lay people and experts as informants, documents and records, artistic works, recorded complaints to municipalities.
Safety and security issues	Interviews, public surveys, media analysis.	Social statistics and surveys, crime records, media and social media representations.
Health issues	Epidemiological studies, laboratory tests, field studies.	Health statistics, test data.
Economic issues	Economic modelling, cost-benefit analysis, direct (revealed preferences) and indirect (stated preferences) valuation methods.	Economic statistics, rent levels, property prices, consumer behaviour.
Mobility and infrastructure issues	Traffic and transport analysis, GIS-based research, land-use studies.	Traffic and transport statistics, geographical information systems.
Environmental and energy issues	Life-cycle analysis, laboratory tests, field studies.	Environmental monitoring data, energy consumption.

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What is considered a service or disservice varies over time and space. Therefore, ecosystem services and disservices should be studied by taking the qualities of different local contexts, cultures and population groups into consideration (Lyytimäki and Sipilä, 2009). The inclusion of local knowledge and interaction with people is essential, as the question is fundamentally one of residents' personal values, beliefs and knowledge bases. Local knowledge of disservices should be systematically collected and processed, using public participation methods adjusted for charting the disservices. However, caution is needed also here. For example, shifting baseline syndrome may influence what people view as the normal or preferred state of the ecosystem. Shifting baseline syndrome refers to changing human perceptions of biological systems, due to a loss of experience of past conditions. It can involve generational amnesia, where knowledge extinction occurs because younger generations are unaware of past conditions, or personal amnesia, where knowledge extinction occurs as individuals forget their own experiences (Papworth et al., 2009). As a result, perception of disservice may be as a result of lack of knowledge of normal functioning of the ecosystem.

Citizen science provides promising opportunities for reducing the cost of labour and data intensive monitoring and research (Dickinson et al., 2012). Citizen science is also a particularly promising approach because it is expected to provide legitimate and more socially robust knowledge, increase awareness of environmental problems, empower citizens to participate and increase their scientific literacy. Volunteer engagement is also associated with improved science-society-policy interaction and more democratic research and governance. Citizen science approaches have been widely used to monitor environmental changes and to chart ecosystem services. New digital tools offer novel platforms for collaboration and present new features for interaction that may be utilised in the assessment of disservices as well.

Comprehensive assessment of ecosystem disservices is obviously an interdisciplinary task. Interdisciplinary expertise is needed not only to cross the boundaries between natural and social sciences but also to cross the boundaries between different sub-disciplines. In many cases, transdisciplinary expertise capable of integrating academic and lay knowledge is required in order to fully utilise all available data and to avoid unnecessary gaps in knowledge generation, leading to better management decisions (Lyytimäki and Petersen, 2014). A transdisciplinary approach may also prove highly useful for the appropriate utilisation of the research results. Early-phase participation by stakeholders decreases the risk of misunderstandings, increases the possibilities for efficient uptake of research results and gives important possibilities for incorporating local tacit knowledge into the assessment. Inclusion of lay knowledge can also increase trust and social cohesion and lessen the likelihood of legal challenges.

Criteria for frameworks for assessing ecosystem disservices

Conceptual frameworks are needed to guide the selection of data and methods aimed at assessing ecosystem disservices. Good conceptual frameworks improve the organisation and analysis of information and minimise the risks of gaps in analyses and assessments.

Such frameworks range from theoretically informed and detailed ones to practically oriented heuristics and rules-of-thumb aimed at providing useful general-level guidelines. So far the research on ecosystem disservices has been characterised by the lack of robust conceptual frameworks.

Various criteria exist for a good conceptual framework. On a general level, they should include identification of the socio-ecological system, anchor the assessment in theory, provide an organisational structure, help to identify relevant information and data gaps, ensure comparability and facilitate communication with the public and decision makers. Importantly, they assist in judging what issues should be categorised as ecosystem disservices (Shackleton et al., 2016). In any case, a good framework should provide a basis for structured and consistent practice aimed at operationalising the data collection, analysis and knowledge utilisation.

A good conceptual framework helps to identify the relevant scale for the assessment. Choosing the relevant spatial and temporal focus requires case-specific tailoring, taking into account both the ecological and governance contexts. For example, urban trees can create habitats for species that cause harm far outside urban parks. Birds or rodents taking shelter in urban parks might search food in rubbish bins and litter the environment outside the park area, a squirrel falling into a water tower can induce health epidemics affecting whole city, and migratory birds nesting or resting in an urban park may cause inconveniences in distant countries. Such instances of harm may remain unnoticed if the assessment is confined to solely the park area.

Because of the dynamics of socio-ecological systems, the services and disservices are also temporally variable. Diurnal, lunar and annual cycles influence what kind of services and disservices are produced by ecosystems, and social cycles influence how they are encountered and experienced. One of the distinctive characteristics of the modern urban environment is the complete or partial absence of natural cycles of diurnal and nocturnal time. Some ecosystem disservices are a result of disturbance caused by night-time lighting. For example, garden lights with certain spectral compositions strongly attract insects and potentially increase the risk of vector-borne diseases such as malaria (Longcore et al., 2015). However, the urban population in affluent societies is accustomed to continuous night-time outdoor illumination and may perceive natural darkness as unnatural and scary. This partly explains why urban night-time forests and parks are often perceived as unpleasant and unsafe, especially by women.

Conceptual frameworks describing ecosystem disservices should include both physical and social aspects in order to produce a realistic and policy-relevant overall picture. Perceptions of dangers lurking in a dark park can be social constructs with little or no correspondence with actual security risks. Furthermore, the origin of such risks can typically be found within human behaviour rather than ecosystem properties or functions. However, this does not mean that such risks are any less real for the people suffering from them. Even in cases where such risks fall outside of the concept of ecosystem disservices, they may be highly relevant for urban green management, as public opinion of urban parks and trees can be strongly influenced by culturally shaped and emotionally charged perceptions.

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A conceptual framework clearly defining the key concepts and their relationships is a prerequisite for successful communication and interaction. As shown by the examples presented above, different things may be referred with the terms such as ecosystem services or disservices. A lack of a common vocabulary between different actors is a key factor making interdisciplinary knowledge production and green urban planning and management complicated and prone to misunderstandings.

Only a few conceptual frameworks specifically aimed at the integrated analysis of both ecosystem services and disservices exist, but various conceptual frameworks have been developed in order to organise the assessment of ecosystem services, spanning from general level check-lists to more complicated and nuanced frameworks. Some frameworks are aimed at harmonising global level assessments while others are adapted to certain unique contexts. Conceptual frameworks focusing specifically on the management of ecosystem services have also been developed (Primmer et al., 2015). The need to study trade-offs between different ecosystem services has been increasingly acknowledged (Hauck et al., 2013). In addition to this, there is a need to study the trade-offs between services and disservices and between different ecosystem disservices. Importantly, in order to anticipate and avoid unwanted surprises, the conceptual framework should also help to identify potential synergies between different ecosystem disservices.

Figure 1 presents an example of a simple conceptual framework, the aim of which is to comprehensively capture the different dimensions that should be taken into account when assessing ecosystem services and disservices. This integrative and holistic framework highlights the role of human individuals both as biological creatures with evolutionary developed physical capabilities and as social creatures with technological and cultural assets emergent from ecosystems (Tapio and Willamo, 2008). The framework differentiates between the major categories of intrapersonal, interpersonal and non-human factors. First, personal psychological and physiological factors determine how urban trees are valued and what effects they may have on individuals. Second, interpersonal social factors include the relationships between urban green areas and the social lifestyles of urban residents. Cultural factors concern urban green areas as part of urban history and place-based identities. The economic factors include both direct and indirect monetary benefits and costs of urban green areas. The legal and administrative factors involve the status of urban green areas in management practices. Third, the ecological sphere, including fundamental bio-geo-chemical processes, is the basis for other spheres and the origin of ecosystem services and disservices.

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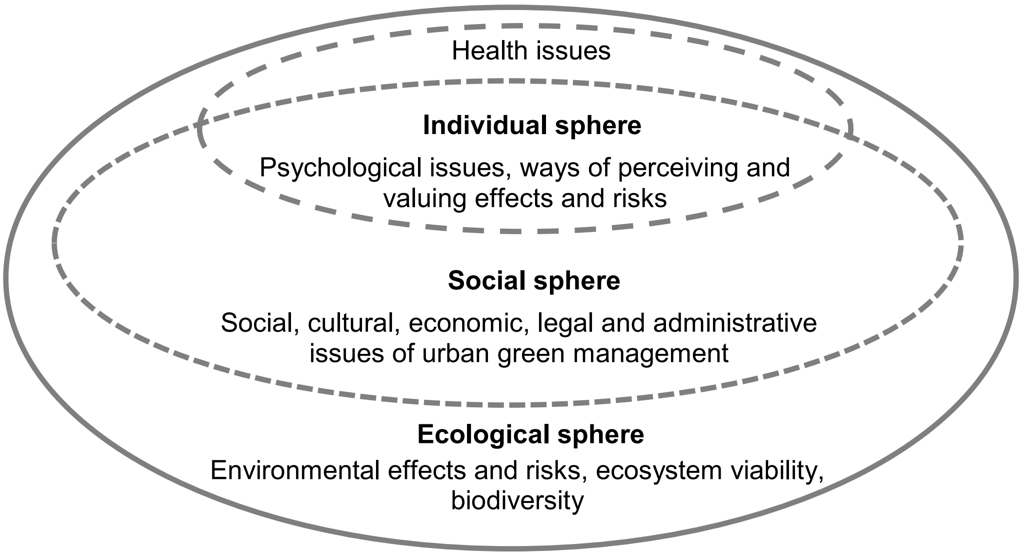

Figure 1. A simple conceptual framework for holistic assessment of urban tree disservices, differentiating between three main spheres (modified from Tapio and Willamo, 2008; Bezák and Lyytimäki, 2011).

Simplified conceptual frameworks may be useful for scoping the overall situation or for overall assessments performed with limited resources. They may also help decision-making by providing easy-to-use heuristics and check-lists (Huutoniemi and Willamo, 2014). However, more detailed frameworks are needed for in-depth assessments. Figure 2 presents an example of a framework aimed at assessment of both ecosystem services and disservices in urban green settings (Escobedo et al., 2011). The framework assumes that an ecosystem service or disservice is a result of a certain ecosystem function based on a particular ecosystem structure and composition of biodiversity. Context, scale and heterogeneity determine whether a particular end product of an ecological system is a service or disservice. The context refers to different uses of urban forests and trees by different people living in different surroundings. Scale refers to the relationship between the size of urban green area and the value of a particular ecosystem service or disservice. It also refers to the importance of taking into account a broad range of economic, social and temporal scales. Management intensity refers to different requirements for management posed by different urban ecosystems, ranging from artificial green walls or roofs to naturally grown urban trees.

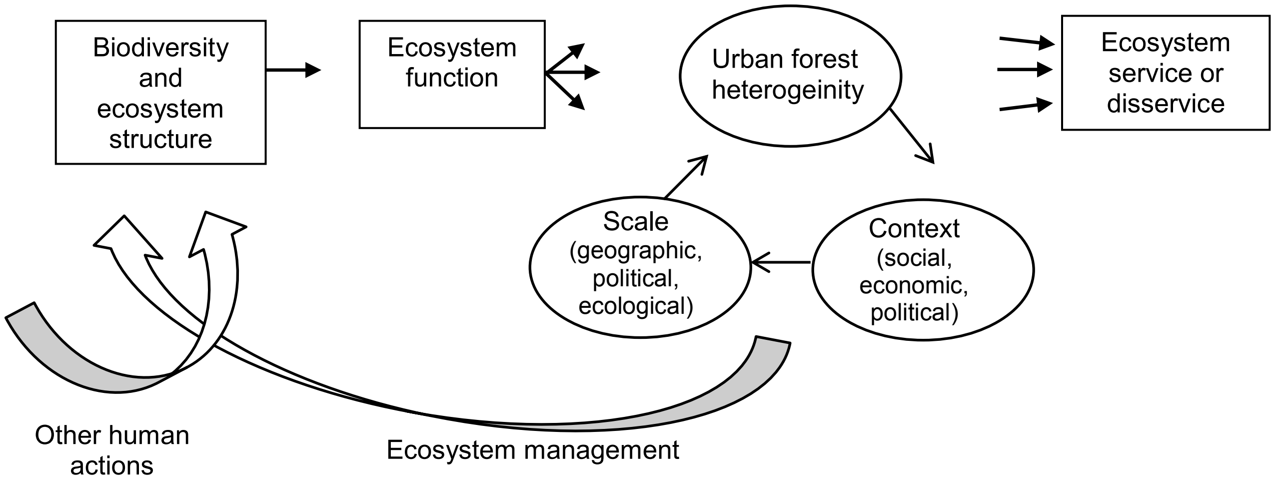

Figure 2. An example of conceptual framework focusing on identification of urban ecosystem services and disservices and their management (modified from Escobedo et al., 2011.).

Wide applicability is a key criterion for a good conceptual framework. However, aiming for a universally applicable framework for ecosystem services and disservices is a task plagued with difficulties because of the multi-faceted and dynamic nature of the socio-ecological systems. This problem is even more pressing regarding procedural frameworks aimed at guiding the utilisation of information. Procedural frameworks can be built based on experiences gained from elsewhere, but they must be adapted to the specific context in order to be able to take into account the different decision-making situations and knowledge needs. As noted by Rinne and Primmer (2016), rather than aiming for a universally applicable analysis, operationalisation of the ecosystem services approach requires case-specific customisation and deliberative co-operation between parties involved.

Factors influencing the management of disservices

All classifications of ecosystem disservices are inherently value-based. What is counted as harmful may differ widely depending on the context of the valuation and the person making the valuation. Age, gender, personal experiences, knowledge level, social settings and cultural background influence people's preferences. For example, density of the vegetation is one of the key features influencing how parks and other green areas are valued, however people of different ages, genders and levels of physical fitness may prefer different densities of vegetation. The tall and leafy trees that are appreciated by many pedestrians may cause annoyance to some pedestrians or to the residents of nearby houses if their view is blocked by the trees. Shading provided by a tree may be highly valued in an urban community located in a tropical climate but not in an urban community located in a cold climate zone.

Successful urban green management must be sensitive not only to different but also changing perceptions from different social groups. Both culturally shared expectations and personal beliefs change over time. Ignorance can swiftly turn into disgust or acceptance when new knowledge of ecosystems is obtained, and new ecosystem disservices may be encountered as a result of changes in urban biodiversity, or due to changes in human perceptions and knowledge alone.

Expectations regarding urban trees are often contradictory. In some cases people may have opposing views as to whether a certain ecosystem function is providing a service or disservice. For example, information about new bird species invading an urban park may be welcomed by a bird watcher but not by those who are concerned about bird excrements potentially forestalling the use of the park. The visiting history can also make a difference: frequent visitors to urban green areas may be more tolerant of disservices associated with urban trees than infrequent visitors would be (Baur et al., 2012).

To make management even more complicated, urban trees typically produce both services and disservices, and their timing, intensity and extent may vary substantially. Some of the disservices may be considered irrelevant or of negligible importance, when compared with ecosystem services that make it possible to fulfil basic human needs such as breathing, eating or resting. However, even minor disservices may become important when considered in relation to everyday practices of urban people in affluent societies. For example, aesthetic discomfort that is not a direct threat to the survival of urban resident can still raise demands for management options that are detrimental to urban biodiversity and ecosystem services, such as demands for intensively managed, artificially illuminated, largely paved and barren green open spaces.

In some cases the best management strategy for minor ecosystem disservices is to learn to tolerate them. In other cases, disservices may cause more serious harm, but they should be tolerated nevertheless because of bigger, related benefits. For example, less intensive urban green management may provide savings in terms of public resources and lead to higher urban biodiversity. However, uncontrolled growth of natural vegetation in urban green spaces may be perceived as an undesirable lack of control (Skandrani and Prévot, 2015). In such cases the key challenge for urban green management is to create adequate public and policy awareness about the relationship between ecosystem services and disservices.

Careful assessment of ecosystem services and disservices helps with their management by giving clear advice as to whether it is the ecosystem or the human behaviour that should be altered. Interactive and participatory approaches are important for understanding and influencing public reactions. However, it should be noted that both the exclusion of public opinion and the uncritical inclusion of resident voices may pave the road for urban green mismanagement.

Even though ecological conditions and the political and societal background to planning and management activities differ considerably across the world, there are some grounds for building commonly shared approaches. Some key trends, such as urbanisation, are advancing throughout the world, and global environmental changes such as climate change require globally coordinated countermeasures. Globally adopted information and communication technologies create opportunities for internationally shared cultural influences that are likely to create more uniform expectations of urban nature.

Media representations, such as high-quality nature documentaries focusing on rare and exotic species in wild natural surroundings, may increase appreciation of nature, but there is also a risk that people may devalue ordinary everyday landscapes, or even perceive them as a disservice. High quality digital representations of nature can encourage people to stay inside in order to avoid the less desirable aspects of real-world nature experiences, including possible exposure to stinging and biting insects or to unpleasant odours, noise, and sights (Lyytimäki, 2012; Stanley et al., 2015). On the other hand, wireless communication and technologies in the realm of augmented reality provide unforeseen opportunities to make the benefits of urban trees more visible to the people visiting urban parks. The challenges and opportunities for urban green management are manifold.

Conclusion

The current debate around ecosystem disservices can be criticised as ahistorical, as it takes the framework of ecosystem services as an explicit reference point. Both concepts are relatively recent ones, but their roots extend deep into history. It can be maintained that the concept of ecosystem services emerged partly as a response to traditional view of nature as wild, dangerous and unpredictable – something to be tamed, cultivated and even eradicated (Cronon, 1996). Against this background, the concept of ecosystem services can be seen as highly useful in highlighting our profound dependence on ecosystem processes and goods. However, research and management focusing solely on ecosystem services may also produce unwanted results by creating overly optimistic expectations of the capabilities of urban trees and ecosystems to improve human well-being and generate other benefits.

The aim of the concept of ecosystem disservices is not to critique but to complement the concept of ecosystem services. It is intended to bring balance to the assessment and management of urban trees, urban green areas and other ecosystems. Therefore, assessments of ecosystem disservices should always be conducted in an integrated manner, also taking into account the services produced by the ecosystem and the social settings of the people involved. This brings forth many challenges as services and disservices may unfold during different temporal and spatial scales and they may affect urban dwellers different ways.

Further research is needed in order to comprehensively map the ecosystem services in relation to the disservices produced by urban trees. Urban ecosystem disservices can be best managed by focusing both on the bio-physical aspects of ecosystems and on the ways in which people perceive and value ecosystem functions. Instead of maximising the gross amount of urban ecosystem services, the aim should be to find the optimal balance between services and disservices, taking into account the whole life-cycle of urban trees.

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