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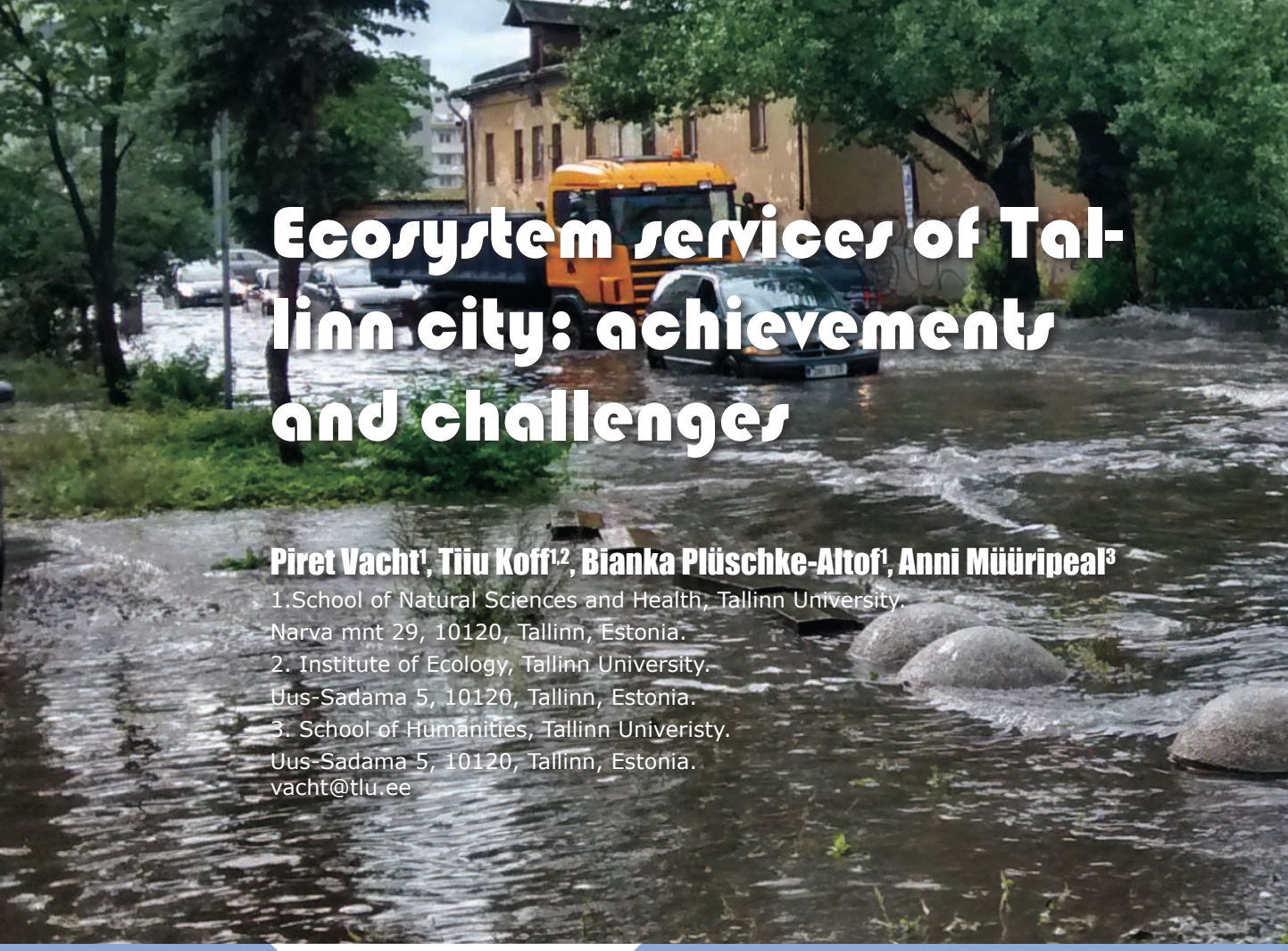

Ecosystem services of Tallinn city: achievements and challenges

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Abstract

Worldwide the process of urbanization is putting increased pressure on the ecosystems of cities. Serving as vital ecosystem service providers that benefit the ecological functioning and human well-being in cities, urban ecosystem are however highly dependent on socio-spatial developments taking place in these urban areas. The case is no different with Tallinn. Based on document analysis and activist research this article gives an interdisciplinary overview of the central ecosystem services offered by the capital of Estonia and discusses major achievements and challenges of the field of ecosystem service provision. As a result it shows that on one hand, the city's ecological conditions are generally favorable to diverse biota and miscellaneous habitats and that numerous steps have been taken by Tallinn city, NGOs and other entities to improve ecosystem services. On the other hand, ecosystem service provision is challenged by the intense urbanization of Tallinn urban area over the last decades causing problems for the socio- spatial development – such as urban sprawl, densification, intense population growth, changed demographics and an inhibited environmental awareness (due to the estrangement from nature) – which affect not only the quantity but also the quality of Tallinn's ecosystem services.

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Seaside south of Kihnu Island. Photo by Anatole Danto, Kihnu, 2018.

Key words

Ecosystem services, Tallinn, urban ecosystem, urban green commons, green spaces, densification, usability, accessibility.

Introduction

An urban ecosystem, such as the ecosystem Estonia's capital Tallinn, is composed of its species, including humans, environmental variables and the complex relationships between them. Defining clear boundaries for an urban ecosystem is difficult because its functioning as well as the relevant fluxes and interactions needed for its functioning extend far beyond administrative borders (Elmqvist et al., 2013).

In the literature, the ecosystem services concept is broadly defined as "the benefits people obtain from ecosystems" (Millenium Ecosystem Assessment, 2005). The concept can also be used as a way to operationalize the complex human-nature relationships influencing socio-ecological decision-making (Evans, 2018). Both, the ecosystem characteristics as well as the socio-spatial

developments in the city, including the attitudes and actions of its dwellers, affect urban ecosystem services (Wilkerson et al., 2018). As shown in figure 1, four main categories of ecosystem services can be differentiated: supporting, provisioning, regulating and cultural (Millenium Ecosystem Assessment, 2005). Against the backdrop of the majority of people already living in urban areas (The World Bank, 2017), it is important that also city environments provide these services. Urban ecosystems are especially important in providing *regulative services* with direct impact on human health and security such as air purification, noise reduction, urban cooling, and runoff mitigation (Bolund & Hunhammar, 1999). But cities also offer *supporting services* by providing habitats for biodiversity. *Provisioning services*, while not the most predominant in most urban areas, are vital as well, providing cities with goods such as local food and water. Social and cultural values are most directly associated with *cultural ecosystem services,* and may include place values, sense of community and identity, physical and mental health, social cohesion, and educational values (Chan et al., 2012).

Figure 1. Overview of Ecosystem Services (authors' illustration) (p. 124).

Based on the concept of ecosystem services, the paper gives an interdisciplinary overview of central ecosystem services offered by Tallinn. Although analytically distinct, different types of ecosystem services are often provided by the same components of urban ecosystems. In this paper we therefore emphasize the interlinkedness as well as the socio-economic and ecological contextuality of ecosystem service provision in Tallinn. Moreover, building on a document analysis of major policy papers and reports (for an overview see references) and an activist research approach that acknowledges the long-stand involvement of the authors in co-shaping ecosystem service provision in Tallinn, the paper aims to discuss major achievements and challenges the city of Tallinn is facing while trying to preserve and enhance the quality and quantity of its ecosystem services. On the case of urban green spaces as ecosystem providers, it will conclude with recommendations for further research.

As ecosystem services are very dependent on the local context, the upcoming section will introduce the ecological, socio-economic and spatial conditions of Tallinn. This will be followed by sections giving an overview of the city's ecosystem services and the achievements and challenges in its provision. Finally, the article will illustrate the interlinkedness of ecosystem services and the contextuality of their provision on the concrete case of urban green spaces.

The ecological and socio-economic context of Tallinn's ecosystem services

Tallinn is located in the northern part of Estonia, at the Gulf of Finland and has the surface area of 159,3 km^2 (figure 2). The city is characterised by diverse landscape (klint, forests, coast, meadows, reed fields, rivers, lakes) with heterogeneous biota and biotopes that also serve as habitats for rare species.

Figure 2. Map of Tallinn (Tallinn web map, 2018) (p. 125).

The most prominent land form of the natural environment is the klint escarpment of the Baltic Klint (the highest point at 48 m above sea level). Areas protected by nature conservancy make up to 13.8% of Tallinn's area. This includes areas in the Natura 2000 network of protected areas, which cover up to 8.2% of the territory (Tallinn City Enterprise Department, 2018). The major green areas of Tallinn are the parks in the historical bastion zone around the Old Town; the baroque Kadriorg Park founded by Tsar Peter the Great in 1718, Tallinn Botanical Garden and Zoo as well as the Open Air Museum in Rocca al Mare.

The city can be characterized also by abundance of blue space: Lake Ülemiste (area of

9.8 km^2) is located near the center of Tallinn and extends to the city's administrative border and from the north the city is surrounded from one side by the Baltic sea. Due to this Tallinn has typical maritime climate. The annual average temperature in Tallinn is 7.5 °C, annual relative humidity is 81% and annual average precipitation is 590 mm (Estonian Environmental Agency, 2015).

The biodiversity in Tallinn is influenced by the abundance of mosaic-like landscapes and communities and it is possible to encounter animals, birds and plants in Tallinn that have become rare elsewhere in Europe. The vegetation of Tallinn has developed together with a strong and diverse anthropogenic impact. Communities can be characterized by eutrophication, instability of community development and the large percentage of horticultural plants (Tallinn City Planning Board, 2008). The vegetation can be characterized by a high phytomass (about 12.3 t/h) that varies significantly in comparison of different city districts, high overall species diversity and high number of invasive species (Tallinn City Planning Board, 2008). At least 2500 plant species have been registered in Tallinn (Tallinn City Planning Board, 2008). About 93.3% of the total phytomass is composed of woody plants. These grow naturally or have been planted, and in total 1275 taxons can be found, about 480 taxons of these are trees. The most common species is pine *Pinus sylvestris*. The gardens of Tallinn have around 200 000 fruit trees, about 85% are apple trees. Natural vegetation and soil is preserved only in the unbuilt areas, especially on the outskirts of town. Therefore, the soils today vary from Technosols, strongly affected by anthropogenic inputs, to mostly quite young but naturally developed Leptosols, Podzols and Gleysols (Estonian Land Board).

Tallinn has habitats where protected plant species e.g alpine mouse-ear *(Cerastium alpinum)*, wedgeleaf saxifrage *(Saxifraga adscendens)*, fringed pink *(Dianthus superbus)* and alpine meadow-grass *(Poa alpina)* grow. Also 14 species of wild orchids (39% of total wild orchid species in Estonia) have been found in Tallinn. The diversity and abundance of animals varies from district to district but in general is considered high. For example red fox (*Vulpes vulpes*), pine marten (*Martes martes*), roe deer (*Capreolus capreolus*), northern bat (*Eptesicus nilssonii*) and European viper (*Vipera berus*) are common in many areas. A large number of European-wide and nationally protected bird species nest in Tallinn. For example over 233 bird species have been encountered in the Paljasssaare conservation area (129.3 km^2), located in the northern part of Tallinn, among them e.g. Bean Goose (*Anser fabalis*), robin (*Erithacus rubecula*) and Sand Martin (*Riparia riparia*) (Tuule et al., 2006). While the biodiversity of Tallinn's soils, that gives information about the functionality of soils, has been studied (Mäe, 2015; Vacht et al., 2018), the results still do not have a good coverage of the entire city, meaning more research in this field is needed.

The sea has greatly influenced Tallinn's socio-economic development as well as its natural environment. This centre of the Hanseatic League with a strategically beneficial location for trading gained its town privileges as long ago as in 1248. As a jewel of medieval architecture, the Old Town earned the recognition as a UNESCO World Heritage site in 1997.

The development of Tallinn during the 20th century was strongly influenced by the Soviet occupation, for example extensive nationalisation of land and redistributed ownership. Due to this, Tallinn became an industrial city characterized by a pulp and paper mill, phosphorite industry, industrial boiler plants and a large number of factories in the city centre. The city's large-scale residential construction spanned from the 1960s to the 1980s. During this time also the public transport network consisting of four main modes of public transit (buses, tramcars, trolleybuses, and trains) was established. Driven by the restoration of Estonian independence in 1991 the major industrial air polluters and water consumers

were shut down and most of the areas covered by them have been since redeveloped. The same time most of the lands nationalised during the Soviet occupation were returned to the former owners or privatised, which was followed by another construction peak in the second half of the 1990s. All of these events strongly influenced the spatial development and land use of Tallinn. Estonian local authorities, including Tallinn, generally only gained ownership of the land under the existing social infrastructure and street network, and city parks. This is why Tallinn owns very little land intended for other purposes. Nowadays the municipal land constitutes less than a third (37.6%) of the land ownership and most of it is covered by public roads and social infrastructure (Tallinn City Enterprise Department, 2018). Likewise, most of the living spaces (97.7%) are in private ownership (Tallinn City Government, 2018). This sets significant restraints for land use planning.

As of 1 October 2018, Tallinn had a population of 452 652 (Tallinn City Government, 2018). Population in Tallinn has increased by 25% over the last 15 years. The birth rate in Tallinn has increased more than in the rest of the country and natural population increase has been positive since 2006 (Statistics Estonia, 2018). Like the rest of Estonia, Tallinn, has an aging population with more people aged 65 and older than aged 0-14 (Statistics Estonia, 2018). Ethnic composition of the population of Tallinn is in 2018 53.3% Estonians, 37.5% Russians, 3.4% Ukrainians and 5.8% other nationalities (Tallinn City Government, 2018). Approximately one third of the Estonian population lives in Tallinn and it contributes almost a half (49–50%) of the Estonian GDP (Tallinn City Government, 2018).

As the trends in other cities, also in Tallinn the exponential growth in car ownership, with increase from 265 passenger cars per 1000 inhabitants in 1995 to 530 in 2016 (UNECE, 2016). The continuous car ownership growth is backed by lack of metropolitan-scale planning, lack in integrated land use and transport planning, poor public transit connectivity and insufficient investment in urban design that would promote walking (Sevtšuk, 2016). A higher number of cars have caused several problems, as the traffic accounts for the majority of the Tallinn's carbon emissions.

To promote the public transport, the city has implemented public transport lanes and priority system, and offers free journeys for the city residents. Since the beginning of 2013, the public transport in urban buses, trolleybuses and trams is free for the residents of Tallinn and since October 2013, Tallinn's registered residents have also been able to use trains free of charge within the city limits. Despite these endeavours, the proportion of the population that use cars as the main mode of mobility between home and work has increased both in Tallinn, from 35% in 2000 to 48% in 2017, and its suburbs, from 40% in 2000 to 64% in 2016 (Jüssi, 2018). In the beginning of 2018, Tallinn City Municipality confirmed and published the Tallinns' Bicycle Strategy, with the goals of increasing the percentage of bicycle use to 11% to all inhabitants of Tallinn and to 25% for mode of mobility between home and school (Tallinn City Bicycle Strategy, 2018).

In the General of Tallinn, that is the basis of City District development plans that in turn are basis for planning and building permits, current green infrastructure is marked and reserved for potential future motorways (Tallinn City Planning Board, 2001). These areas have the geographical and spatial characteristic of connecting inner city areas with outer city areas, which makes them valuable both as a way of connecting fragmented green areas and potentially serving as motorized vehicle arteries. This conflict of interest, access to nature vs access to the city, has been sharpened by the increased pressure of car-oriented mobility. An example of this conflict is the Reidi Road project, currently under construction. A socially active seaside green area (Cerrone, 2016), was declassified from being a part of Kadrioru park (Estonian Environmental Board, 2016b) and currently a two-plus-two traffic lanes road is being built on the area.

Tallinn's ecosystem services: major achievements and challenges

In the following we will give an overview of the main ecosystem services in Tallinn based on the analytical divisions between provisioning, regulating, cultural and supporting services outlined above (figure 1). For each service, the main achievements and challenges will be outlined and major initiative introduced.

Provisioning ecosystem services

Lake Ülemiste (area of 9.8 km^2) provides the city with 88% of its drinking water (Tallinn City Enterprise Department, 2018). The rest of the city uses local groundwater for drinking water. While the water is pumped mostly from the city territory, this provisioning service relies on the ecosystem services provided also outside the cities administrative boundaries: the filtering capacity of the surrounding permeable land, back-up water bodies and their ecosystems. The quality of drinking water from both sources is in accordance with the EU drinking water directive (Tallinna Vesi, 2017). There are, however, some problems with the quality of water in Tallinn city water system, mainly due to old and corroded pipes which may lead to the increase of iron in the consumable water.

Since 2011 there have been several campaigns, one of them called "Tapwater is drinking water!" that inform people about the high quality of tap water and encourages both the people and restaurants and other public enterprises to offer tap water as drinking water. Also some public tap water stations have been established to make it more available for people in outdoor public space. However, the total number of public tap water stations should be increased and also water stations should be places that can be accessed throughout the year, to improve availability.

Historically, Tallinn has rented land for citizens for growing vegetables and fruit at least since the 1920s. The largest urban gardens were located at the time in the areas that consisted of suburban of apartment buildings (e.g. Pelgulinn). During the Soviet era, new type of rental garden patches, cooperatives, were founded. Most of these were located outside of Tallinn. While some pilot studies were carried out already in 2007-2008 (Tint & Robal, 2009), the city of Tallinn has been actively experimenting with urban gardening since 2016. Today, Tallinn has about 2000 ha of private gardens, which makes up about 12% of the city territory (Tuhkanen et al., 2018). Many of those gardens grow some products. There has been no collection of data, how much or what kind of food is grown, therefore it is difficult to assess how large its impact as provisioning ecosystem services is. According to NATTOURS survey (Tuhkanen et al., 2018) about 31% of citizens in Tallinn grew fruit, vegetables or herbs. Most grew food on their balcony (48%) or home garden (38%). Currently the percentage of people who grow food in community gardens (or rental garden patches) is low, only 3%. The demand for food related provisioning ecosystem services can be identified through the increasing interest in growing your own food: roughly a third (35%) of the people who did not grow vegetables, fruit or herbs the year before, would like to do so (Tuhkanen et al., 2018). Providing people with the possibility of growing at last a part of their own food is a challenge for the city.

Most areas outside of the old town region in Tallinn are well suited for growing food, as they once were meadows and farmland. Due to lack of a complete soil pollution map on Tallinn, in areas where there is suspicion of pollution or where the humus horizon is too thin raised beds with off-site soil together with compost should be used for growing food. Food safety is generally not an issue in Tallinn if the main principles are followed: root vegetable should not be grown in polluted soils and leafy greens should not be grown in areas with high air pollution or washed very thoroughly (Tint & Robal, 2009). Some pilot studies from various parts of Tal-

linn have been conducted by the students of Tallinn University to study the properties of soils in urban wastelands (e.g. Mäe, 2015; Soo, 2017; Täll, 2017). These show that most of the analysed sites are not polluted by heavy metals (Riigi Teataja, 2010). Some have also analyzed the content of heavy metals in the food grown in these areas (Täll, 2017). These preliminary results have proven the food safe to eat even though grown in the vicinity of heavy traffic (Täll, 2017). Research is ongoing to prove the safety of locally produced foods.

With its miscallenous landscape and diverse plant communities large areas of Tallinn can be used for beekeeping. Several private gardens have bee-hives, there are two also on the rooftop of Tallinn University and probably the most famous beehives of Talinn are located in the garden of the Office of the President of the Republic of Estonia. Besides providing honey, bees offer together with other insects an important ecosystem service - the pollination of plants.

Regulating ecosystem services

For Tallinn water flow regulation and runoff mitigation is becoming more important as the increase in impermeable surface area in the cities reduces the capacity of water to percolate in soils, increasing the volume of surface water runoff and thus increasing the vulnerability to water flooding (figure 3). This falls under scope the regulating ecosystem services provided by the city's ecosystems.

Figure 3. Example of rain water caused flodding in Tuukri street, Tallinn (Kapanen, 2014) (p. 131).

One of the objectives that the city has set with its strategic plans and projects is a reduction of the proportion of water-resistant surfaces in car parks and yards, and increasing the proportion of green areas, however this aim is proving difficult to achieve. Currently the share of water-permeable surfaces is 63% and ca 71% with the inclusion of water bodies (blue areas). 9% of the territory of Tallinn is covered with buildings, while other paved surfaces (mostly car parks, streets) cover 19%. In the city centre, however, paved surfaces cover 65.3%. Immersion of storm water into the soil has been required where possible instead of its direction into the sewerage system. A planned solution to reducing the area of paved surfaces is to build car parks inside new buildings. However, with recent road developments and densification of the city center, while not officially researched, it is doubtful that the number of paved surfaces has been successfully decreased.

An important measure to limit the area of impervious surfaces is stipulated in Tallinn's Construction Regulation (Riigi Teataja, 2017) which imposes a minimum green area for a property based on its surface area. This requirement is observed in area management plans, detailed zoning plans and design specifications. It is a separate question requiring additional research whether these requirements and attempts for controlling water flow are sufficient to mitigate potential climate change related extreme weather events.

The coastline of Tallinn has six regions (in total 1,7 km^2) that are prone to floods. These areas are included in the area management plans of city districts, and taken into account when plans and projects are processed. Measures are prescribed for these areas to avoid flood damage, and these are considered when areas of buildings and other sites sensitive to flood damage are planned. According to the city, the flood risk is taken into consideration when planning and proceeding projects. Risk reduction and mitigation methods are used in the projects that are located within these regions. Here again, further research is needed to prove the sufficiency of these planning and regulation methods.

Tallinn is currently one of the European capitals with the cleanest ambient air. According to the World Health Organisation (WHO, 2014) Tallinn is one of the 500 cities with the

cleanest air in the world. Yet this is not due low volume of pollution emitted by the city and its dwellers, but the fact that Tallinn is a coastal city, where good circulation of air generally prevents the emergence of high concentrations of pollutants. Tallinn's ambient air quality reflects the great societal changes in recent history. Estonia regaining independence in 1991 brought with it the restructuring of the economy, shutdown of polluting industries and a decrease of emissions from point sources. At the same time, air pollution from the traffic increased. In Tallinn the main pollutants are fine particles PM_{10} and $PM_{2,5}$, ozone, NO_x, SO_2 and CO. The air quality level in Tallinn has significantly improved over the years (Estonian Statistics, 2018) and the pollution levels constantly remain under the limits imposed by the European Union (EU Directive 2008/50/EC).

Tallinn's extensive green spaces and diverse foliage help bind fine dust and preserve the ambient air quality. A more than 150-year old zone of parks surrounding the Old Town helps to bind the air pollution in the city centre area. Tallinn maintains over 35.31 km^2 of public green areas, comprising 22.2% of its territory (Tallinn Environmental Board, 2016a). Urban green spaces and their role as ecosystem service provider is discussed further in the following chapter.

Cultural ecosystem services

The ecosystems of Tallinn also offer various cultural ecosystem services which are also interlinked with other types of services often provided by the same system. Tallinn has improved the recreation and nature education possibilities at the coastline that has was inaccessible during the Soviet times by building bird watching towers, marking down hiking- and education trails. The most notable areas for these activities are Paljassaare that is one of the Natura 2000 sites and Pääsküla bog that is under local protection since 2014. However, the coastline accessability is also today under threath by building- and road developments. Figure 4 describes a case study of beetapromenaad, an grass-root achievement on coastline accessabilty. Also there are five public beaches with good water quality in Tallinn offering the inhabitants recreational services. While the satisfaction survey of 2006 indicated that 76% of residents were satisfied with the status of coastal areas, this indicator had increased to 94% by 2013 (Eesti Uuringukeskus, 2013). Pirita and Pikakari beaches were awarded the internationally recognised Blue Flag eco-label between 2014 and 2015.

Figure 4. Case study of beetapromenaad (Facebook Group "mereTallinn//seaTallinn" and Instagram #beetapromenaad) (p. 133).

Estonian Environmental Agency together with Tallinn University created in 2014-2015 a digital platform and application for digital discovery trails that offer educational activities all over Estonia. In Tallinn there are nearly 30 digital learning trails (https://keskkonnaharidus.avastusrada.ee/et) offering a chance to independently discover the city's nature. These nature education trails are suitable for various education levels (Väljataga et al., 2017). This means that besides the city's actions on improving nature education opportunities in Tallinn also other entities play a significant role in this.

Supporting ecosystem services

Supporting ecosystem services such as habitat provision and biodiversity are largely provided by the green areas of Tallinn. The following chapter focuses on the role of urban green spaces as ecosystem service providers in more detail together with the achievements made and challenges the city is facing in relation to urban green spaces.

Role of urban green spaces in providing ecosystem services

The term urban green spaces refers to the diversity of greenery in the city, incl. urban forests, parks, allotment and community

gardens, brownfields, green roofs and street greenery. All of these elements are important providers of ecosystem services (Elmqvist et al., 2013) offering regulating (air purification, noise reduction, temperature regulation, stormwater runoffs), supporting (habitats for biodiversity), provisioning (especially on the emerging field of community gardening) as well as cultural services (i.e. recreation). As a result, it is urban green spaces that crucially contribute to the well-being and health of city residents (Elmqvist et al., 2013). They therefore provide a vivid example of how various ecosystem services are interlinked, but also of the specific local context in which service provision can take place and/or is inhibited.

The green spaces of Tallinn (figure 5) comprise of large landscape protection areas (incl. Pirita river valley, Aegna island, Nõmme-Mustamäe landscape reserve), the bird protection area on Paljassaare, and about 70 parks and other forms of green spaces (e.g. yards and graveyards). During the last decades, many green spaces in the center of Tallinn were reconstructed and new ones created with Pae Park in Lasnamäe district being the most prominent example. This former limestone quarry is now the site of a 22 ha park. By making use of Tallinn's brownfields (also known as wastelands or urban wilderness, see: Atkinson et al., 2014; Mathey et al., 2018) that cover about 7% of the city territory (Karro-Kalberg, 2011), Pae Park has added to the diversity of the district's green spaces as well as the quality of life in the adjacent residential areas. The largest share of Tallinn's green areas is however comprised of forests (31.2 km^2 ha) out of which the majority is either under state or local protection and maintained according to a management plan. In recent years, more and more forests have been accommodated to encourage outdoor physical activities of city dwellers by creating bicycle paths, health tracks, picnic sites, disc golf courses and outdoor gyms.

Figure 5. Thematic map of green areas of Tallinn (Tallinn City Planning Board, 2008) (p. 135).

Supporting services: habitats for biodiversity

Despite Tallinn's great ecosystem potential due to the various landscapes and recent investments in green space (re)constructions, green areas have been heavily affected by human impact, which has reduced habitat diversity (Tallinn City Planning Board, 2008). As a result, well-established communities as well as communities typical of nutrient-poor habitats have disappeared. Large areas are covered with a mixture of ruderal- and horticultural plants. On sandy soils, that are normally habitats for dry boreal and boreal heath forests the mixture of evergreen and broad leaved forest is common. Some areas are affected by erosion of soil surface and compaction of soil due to trampling or vehicle use. Large wetland habitats, especially bogs sensitive to eutrophication, have transformed due to draining and peat extraction, air pollution and sewage water. Most of the natural communities have been affected by human influence which has resulted in the loss of many naturally existing species. Parts of the garden city districts have distinct communities containing fruit trees and decorative plants, vegetables are not grown in large quantities but in some areas these garden habitats can be very diverse. The diversity of trees in Tallinn varies greatly between city districts, indicating the concentration of more species for example in the Kesklinn district and less diversity in Lasnamäe (Tallinn City Planning Board, 2008). The amount of trees in the city is, however, in decline, mostly due to rise of densification. In the past 35 years about roughly 250 000 trees have been cut down from the housed areas and cemeteries, planted trees only make up about one quarter of that number.

Zooming in to the individual species protection level, the city has many ecosystems that are habitats for rare species and has taken measures to improve their habitat conditions. For example the Habitat Directive has organized mowing and grazing of overgrown coastal meadows in such a way that it

improves the habitat conditions of the large copper butterfly *(Lycaena dispar),* protected orchid species as well as the feeding and resting conditions of open-habitat birds. Under the leadership of the Tallinn Environmental Office, Scottish mountain cows were brought to Paljassaare's bird conservation area (figure 6) to help restore species-rich coastal meadows. In order to protect other species, the control of invasive species is being carried out annually. Thanks to this, the spreading of invasive hogweed *(Heracleum)*, which covers about 3.4 ha in Tallinn, is now under control. Tallinn also has plans to become a part of the Pesticide Free Towns network in the near future, which will benefit many species, including humans, in the city.

Figure 6. Case study of Laagna Aed community garden (Lasnaidee, 2018) (p. 136).

Next to the reduction of vegetation and greenery, the main challenges for habitat diversity are connected to the lack of green infrastructure or corridors that enable animals to move to other green areas. In most city districts, the protecting and maintaining of such green corridors has been problematic as fragmentation of green spaces continues due to the ongoing building and road developments. Moreover, green space planning has been very focused on human needs and benefits, but less on the habitat improvements for other species. For example, there have been several campaigns for placing birdhouses in Tallinn's parks, but little attention is paid on the later maintenance of these habitats or analysis of potential ecological trap creation. Also in some regions that are expected to increase in their inhabitant size in the next decade (e.g. Kalamaja district), there are no plans to significantly increase the quantity or quality of green spaces. This points to a more general clash of interest that surrounds the topic of biodiversity, as biodiversity is often weighed against issues of green space usability for human recreational needs and landscape aesthetics. While biodiversity preservation would often call for more 'wild' natural habitats, concerns for usability and aesthetics often result in rather 'polished' green spaces that could inhibit biodiversity. These contradicting interests have also been acknowledged in other urban contexts (Sooväli-Sepping, 2017).

Regulating services: air purification, noise reduction, temperature regulation, and stormwater runoff

Because trees and vegetation are essential for air purification, carbon capture, habitats, mitigation of the heat island effect and stormwater runoff, it is vital that the city finds ways to reduce the above mentioned losses. One of the methods Tallinn uses to reduce the impact of tree felling is the obligation of replacement-planting for building projects that take down valuable trees. The number of trees that should be planted depends on the felling value class, reason for felling and the diameter of the tree. However, this method does not require the trees to be planted in the same area, potentially leaving some districts without replacement vegetation and provision of ecosystem services provided by those trees (e.g habitats for birds, air purification, noise reduction, stormwater mitigation etc., see: Karro-Kalberg, 2017). Also, while this method considers most green spaces, brownfields as the most biodiverse urban landscapes (e.g. Bonthoux et al., 2014) do not fall under this regulation (Riigi Teataja, 2013).

The city of Tallinn has also recognized the noise reducing effect of urban greenery and vegetation, which are demonstrated in the recently updated strategic noise maps. Even though these have initiated action plans for a further reduction of environmental noise (Leemet & Vohta, 2018), there are no studies analyzing the effects of the green space decrease as result of ongoing real-estate and infrastructure developments and which effect it has on the noise level.

Beyond that, urban green spaces as well as blue spaces (i.e. surface waters within the

city) offer temperature regulation services. Blue spaces cool down the surrounding air by evaporation and convection (Spronken-Smith et al., 2001), green space vegetation offers shade, absorbs heat from the air through evapotranspiration (particularly when humidity is low, Hardin and Jensen, 2007), and provides areas and surfaces for water to evaporate (Givoni, 1991). The presence of urban heat islands has been estimated in Tallinn using satellite imagery with a thermal channel (Roose et al., 2015). The results indicate that green spaces in the city suffer under the heat sunshine to a tangibly lesser extent (up to +5 ° C) than areas with high-rise buildings or industrial and commercial areas. High-rise residential areas in Tallinn (Lasnamäe, Õismäe) as well as industrial and commercial areas have a leap of temperature of over 15°C. This means temperatures above + 45 / + 50° C during hot summer days (Roose et al., 2015). A detailed spatial picture of these islands' location within the city and where extreme temperature jumps occur require however further studies and more detailed statistics for public health.

Tallinn is not geographically and climatically ideally located for fully taking advantage of green roofs and their potential as regulating service providers e.g. as stormwater runoff. As of 2016 there is roughly 3500 m^2 of green roof surface in Tallinn (Salu, 2016). On average the depth of the soil surface on these roofs is less than 15 cm which means that mostly these are extensive green roofs (Salu, 2016). These roofs help to reduce stormwater runoff by roughly 1200 m^3/year (Salu, 2016) which is only about 0.02% of total urban stormwater (AS Tallinna Vesi, 2004). Also costs on heating are lessened thanks to these roofs and in some extent air pollutants are removed by green roofs (Center for Neighborhood Technology, 2010). In Tallinn green roofs are mostly established to enhance the visual appearance or for eco-branding the building. Due to the elevated building and maintenance costs of intensive green roofs (soil layer >15 cm) they are not prefered by developers. Intensive green roofs would offer ecosystem services in larger volume (Center for Neighborhood Technology, 2010). Motivating the establishment of more intensive green roofs and increasing the area covered with extensive green roofs especially in the densified urban areas that have had severe losses of green spaces is a challenge.

Cultural services: provision, accessibility, quality, usability

At first glance the provision of urban green spaces in Tallinn looks quite satisfactory. That about 27% of the city area are covered with greenery, which makes per capita 90 m^2 of public green areas and 207 m^2 of areas with vegetation (Tuhkanen et al., 2018), indicates a fair situation in terms of green space provision. Tallinn green spaces are host to many cultural and sport-related outdoor events offering a large variety of cultural ecosystem services. The most popular of them, the festival of Wandering Lights ("*Valgus kõnnib*") takes place every year in September in Kadriorg, in one of the largest and most representative city parks. By filling green space with various light installations, the festival offers a fresh angle on the park - and a reason to spend time in nature. However, when taking a closer look, next to regulating and supporting ecosystem service provision also cultural services of green spaces point to room for improvement.

Green space statistics show a rather good access to urban green areas as 81.1% of the residents of Tallinn and 68.1% of the residents of the city centre live within 300 metres of the nearest green urban area larger than 5000 m^2 (Tallinn City Enterprise Department, 2018). Many residents also use their gardens as green areas. Yet, the city faces tangible challenges in terms of a decline and inequalities in green space provision. Environmental strategy documents verify a continuous decline of areas with green covers in Tallinn (Tallinn Environmental Board, 2013b; 2016a; Environmental Protection Strategy 2013-2018): between 2005 and 2012 for example by 2.8 km^2 or 13.6 m^2 per inhabitant (table 1).

Table 1. Green space decline in Tallinn. Source: Tallinn Environmental Board, 2013a (p. 139).

To a large extend, this reduction is the result of a regional polarization and centralization in Estonia, where more and more people move to Tallinn urban area. This development has largely come at the expense of green spaces, either in the surroundings fostered by urban sprawl or in the city center that is becoming more densified. Both trends - urban sprawl and densification - resulted in losses of green spaces for real-estate construction (Tallinn City Planning Board, 2008; Kangur, 2015). This points to a problematic market value of green spaces, which are often treated as expandable land resource for building activities (*ibid*., Republic of Estonia Ministry of Environment, 2005). Next to their decline, the provision of public green spaces is inhibited also by the uneven spread among city space. As indicated in Figure 5, large areas with vegetation can be found in Kesklinn, Nõmme and Pirita districts (where also city forest are located), while in Põhja-Tallinn (especially Kopli and Kalamaja boroughs), Kristiine and Lasnamäe publicly available vegetated areas are less than 35 m^2 per inhabitant. This means that there are wide areas in the city, where reachable parks in 300 m to 1000 m distance are missing or the access to them is inhibited. Limited access to the recreational benefits provided by green spaces thus impacts the lives of around 60 000 city inhabitants (Tallinn City Planning Board, 2008; Tallinn Environmental Board, 2013a,b).

Next to the quantity and equal access, the provision of cultural ecosystem services also depends on the quality of green spaces. While the city has invested into the built infrastructure of green spaces, especially playgrounds and outdoor gyms (Tallinn Environmental Board, 2010), their usability for different age groups is still limited. This especially concerns possible (physical) activities for the elderly and teenage residents (ibid.). These are however, next to mothers with small children, the main user groups of green spaces in Tallinn (Järv et al., 2006). The lack of (age-)suitable activities also shows in the usage purposes of green spaces, where "spending free time" makes up for only 9%. More popular purposes are walking, transpassing and waiting for somebody, which renders the average stay in green spaces rather short: between 15 and 30 minutes (ibid.). It is therefore a challenge to improve green space quality in a way that enables also the groups today not fully benefiting from the ecosystem services of urban green space to find reasons to visit these areas more often and find activities that lengthen their stay thus increasing their well-being.

Another factor influencing the quality of green spaces is related to their accessibility, physical as well as social. The challenge of accessibility with different modes of transportation (public transport, car, bicycle, by foot and with walking aids) has been pinpointed in several strategic documents, incl. the most recent green network planning guide (Kutsar et al., 2018). This also points to the general issue of walkability in Tallinn, which directly influences possibilities to access green spaces for recreational purposes. Social accessibility entails questions of the image that green spaces prevail to people: do they feel safe, are these spaces dominated by certain groups (thus exclusive to others) and what level of care do they portray (incl. problems of littering and vandalism)? Next to physical accessibility, these social aspects crucially influence the cultural ecosystem service provision. While there is a general awareness of these issues (Kutsar et al., 2018; Tallinn Environmental Board, 2007), social aspects of green space use (and non-use) need a more thorough investigation.

Provisioning services: community and private gardens

Another type of green space, community and private gardens, enable the production of local food. While there is a long history of gardening in Tallinn, only in recent years,

the city has been actively promoting urban gardening. In 2017 Tallinn city government introduced an urban gardening mapping application (gis.tallinn.ee/linnaaed/) to locate people who are interested in community gardening and to find out where these people would like gardens to exist at. Also a timeline for creating community gardens was compiled. There has been so far few advances based on the information gathered and following the timeline. However, an urban gardening project manager's position has been created at the city´s Environmental Board, which creates hope for new advances in this field in the future. While several smaller urban gardens have been piloted in the past few years, the so far the most successful community garden Laagna Aed was established in 2018 in Lasnamäe district (figure 7). Several NGOs have been established that aim to promote or practice of urban gardening Tallinn.

Figure 7: Extracts of photos of the Laagna garden from the https://lasnaidee.ee/ site (authorization from the NGO Lasnaidee) (p. 141).

The main challenges in this field are proving that the food grown in Tallinn is safe to eat, improving awareness about both the safety and benefits of growing your own food. As for creating new community gardens, the most difficult aspect is finding the land that is both suitable and available for creating a community garden.

Conclusion

Green areas are important part of the urban ecosystem as they help to increase human well-being, provide room for activities and offer various ecosystem services. Due to anthropogenic processes (e.g. urbanization, densification), improving the quality and quantity of ecosystem services by better management and planning, is critical to socio-ecological sustainability (Wilkerson et al., 2018). Socio-economic factors shape the quantity and quality of green spaces and their ability to provide ecosystem services through management and planning decisions (Wilkerson et al., 2018). The challenge in preserving the supporting ecosystem service quality and quantity greatly lies in preserving and enhancing all types of urban green spaces today offering miscellaneous habitats for diverse biota. Besides improving and creating new habitats, while avoiding the creation of an ecological trap by better planning and maintaining green corridors, also the response diversity of these communities should be knowingly improved to increase the resilience of these ecosystems. In conclusion, while many of the aspects influencing the provision of ecosystem services have been addressed in Tallinn, many of these achievements are still not enough to improve ecosystem service quality and quantity. Also dealing with green space use through increasing environmental knowledgeability is vital for both conservation of green space and enhancement of green space quantity and quality. Many challenges are still ahead, from local issues like spatial planning in accordance with ecological conservation principles and demographic shifts (e.g aging population) to global challenges of climate change related extreme weather events.

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REFERENCES (p. 142)

Entrance of the Ilumetsa meteorite impact geomorphosite in south-eastern Estonia (photo : Anne-Marie Meyer, 2018).