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Urban horticulture and ecosystem services: challenges and opportunities for greening design and management

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Urban horticulture e servizi ecosistemici: sfide e opportunità per la progettazione e gestione del verde urbano

Riassunto. La crescente urbanizzazione, abbinata al grave ed inarrestabile fenomeno del consumo di suolo, ha comportato negli ultimi anni la forte necessità di una più attenta e lungimirante gestione dell'ambiente urbano per il conseguimento di livelli qualitativi accettabili in una logica di effettiva sostenibilità delle risorse ambientali. Il comparto produttivo "ortoflorofrutticolo" svolge un ruolo importante nelle politiche e strategie operative di gestione accorta e virtuosa delle realtà urbane, nella prospettiva di corretta scelta ed utilizzazione della vegetazione per poter fornire una pluralità di fondamentali servizi ambientali e culturali a favore della società. Si tratta al riguardo, dei cosiddetti servizi ecosistemici, definiti come i benefici che derivano all'uomo dal complesso degli ecosistemi naturali e degli agroecosistemi. Su questi temi si è avviato un vivace e proficuo dibattito in ambito accademico e nella società civile sul ruolo e importanza dell'orticoltura urbana nell'assicurare alle popolazioni urbanizzate molteplici servizi ecosistemici, anche nella prospettiva di meglio comprendere le sfide e le opportunità future in termini di sviluppo realmente sostenibile dei sistemi urbani. L'obiettivo del presente lavoro è di offrire una panoramica ampia e approfondita dei principali concetti e problematiche attualmente oggetto di discussione nel campo dai servizi ecosistemici. In particolare, sono stati analizzati gli studi condotti nei paesi sviluppati in contesti urbani con un approfondimento ai temi più innovativi e promettenti rappresentati dalle infrastrutture verdi. Sono riportati esempi di recenti ricerche che dimostrano il ruolo multifunzionale delle aree verdi urbane nel fornire cibo, nell'assicurare elevati livelli di biodiversità, nel provvedere a servizi di impollinazione, nel mitigare il cambiamento climatico, nel gestire in modo sostenibile ed avveduto l'acqua, la qualità dell'aria ed, infine, nel garantire l'istruzione e il benessere della popolazione. Sono inoltre suggerite linee guida per la pianificazione e la progettazione del verde urbano.

Key words: aree verdi, soluzioni nature based, biodiversità, impollinatori, benessere.

Introduction

The XXI century fixed the birth of a new paradigm for cities planning, design and management: the multifunctional role of the green infrastructure was recognized and became a goal to be achieved for all the cities in developed and developing Countries. The urbanization and land consuming, together with the growth of people living in and around cities, enhanced the need to take care of the quality of the urban environment. Since 1990s, scientists started working on urban ecosystem, urban ecology, and urban nature. New methods and indicators were developed outlining that the quality of urban green spaces is one of the key factors for improving the quality of life in such dense urbanized environments. Horticulture plays an important role in this contest assessing the scientific principles in defining what, where and how plants must be used in order to provide a multiple range of services for the society.

In Europe, the Millennium Ecosystem Assessment (MA, 2005) set up the Ecosystem Services (ES) concept with the aim of assessing the consequences of the ecosystem's change on human well-being. The document outlined strategies for the future by focusing on the importance of urban environment due to its precious ecological and environmental functions. ES are defined as the benefits that humans derive from ecosystems. They support directly or indirectly our survival and quality of life. Healthy ecosystems are the

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foundation for sustainable cities, influencing and affecting human well-being and most economic activity (TEEB, 2011). According with the MA, ES are divided in four categories: Provisioning, Supporting, Regulating, and Cultural.

The urban ecosystem of each city is composed by a different combination of green points, lines and areas of different dimension, age and species composition. The green infrastructure involves the soil, water and air matrixes, which must be studied using a holistic approach. Creating healthy and resilient cities, integrating the urban ecology principles into design and management actions, is recommended (McDonnell and MacGregor-Fors, 2016).

The aim of the paper is to debate on the application of the ecosystem services approach in urban horticulture, discussing on challenges and opportunities for future sustainable urban greening design and management. Examples of recent research experiences will be reported.

In order to assess the multifunctional role of urban greening, a review of papers published in the recent years was done. The authors used the most interesting references under their opinion, for offering an overview of the main concepts and issues under discussion. In particular, studies carried out in the developed Countries, done in urban contests with attention to the green infrastructure and discussing selected ES were analysed.

Urban horticulture and ecosystem services

Urban landscapes are the everyday environment for the majority of the global population: since 2015 almost the 80% of the Europeans lives in urban areas. The continuous growth in the number and size of urban areas poses great challenges for ensuring human welfare in cities while preventing an increasing loss of biodiversity. Urbanization affects ES in terms of habitat loss, habitat fragmentation, stormwater management, water and air pollution and loss of cultural values. In the following paragraphs will be discussed: food provisioning; pollination and biodiversity supporting; climate change, water management and air pollution regulating; and cultural ES.

Provisioning

Agriculture plays a key role in managing the peri-urban landscape and the social, aesthetic and environmental functions of urban metropolitan areas. Agroecosystems provide food, fiber and fuel. In the process of producing such goods, however, they depend on numerous support and regulation services, such as soil fertility and pollination (MA, 2005). It is therefore necessary to use environmentally friendly and sustainable cultivation techniques, avoiding as far as possible the use of pesticides, integrating soil fertility and biodiversity conservation (Tscharntke *et al*., 2012). In the case of urban environment, urban and peri-urban agriculture has been defined as the cultivation of crops and rearing of animals for food and other uses within and surrounding the boundaries of cities. Community gardens, allotments, backyard gardens, rooftop gardens and urban farms comprehend a multifunctional production activities, and contribute to fresh food availability, as well as to the greening of the cities.

Despite from the land consumption, several studies have pointed out how urbanisation offers new opportunities for the urban agriculture. In particular, the main challenges to deal with are that the consumers increasingly prefer regional production, particularly for high quality, and natural products such as vegetable or ornamental crops. Furthermore, the urban population prefers landscape amenities derived from a heterogeneous and small-scale farm structure punctuated with natural elements (Zasada *et al*., 2011).

In Italy, Bologna has always been at the forefront of urban green management, especially with regard to urban agriculture and horticulture. Mapping and quantifying flat roofs suitable for gardening, Orsini *et al*. (2014) determined that the city has a potential of 82 ha of rooftop gardening surfaces, enabling the annual production of over 12.000 t of vegetables a year, covering the 77 % of the urban vegetable requirement. Also the Turin metropolitan Authorities have been recently involved in several projects in order to improve the quantity and quality of local food production, and to promote an informed consume by citizens. With the idea that urban agriculture can also contribute to reduce the cost of managing urban green areas and to introduce alternative forms of management of public spaces, in 2013 the Turin municipality promoted the project 'Torino città da coltivare' (Tecco *et al*., 2017). The surface of urban gardens in the last five years enhanced up to more than 100 ha (5 m^2/inhabitant) and in 2017, the first report for the urban food strategy was launched (www.atlantedelcibo.di.unito.it). European (Life, H2020, Interreg programs) and Regional research projects are in progress in order to assess the urban strategy for the implementation of the ecosystem services provided by urban agriculture, horticulture and, more in general, green areas.

Supporting: Pollination and Biodiversity

In urban green areas, such as in natural and agroe-

cosystems, pollination is an important ecosystem service in order to provide a good productivity and the conservation of biodiversity. Biodiversity itself is an important driver of ecosystem functions and services. Insect pollination is necessary for crops and wild plant species, and bees are the most important pollinating taxon. Many studies have been conducted on pollinators and pollination services in agricultural systems (Brown and Paxton, 2009; Carré *et al*., 2009), but on the other hand the effects of urban areas are poorly known (Blum, 2016).

In the cities, the high number of closed surfaces, the fragmentation, and the isolation of natural plant populations, influence pollinators and plant pollination, but urban land use can potentially be beneficial to pollinators. Generally, bees need a suitable nesting site and food (pollen and nectar). Concerning nesting, many locations, including soil, pre-existing cavities in walls and other structures, wood and wood substrates, and heterogeneous urban habitats can provide suitable nesting sites for a wide range of bee taxa (Neame *et al*., 2012). Abundance of cavity-nesting species are registered in urban areas while soil-nesting species are scarce (Mazzeo and Torretta, 2015). Urban land contains habitats such as green areas with parks, community and private gardens, allotments, cemetery, ruderal areas, railways. Green roofs can be also used by pollinators as foraging and nesting habitat (Ksiazek *et al*., 2012; MacIvor *et al*., 2015).

Urban areas across all of Europe seem to contain higher levels of biodiversity than unpopulated areas. Surveys of 15 urban and suburban parks in Flanders, Belgium, revealed that the 15 parks contained about 30%, 50%, 40%, and 60% of the total number of wild plant species, breeding birds, butterflies, and amphibians still occurring in Flanders, respectively. Urban parks therefore function as an important reserve of biodiversity in Flanders (Alvey, 2006)

Urban ecosystems can support bees with trees, shrubs, herbaceous plants, flower beds, weeds (Tommasi *et al*., 2004) as well as selected edible plants (Corbet *et al*., 2001). However higher levels of spontaneous species and cultivated plant communities are present, including more exotic species than rural plant communities, that supply floral resources all year long. Moreover, urban sites are often warmer than surrounding landscapes. Extent of green areas, plant species diversity, floral density have positive effects on plant-pollinator interactions (Hennig and Ghazoul, 2012). In addition, green urban areas are rarely treated with pesticides respect to agricultural areas.

Garnbuzov *et al*. (2015), using waggle dance decoding technique, showed that in urban parks and gardens in UK foraging by honey bees was mostly local and within surrounding urban area, indicating sufficient forage nearby and year-round. Most studies on pollination in urban environments focused on the pollinating insects and the diversity and abundance of pollinator communities in relation to urban land use. A review by Hernandez *et al*. (2009) reported that the most of studies were conducted in Africa, Asia, Brazil, Europe, Germany, North America, South America and the United Kingdom, and remnant habitats and managed gardens were studied more frequently than home gardens, parks, or unmanaged sites.

Conversely, some studies comparing urban and suburban areas with agricultural lands revealed that moderately urbanized environments facilitate pollinator persistence. Bumblebee colony growth and nest densities were higher in flower-rich suburban gardens than farmland (Goulson *et al*., 2010) or other types of rural habitats.

Study on the effects of pollen limitation on fruit/seed set production in NY community gardens was carried out (Werrel *et al*., 2009). The results showed that garden size and floral cover influence pollen deposition on cucumber plants enhancing fruit production.

Cussans *et al*. (2010) demonstrated that gardens are beneficial both to pollinators and the process of pollination in UK. Seed set of *Glechoma hederacea* and fruit set of *Lotus corniculatus*, and social bees visiting flowers were higher in gardens than in arable farmland. Visitation rates of *Trifolium repens* by bumble bees in the center of Belgium responded positively to urban land use resulting in higher visitation rates and increased seed set (Verboven *et al*., 2014). The effects of mobile garden used in residential yards in Chicago were evaluated on fruit and seed set of *Cucumis sativus, Solanum melongena* and *Echinacea purpurea* and demonstrated that diversity of wild bees contributed to pollination services within city (Lowenstein *et al*., 2015).

The research group in Turin carried out studies on urban pollination demonstrating that it is dependent mainly on wild bees, while honey bees are less abundant. Recently more honey bees were registered due to a considerable number of honey bee hives placed in the gardens, parks, green rooftops of many towns of the word. In 2014, Vercelli and Ferrazzi analysed the foraging resources of the city of Turin and calculated the potential melliferous yield in public and private green areas. The study highlighted the high amount of bee flora in urban area consisting melliferous plants (i.e. *Acer* spp., *Aesculus hippocastanum, Robinia pseudoacacia, Tilia* spp.), anemophilous

plants (i.e. *Ulmus, Populus, Quercus*), shrubs, herbs and wild flora (i.e. *Taraxacum officinale, Trifolium repens, Salvia pratensis*). This species support honey bees with nectar, pollen and honey dew around all the year and give an opportunity to urban beekeeping, also producing a local monofloral and multifloral honey.

Regulating

Climate change alters the quantity, quality and time of the ecosystem service flows, such as fresh water and food (Ash *et al*., 2010). Healthy ecosystems can reduce the impacts of climate change. The vegetation provides climate regulation services by capturing carbon dioxide from the atmosphere.

Climate change may affect plant growth through different rainfall regimes, increased demand for evapotranspiration and a different season length. It is necessary to study the interactions and impact of the various factors to better understand how ecosystem can be modified in order to achieve the best solutions any time (Runting *et al*., 2017).

Concerning the water management, green areas help to meet the need for water by regulating the water cycle, filtering impurities by adjusting soil erosion. Population growth and economic growth have led to a rapid consumption of water resources, and many natural systems have been replaced by highly modified and man-made systems. In a recent study by Gittleman *et al*. (2017), the benefits of rainwater management in community gardens were analyzed by comparing two methods for assessing the infiltration rates of community garden storms in New York City. Community gardens contribute to retaining millions of liters of water per year. This is closely related to the urban stormwater runoff and flash flooding, that occurs when impervious surface cover increases with continued urbanization. This is a challenge to conventional urban water resource management and requires new ways of thinking about retaining, retarding, and using stormwater within the urban landscape-water sensitive urban design (Livesley *et al*., 2016). Innovative multidisciplinar (planners and designers) approaches suggest to use modular systems combining transportation, drainage and waste processing by capturing, storing and infiltrating stormwater locally. Solutions including bare soil and permeable pavement with size equal to the lateral canopy extension is suggested for water conservation and tree cooling capacity ehnancement (Vico *et al*., 2014).

In terms of cooling effect, street trees, parks, green roofs and green walls can also contribute to reduce the urban heat island (Nortona *et al*., 2015). Increasing temperatures and the risk of heat wave events, like in the last 2017 summer, represent a serious public health problem (Bowler *et al*., 2010). Understanding differences in cooling effects among parks may help urban planners and greening designers to make appropriate decisions regarding species choice, and size and shape of green spaces. For example, recent studies in Mediterranean cities, highlighted that species of *Eucalyptus, Olea* and *Acacia* are more effective in cooling the urban environment than *Cupressus* and *Grevillea* (Feyisa *et al*., 2014). Furthermore, new technologies have been developed using innovative living walls. In particular, Serra *et al*. (2017) showed how modular green vertical systems provide good thermal transmittance values during both the heating and cooling seasons, demostrating that designers could efficiently combine different materials/ species/ technical solutions, according to the goals and expected results (aesthetic value, energy saving, noise reduction, money sparing, etc.).

Regarding air pollution, trees, green roofs and green walls are widely used. In US the amount of annual gaseous air pollution (O_3, PM_{10}, NO_2, SO_2, CO) removed by urban trees and shrubs was estimated at 711.000 t (Nowak, 2006). An European review outlined that the effect of vegetation on urban air quality depends on vegetation design and on level of air pollution in the area. Vegetation should be close to the source and, to improve deposition, it should be hairy and with a large leaf area index (Janhäll, 2015).

Cultural

As defined by MA (2005), the cultural services are the non-material benefits that people derive from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences, including: Cultural diversity; Spiritual and religious values; Educational values; Inspiration; Aesthetic values; Social relations; Sense of place; Values of cultural heritage; Recreation and ecotourism. Cultural ecosystem services are at the interface between nature and culture, tangible and intangible heritage, biological and cultural diversity (Tengberg *et al*., 2012).

Socio-cultural assessment is becoming increasingly important, following the desire to map and shape ecosystem services especially for a stronger political support (Plieninger *et al*., 2015).

Sanesi *et al*. (2006) conducted a study on the perception of green spaces by citizens, showing how they are perceived as essential elements to mitigate heat waves. The citizens have a clear perception of the poor size of the green spaces in their city, and they

underlined the lack of maintenance, especially in peri-urban locations. In addition, women and pensioners pointed out problems related to the lack of security and surveillance, especially during the evening.

Recently, a study carried out in Parco Nord (Milan) suggested a participatory mapping approach for assessing cultural ecosystem services' people perception (Canedoli *et al*., 2017). This method has shown that the local population's perceptions provide a rich basis for the development of sustainable land management strategies.

In addition, it is essential to increase people awareness of biodiversity, highlighting that the richness of species in natural environments deserves to be protected for the benefit of both nature and individuals (Carrus *et al*., 2015).

Andersson *et al*. (2014) emphasized the strong link between Cultural ES, civic engagement and ES management by providing opportunities for education, strengthening the sense of the site, and promoting community building. Furthermore, Somajita and Nagendra (2017) explained how environmental awareness is a dynamic process aimed at increasing our knowledge and knowledge understanding of the environment. The emotional engagement of individuals tends to shape environmental awareness and attitudes, resulting in participation in eco-friendly decisions. School gardens can be a tool for young citizens education (Russo *et al*., 2017).

Conclusions and perspectives

Analysing the recent literature scientists agree that the environmental issues, such as climate change and the loss of biodiversity, have an impact on human health and the contact with a green space is associated with well-being. Otherwise, it is important to consider some potential disservices that green infrastructures can produce. Concerning food provisioning, the risk of consuming vegetables grown on soil contaminated by heavy metals and pollutants, and the use of polluted water caused by fertilizers and chemical inputs are the main problems. The presence of pollutants in bee products, and the problems related to the interaction between bees behaviors and people use of greening are other significant examples. Moreover, the development in the urban environment of invasive plant species can enhance the risk of allergies.

In this context, green spaces do not necessarily improve the health of urban ecosystems or promote biodiversity, but they have to be properly designed and managed (Dean *et al*., 2011). It is necessary to provide human and financial resources in the restoration, protection and enhancement of green infrastructures and ecosystem services in cities both from an ecological and social point of view. Many decisions are made for the purposes of generating benefits for people (Canedoli *et al*., 2017), but at the same time the importance of cultural services and values is currently not recognized in landscape planning and management (Tengberg, 2012). The quantification of ecosystem services must be included in the decision-making processes related to the use and management of urban spaces. The main actions for more livable cities to be applied would be found within the frame of the nature-based solutions.

Guidelines for design and management

In this context, the native species restoration, the use of wildflowers, perennials and shrubs plants, and non-native species, that are not invasive, are needed. Many municipalities have set up invasive species management programs and do not actively plant invasive species (Alvey, 2006). More in general, concerning the plant composition, usually standard palette of common horticultural species for a given climatic zone are used, resulting in stereotype landscape designs and species assemblages. Local botanical-ecological research could be developed to identify, test and extend the use of indigenous plants and botanic gardens could play an important role (Jim, 2013).

Many species can promote biodiversity in cities, having a positive effect also on safeguarding and enhancing pollinators and pollination function. Urban areas can be made more pollinator-friendly, offering consistent refuges and food resources. Some initiative were promote in according of these actions and, in Italy thank to a campaign "Bee-friendly Municipalities", a lot of local authorities has been adopted a set of concrete actions for environmental protection and rehabilitation of territories through the protection of bees and beekeeping valorization (www.coobeerationcampaign.org).

Furthermore, multifunctional networks (greenways, ecological networks, blue-green networks, riverways, and parkways) provide the connectivity in urban ecosystems (Ignatieva *et al*., 2011). The Emscher Park in the Rhur and Rhine Valleys in western Germany provides a successful example of a multifunctional blue-green network (Ahern *et al*., 2013).

In addition, adopting specific urban food strategies in planning agenda for the metropolitan areas, and supporting all the wide range of urban agriculture initiatives can enhance the cities' capacity to provide short alternative food networks and the natural

biophilic attitude in the young generations. Moreover, studies on the adaptation of the urban ecosystem to climate change are required, in order to find solutions for more resilient cities.

In conclusion, raising education, culture and awareness on urban horticulture and ecosystem services topics are the further aim, together with the promotion of monitoring programs in order to gain the quality of the urban ecosystem and citizens well-being. A new planning and design multidisciplinary strategy in cities requires the integration among agronomists, ecologists, landscape architects, urban planners, politicians, and representatives of the civil society using an inclusive approach.

Abstract

The urbanization and land consuming, together with the growth of people living in and around cities, enhanced the need to take care of the quality of the urban environment. Horticulture plays an important role in this contest, defining what, where and how plants must be used in order to provide a multiple range of services for the society. Ecosystem services are defined as the benefits that humans derive from ecosystems. The aim of the paper is to debate on the application of the ecosystem services (Provisioning, Supporting, Regulating, and Cultural) approach in urban horticulture, discussing on challenges and opportunities for future sustainable urban greening design and management. The authors offer an overview of the main concepts and issues under discussion. In particular, studies carried out in the developed Countries, done in urban contests, with attention to the green infrastructure and discussing selected ecosystem services were analysed. Examples of recent researches are reported, demonstrating the multifunctional role of urban green areas in providing food, biodiversity, pollination, climate change mitigation, water management, air quality, education and well-being. Guidelines for planning and design urban greening are suggested.

Key words: green areas, nature-based solutions, biodiversity, pollinators, well-being.

References

Ahern J., 2013. *Urban landscape sustainability and resilience: the promise and challenges of integrating ecology with urban planning and design.* Landscape Ecology 28: 1203–1212.

Alvey A.A., 2006. P*romoting and preserving biodiversity in the urban forest*. Urban Forestry & Urban Greening 5: 195–201.

Andersson E., Tengö M., Mcphearson T., Kremer P., 2014. *Cultural ecosystem services as a gateway for improving urban sustainability.* Ecosystem Services, 12: 165-168.

Ash N., Bennett K., Reid W., Irwin F., Ranganathan J., Scholes R., Tomich T.P., Brown C., Gitay H., Raudsepp-Hearne C., Lee M., 2010. *Assessing Ecosystems, Ecosystem Services, and Human Well-being*. In: Ash N., Blanco H., Brown C., Garcia K., Henrichs T., Lucas N., Raudsepp-Hearne C., Simpson R.D., Scholes R., Tomich T.P., Vira B., Zurek M. ed., Ecosystems and Human Well-Being. A Manual for Assessment Practitioners, Island Press (Washington): 20-52.

Blum J., 2016. *Urban Horticulture: Ecology, Landscape, and Agriculture* CRC Press (Boca Raton, Florida) 330 pp.

Bowler D. E., Buyung-Ali L., Knight T. M., Pullin A.S., 2010. *Urban greening to cool towns and cities: A systematic review of the empirical evidence*. Landscape and Urban Planning 97: 147-155.

Brown M.J.F., Paxton R.J., 2009. *The conservation of bees: a global perspective.* Apidologie 40: 410–416.

Canedoli C., Bullock C., Collier M.J., Joyce D., Padoa-Schioppa E., 2017. *Public Participatory Mapping of Cultural Ecosystem Services: Citizen Perception and Park Management in the Parco Nord of Milan (Italy).* Sustainability 9(891): 1-27.

Carré G. Roche P., Chifflet R., Morison N., Bommarco R., Harrison-Cripps J., Krewenka K., Potts S.G., Roberts S.P.M., Rodet G., Settele J., Steffan-Dewenter I., Szentgyörgyi H., Tscheulin T., Westphal C., Woyciechowski M., Vaissière B.E., 2009. L*andscape context and habitat type as drivers of bee diversity in European annual crops.* Agriculture, Ecosystems and Environment 133: 40-47.

Carrus G., Scopelliti M., Lafortezza R., Colangelo G., Ferrini F., Salbitano F., Agrimi M., Portoghesi L., Semenzato P., Sanesi G., 2015. *Go greener, feel better? The positive effects of biodiversity on the well-being of individuals visiting urban and peri-urban green areas.* Landscape and Urban Planning 134: 221–228.

Corbet S.A., Bee J., Dasmahapatra K., Gale S., Gorringe E., La Ferla B., Moorhouse T., Trevail A., Van Bergen Y., Vorontsova M., 2001. *Native or exotic? Double or single? Evaluating plants for pollinator-friendly gardens.* Annals of Botany 87: 219–232.

Cussans J., Goulson D., Sanderson R., Goffe L., Darvill B., Osborne J.L., 2010 *Two Bee-Pollinated Plant Species Show Higher Seed Production when Grown in Gardens Compared to Arable Farmland*. PLoS ONE 5(7): e11753. doi:10.1371/journal.pone.0011753

Dean J., Van Dooren K., Weinstein P., 2011. *Does biodiversity improve mental health in urban settings?* Medical Hypotheses, 76: 877–880.

Feyisa G. L., Dons K., Meilby H., 2014. *Efficiency of parks in mitigating urban heat island effect: An example from Addis Ababa.* Landscape and Urban Planning 123: 87– 95.

Garnbuzov M., Schürch R., Ratnieks F.L.W., 2015. *Eating locally: dance decoding demonstrates that urban honey bees in Brighton, UK, forage mainly in the surrounding urban area.* Urban Ecosystems 18: 411-418.

Gittleman M., Farmer C.J.Q., Kremer P., Mcphearson T., 2017. *Estimating stormwater runoff for community gardens in New York*. Urban Ecosystems, 20: 129-139.

Goulson D., Lepais O., O'connor S., Osborne J.L., Sanderson R.A., Cussans J., Goffe L., Darvill B., 2010 *Effects of land use at a landscape scale on bumblebee nest density and survival.* Journal of Applied Ecology 47: 1207-1215.

Hennig E.I., Ghazoul J., 2012. *Pollinating animals in the urban environment.* Urban Ecosystems, 15: 149-166.

Hernandez J.L., Frankie G.W., Thorp R.W., 2009. *Ecology of Urban Bees: A Review of Current Knowledge and Directions for Future Study.* Cities and the Environment 2(1): article 3,

15 pp.

Ignatieva M., Stewart G. H., Meurk C., 2011. *Planning and design of ecological networks in urban areas.* Landscape Ecology 7: 17-25.

Janhäll S., 2015. *Review on urban vegetation and particle air pollution - Deposition and dispersion.* Atmospheric Environment 105: 130-137.

Jim C.Y., 2013. *Sustainable urban greening strategies for compact cities in developing and developed economies.* Urban Ecosystems 16: 741-761.

Ksiazek K., Fant J., Skogen K., 2012. *An assessment of pollen limitation on Chicago green roofs.* Landscape and Urban Planning 107(4): 401-408.

Livesley S.J., Mcpherson E.G., Calfapietra C., 2016. *The Urban Forest and Ecosystem Services: Impacts on Urban Water, Heat, and Pollution Cycles at the Tree, Street, and City Scale.* Journal of Environmental Quality, 45: 119-124.

Lowenstein D.M., Matteson K.C., Minor E.S., 2015. *Diversity of wild bees supports pollination services in an urbanized landscape.* Oecologia 179: 811-821.

Ma, 2005. *Ecosystems and human well-being: current state and trends: Findings of the Conditions and Trends Working Group*. In: Hassan, Scholes, Ash (Eds.), Millennium Ecosystem Assessment (MA). Island Press, Washington.

Macivor J.S., Ruttan A., Salehi B., 2015. E*xotics on exotics: Pollen analysis of urban bees visiting Sedum on a green roof.* Urban Ecosystems 18: 419-430.

Mazzeo N.M., Torretta J.P., 2015. *Wild bees (Hymenoptera: Apoidea) in a urban botanical garden in Buenos Aires, Argentina.* Studies on Neotropical Fauna and Environment, 50(3): 182-193.

Mcdonnell M.J., Macgregor-Fors I., 2016. *The ecological future of cities.* Science 352(6288): 936-938.

Neame L.A., Griswold T., Elle E., 2012. *Pollinator nesting guilds respond differently to urban habitat fragmentation in an oak-savannah ecosystem*. Insect Conservation and Diversity 6: 57-66.

Norton B.A., Coutts A.M., Livesley S.J., Harris R.J., Hunter A.M., Williams N.S.G., 2015. *Planning for cooler cities: A framework to prioritise green infrastructure to mitigate high temperatures in urban landscapes*. Landscape and Urban Planning 134: 127-138.

Nowak D.J., Crane D.E., Stevens J.C., 2006. *Air pollution removal by urban trees and shrubs in the United States*. Urban Forestry & Urban Greening 4:115–123.

Orsini F., Gasperi D., Marchetti L., Piovene C., Draghetti S., Ramazzotti S., Bazzocchi G., Gianquinto G., 2014. *Exploring the production capacity of rooftop gardens (RTGs) in urban agriculture: the potential impact on food and nutrition security, biodiversity and other ecosystem services in the city of Bologna.* Food Security 6: 781-792.

Plieninger T., Bieling C., Fagerholm N., Byg A., Hartel T., Hurley P., Lopez-Santiago C.A., Nagabhatla N., Oteros-Rozas E., Raymond C.M., Van Der Horst D., Huntsinger L., 2015. *The role of cultural ecosystem services in landscape management and planning*. Current Opinion in Environmental Sustainability, 14: 28-33.

Runting R.K., Bryan B.A., Dee L.E., Maseyk F.J.F., Mandle L., Hamel P., Wilson K.A., Yetka K., Possingham H.P., Rhodes J.R., 2017. *Incorporating climate change into ecosystem service assessments and decisions: a review.* Global Change Biology, 23: 28-41.

Russo A., Escobedo F.J., Cirella G.T., Zerbe S., 2017. *Edible green infrastructure: An approach and review of provisioning ecosystem services and disservices in urban environments.* Agriculture, Ecosystems and Environment 242: 53-66.

Sanesi G., Lafortezza R., Bonnes M., Carrus G., 2006. *Comparison of two different approaches for assessing the psychological and social dimensions of green areas.* Urban For Urban Greening 5: 121–129.

Serra V., Bianco L., Candelari E., Giordano R., Montacchini E., Tedesco S., Larcher F., Schiavi A., 2017. *A novel vertical greenery module system for building envelopes: The results and outcomes of a multidisciplinary research project.* Energy and Buildings 146: 333-352.

Somajita P., Nagendra H., 2017. *Factors Influencing Perceptions and Use of Urban Nature: Surveys of Park Visitors in Delhi*. Land doi:10.3390/land6020027.

Tecco N., Coppola F., Sottile F., Peano C., 2017. *OrtiAlti as urban regeneration devices: An action-research study on rooftop farming in Turin.* Future of Food: Journal on Food, Agriculture and Society, 5(1): 70 -78.

TEEB - The Economics of Ecosystems and Biodiversity, 2011. *TEEB Manual for Cities: Ecosystem Services in Urban Management.* www.teebweb.org.

Tengberg A., Fredholm S., Eliasson I., Knez I., Saltzman K., Wetterberg O., 2012. *Cultural ecosystem services provided by landscapes: Assessment of heritage values and identity.* Ecosystem Services 2: 14–26.

Tommasi D., Miro A., Higo H., Winston M., 2004. *Bee diversity and abundance in an urban setting*. The Canadian Entomologist, 136(6), 851-869.

Tscharntke T., Clough Y., Wanger T.C., Jackson L., Motzke I., Perfecto I., Vandermeer J., Whitbread A., 2012. *Global food security, biodiversity conservation and the future of agricultural intensification.* Biological Conservation 151: 53-59.

Verboven H.A.F., Aertsen W., Brys R., Hermy M., 2014. *Pollination and seed set of an obligatory outcrossing plant in an urban–peri-urban gradient.* Perspectives in Plant Ecology, Evolution and Systematics 16: 121-131.

Vercelli M., Ferrazzi P., 2014. *Increase of bee flora in public and private green areas: melliferous potential of Turin (Piedmont, Northwest Italy)*. In: Book of Abstracts - 1° Symposium ApiEcoFlora (San Marino) p. 37.

Vico G., Revelli R., Porporato A., 2014. *Ecohydrology of street trees: Design and irrigation requirements for sustainable water use.* Ecohydrology 7: 508-523.

Werrell P.A., Langellotto G.A., Morath S.U., Matteson K.C., 2009. *The Influence of Garden Size and Floral Cover on Pollen Deposition in Urban Community Gardens.* Cities and the Environment 2(1): article 6, 16 pp.

Zasada I., Fertner C., Piorr A., Nielsen T.S., 2011. P*eri-urbanisation and multifunctional adaptation of agriculture around Copenhagen*. Geografisk Tidsskrift-Danish Journal of Geography 111: 59-72.