Sustainable Planning for Peri-urban Landscapes

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1 Peri-urban Landscapes

In the past decades, different typologies of peripheral landscapes have emerged as a result of dynamic processes of urban development and relative change in natural, seminatural, and agricultural areas. Historically, the concept of periphery has expressed a distance (or separation) with respect to a core, in terms of geographic, economic, political, and social factors (Bourne 2000). The addition of new urban agglomerations far from existing poles, the "peripheralization" of areas that had no peripheral characters previously following changes in economic and social conditions (e.g., migration), and the development of infrastructure are the most relevant of these processes. Peripheries have been characterized by particular features such as remoteness, isolation, and harsh natural conditions, but, on the other hand, they could sometimes offer favorable conditions to attract new urban developments.

Among the different types of peripheries, peri-urban contexts are located somewhere in between the urban core and the rural landscape (Meeus and Gulinck 2008) and represent an "uneasy phenomenon" (Allen 2003) to be defined, both geographically and conceptually. Attempts in establishing a comprehensive set of criteria for the definition of peripheral landscapes which make it possible to capture their

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different features (Piorr et al. 2011) are incomplete or not robust enough to ensure transferability to other geographical contexts besides the ones where they have been elaborated. The changing, dynamic, complex, and heterogeneous nature of peripheral landscapes remains irreducible to single interpretations and approaches for their definitions and therefore for their planning and management.

Many attempts have been made to identify and classify peri-urban areas using parameters such as urban centrality, hierarchy, urban–rural relationships, and the degree of urbanity and remoteness (OECD 2002; Dijkstra and Poelman 2008; EUROSTAT 2010). All these research showed the limit of using administrative units such as NUTS levels as geographical units of the analysis, therefore not considering that the spatial extent of peri-urban areas cannot be reducible to administrative boundaries.

For European countries and in the context of the PLUREL project, Zasada et al. (2013) delineated a method to identify degrees of peri-urbanity by using population density of particular classes of Corine land use/land cover and logistic regression models. These authors showed that peri-urban areas occur in the United Kingdom, the Netherlands, Belgium, Northern Italy, Western and Southern Germany along the Rhine valley, and in Southern Poland, mainly within bigger urban conurbations or metropolitan areas.

This chapter outlines the main characteristics and peculiarities of peri-urban landscapes and introduces examples of planning approaches and topics that can be found in current research about sustainable planning. We will refer to peri-urban landscapes as those areas that are partly located outside the more compact part of a city and can spread to the surrounding rural area following low-density patterns of development and covering larger areas than peri-urban neighbors of single municipalities. They are characterized by low density and a mixture of diverse land uses, including non-urban and seminatural uses (Gallent et al. 2006). Peri-urban landscapes represent a diffuse and blurred territory where urban and rural development processes meet, mix, and interact at the edge of the cities.

Being at the edge of cities' limits, peri-urban areas are planned through diverse instruments or schemes: they can be planned by municipal land-use plans regulating the use of the land within administrative border of the municipality (master plans, land-use plans, zoning regulations) or be under the spatial jurisdiction of metropolitan, regional, or landscape plans implemented by regional authorities. This means that peri-urban areas can be planned under diverse planning levels, therefore requiring an appropriate coordination (see section "The need of a metropolitan planning and governance for the peri-urban").

One of the most common features of peri-urbanization processes deals with the progressive colonization of the agricultural and forest landscapes through different land-use changes (Geneletti et al. 2017). Peri-urban areas are progressively acknowledged as areas with peculiar features. Some authors highlight that new functions, not properly urban or fully rural, emerge in these spaces (Korthals Altes and van Rij 2013).

Peri-urban landscapes cannot be understood only in terms a progressive intensification of urban functions in the rural or seminatural environment but rather as a space of "interaction between urban and rural elements" (Rauws and de Roo 2011, in Loupa Ramos et al. 2013).

The following subsections of this chapter introduce and describe different types of peri-urban landscapes, particularly focusing on some categories of forest, agricultural, and other ecosystems that can be found in peri-urban contexts, often highly mixed and intertwined with other human uses of the land. These categories represent general families of landscapes that can be found in peripheral contexts of Europe, where a varied range of mixed land uses and land covers can be observed in areas where the influence of humans is dominant. Despite the urban environment these categories belong to, they refer to particular urban ecosystems characterized by low or null presence of built-up areas. Some particular types of ecosystems, such as private green spaces or domestic gardens (DTLR 2002), will not be included in the previous categories because they are mostly part of urban patches and private owned.

As it will be described, these landscapes are able to provide important functions and relative ecosystem services, such as biodiversity in urban areas, production of O_2, reduction of air pollutants and noise, regulation of microclimates, reduction of heat island effect, and supply of recreational value, and play a fundamental role in health, well-being, and social safety (La Rosa and Privitera 2013; Vejre et al. 2010).

1.1 Peri-urban Forests

In this chapter, urban and peri-urban forests are considered as the most natural ecosystems in an urban–rural context, whose composition, structural diversity, and overall character rely greatly on the demands for (non-monetary) goods and services. An accepted definition of urban forestry is the one based on Miller (1997), who describes urban forestry as "the art, science, and technology of managing trees and forest resources in and around urban community ecosystems for the physiological, sociological, economic, and aesthetic benefits trees provide society." Therefore, urban forestry is strictly related to the positive impacts of trees on human well-being (Fig. 1).

According to Forrest et al. (1999), a range of possible definitions of urban forests have been used in different European countries, demonstrating how the concept and term are open to different interpretations and planning approaches. These definitions highlight once again one of the most important features of urban forest, that is, their ability to connect the human need for the natural environment in urban areas with life support systems of a persistent forest ecosystem. This connection substantially contributes to the well-being of urban societies.

A comprehensive review of definitions of an urban forest is provided in Konijnendijk (2003): in this work the author focuses on the difficulties in finding a shared definition of what is meant by "urban" or "forest." The term "forest," for instance, may be related to its more traditional definition, while in urban areas terms such as "other wooded land" and "trees," used by FAO for its forest resource assessments (FAO 2002), can be particularly more appropriate to describe urban parks, gardens, and street trees. By including small woods, parks, and gardens with

Fig. 1 Benefits of trees in urban contexts (Source: FAO, available at http://www.fao.org/documents/card/en/c/427898a5-e452-4dbb-87ed-4b25286de3b4)

an area size or canopy cover that are below thresholds for “forest,” the traditional forest concept has been broadened considerably.

This definition can be also extended to peri-urban contexts, located between the urban core and rural or (semi)natural surroundings, where the size of forests could be larger but proximity and accessibility by urban residents of the city centers are lower. Peri-urban forests form a kind of mixed system, with higher societal influence on management objectives compared to other sides, but still acting as connective element to rural sites with their demands on classical forest ecosystem services.

Furthermore, as it will be discussed later on, peri-urban forests can suffer from high pressure of urban development or request for further farmland. However, the difference between urban and peri-urban could be very smooth and difficult to be defined, as boundaries of cities are extremely difficult to identify, especially in large or sprawled urban areas or metropolitan regions.

Peri-urban forests are particularly under pressure as they are continuously used for recreation and (non-) monetary provisioning services (mushrooms, berries, hunting, drinking water), while they can supply many regulating ecosystem services (e.g., providing cool, clean, and fresh air to the urban environments, protection against flooding).

As the actor groups in peri-urban forests are much more complex compared to pure urban or rural forests, societal processes can be considered as the key drivers in how intense and with which key objectives peri-urban forest planning and management are conducted. Being part of urban systems, some actors might expect well-designed road infrastructure for hiking, cycling, horse riding, or country skiing and relative good accessibility and the availability of parking space for these activities. This might require, for example, more investments into the nice design of forest edges with more mixed or deciduous tree species and more structural diversity. Indirectly, the increased usage of these forests for recreational activities leads also to more needs for protective measures, for example, against further urban development (see section “Peri-urbanization and sprawl processes”) or forest fires (fire strips). On the other hand, in their more rural context, peri-urban forests are expected to provide also jobs and traditional forest products such as timber (lumber, fuel wood, industrial wood) for creating income and contribute to sustainable rural development. In addition, expectations to conserve a high biodiversity levels are enhanced through the more intense perception of biodiversity from urban contexts.

Urban forest structure is a determinant of ecosystem function, which has been documented as a mean of mitigating environmental quality problems associated with the urban-built environment (Nowak et al. 2006). The structure and subsequent function of the urban forest will therefore determine the provision of ecosystem services and goods (De Groot et al. 2010). Thus, by modifying the structure of the urban forests, as well as their size and composition, planners may be able to modify certain ecosystem functions in order to maximize human well-being in cities. From a planning perspective, peri-urban forests should connect the more rural landscape parts with the rest of the urban green infrastructure to ensure that all relevant cultural and regulating services are sustained (see section “Trace-Gas Driven Ecosystem Services”). On the other hand, disservices from the movement of some species such as foxes, wild boar, or other animals might become an issue for peri-urban residents.

1.2 Farmlands and Peri-urban Agriculture

Agricultural areas, in use or abandoned, are one of the most typical landscapes of peri-urban contexts and can be the result of fragmentation processes due to urbanization pressures (Fig. 2). Agriculture in metropolitan areas contrasts sharply with its non-urban counterpart. As observed by Heimlich (1989), the longer areas are affected by urban pressures, the greater the adaptation they reflect in some farm characteristics. Since these areas are part of wider metropolitan contexts, their

Fig. 2 Example of cultivated vineyards (left 2**a**) and abandoned agricultural terraces (right 2**b**) in Italy located in peri-urban contexts in Sicily (southern Italy)

services assume higher importance for the number of people that can benefit from them (Swinton et al. 2007). In fact, agriculture both provides and receives services that extend beyond the provision of food, fiber, and fuel, so that only in their absence do they become most apparent (Fig. 3). Among the managed ecosystems, farmlands offer special potential because of their variety of generated ecosystem services. This potential arises from both their broad spatial extent and human management objectives focused on biotic productivity (Swinton et al. 2007). At the same time, agriculture offers an important potential to diminish its dependence on external agrochemical inputs by reliance on enhanced management of supporting ecosystem services (Fig. 3).

New Forms of Urban Agriculture (NFUA) are typical in peri-urban contexts and are characterized by high level of multifunctionality and general post-productive attitude (Zasada 2011). Urban agriculture is defined as "the growing, processing, and distribution of food and non-food plant and tree crops in farmlands that are mainly located on the fringe of an urban area" (Zezza and Tasciotti 2010). A growing evidence from empirical and experimental research also suggests that incorporating NFUA into the urban environments may improve the sustainability level of cities, taking advantage of the multiple benefits and services that can be generated.

Urban agriculture is particularly present in developing countries and often produces perishable products such as fruits and vegetables. This type of agriculture

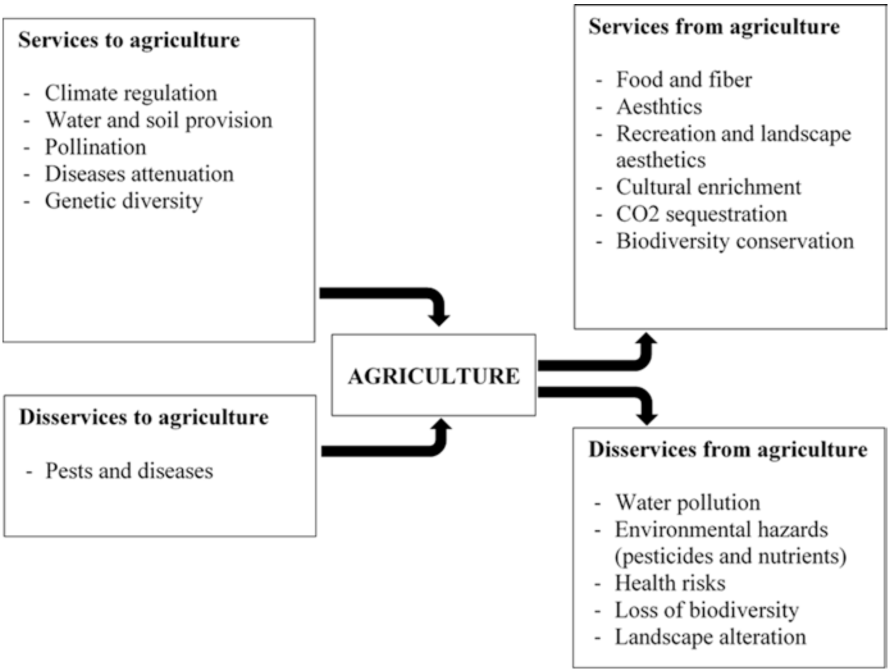

Fig. 3 Main ecosystem services and disservices of agriculture (Modified from Swinton et al. (2007))

meets a local and growing urban demand for food, but it also generates an intensifying conflict "between the maintenance of local agricultural production and the rapid and often uncontrolled consumption of land by growing urban activities and infrastructures" (Aubry et al. 2012).

In China, peri-urban agriculture has also been characterized by the specialization and diversification of traditional agriculture. In the Beijing areas, such NFUA have been mostly initiated by local residents and include agro-tourism, enterprise-based food processing, high-tech agro-enterprises/agro-parks, and farmer collective activities (Yang et al. 2016). In Europe and North America, NFUA are emerging in response to low-density urbanization patterns and aim at producing "local" food as a way to enhance food security by shortening food supply chains (Benis and Ferrao 2017).

A highly differentiated set of NFUA can be found in peri-urban landscapes (La Rosa et al. 2014). Urban farms represent a partnership of mutual commitment between farms and communities of users/supporters which provide a direct and short link between the production of agricultural goods and their consumption. Community-supported agriculture consists of agricultural practices that are directly economically supported by users and communities that take advantage of food produced in the supported farms. They can provide environmental benefits due to an environmentally friendly production process as well as reduced "food miles" thanks to the proximity of production and consumption. Allotment gardens are more oriented to generate social values, including active participation in the management of gardens by particular social groups such as children and retired or unemployed people. Finally, agricultural parks are larger agroforestry systems where food production (mainly by private farms) is promoted and safeguarded along with more general rural and seminatural landscapes. They are public-managed areas that support existing wildlife management and protection and promote the fruition and access of the park, therefore providing important cultural and aesthetics services.

Peri-urban agriculture differs from urban agriculture often practiced by urban residents as part-time activity on available open spaces. Peri-urban agriculture is characterized by small- or medium-sized farms in urban fringe areas, where these farms have to deal with both market globalization and urban urbanization processes (Clark and Munroe 2013). In between globalization and urbanization, peri-urban agriculture is therefore struggling to re-create networks of food provision that are alternative to the global agri-food system that is consumed in cities (Paül and McKenzie 2013).

Farmlands within or near towns are no longer considered simply as reserves of land for future urbanization and are becoming a challenging issue in urban planning that aims at conserving and enhancing productive function and ecosystem services provided by urban and peri-urban farmlands. There are two key concepts that must be kept in consideration by planners when dealing with urban and peri-urban agriculture: the sustainability of the production, both at the farm (internal) and territorial (external) level, and the multifunctionality of the activities achieved by agriculture (Aubry et al. 2012).

1.3 Other Types of Peri-urban Landscapes

Peri-urban landscapes include other forms of seminatural ecosystems, which, in Europe, are mainly made up of shrub and grass vegetation, typical green elements with a limited height of less than 5–6 meters. In Mediterranean areas, shrublands are ecosystems with a long history of grazing by domestic animals, and their biome can reach its maximum extent. Much of these formations are considered a subclimax developed on degraded and eroded soils and maintained in part by fire and goats or sheep. In arid and semiarid areas, such as Mediterranean landscapes, low amounts of rain do not allow for a continuous vegetation cover, resulting in a typically patchy landscape. In addition to their role in plant interactions, shrubs strongly modify plant dispersal patterns by processes such as trapping of water-, wind-, and bird-dispersed seeds (Aguiar and Sala 1999). Thus, they are a key element for community structure and dynamics in semiarid ecosystems, and they act as "hot spots" of diversity in these areas (Pugnare and Lázaro 2000).

In peri-urban contexts, grasslands are habitats that can be present in parks, brownfields, and other derelict land, disused quarries, and along roads or transportation buffers. The type of grassland varies with the geographic features, acidity of soils, and moisture level (dry or damp grassland). They also support a range of grasses and wildflowers, such as grasses, forbs, shrubs, trees, vertebrate animals, and invertebrate animals. Remnant seminatural grasslands, in particular those serving as habitat fragments, are essential to the maintenance of diverse terrestrial arthropod communities in human-dominated landscapes. These temperate biomes are extremely important, as they include diverse and productive terrestrial ecosystems that are among the most threatened in the world, suffering from pressures by urbanization and agricultural processes. In many urban contexts, these areas are often restricted to linear remnants along roads and railways. These linear patches are, however, at a great risk of edge effects that alter vegetation composition by promoting exotic species invasion (Forman 1995). Understanding and mitigating these impacts are of increasing importance for biodiversity conservation in peri-urban areas.

Another important category of peri-urban landscapes are urban lawns, typical and frequent urban biotopes in cities, especially found in urban parks, private gardens, playing fields, golf courses, public places (squares, plazas, etc.), schoolyards, and along streets, roads, and tramways. The presence of lawns is also widespread in private gardens and front- and backyards, especially in suburban areas, where detached houses represent the typical form of urban settlement.

All these types of peri-urban landscapes are particularly sensitive to human activities and continuously under pressure from them. Characterizing the different drivers of changes in peri-urban landscapes can provide relevant information to set up policies aimed at their protection and management.

2 Drivers of Changes in Peri-urban Landscapes

All types of landscapes described in the previous section may provide a complete array of ecosystem services, as also described in chapters “Ecosystem Services From Forest Landscapes: An Overview” and “Ecosystem Services From Forest Landscapes: Where We Are and Where We Go”.

However, peri-urban landscapes have a unique characteristic that makes them highly different from other landscapes: their proximity to or partial inclusion in urban systems makes them particularly vulnerable to pressures by urban development or related activities. Peri-urban landscapes have gone through a series of socioeconomic transitions that have deeply modified their territorial assets and spatial land uses. Particularly, agricultural and seminatural areas have been deeply affected by low-density urban developments. Such developments have fragmented farmlands and seminatural areas, producing not-continuous, low-density, and highly mixed urban patterns.

2.1 Peri-urbanization and Sprawl Processes

Despite a decreasing population in many European countries, urban expansion due to spatial development pressure has been an impressive driver of very high consumption of land and agricultural resources. In the period between 1990 and 2000, at least 2.8% of Europe’s land experienced a change in use “including significant increase in urban areas” (Commission of the European Communities 2006). The European Environment Agency (EEA) has described the process of urban sprawl “as the physical pattern of low-density expansion of large urban areas, under market conditions, mainly into the surrounding agricultural areas” (EEA 2006). It is an urban development process that “separates where people live from where they shop, work, recreate and educate—thus requiring cars to move between zones” (Sierra Club 1999).

Sprawl is the leading edge of urban growth, and it is usually related to limited planning control in land allocation. Urban development is usually patchy, scattered, and strung out, with a tendency for discontinuity. It leapfrogs over areas, leaving agricultural enclaves (Fig. 4). Sprawling cities, the opposite of compact cities, are full of empty spaces that indicate the inefficiencies in development and highlight the consequences of uncontrolled growth (EEA 2006). More recently, EEA has advocated for a reuse of developed land that is not used anymore to address the risks of further sprawl (EEA 2015).

Among all definitions that can be found in the literature, some recurrent terms highlight the main (negative) features of sprawl: “spreading,” “scattered,” “low density,” “car dependent,” “environmental externalities,” and “social disparities.” The externalities and impacts of sprawl on the environment and landscape have been the focus of several studies and include the loss of fragile environmental lands, increases in air pollution and energy consumption, decreases in the aesthetic appeal of the landscape, the loss or fragmentation of farmland and forests, a reduction in biodiversity, increases in water runoff and risks of flooding, and ecosystem fragmentation (Johnson 2001).

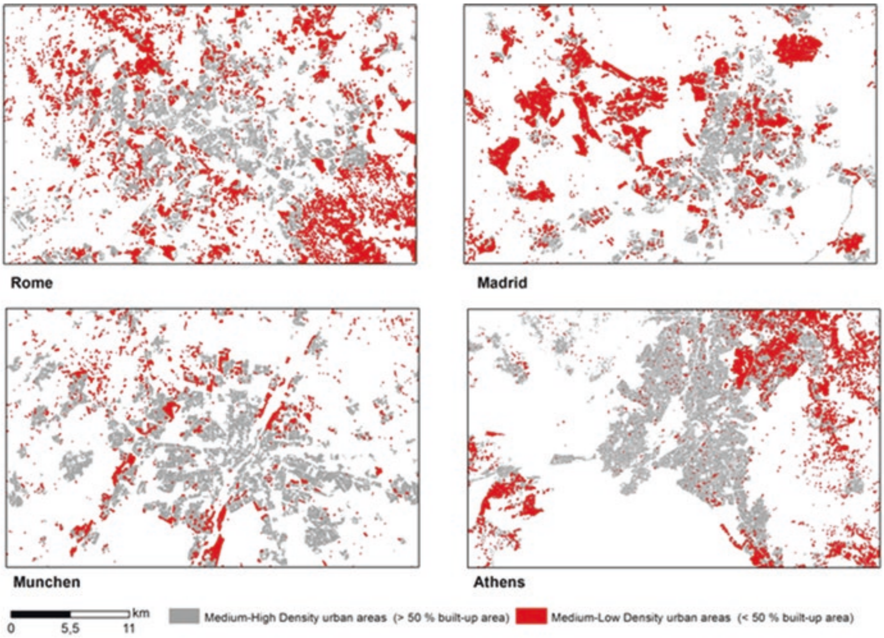

Fig. 4 Low-density peri-urban areas in the metropolitan areas of four European capitals according to 2012 Urban Atlas data (EEA 2015). It can be seen that low-density peri-urban patches are largely the prevailing categories of urban areas when considering the metropolitan contexts

Land sustains many ecosystem functions (e.g., production of food, habitat for species, recreation, water retention, and storage) that are directly linked with existing land uses. Impacts on natural areas are also exacerbated by the increased proximity and accessibility of urban activities to these areas, which in the past were farther from "urban influence." This proximity produces stress on ecosystems and species through noise and air pollution. Moreover, the fragmentation caused by transport infrastructures and other urban-related activities creates significant barrier effects that can degrade the ecological functions of natural habitats. From an ecological point of view, fragmentation can heavily modify corridor spaces for species or can isolate populations by reducing habitats to extend below the minimum area required for the survival of these species. The loss of agricultural and forest land also has major impacts on biodiversity, involving the risk of losing some valuable biotopes for many species, particularly birds.

According to the EEA (2006), in Europe urban development tends to "consume the best agricultural lands, displacing agricultural activity to both less productive areas (requiring higher inputs of water and fertilizers) and more remote upland locations (with increased risk of soil erosion). In addition, the quality of farmlands that are not urbanized but in the vicinity of sprawling cities has also been reduced." The loss of agricultural land is often directly connected to land consumption due to sprawl processes (Thompson and Stalker Prokopy 2009). There are several consequences to this: landscape fragmentation and simplification, loss of biodiversity, decreased agricultural land value, and increased externalities of urban sprawl (Johnson 2001). New urbanizations often occur in proximity to already urbanized areas or existing infrastructure because the price of agricultural land is lower if compared to residential zone land. Agricultural land usually becomes a highly attractive target for investors and urban developers (EEA, 2006). For these reasons, the hazard of loss of agricultural land may be potentially higher in areas close to already urbanized lands or roads. In contemporary metropolitan contexts, rural land and its agroecological features are exposed to dramatic pressures that are driven by the expansion of the urban influence on areas that once were considered as purely rural (Donadieu 1998). In this context, farmlands suffer from a wide range of pressures by urbanization processes. These pressures are physical, environmental, and socioeconomic (EEA 2006).

Urban developments in peri-urban contexts are not continuous and show low-density patterns so that outside the main city, the landscape is characterized by a strong degree of farmland fragmentation and mixes of urban and non-urban uses. The relationship between the agricultural landscape and the city has produced a particular contemporary peri-urban landscape, where residential low-density settlements are mixed with farmlands that have been partially modified and reduced by urbanizations. A low-density settlement has widely become the main landmark of new metropolitan areas.

More and more people in Europe are moving away from the center of metropolitan areas, apparently attracted by the imagined quality of life in these rural settings, to live in residential developments built on converted peri-urban farmlands. “The detached terrace-houses and semi-detached houses condense the new type of residential landscape in the metropolitan peripheries of the cities of southern Europe” (Munoz 2003), and settlements belonging to different municipalities, once far from another, are getting closer and closer and become parts of larger metropolitan areas.

In these new metropolitan areas, the concept of rural–urban fringe, as appeared in the geography and planning literature from the 1930s (Whitehand 1988), is today more and more smooth, and it may be difficult to distinguish what is urban from what is rural. A chaotic set of land uses is “a product of post-war planning legislation that has partly fossilized some patterns of use, but it is also a reflection of dynamic change as certain components of these areas have grown as part of complex and singular developments” (Gant et al. 2011). Moreover, in new metropolitan contexts, rural land and the relative ecosystems are exposed to dramatic pressures that are driven by the expansion of the urban influence on areas that once were considered as purely rural (Donadieu 1998).

What’s left today of the seminatural and agricultural areas in peri-urban landscapes? A different mix in types and sizes of residual and non-urbanized areas deeply characterizes metropolitan landscapes in many European regions, such as farmlands (abandoned or still in use), small orchards, wood and shrub areas, local parks, regional parks, reserves and natural protected areas, and grasslands (Fig. 5).

Gallent and Shaw (2007) identified a number of anthropic land uses in the transition zone from urban to rural of the greenbelts in the United Kingdom: (i) service functions and commercial activities, (ii) noisy and unsociable uses pushed away

Fig. 5 Examples of non-urbanized areas of different types and sizes in peri-urban contexts: agricultural spaces and other non-urbanized areas are intertwined with low-density urban settlements in the metropolitan area of Rome

from people, (iii) transient uses such as markets, (iv) bulk retail, (v) light manufacturing, (vi) warehousing and distribution, (vii) public institutions, (viii) degraded farmland, (ix) fragmented residential development (often centered on road junctions), and (x) areas of unkempt rough or derelict land awaiting reuse. These land-use patterns are very similar to the ones that can be found in other European contexts, with various ranges of size and extent.

2.2 Climate Change

Climate change has been predicted to have many consequences for human health arising from the direct and indirect impacts of changes in temperature and precipitation (Patz et al. 2005). One of the primary public health concerns is an increase in the intensity and frequency of heat waves, which have been linked with heat stroke, hyperthermia, and increased mortality rates (Tan et al. 2004).

These consequences appear to be more dramatic in urban and peri-urban areas, which will be especially vulnerable to the negative aspects of climate change (such as more frequent and severe floods and heat waves), due to the higher concentration of people and human activities, although at a lesser extent than in dense urban areas. Climate change impacts on peri-urban landscapes include impacts on the peri-urban agriculture systems: for example, impacts of flooding, groundwater salinization, sea level rise, heat stress, drought, and changes in resources availability are likely to intensify with climate change and especially in Africa and Asia (Padgham et al. 2015). Therefore, the existence of peri-urban agriculture can be threatened by the convergence of urban development (as discussed in the previous section) and climate change pressures.

Thus, there is a pressing need to evaluate strategies that may adapt against further increases in temperature in peri-urban areas and the associated negative impacts on human health. The most common adaptation strategy is to “green” urban areas, essentially by increasing the abundance and cover of vegetation (Gill et al. 2008). As a complement to such adaptation measures, particularly in peri-urban contexts, there is a need to ensure that future land-use development does not worsen the current risk level (especially hydrological risk), either through influencing the hazards themselves or through affecting the future vulnerability and adaptive capacity of the urban system.

Spatial planning of peri-urban landscapes therefore has a critical role to play in mitigating the severity of hazards and in reducing the levels of exposure and vulnerability experienced by the urban system. Different scales of planning from macroscale land-use planning to microscale urban design are both important to this process, responding to the different scales over which risk and vulnerability are expressed (O’Brien et al. 2004).

This recognizes that although many aspects of adaptive behavior associated with vulnerability reduction strategies are the result of a decision-making process that operates at an individual level, the government and other policy makers can address this process through their activities. Given the length of time involved in the strategic planning process, and the long lifetime of urban infrastructure, it is critical that decision-making aimed at mitigation of or adaptation to climate change does not reinforce negative feedback in any part of the process (Lindley et al. 2006). The urgency for information to assist with "climate conscious" planning is evident and asks for detailed tools for the assessment of different urban features that are involved in climate change processes.

For peri-urban forests, an increased awareness of climate change leads in many countries to an increase in the harvesting of fuel wood through private actors, so that in trend, less woody debris are available for supporting biodiversity and for being incorporated in the organic matter cycles. Other indirect drivers connected with urban activities are larger emissions of pollutants, namely, NOx and particulate matter. These disturb matter cycles, might lower the competitiveness of some species, and thus shape the development of forest species communities. Forests close to large urban congestions often suffer from decline and are more vulnerable to climate change. Typical climax communities might now develop due to these disturbances.

2.3 Farmland Abandonment

Among the many available definitions, farmland abandonment can be defined as the cessation of land management which might lead to modifications in biodiversity and ecosystem services provision (Terres et al. 2015). There are several different reasons for it, and these reasons are often concurrent, hardly separable, and context specific. Drivers of abandonment depend on the result of their co-occurrence and interactions (Coppola 2004) and can be natural/geographical constraints (including changes in geo-climatic features), land degradation, socioeconomic factors, or political changes in national or regional assets.

Terres et al. (2015) classified the driving forces of abandonment into unsuitable environmental conditions, low farm stability and viability, and the regional context. They identified the most relevant drivers as low farm income, low farm dynamism/adaptation capacity, aging farmer population, low farmer qualifications in farm management, small farm size, and enrollment in specific agricultural schemes. Drivers from the regional context were identified as the presence of weak land markets, previous farmland abandonment, and remoteness and low population density.

In peri-urban contexts, processes of farmland abandonment are also linked to sprawl processes (Thompson and Stalker Prokopy 2009). Urban development and agriculture compete for the same land, as farmlands closer or adjacent to urban areas are ideal places for urban expansion. Farmers' reasons for selling farmlands in this process are clear, as they can get substantial financial benefits by the sale of farmland for new housing or other urban developments, especially in times of a general crisis of agriculture. On the other hand, agricultural soils need to be conserved, since they are almost nonrenewable resources and soil sealing reduces or eliminate soils' capacity to perform their essential functions.

Farmland abandonment can also generate contrasting perceptions in people living in peri-urban areas (Benjamin et al. 2007). Abandoned farmlands can be seen as "useless spaces" with no proper status or even as elements not aesthetically pleasant or even unsafe. But they can also generate poetic connotation and feelings of freedom or be considered as important ecological spaces where natural field succession processes are taking place.

This contrasting perception by residents and neighbor farmers should be carefully considered when imagining new planning scenarios for abandoned farmlands. In fact, because of their proximity to city but also to existing farmlands or forests, abandoned farmlands in peri-urban areas represent an interesting opportunity for the sustainable spatial planning of metropolitan areas, as they can be considered as new components of new agricultural landscapes (see section "Planning New Forms of Agriculture in peri-urban contexts"). Proximity to the city can provide an advantage for diversification and innovation, offering new opportunities for farmers to sustain or even increase their income by reaching new short-distance markets (Benjamin et al. 2007).

3 Existing Sustainable Planning Approaches for Urban Peripheral Landscapes

Sustainable planning can be considered as a combination of knowledge, science, and creativity to design, evaluate, and implement a set of justified actions in the public domain, which encompass the different dimensions of sustainability such as environment, economy, and social sphere (Friedmann 1987; Berke and Conroy 2000). In this section, we present some examples of planning approaches, solutions, and topics proposed by current academic research and planning practice that might be suitable to be applied to define new planning scenarios aimed at conserving and/or enhancing the sustainability of peri-urban landscapes as defined in section "Peri-urban Landscapes".

3.1 Planning and Design of Peri-urban Greenery

One of the objectives of sustainable spatial planning is to promote equitable access to social and economic resources and therefore improve environmental health of people living in urban contexts (Berke and Conroy 2000). To this end, socially inclusive planning approaches to greenery in peripheral urban contexts should maximize its social benefits based on convergence of human interests (accessibility and qualities of goods and services, culturally appropriate development and fulfillment, self-reliance, etc.), considering equity and disparity within the current population and between present and future generations (van Herzele et al. 2005). This is particularly relevant in peripheries worldwide, where access to resources is often limited or disputed among different social groups. Since access to green spaces is important to human health and well-being, the reduction of the uneven distribution of green spaces within cities (especially those most populated) is one of the key objectives of sustainable planning (e.g., Dai 2011), as urban areas with lowest green land covers have been related to residents with lower socioeconomic status (Aquino and Gainza 2014).

However, within the large body of research on accessibility to greenery (e.g., Neuvonen et al. 2007; Schipperijn et al. 2010; Sugiyama et al. 2008; Swanwick 2009; La Rosa 2014), peri-urban areas have been less explored. Green spaces located outside the urban core such as seminatural areas, woodlands, fringe forests, country/agricultural parks, and peri-urban open spaces are appreciated by users for their recreation and leisure activities even more than intensively maintained green areas (Žlender and Ward Thompson 2017), because they are able to provide a diverse kind of "nature" and satisfy different recreational needs (Rupprecht et al. 2015).

Žlender and Ward Thompson (2017) recently compared two cities (Ljubljana and Edinburgh) with relative different green space strategies for the peripheries (green wedges for Ljubljana, greenbelts for Edinburgh) and demonstrated how the specific strategy of each city affects people's access and their use of peri-urban greenery. While the strategy of green wedges for Ljubljana is used by people because they reach the city center from periphery, the greenbelts in Edinburgh are mostly used for recreational purposes much less than the green spaces within the city (Žlender and Ward Thompson 2017).

This research also highlighted the importance of preference for greenery of different social groups as important information for urban planners. Results from the same authors showed that residents of the most central parts of cities preferred seminatural green spaces and other linear greenery (e.g., green corridors) that can be easily accessed from home. Tu et al. (2016) explored the heterogeneity of people's preferences for green spaces by using a choice experiment in Nancy (France). Authors showed that the willingness to pay for having peri-urban forests in the vicinity of their home increases with the frequency of forest visits, although the respondents' preferences varied significantly with income differences and the possible ownership of private green (as a substitute for being close to parks).

Shkaruba et al. (2017) explored how green space planning has been affected by the interplays of socialist and post-socialist systems, in the context of rural–urban peripheries of two middle-sized cities in Belarus (Mahilioŭ) and Russia (Pskov). Authors discussed how planning options in the two cities are looking for a compromise between a compact city cherished by the socialist planning tradition (still supported by existing spatial regulations and frameworks) and an increasing tendency toward urban sprawl as the western way of modern development. These options have consequences for green spaces that remain somehow under high pressure by urban development: in fact, the most common outcomes of urban development include ecosystem fragmentation, major disturbance of ecosystems, and loss of forest and other valuable ecosystems, and these negative outcomes can be the results of planning choice or failures of planning implementation (Shkaruba et al. 2017).

Conedera et al. (2015) performed a quantitative survey in a peri-urban area of the Southern Alps in Switzerland about the importance of green and the frequency of the visits to green spaces. Results showed that maintaining a visual relation with the green area and vegetation is important to the perceived general quality of life for the peri-urban residents that live far from the city center and closer to the mountain slopes. These findings suggested that land planners and managers should consider the proximity of the place of residence and the background green of the mountain slopes, for example, by ensuring and conserving visibility of the greenery when designing urban development.

3.2 Ecosystem Services-Based Planning

The integration of ecosystem services into spatial planning has recently attracted interest of current research about sustainability issues (see chapter "Ecosystem Services From Forest Landscapes: An Overview"). Spatial planning processes lead to decisions that usually modify land uses and may affect the quantity, quality, and distribution of a wide set of ecosystem services that are benefited by humans. Hence, it is crucial to use information on ecosystem services to support planning processes (Geneletti 2013).

Many scholars believe that ecosystem services might be able to improve decisions on land use by adding the information on the services (with relative values) provided by ecosystems in an urban context and also highlighting trade-offs among different planning scenarios (Albert et al. 2014; Dorning et al. 2015). Several authors have suggested that the ES concept has a potential to facilitate land-use planning and landscape governance by facilitating knowledge exchange between involved stakeholders and connect them at different spatial scales or administrative levels (Opdam et al. 2015). Particularly, the spatial dimension of ES is a key issue for involving stakeholders in the planning process, since they are usually more interested in knowing where a decision is made rather than the reasons behind the decision itself (Fürst et al. 2014).

However, the integration of ES in real planning processes and the use of information coming from ES assessments are still not consolidated and/or not yet producing relevant results in terms of improved sustainability, especially for urban systems (Haase et al. 2014).

There are several reasons for this incomplete integration, such as differences in terminology, the emphasis on existing assessment methods and economic values, and the dominant scale of application (Opdam et al. 2015). Also, the lack of binding norms in national planning systems hampers or delays the integration. To this end, Woodruff and BenDor (2016) believe that the missing integration between ES and planning is also due to the inability of plan quality guidance to incorporate ecosystem services and to guide practitioners in how to include ES information to improve spatial plans.

Geneletti et al. (2017) showed that in peri-urban landscapes, ES-based planning approaches have been rarely applied and that the research on these contexts is still limited and under development. Some exceptions are present in researches that explore how to plan new spatial configuration of remnant peri-urban agricultural lands and other types of non-urbanized areas in new planning scenarios (Lee et al.

2015; La Rosa and Privitera 2013). The management and protection of services by agro-ecosystems is considered crucial in the context of urban growth of peri-urban landscapes and thus appropriate tools to inform and guide planning choices for highly complex landscapes such as those in peri-urban areas. Focusing on farmlands as part of the peri-urban green infrastructure (see section "Trace-Gas Driven Ecosystem Services"), Lee et al. (2015) proposed a set of metrics to assess ecosystem services with landscape composition and configuration metrics for each of the research sites. Results for the case study of a plain area in Taiwan showed that agroecosystem services are related with the spatial configuration of paddy rice fields and that it is possible to guide the agricultural land-use change to optimize spatial configuration and therefore to conserve the agroecosystem services—especially the regulation of potential flooding events.

La Rosa and Privitera (2013) developed a planning scenario of new land uses for existing open unmanaged spaces in peri-urban contexts of South Italy, by evaluating their suitability to new land uses that increase the overall provision of ecosystem services for the entire metropolitan area. The obtained results showed a new spatial configuration of land use that provide municipalities or other metropolitan public bodies in charge of spatial planning (provinces, metropolitan areas) different possibilities for the planning policies aimed at the conservation and increased provision of ecosystem services.

The high complexity of peri-urban contexts in terms of pressure on land and possible conflicts that the use of land can generate characterizes the work by Gret-Regamey et al. (2016) that developed a spatial decision support tool to support the allocation of new urban development zones for the city and hinterland of Thun in Switzerland. The tool evaluates different alternatives of new urban developments based on ecosystem services and locational factors, and it reveals that when ecosystem services are taken into account, the most suitable locations of developments are given by the more compact part of urban centers rather than those in the peri-urban areas. This means that the ecosystem services provided in peri-urban areas were considered important to be conserved by the stakeholders that used the tool.

3.3 Nature-Based Solutions and Green Infrastructure

In urban contexts, there is a growing interest in using and deploying natural ecosystems to provide solutions to several urban issues and improve the overall sustainability of urban environments (Cohen-Shacham et al. 2016). These nature-based solutions provide sustainable, cost-effective, multipurpose, and flexible alternatives for various planning objectives and can significantly enhance resilience of cities. They can be many types of "actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (Cohen-Shacham et al. 2016). Furthermore, by reshaping the built environment, nature-based solutions can enhance the inclusivity, equitability, and livability of cities, regenerate deprived districts through urban regeneration programs, improve mental and physical health and quality of life for the citizens, reduce urban violence, and decrease social tensions through better social cohesion (particularly for some vulnerable social groups, such as children, elderly, and people of with low socioeconomic status).

Many definitions are available for green infrastructure (GI) (see Pulighe et al. 2016 for a comprehensive review): among the available definitions, Tzoulas et al. (2007) define GI as "all natural, semi-natural and artificial networks of multifunctional ecological systems within, around and between urban areas, at all spatial scales." This definition emphasizes the holistic ecosystem vision of urban environments (including the abiotic, biotic, and cultural functions) and claim for multi-scale approaches able to take into account the scale-dependent relationships of ecological processes occurring in cities, with particular reference to the human health and well-being of citizens and residents. For these reasons, GI can be considered as a nature-based solution that has become the focus of increasing interest in sustainability science and planning.

In particular, for peri-urban areas, GI aims at the following actions:

(i) Environmental protection and integration of agriculture into urban context, providing specific new urban agricultural land-use types such as agricultural parks, community-supported agriculture, and allotment gardens. These land uses can provide various improvements, such as increasing local food production in the city, becoming areas for leisure, and supporting the integration of socially deprived population groups.
(ii) Development of suburban green areas in order to provide a more equal distribution of public parks and gardens.
(iii) Enhancement of current urban green spaces by improving quality, usability, and accessibility (La Greca et al. 2011; O'Brien et al. 2017).

According to these objectives, the planning of GI in peri-urban contexts should also include agriculture and farmlands. If green areas act as an infrastructure for the well-being of contemporary society, agricultural areas must be included in this infrastructure of spaces providing ES.

Planning GI requires different strategic objectives to be defined for peripheral landscapes, such as environmental protection, leisure, local green services, and urban agriculture. This might allow the identification of new metropolitan scenarios of land uses (La Rosa and Privitera 2013). In fact, planning strategies for peripheral landscapes should be related to the entire urban and peri-urban surroundings, and metropolitan areas appear to be the most appropriate scale for such scenarios.

3.3.1 Sustainable Urban Drainage Systems

Urbanization processes are responsible for altering natural flow patterns in terms of runoff volumes and peaks. Conventional storm water systems are pushed beyond their drainage capacity and may lead to more frequent and intense floods.

Urban planning can deeply affect the hydrologic response of catchments. Then, understanding potential effects of urban development on the water runoff drainage system represents a crucial issue in the planning process (Miguez et al. 2009), and the use of sustainable urban drainage systems (SUDS) can help minimizing these effects.

Specifically, SUDS are particular NBS that consist "of a range of technologies and techniques used to drain storm water/surface water in a manner that is more sustainable than conventional solutions" (Fletcher et al. 2014). They are based on the philosophy of mimicking the natural predevelopment site hydrology and follow the principles and goals of low-impact development (Ahaiblame et al. 2012). Conventional techniques collect and channel water out of the catchment as fast as possible through structural storm water conveyance systems (channels, pipes, pumps, regulators, and end-of-pipe solutions) at the outlet of a drainage area. On the contrary, SUDS aim at keeping water on-site as much as possible using landscape features and natural processes (Pappalardo et al. 2017).

Despite the relevance of peripheral contexts in current processes of urban development, limited attention has been given to the hydrological impacts of urbanization on previously rural areas. Existing research confirms the evident changes in hydrological regime in peri-urban areas and particularly underlines the complexity of catchments that present a mix of fast and slow hydrologic response as a result of combining artificial with natural flow pathways (Miller et al. 2014).

Two challenges are raised for the adoption of SUDS in peripheral urban landscapes (Barbedo et al. 2014): (i) to promote the preservation of existing (semi)natural ecosystems with related functions and services and (ii) to apply new technologies for the transformation of land and water resources. Peri-urban landscapes are subject to major socioeconomic pressures for further development and land transformations, posing a big challenge to the implementation of measures aimed at the regulating ecosystem services of water runoff.

Barbedo et al. (2014) use a model to test hypothetical changes in the land uses of a coastal city in Brazil. Authors tested how different scenarios of urban densification can respond to the needs of a growing population while safeguarding cultural landscapes of high environmental value. They demonstrated how water flow regulation services of runoff can be improved and that restoring natural functions of peri-urban floodplains may reduce events of urban flooding.

Pappalardo et al. (2016) modeled the effect of urban development for a peri-urban catchment in Italy, evaluating the potential impact of development on the urban storm water drainage systems (Fig. 6). Authors compared flow peak catchment releases under scenarios of pre- and post-urban development and derived a set of flow release restrictions to be included in the local land-use master plan in order to ensure hydraulic invariance in the two scenarios. Results from the modeling showed that release restrictions could be achieved by SUDS modeled for runoff events with low return periods (1–3 years) and that release restrictions should be defined among areas involved in the urban development proportionally to the extent and type of these developments.

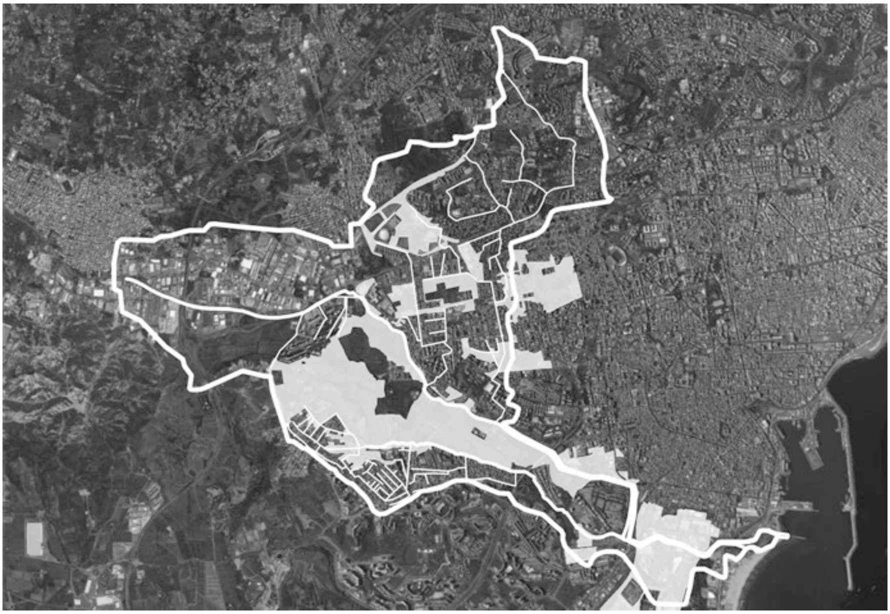

Fig. 6 Modeling of the effects of new urban developments on runoff for a peri-urban basin in Sicily (Italy): in white the areas for the new urban developments for which the release restrictions are defined (Modified from Pappalardo et al. (2016))

3.4 Planning New Forms of Agriculture in Peri-urban Contexts

Spatial planners and decision-makers are required to consider New Forms of Urban Agriculture (NFUA), as defined in section "Farmlands and peri-urban agriculture" in peri-urban contexts, since in these areas, low-density urban development keeps growing and threatening agricultural lands (European Environmental Agency 2006). To this end, a better understanding of the different features of current peri-urban landscapes would allow identification of the land uses that are most suitable to fulfill the multifunctional aims of NFUA and take part of new planning scenarios (La Rosa et al. 2014).

Areas for urban agriculture can be planned and designed in different forms and to different scales to contribute to biodiversity conservation and provide a massive range of ecological benefits for urban residents (Deelstra and Girardet 2000). The integration of urban agriculture into densely populated areas might greatly extend opportunities for mixing food production with social, cultural, and recreational functions of urban green spaces (Taylor Lovell 2010).

To be a feasible alternative in cities and cohabit with other urban land uses, urban agriculture should include ecological and cultural functions in addition to the direct benefits of food production (Taylor Lovell 2010). A transition from traditional agriculture into a multifunctional one can produce several benefits for society (Zasada 2011), thanks to the localization of farms near or inside dense urban areas and the consequent easier transfer of services and goods from the agriculture activities to the urban environment.

Urban planning needs to include in planning scenarios for peri-urban landscapes a wide range of functions including urban agriculture and other typologies of green spaces for leisure, biodiversity protection, and recreation. This scenario has to be designed according to the specific features of geographical contexts (Hough 2004). However, the integration of urban agriculture in land-use planning has been seldom considered in top-down urban planning, and urban agriculture practices have often been implemented from the bottom-up and spontaneously (Taylor Lovell 2010).

As an example of planning of NFUA, a recent research by La Rosa et al. (2014) proposed a GIS-based multi-criteria model to check the suitability of land-use transitions of current open spaces (farmlands, abandoned farmlands, seminatural areas, mainly located in the peripheral areas of the city) to New Forms of Urban Agriculture, by delineating scenarios that aim to increase the provision of ecosystem services such as food production in urban contexts and access to green spaces. The model returned some scenarios for NFUA that integrate urban agriculture in peri-urban contexts of the city and provide useful information for urban planning policies aimed at reaching a multifunctional and sustainable land use for current urban open spaces and protecting existing productive farmland from urban development pressures (Fig. 7).

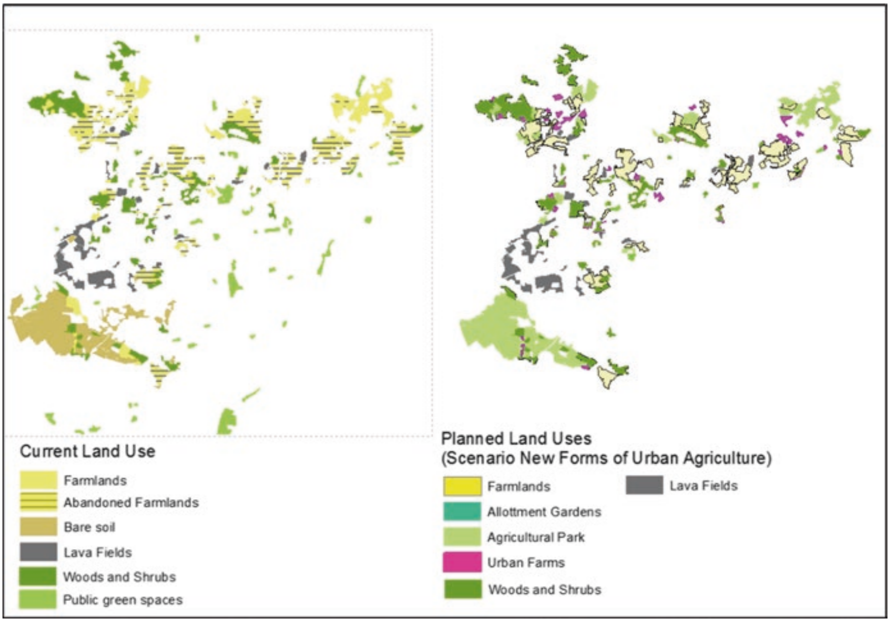

Fig. 7 Example of planned scenarios of New Forms of Urban Agriculture for the peri-urban context of Catania, Italy (Modified from La Rosa et al. (2014))

In an analysis of the peri-urban agriculture in the Beijing peri-urban area, Yang et al. (2016) highlighted the importance of multifunctionality and diversity in agricultural development literature. The authors also recognized the role of the local municipal government in promoting bottom-up local initiatives for the inclusion of these activities into land-use plans. However, both the built-up land and lands needed for peri-urban agriculture activities require collective land with ambiguous property rights, which hinders large-scale projects of peri-urban agriculture and discourages long-term investments (Yang et al. 2016). Provè et al. (2016) suggested that NFUA could hardly benefit from a governance strategy that only stimulates advocacy and institutional support. Adding more specific needs coming from the urban world (e.g., request for specific goods or creating local markets) and integrating other functions (e.g., leisure and tourism) can stimulate peri-urban agriculture toward its full potential. Furthermore, NFUA can be part of municipal programs and investments for public greenery and environmental conservation, but their planning cannot be reduced to the administrative boundaries of a single municipality as their extent go beyond these boundaries. To this end, synergies and coordination among different administrative levels should be pursued within larger metropolitan regions (see next section).

4 Planning and Challenges for peri-urban Landscapes

4.1 The Need of a Metropolitan Planning and Governance for the peri-urban

Current literature is increasingly debating the role of peri-urban areas as part of wider metropolitan contexts (Ros-Tonen et al. 2015; Salet and Savini 2015) that range from large urban agglomerations to smaller local metropolitan areas. This character reflects the manifold links and relations between peri-urban areas and core centers, either in terms of geographical assets, physical connections, and flows (of goods and people) or in terms of processes, including population and urbanization growth and other more specific processes, for example, eco-gentrification (Goodling et al. 2015).

This argument is in line with the current debate on the most effective administrative level at which to plan peri-urban systems (Kline et al. 2014). Understanding the continuous changes that occur in the functional and sociopolitical relations between the urban core and peri-urban areas and framing them in their institutional and administrative context are a prerequisite for effective planning (Salet et al. 2015).

The metropolitan condition of peripheries requires working on more complex relations than those between a specific peri-urban area and its reference core city or rural landscape represented by the traditional core–periphery model. First and most important, peripheries as part of metropolitan systems need to face crossadministrative boundary phenomena and to address the interlinked issues that are relevant at different scales (e.g., the relation between mobility and the urban form).

This is particularly relevant for the accessibility of several urban functions (health, commercial, retail, parks, and other recreational activities) that could be limited or not present in peri-urban areas. In some instances, functions can be shared among different municipalities belonging to the same metropolitan area. Contemporary metropolitan areas require forms and instruments of spatial governance that are able to integrate different planning levels and sectors but are often not presented in national planning instruments or schemes.

Although the dynamics of the transformation of peri-urban areas are certainly not independent from the dynamics of the more central parts in the city, peri-urban areas of developing metropolises exhibit specific characteristics that make their governance (as defined below) a distinctive challenge that deserves the attention of planners. These specific and interlinked characteristics result from a combination of rapid socio-ecological transformations, conflicting stakes and interests, environmental vulnerability, and a lack of an adequate political–administrative jurisdiction.

As an example of the relation between peri-urban areas and metropolitan systems, Padeiro (2016) studied the relation between land-use changes and municipal management plans in the Lisbon Metropolitan Area. The author found that the distance to the capital and former urban dynamics were more significant drivers of land-use change than the land-use plans.

Due to the complexity and highly changing features of peri-urban landscapes, planning of these regions might therefore have to shift away from traditional land-use design and act as a flexible platform to imbalance the activity of public policies and private initiatives, where trade-offs between different uses of the land can be negotiated (Moreira et al. 2016).

4.2 Planning Instruments, Spatial Governance, and Transferability of Approaches

The planning of peri-urban landscapes requires changes in the relations among different administration levels (e.g., local, metropolitan, or regional level), making necessary new political arrangements within the metropolitan areas where they are located. Overall, a combination of local and supra-local schemes (in planning, governance, regulations, and agreements) is viewed as necessary (Webber and Hanna 2014). Furthermore, an effective coordination between different levels of land-use planning is considered crucially important (Carruthers and Vias 2005).

To achieve this coordination, more complex and advanced planning schemes and instruments are needed. In some cases, the integration of different planning levels also means an integration between traditional planning based on spatial administrative units and more innovative tools. To this end, links among different planning levels should be revised and strengthened, involving all levels of the planning process, from the master plan to the subdivision plan and zoning (Lörzing 2006). Many authors suggest a possible combination of different approaches (e.g., traditional and innovative, top-down and bottom-up) that can work at different and integrated scales (e.g., the more strategic at the regional and metropolitan levels with the more operational at the very local level).

Classic planning approaches can be critical to apply in peri-urban and not effective in achieving sustainability. One example is the traditional classic land-use zoning that is viewed as acting as a barrier to sustainable development in peri-urban areas because it fails to consider their complex and dynamic features (Haller 2014) and the multifunctional use of spaces that support socially and environmentally sustainable practices, for example, the use of vacant residential lots for new forms of agriculture (Hara et al. 2013). Other planning instruments, such as master plans or local land-use plans, appear unable to consider peri-urban as part of larger metropolitan regions and are hence inadequate to act as effective solutions (Roose et al. 2013).

Some authors also report concerns about the lack of binding norms to protect peri-urban land that is considered valuable and strategic for sustainable development from urban development. This happens not only with farmlands in peri-urban areas but also with unmanaged open spaces and vacant lands in peripheral neighborhoods, where ecological auto-determination and unplanned but socially relevant land uses can flourish (Foster 2014). Additionally, to a certain degree, regulations are seen as a necessary legal frame to ensure more effective integration of planning choices in metropolitan systems (Carruthers and Vias 2005).

A recent work by Moreira et al. (2016) proposed alternative administrative units than traditional municipalities to better target sectorial policies at local scale within peri-urban contexts. For the Metropolitan Area of Lisbon, authors mapped different peri-urban areas and associated dynamics of landscape change through a set of landscape indicators to identify seven different units where to adopt inter-municipal planning policies and regulations adaptable to manage the urban and non-urban land uses, as well as promoting market tools to regulate land-use change initiatives in the desired directions. Such an approach might be able to avoid planning choices about future land-use and urban functions in metropolitan areas that have been traditionally based on the neat separation of spaces, administrative units, and related spatial policies.

The issue of appropriate schemes of governance for peri-urban landscapes relates to the ongoing debate about alternative modes of spatial governance. Governance is acknowledged as a key issue for these areas, which are frequently divided into different jurisdictions but also characterized by administrative overlaps (Korthals Altes and van Rij 2013) or by political marginality (Cash 2014). These uncertainties may lead to informality in urban development. Multilevel governance (MLG) plays a crucial role to effectively supporting the coordination of planning instruments. MLG is defined as the interplay of institutions, mechanisms, and processes through which political and administrative authority is exercised across different levels (Goldthau 2014). MLG is categorized into two types depending on its orientation toward particular administrative areas or particular policy problems (Hooghe and

Marks 2003). In the first type, bundled MLG, jurisdictional boundaries are separated and not intersecting or overlapping, where each level is assigned distinctive functions and clear lines of responsibility (Smith 2007). Here, the authorities and powers are bundled together within a jurisdiction, with those jurisdictions at the lower level "nested" into higher ones. Type I follows a rather traditional hierarchy of different levels of governance documents. However, its deficit is that it does not react properly to spillover effects, for example, while analyzing ecosystem services benefitting and provisioning areas. In the second type, the flexible jurisdictions form a complex pattern of formal and informal institutions and networks that often overlap with each other. They are no longer related to a jurisdiction but focus on specific policy sectors with task-specific institutions (Hooghe and Marks 2003). Implementing the second type of MLG produces a rich pattern of both formal, statutory spaces and "soft spaces" as more functional, fluid, and governance arrangements. Soft spaces involve creating new functional spaces inconsistent with political territorial boundaries (Allmendinger et al. 2015), which may result in "inefficiencies, spatial externalities, and spillovers" (Moss and Newig 2010).

An example of flexible governance for peri-urban contexts is proposed by Hedblom et al. (2017) with reference to Swedish examples: in Stockholm, the system of green wedges, a landscape previously unrecognized as environmental relevant, has become acknowledged and incorporated in multilevel landscape governance among the municipality, regional authorities, and NGOs. These partners established a long-term commitment and finally formalized a local-level governance structure at local level allowing the conservation of multiple functionalities the wedges provided to the peri-urban population.

Transferability of planning approaches to other geographical contexts is a key issue to evaluate their real flexibility and robustness. Geneletti et al. (2017) found a high level of uncertainty about the real transferability of successful planning approaches to contexts, in which physical, environmental, and socioeconomic conditions are different than the ones where these approaches have been developed (Ryan and Throgmorton 2003). One of the most important issues that make approaches difficult to transfer relies on the institutional variability of planning schemes and related legislation. Many papers highlighted that specific contexts call for specific approaches to incorporate sustainability in several respects of peri-urban planning processes (Todes 2004) and to fit the local specificities of spatial legislation (Harman and Choy 2011). For example, this is the case with approaches of performance-based planning, whose implementation represents a major challenge even for administrations with high institutional capacity (Baker et al. 2006): the possibility of its adoption in other contexts with different planning and governance systems should not be taken for granted and requires further investigation.

4.3 Challenges and Raised Trade-Offs in Planning Approaches

Several challenges can be identified when evaluating the effectiveness of sustainable planning to peri-urban landscapes. One of the most relevant is the aforementioned possibility to use traditional approaches (land-use Euclidean zoning, master plans, spatial regulations), mainly because these instruments may be not able to address the fast-changing features of peri-urban areas. Furthermore, such standalone instruments could be vulnerable to formal and informal pressures on planning processes (Mason and Nigmatullina 2011).

Another limitation highlighted by current research raised concerns of the real socio-environmental effectiveness of sustainable planning approaches and the measurability of the environmental effects of the sustainable development of peri-urban areas (Zimmerman 2001). Uncertainties about the short-/long-term environmental sustainability and the potential unwanted outcomes generated from the application of (presumed) sustainable planning approaches have been highlighted. Sustainable models for peri-urban areas have been unable to show whether the solution proposed is ecologically sound and even whether it can be considered livable. An important example of socio-environmental effects of planning is the positive correlation between population growth and the close proximity of peri-urban green spaces in the cities of Antwerp and Ghent (Van Herzele and Wiedemann 2003). This implies that, indirectly, development of peri-urban green spaces can generate more requests for urban development for people wishing to live close to greenery and thus can generate more urban sprawl.

A big challenge is related to the economic resources needed to implement any planning decision. This is a crucial issue, in times when many local authorities (e.g., municipalities) are experiencing a continuous decrease of available budget to be used for the acquisition of land needed to develop new public green spaces or other forms of public service. To this end, alternative sources of funding should be sought, such as grants or incentive schemes, by which landowners could be economically encouraged to directly create or manage new green spaces. Such mechanisms can also produce more effective results if linked to engagement of stakeholders who might provide additional economic support. For example, local communities might be willing to pay a limited fee to have access to green spaces that can be planned by local governments in private lands. Through the budget coming by these fees, the management costs could be covered. Other forms of land acquisition for public spaces include Transfer of Development Rights mechanisms. Landowners and developers exchange a right to build on concentrated portions of property with the obligation to transfer to the municipality the remaining area, zoned for public use (e.g., green spaces). This can increase the overall provision of public green spaces at reduced costs for the municipality (Martinico et al. 2014).

A recent study by Geneletti et al. (2017) reviewed approaches of sustainable planning for urban peripheries and peri-urban areas in particular, revealing challenges and trade-offs that emerge from existing planning research on peri-urban systems. An important category of trade-offs concerns the relation between peri-urbanization processes and the landscapes produced by these processes. For example, Haller (2014) argued that, even if the process of urbanization and peri-urbanization cannot be claimed as positive or negative per se but can produce both positive and negative outcomes, these need to be balanced considering the local socioeconomic and environmental characteristics of the context.

In fact, the possibility of generating sustainable and eco-compatible development can clash with socio-environmental and, particularly, equity issues. New peri-urban developments or retrofitting may generate inequalities by providing opportunities for particular social groups to get preferential access to environmental amenities and therefore allowing an unequal access to ecological/environmental benefits at the cost of low-density urban development (Leichenko and Solecki 2008).

Focusing more on planning approaches, some trade-offs may result from the application of particular spatial planning concepts. An example is the concept of the "compact city," where urban densification and consolidation can generate trade-offs with the condition of urban livability (Westerink et al. (2013). In developing countries, the increase of density as a solution to low-density developments located in peri-urban areas poses issues of availability of green spaces for the growing population (Ramos-Santiago et al. 2014). On the contrary, the request of having pleasant peri-urban environments may clash with the need for water conservation and sustainable management (Carruthers and Vias 2005).

5 Conclusions and Perspectives for Further Research

The previous sections have revealed how peri-urban landscapes are particular socio-ecological systems where it is challenging to find consolidated, easy-to-replicate planning approaches to enhance their level of sustainability. This is mainly due to their dynamic characters, fast-changing nature, and the many pressures that they have to face, especially from humans that tend to want more land for their different activities.

Different land-use and land-cover compositions and configurations as well as different and quick changing socioeconomic structures produce very diverse types of peri-urban landscapes, which are difficult to reduce and to classify. As a direct consequence, research on planning approaches of these systems is still limited and scattered, and they are more focused on solving context-specific issues than on providing comprehensive frameworks for sustainable planning.

According to the ongoing research, one of the most relevant approaches and topics for the planning of peri-urban landscapes is related to providing equal and facilitated access to green spaces for the different social subjects living nearby. Inclusive planning approaches to peri-urban greenery contexts should maximize the social benefits of woodlands (accessibility and qualities of goods and services, culturally appropriate development and fulfillment, self-reliance, etc.). The consideration of factors of equity and possible disparity within the current peri-urban population and between the present and future generations are crucial issues to be taken into account in making planning decisions (van Herzele et al. 2005).

Ecosystem services-based planning is an emerging field of research but still rarely applied in peri-urban contexts. New scenarios can be planned in order to conserve and/or maximize the overall provision of ES by peri-urban landscapes. The management and protection of ecosystem services by agro-ecosystems located in peri-urban and other peripheral areas is a possible way to fight against sprawl urban developments and reduce their negative impacts.

Nature-based solutions and green infrastructure provide sustainable, multipurpose, and flexible alternatives for various planning objectives. Particularly for peri-urban landscapes, green infrastructure may be able to achieve a multiple set of planning objectives such as environmental protection, the development of greenery with new distributions of public parks and gardens, the enhancement of the accessibility of current public green spaces, and the integration of peri-urban agriculture.

With reference to this last point, the possibility to readdress existing farmlands and—much importantly—abandoned farms to New Forms of Urban Agriculture is a fundamental planning strategy for peri-urban landscapes that fulfills multifunctional objectives including food safety, landscape conservation, and ES provision. Planning scenarios of NFUA have to be designed according to the specific features of geographical contexts and particularly evaluating variables such as accessibility by local residents. NFUA can be part of municipal programs and investments for public greenery and environmental conservation. However, due to the large size of these areas, their planning requires synergies and coordination among different administrative levels (e.g., for the creation of large agricultural parks).

This presence of many different public bodies and administrations raises the crucial issue of the choice of the most effective spatial governance instrument and mechanism that should be used to apply the sustainable planning approaches discussed in this chapter. Peri-urban landscapes have to be included in wide metropolitan systems, presenting complex relations with both the main cities and the rural surroundings. It is therefore important that new types of flexible metropolitan governance and related planning instruments are established and that they can integrate different planning levels (municipalities, provinces, regions) and sectors.

According to these considerations, Table 1 reports the main characteristics of peri-urban landscape together with planning recommendations and possible approaches (with reference to the scale of application).

Some future directions can be envisaged for new research on planning of peri-urban landscapes. First, it is essential to further explore to which extent some approaches that performed well in a particular context could be reused in other contexts with similar characteristics. This is probably the most relevant issue, as many examples from current literature have revealed uncertainties with regard to the transferability of successful case studies to other geographical contexts.

Another important research improvement includes the evaluation of the socio-environmental effects and outcomes of planning approaches that are adopted. In

Table 1 Synthesis of characteristics, planning recommendations, and planning approaches for peri-urban landscapes

Characteristic of peri-urban landscapes	Planning recommendations	Suitable planning approaches	Scale
High proximity to urban areas	Ensure equal accessibility to resources/services	Planning and design of peri-urban greenery Nature-based solutions	Local Local
Mix of land uses	Avoid rigid zoning Support/allow the multifunctional use of the land and the reuse of vacant/abandoned lots	Planning new forms of urban agriculture Ecosystem-based planning Green infrastructure planning	Regional Regional/metropolitan Local
Presence of ecological and agricultural values	Develop binding norms/regulations to protect land from urban development	Planning and design of peri-urban greenery Planning new forms of urban agriculture Nature-based solutions	Regional Local Local
High pressure for further urban development	Develop binding norms/regulations to mitigate/avoid urban sprawl	Strategic planning Planning and design of peri-urban greenery Nature-based solutions	Regional Regional/metropolitan Local
Part of wider metropolitan contexts	Co-development of metropolitan plans integrated with lower planning levels (municipal/local) by institutional and local stakeholders New planning instruments (strategic plans, landscape metropolitan plan)	Multilevel spatial governance Strategic planning	Regional Regional

some cases, specific approaches may eventually result in unsustainable outcomes, instead of a higher level of sustainability. This could happen if the effects on different sectors or at different scales are not adequately addressed. For example, urban planning aimed at densification to reduce sprawl can generate problem of green space availability for the growing peri-urban population. Methods and monitoring programs are needed to provide quantitative evidence on the extent to which a proposed solution can be considered sustainable and livable.

Finally, the same characteristics that make peri-urban landscapes challenging contexts for sustainable planning offer, on the other way, interesting and unique opportunities for current planning approaches. In particular, these opportunities are based on the local resources of peri-urban areas, including both environmental resources (e.g., through ecosystem services-based planning) and socioeconomic resources (e.g., through the integration of bottom-up processes into top-down approaches). Examples include the possibility of planning peri-urban landscapes by mixed configuration of new housing and different types of highly accessible green spaces and other spaces for local food production. Abandoned spaces and vacant lands can be turned into positive resources that increase socio-ecological opportunities and offer more sustainable food production for the peri-urban population.

To this aim, a shift in the conceptualization of the peri-urban contexts from the traditional urban-centric approaches (e.g., including zoning and vertical land-use planning) to an environmental and ecosystem-based interpretation is crucial. This will also allow a better understanding—and consequent regulation—of the social and economic consequences of the peri-urbanization processes (e.g., in terms of environmental intra- and intergenerational equity) and increase the overall sustainability level of these complex and dynamic systems.

References

Aguiar MR, Sala OE (1999) Patch structure, dynamics and implications for the functioning of arid ecosystems. Trends Ecosyst Evol 14:273–277

Ahaiblame L, Engel B, Chaubey I (2012) Effectiveness of low impact development practices: literature review and suggestions for future research. Water Air Soil Pollut 223(7):4253–4273

Albert C, Aronson J, Fürst C, Opdam P (2014) Integrating ecosystem services in landscape planning: requirements, approaches, and impacts. Landsc Ecol 29:1277–1285

Allen A (2003) Environmental planning and management of the peri-urban interface: perspectives and emerging field. Environ Urban 15:135–147

Allmendinger P, Haughton G, Knieling J, Othengrafen F (2015) Soft spaces, planning and emerging practices of territorial governance. In: Allmendinger P, Haughton G, Knieling J, Othengrafen F (eds) Soft spaces in Europe. Re-negotiating governance, boundaries and borders. Routledge, London, pp 3–21

Aquino FL, Gainza X (2014) Understanding density in an uneven city, Santiago de Chile: implications for social and environmental sustainability. Sustain Basel 6:5876–5897

Aubry C, Ramamonjiso J, Dabat MH, Rakotoariso J, Rakotondraib J, Rabeharison L (2012) Urban agriculture and land use in cities: an approach with the multi-functionality and sustainability concepts in the case of Antananarivo (Madagascar). Land Use Policy 29:429–439

Baker DC, Sipe NG, Gleeson BJ (2006) Performance-based planning: perspectives from the United States, Australia, and New Zealand. J Plan Educ Res 25(4):396–409

Barbedo J, Miguez JM, van der Horst D, Marins M (2014) Enhancing ecosystem services for flood mitigation: a conservation strategy for peri-urban landscapes? Ecol Soc 19(2):54

Benis K, Ferrão P (2017) Potential mitigation of the environmental impacts of food systems through urban and peri-urban agriculture (UPA)–a life cycle assessment approach. J Clean Prod 140:784–795

Benjamin K, Bouchard A, Domon G (2007) Abandoned farmlands as components of rural landscapes: an analysis of perceptions and representations. Land Urban Plan 83:228–244

Berke PR, Conroy MM (2000) Are we planning for sustainable development? J Am Plann Assoc 66(1):21–33

Bourne LS (2000) Living on the edge: conditions of marginality in the Canadian urban system. In: Lithwick H, Gradus Y (eds) Developing frontier cities, the GeoJournal Library. Springer, Netherlands, pp 77–97

Carruthers J, Vias AC (2005) Urban, suburban, and exurban sprawl in the Rocky Mountain West: evidence from regional adjustment models. J Reg Sci 45(1):21–48

Cash C (2014) Towards achieving resilience at the rural–urban fringe: the case of Jamestown, South Africa. Urban Forum 25(1):125–141

Clark JK, Munroe DK (2013) The relational geography of peri-urban farmer adaptation. J Rural Community Dev 8(3):15–28

Cohen-Shacham E, Walters G, Janzen C, Maginnis S (2016) Nature-based solutions to address global societal challenges. IUCN, Gland

Commission of the European Communities (2006) Thematic strategy for soil protection. www.ec.europa.eu/environment/soil. Accessed 10 May 2017

Conedera M, Del Biaggio M, Seeland K, Moretti M, Home R (2015) Residents' preferences and use of urban and peri-urban green spaces in a Swiss mountainous region of the Southern Alps. Urban For Urban Gree 14:139–147

Coppola A (2004) An economic perspective on land abandonment processes. Paper presented at the AVEC Workshop on Effects of land abandonment and global change on plant and animal communities, 11–13 Oct 2004, Anacapri, Italy

Dai D (2011) Racial/ethnic and socioeconomic disparities in urban green space accessibility: where to intervene? Landsc Urban Plan 102:234–244

de Groot RS, Alkemade R, Braat L, Hein L, Willemen L (2010) Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making. Ecol Complex 7:260–272

Deelstra T, Girardet H (2000) Urban agriculture and sustainable cities. In: Bakker N, Dubbeling M, Gundel S, Sabel-Koschela U, de Zeeuw H (eds) Growing cities, growing food: urban agriculture on the policy agenda. Deutsche Stiftung fur Internationale Entwicklung (DSE), Feldafing, pp 43–65

Dijkstra L, Poelman H (2008) Remote rural regions: how proximity to a city influences the performance of rural regions. In: COM—Commission of the European Communities (ed) Regional policy 1/2008. European Commission, Brussels, pp 1–7

Donadieu P (1998) Les Campagnes Urbaines. Actes Sud, Arles

Dorning MA, Koch J, Shoemaker DA, Meentemeyer RK (2015) Simulating urbanization scenarios reveals tradeoffs between conservation planning strategies. Landsc Urban Plan 136:28–39

DTLR (Department for Transport Local Government and the Regions) (2002) Improving urban parks, play areas and green spaces. Improving Urban Parks, Play Areas, London

EEA (European Environmental Agency) (2006) Urban sprawl in Europe The ignored challenge. Report 10. EEA, Copenhagen

EEA (European Environmental Agency) (2015) State of the environment report. EEA, Copenhagen

EUROSTAT (2010) Regional yearbook 2010. Chapter 15: a revised urban–rural typology. EUROSTAT, Luxemburg, pp 240–253

FAO (2002) Urban and peri-urban forestry sub-programme: strategic framework for the Biennium 2002–2003 and mid- term 2002–2007. FAO FORC, Rome

Fletcher TD, Shuster W, Hunt WF, Ashley R, Butler D, Scott A, Trowsdale S, Barraud S, Semadeni-Daves A, Bertrand-Krajewski JL, Mikkelsen PS, Rivard G, Uhl M, Dagenais D, Viklander M (2014) SUDS, LIDS, BMs, WUDS and more – the evolution and application of terminology surrounding urban drainage. Urban Water J 12(7):525–542

Forman RTT (1995) Land mosaics. The ecology of landscapes and regions. University Press, Cambridge

Forrest M, Konijnendijk CC, Randrup TB (eds) (1999) COST action E12-Research and Development in urban forestry in Europe. Official Printing Office of the European Communities, Luxembourg

Foster J (2014) Hiding in plain view: vacancy and prospect in Paris' Petite Ceinture. Cities 40:124–132
Friedmann J (1987) Planning in the public domain: from knowledge to action. Princeton University Press, Princeton
Fürst C, Opdam P, Inostroza L, Luque S (2014) A balance score card tool for assessing how successful the ecosystem services concept is applied in participatory land use planning. Landsc Ecol 29:1435–1446
Gallent N, Shaw D (2007) Spatial planning, area action plans and the rural next urban fringe. J Environ Plan Manag 50:617–638
Gallent N, Andersson J, Bianconi M (2006) Planning on the edge : the context for planning at the rural-urban fringe. Routledge, Abingdon
Gant RL, Robinson GM, Shahab Fazal S (2011) Land-use change in the 'edgelands': policies and pressures in London's rural-urban fringe. Land Use Policy 28:266–279
Geneletti D (2013) Ecosystem services in environmental impact assessment and strategic environmental assessment. Environ Impact Assess Rev 40:1–2
Geneletti D, La Rosa D, Spyra M, Cortinovis C (2017) A review of approaches and challenges for sustainable planning in urban peripheries. Landsc Urban Plan 165:231. https://doi.org/10.1016/j.landurbplan.2017.01.013
Gill SE, Handley JF, Ennos AR, Pauleit S, Theuray N, Lindley SJ (2008) Characterising the urban environment of UK cities and towns: a template for landscape planning. Landsc Urban Plan 87:210–222
Goldthau A (2014) Rethinking the governance of energy infrastructure: scale, decentralization and polycentrism. Energy Res Soc Sci 1/0:134–140
Goodling E, Green J, McClintock N (2015) Uneven development of the sustainable city: shifting capital in Portland, Oregon. Urban Geogr 36(4):504–527
Gret-Regamey A, Altwegg J, Sirén EA, van Strien MJ, Weibel B (2016) Integrating ecosystem services into spatial planning—a spatial decision support tool. Landsc Urban Plann 165:206. https://doi.org/10.1016/j.landurbplan.2016.05.003
Haase D, Larondelle N, Andersson E, Artmann M, Borgström S, Breuste J, Gomez-Baggethun E, Gren A, Hamstead Z, Hansen R, Kabisch K, Kremer P, Langemeyer J, Rall E, McPhearson T, Pauleit S, Qureshi S, Schwarz N, Voigt A, Wurster D, Elmqvist T (2014) A quantitative review of urban ecosystem service assessments: concepts, models, and implementation. Ambio 43:413–433
Haller A (2014) The "sowing of concrete": peri-urban smallholder perceptions of rural–urban land change in the Central Peruvian Andes. Land Use Policy 38:239–247
Hara Y, Murakami A, Tsuchiya K, Palijon AM, Yokohari M (2013) A quantitative assessment of vegetable farming on vacant lots in an urban fringe area in Metro Manila: can it sustain long-term local vegetable demand? Appl Geogr 41:195–206
Harman BP, Choy DL (2011) Perspectives on tradable development rights for ecosystem service protection: lessons from an Australian peri-urban region. J Environ Plann Manag 54(5):617–635
Hedblom M, Andersson E, Borgströmc S (2017) Flexible land-use and undefined governance: from threats to potentials in peri-urban landscape planning. Land Use Policy 63:523–527
Heimlich RE (1989) Metropolitan agriculture: farming in the city's shadow. J Am Plann Assoc 55:457–466
Hooghe L, Marks G (2003) Unraveling the central state, but how? Types of multi-level governance. Am Polit Sci Rev 97(2):233–243
Hough M (2004) Cities and natural process: a basis for sustainability. Routledge, New York
Johnson MP (2001) Environmental impacts of urban sprawl: a survey of the literature and proposed research agenda. Environ Plann A 33:717–735
Kline JD, Thiers P, Ozawa CP, Alan Yeakley J, Gordon SN (2014) How well has land-use planning worked under different governance regimes? A case study in the Portland, OR-Vancouver, WA metropolitan area, USA. Landsc Urban Plann 131:51–63
Konijnendijk CC (2003) A decade of urban forestry in Europe. Forest Policy Econ 5:173–186

Korthals Altes WK, van Rij E (2013) Planning the horticultural sector. Managing greenhouse sprawl in the Netherlands. Land Use Policy 31:486–497
La Greca P, La Rosa D, Martinico F, Privitera R (2011) Agricultural and green infrastructures: the role of non-urbanised areas for eco-sustainable planning in a metropolitan region. Environ Pollut 159:2193–2202
La Rosa D (2014) Accessibility to greenspaces: GIS based indicators for sustainable planning in a dense urban context. Ecol Indic 42:122–134
La Rosa D, Privitera R (2013) Characterization of non-urbanized areas for land-use planning of agricultural and green infrastructure in urban context. Landsc Urban Plann 109:94–106
La Rosa D, Barbarossa L, Privitera R, Martinico F (2014) Agriculture and the city: a method for sustainable planning of new forms of agriculture in urban contexts. Land Use Policy 41:290–303
Lee Y-C, Ahern J, Chia-Tsung Yeh C-T (2015) Ecosystem services in peri-urban landscapes: the effects of agricultural landscape change on ecosystem services in Taiwan's western coastal plain. Landsc Urban Plann 139:137–148
Leichenko RM, Solecki WD (2008) Consumption, inequity, and environmental justice: the making of new metropolitan landscapes in developing countries. Soc Nat Resour 21:611–624
Lindley SJ, Handley JF, Theuray N, Peet E, Mcevoy D (2006) Adaptation strategies for climate change in the urban environment: assessing climate change related risk in UK urban areas. J Risk Res 9:543–568
Lörzing H (2006) Reinventing suburbia in The Netherlands. Built Environ 32(3):298–310. https://doi.org/10.2148/benv.32.3.298
Loupa Ramos I, Ferreiro M, Colaço C, Santos S (2013) Peri-urban landscapes in metropolitan areas: using transdisciplinary research to move towards an improved conceptual and geographical understanding. In: proceeding of the AESOP-ACSP joint congress, 15–19 July 2013, Dublin, p 1145. Available at http://aesop-acspdublin2013.com/uploads/files/AESOP_Programme_final.pdf. Accessed 10 May 2017
Martinico F, La Rosa D, Privitera R (2014) Green oriented urban development for urban ecosystem services provision in a medium sized city in southern Italy. iForest 7:385–395. https://doi.org/10.3832/ifor1171-007
Mason RJ, Nigmatullina L (2011) Suburbanization and sustainability in metropolitan Moscow. Geogr Rev 101(3):316–333
Meeus S, Gulinck H (2008) Semi-urban areas in landscape research: a review. Living Rev Landsc Res 2:1–45
Miguez MG, Mascarenhas F, Canedo de Magalhães L, D'Alterio C (2009) Planning and design of urban flood control measures: assessing effects combination. J Urban Plann Dev 135(3):100–109
Miller RW (1997) Urban forestry: planning and managing urban green spaces, 2nd edn. Prentice Hall, New Jersey
Miller JD, Kim H, Kjeldsen TR, Packman J, Grebby S, Dearden R (2014) Assessing the impact of urbanization on storm runoff in a peri-urban catchment using historical change in impervious cover. J Hydrol 515:59–70
Moreira F, Fontes I, Dias S, Batista e Silva J, Loupa-Ramos I (2016) Contrasting static versus dynamic-based typologies of land cover patterns in the Lisbon metropolitan area: towards a better understanding of peri-urban areas. Appl Geogr 75:49–59
Moss T, Newig J (2010) Multilevel water governance and problems of scale: setting the stage for a broader debate. Environ Manag 46(1):1–6
Munoz F (2003) Lock living: urban sprawl in Mediterranean cities. Cities 20(6):381–385
Neuvonen M, Sievänen T, Tönnes S, Koskela T (2007) Access to green areas and the frequency of visits—a case study in Helsinki. Urban For Urban Gree 6:235–247
Nowak DJ, Crane DE, Stevens JC (2006) Air pollution removal by urban trees and shrubs in the United States. Urban For Urban Gree 4:115–123
O'Brien K, Sygna L, Haugen JE (2004) Vulnerable or resilient a multi-scale assessment of climate impacts and vulnerability in Norway. Clim Change 64:193–225

O'Brien L, DeVreese R, Kern M, Sievanen T, Stojanova B, Atmis E (2017) Cultural ecosystem benefits of urban and peri-urban green infrastructure across different European countries. Urban For Urban Gree 24:236. https://doi.org/10.1016/j.ufug.2017.03.002
OECD (2002) Redefining territories: the functional regions. Organisation for economic co-operation and development (OECD), Paris
Opdam P, Albert C, Fürst C, Gret-Regamey A, Kleemann J, Parker DC, La Rosa D, Schmidt K, Villamor GB, Walz A (2015) Ecosystem services for connectingactors – lessons from a symposium. CASES – Change Adapt Soc Ecol Syst 2:1–7
Padeiro M (2016) Conformance in land-use planning: the determinants of decision, conversion and transgression. Land Use Policy 55:285–299
Padgham J, Jabbour J, Dietrich K (2015) Managing change and building resilience: a multi-stressor analysis of urban and peri-urban agriculture in Africa and Asia. Urban Climate 12:183–204
Pappalardo V, Campisano A, Martinico F, Modica C (2016) Supporting urban development master plans by hydraulic invariance concept: the case study of Acquicella catchment. Proceedings of the 9th International Conference Novatech, Lyon, July 2016
Pappalardo V, La Rosa D, La Greca P, Campisano A (2017) The potential of GI application in urban runoff control for land use management: a preliminary evaluation from a southern Italy case study. Ecosyst Serv., https://doi.org/10.1016/j.ecoser.2017.04.015 26:345
Patz JA, Campbell-Lendrum D, Holloway T, Foley JA (2005) Impact of regional climate change on human health. Nature 438(7066):310–317
Paül V, McKenzie FH (2013) Peri-urban farmland conservation and development of alternative food networks: insights from a case-study area in metropolitan Barcelona (Catalonia, Spain). Land Use Policy 30:94–105
Piorr A, Ravetz J, Tosics I (2011) Peri-urbanisation in Europe: towards a European policy to sustain urban-rural futures. University of Copenhagen – Academic Books Life Sciences, Copenhagen
Provè C, Dessein J, de Krom M (2016) Taking context into account in urban agriculture governance: case studies of Warsaw (Poland) and Ghent (Belgium). Land Use Policy 56:16–26
Pugnare FI, Lazaro R (2000) Seed bank and understorey species composition in a semi-arid environment: the effect of shrub age and rainfall. Ann Bot London 86:807–813
Pulighe G, Fava F, Lupia F (2016) Insights and opportunities from mapping ecosystem services of urban green spaces and potentials in planning. Ecosyst Serv 22:1–10
Ramos-Santiago LE, Villanueva-Cubero L, Santiago-Acevedo LE, Rodriguez-Melendez YN (2014) Green area loss in San Juan's inner-ring suburban neighborhoods: a multidisciplinary approach to analyzing green/gray area dynamics. Ecol Soc 19(2)
Rauws W, de Roo G (2011) Exploring transitions in the peri-urban area. Plan Theory Pract 12(2):269–284
Roose A, Kull A, Gauk M, Tali T (2013) Land use policy shocks in the post-communist urban fringe: a case study of Estonia. Land Use Policy 30(1):76–83. https://doi.org/10.1016/j.landusepol.2012.02.008
Ros-Tonen M, Pouw N, Bavinck M (2015) Governing beyond cities: the urban-rural interface. In: Gupta J, Pfeffer K, Verrest H, Ros-Tonen M (eds) Geographies of urban governance. Advanced theories, methods and practices. Springer International Publishing, Cham, pp 85–105
Rupprecht CD, Byrne JA, Ueda H, Lo AY (2015) It's real, not fake like a park': residents' perception and use of informal urban green-space in Brisbane, Australia and Sapporo, Japan. Landsc Urban Plann 143:205–218
Ryan S, Throgmorton J (2003) Sustainable transportation and land development on the periphery: a case study of Freiburg, Germany and Chula Vista, California. Transportation Res D-Tr E 8:37–52
Salet W, Savini F (2015) The political governance of urban peripheries. Environ Plann C 33(3):448–456
Salet W, Vermeulen R, Savini F, Dembski S, Thierstein A, Nears P, Vink B, Healey P, Stein U, Schultz H, Salet W, Vermeulen R, Savini F, Dembski F (2015) Planning for the new European metropolis: functions, politics, and symbols/metropolitan regions: functional relations between the core and the periphery/business investment decisions and spatial planning policy/metro-

politan challenges, political responsibilities/spatial imaginaries, urban dynamics and political community/capacity-building in the city region: creating common spaces/which challenges for today's European metropolitan spaces? Plann Theory Pract 16:251–275. https://doi.org/10.1080/14649357.2015.1021574

Schipperijn J, Ekholm O, Stigsdotter UK, Toftager M, Bentsen P, Kamper-Jørgensen F, Randrup TB (2010) Factors influencing the use of green space: results from a Danish national representative survey. Landsc Urban Plann 95:130–137

Shkaruba A, Kireyeu V, Likhacheva O (2017) Rural–urban peripheries under socioeconomic transitions: changing planning contexts, lasting legacies, and growing pressure. Landsc Urban Plann.: dx.doi.org 165:244. https://doi.org/10.1016/j.landurbplan.2016.05.006

Smith A (2007) Emerging in between: the multi-level governance of renewable energy in the English regions. Energy Policy 35(12):6266–6280

Sugiyama T, Leslie E, Giles-Corti B, Owen N (2008) Association of neighbourhood greenness with physical and mental health: do walking, social coherence and local social interaction explain the relationship? J Epidemiol Commun H 62(5):e9

Swanwick C (2009) Society's attitudes to and preferences for land and landscape. Land Use Policy 26:S62–S75

Swinton SM, Lupi F, Robertson GP, Hamilton SK (2007) Ecosystem services and agriculture: cultivating agricultural ecosystems for diverse benefits. Ecol Econ 64:245–252

Tan Z, Zhang F, Rotunno R, Snyder C (2004) Mesoscale predictability of moist baroclinic waves: experiments with parameterized convection. J Atmos Sci 61:1794–1804

Taylor Lovell S (2010) Multifunctional urban agriculture for sustainable land use planning in the United States. Sustain 2:2499–2522

Terres JM, Nisini Scacchiafichi L, Wania A, Ambar M, Anguiano E, Buckwell E, Coppola A, Gocht A, Nordström Källström H, Pointereau P, Strijker D, Visek L, Vranken L, Zobena A (2015) Farmland abandonment in Europe: identification of drivers andindicators, and development of a composite indicator of risk. Land Use Policy 49:20–34

The Sierra Club (1999) The dark side of the American dream: The costs and consequences of suburban sprawl. Available at http:// http://www.sierraclub.org/sprawl/report98/report.asp

Thompson A, Stalker Prokopy L (2009) Tracking urban sprawl: using spatial data to inform farmland preservation policy. Land Use Policy 26:194–202

Todes A (2004) Regional planning and sustainability: limits and potentials of South Africa's integrated development plans. J Environ Plann Manag 47(6):843–861

Tu G, Abildtrup J, Serge Garcia S (2016) Preferences for urban green spaces and peri-urban forests: an analysis of stated residential choices. Landsc Urban Plann 148:120–131

Tzoulas K, Korpela K, Venn S, Yli-Pelkonen V, Kazmierczak A, Niemela J, James P (2007) Promoting ecosystems and human health using green infrastructure: a literature review. Landsc Urban Plann 81:167–178

Van Herzele A, Wiedemann T (2003) A monitoring tool for the provision of accessible and attractive urban green spaces. Landsc Urban Plann 63:109–126

Van Herzele A, De Clercq EM, Wiedemann T (2005) Strategic planning for new woodlands in the urban periphery: through the lens of social inclusiveness. Urban For Urban Gree 3:177–188

Vejre H, Søndergaard Jensen F, Jellesmark Thorsen B (2010) Demonstrating the importance of intangible ecosystem services from peri-urban landscapes. Ecol Complex 7:338–348

Webber S, Hanna K (2014) Sustainability and suburban housing in the Toronto region: the case of the Oak Ridges Moraine conservation plan. J Urban Int Res Placemaking Urban Sustain 7(3):245–260

Westerink J, Haase D, Bauer A, Perpar A, Grochowski M, Ravetz J, Jarrige F, Aalbers C (2013) Dealing with sustainability trade-offs of the compact city in peri-urban planning across European city regions. Eur Plan Stud 21:473–497

Whitehand JWR (1988) Urban fringe belts: development of an idea. Plan Perspect 3:47–58

Woodruff SC, BenDor TK (2016) Ecosystem services in urban planning: comparative paradigms and guidelines for high quality plans. Landsc Urban Plann 152:90–100

Yang Z, Hao P, Liu W, Cai J (2016) Peri-urban agricultural development in Beijing: varied forms, innovative practices and policy implications. Habitat Int 56:222–234

Zasada I (2011) Multifunctional peri-urban agriculture-a review of societal demands and the provision of goods and services by farming. Land Use Policy 28:639–648

Zasada I, Loibl W, Berges R, Steinnocher K, Koestl M, Piorr A, Werner A (2013) Rural-urban regions: a spatial approach to define urban-rural relationships in Europe. In: Nilsson K, Pauleit S, Bell S, Aalbers C, Nielsen TAS (eds) Peri-urban futures: scenarios ad models for land use change in Europe. Springer, Berlin Heidelberg, pp 45–68

Zezza A, Tasciotti L (2010) Urban agriculture, poverty, and food security: empirical evidence from a sample of developing countries. Food Policy 35:265–273

Zimmerman J (2001) The “nature” of urbanism on the new urbanist frontier: sustainable development, or defense of the suburban dream? Urban Geogr 22(3):249–267

Žlender V, Ward Thompson C (2017) Accessibility and use of peri-urban green space for inner-city dwellers: a comparative study. Landsc Urban Plann 165:193. https://doi.org/10.1016/j.landurbplan.2016.06.011