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REVIEW

The future of urban agriculture and biodiversity-ecosystem services: Challenges and next steps

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Abstract

Urban landscapes are spatially constrained, and vegetative land uses that provide beneficial ecosystem services are difficult to maintain. Urban agricultural (UA) systems appear in many forms – from community farms and rooftop gardens to edible landscaping and urban orchards – and can be productive features of cities and provide important environmental services. As highly managed plant communities, UA can exhibit high levels of biodiversity, often exceeding that of other green space areas within the city. Additionally, it is likely that variation in vegetation cover, diversity, and structure influence not only the biodiversity in UA, but also the quantity and quality of ecosystem services supported by such systems. The biodiversity and ecosystem services (B&ES) of UA can have potentially large societal and environmental benefits for cities, such as enhanced food security, air quality, and water regulation. Yet few studies have synthesized knowledge regarding UA vegetation management impacts on the quantity, quality, and stability of B&ES provided. This article presents the first survey of the existing research on the characteristics of UA management and their potential to support ecosystem service delivery. Specifically, we examine: (1) biodiversity patterns in UA, (2) ecosystem services provided by UA, and (3) the challenges of promoting UA systems that support B&ES. Overall, our review reveals that varied vegetative structure, increased native plant diversity, and reduction of urban impervious surface are key features of UA systems that contribute significantly to urban biodiversity and provide important ecosystem services such as pollination, pest control, and climate resilience. We conclude with a discussion of critical gaps in current research and strategies to better understand and support UA and ecosystem services.

Zusammenfassung

Urbane Landschaften sind räumlich eingegrenzt, und Landnutzungen durch Pflanzungen, die nützliche Ökosystemdienstleistungen erbringen, sind schwer zu unterhalten. Systeme der urbanen Landwirtschaft (UL) erscheinen in vielerlei Formen -von Gemeinschaftshöfen und Dachgärten bis hin zu ‘edible landscaping’ und urbanen Obstplantagen- und können produktive Elemente in Städten sein und wichtige Umweltdienstleistungen erbringen. Als intensiv bewirtschaftete Pflanzengemeinschaften kann UL reiche Biodiversität aufweisen, die oft die von anderen urbanen Grünzonen übertrifft. Zudem ist es wahrscheinlich, dass die Variation der Vegetation, Diversität und Struktur nicht nur die Biodiversität in der UL beeinflusst, sondern auch Quantität und Qualität der Ökosystemdienstleistungen, die von solchen Systemen erbracht werden. Die Biodiversitäts- und Ökosystemdienstleistungen der UL können potentiell großen Nutzen für Gesellschaft und Umwelt der

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Städte haben, z.B. bessere Nahrungsv ersorgung, Luftqualität und Wasserregulation. Nur wenige Studien haben indessen den Wissensstand zum Einfluss des Managements der Vegetation in der UL auf die Quantität, Qualität und Stabilität der erbrachten Biodiversitäts- und Ökosystemdienstleistungen zusammengefasst. Dieser Artikel bietet den ersten Überblick über die Forschung zu den Merkmalen der UL und ihrem Potential Ökosystemleistungen zu unterstützen. Im Einzelnen untersuchen wir die Biodiversitätsmuster in der UL, die erbrachten Ökosystemdienstleistungen und die Schwierigkeiten bei der Förderung von UL-Systemen, die Biodiversitäts- und Ökosystemdienstleistungen unterstützen. Insgesamt zeigt unser Review, dass eine vielfältige Vegetationsstruktur, erhöhte Pflanzendiversität und die Reduktion von undurchlässigen urbanen Bodenoberflächen die Schlüsselfaktoren sind, die UL signifikant zu urbaner Biodiversität beitragen lassen und für wichtige Ökosystemdienstleistungen wie Bestäubung, Schädlingskontrolle und ein ausgeglicheneres Stadtklima sorgen. Abschließend diskutieren wir die kritischen Lücken der gegenwärtigen Forschung und Strategien, um die UL und ihre Ökosystemdienstleistungen besser zu verstehen und zu unterstützen.

Keywords: Food security; Urban planning; Vegetation complexity; Agricultural management; Gardens; Green space

Introduction

Urbanization is a major driver of land cover change worldwide (Grimm et al., 2008) and affects the biophysical and socioeconomic landscape. It is estimated that by 2030 >60% of the global population will live in urban areas (United Nations, 2005). Furthermore, in many parts of the world, human development is expanding rapidly at the edge of urban areas (Brown, Johnson, Loveland, & Theobald, 2005) and the quality of rural habitat is declining owing to agricultural intensification (Benton, Vickery, & Wilson, 2003). Thus, green spaces found within urban landscapes are quickly becoming important refuges for native biodiversity (Goddard, Dougill, & Benton, 2010).

Urban planners are increasingly interested in maintaining agriculture within and around cities due to food security concerns. Many cities contain ‘food deserts’, where access to fresh produce is limited due to reduced proximity to markets, financial constraints, or inadequate transportation (Thomas, 2010; ver Ploeg et al., 2009). In response to food insecurity, urban agriculture (UA) has expanded rapidly. For example, in the US, UA has expanded by >30% in the past 30 years, especially in under-served communities (Alig, Kline, & Lichtenstein, 2004). This is because urban agriculture can be very productive, providing an estimated 15–20% of the global food supply (Hodgson, Campbell, & Bailkey, 2011; Smit, Nasr, & Ratta, 1996), and cities can provide good infrastructure, access to labor, and low transport costs for local food distribution (Hodgson et al., 2011). Additionally, interest in UA has escalated recently due to the desire to transform vacant land in post-industrial cities and to address nutrition and childhood obesity issues in disadvantaged urban neighborhoods (Yadav, Duckworth, & Grewal, 2012).

Though public and scientific interest in UA has grown dramatically in the past two decades, there are still significant challenges for integrating UA in an increasingly spatially constrained urban landscape. Much of the debate is centered on land-use trade-offs of UA versus other types of urban development. Although there are a number of socioeconomic considerations that affect the development and proliferation of UA in cities, this review will focus on the ecological aspects of the UA system and how they can be designed to maximize the environmental and health benefits in order to increase acceptance of this particular land use in the urban sphere.

One way to encourage the integration of UA is to better understand how planned and associated biodiversity within these systems contribute to urban ecosystem services. However, there are three major gaps in the literature regarding UA status and impacts that limit our ability to increase the range of benefits and ecosystem services that could come from UA systems. First, biodiversity patterns in urban agroecosystems have only recently been documented (Beniston & Lal, 2012) and require synthesis. Second, ecological communities within UA may translate to the delivery of valuable ecosystem services (e.g., pollination, pest-control, water regulation) (Daily, 1997); however, the availability of these services within UA has not been well-established. Finally, little is known about the role of UA in mediating resilience to major threats, specifically climate variability (Eriksen-Hamel & Danso, 2010). Considering the potential benefits of UA for improved ecosystem functioning, in this review we discuss (1) the ability of UA to support local and landscape level biodiversity, (2) the role of UA in providing ecosystem services, and (3) the agenda for future UA research.

What is urban agriculture?

Urban agriculture (UA) is defined as the production of crop and livestock goods within cities and towns (Zezza & Tasciotti, 2010), generally integrated into the local urban economic and ecological system (Mougeot, 2010). UA can include the peri-urban agricultural areas around cities and towns, which may provide products to the local population (Mougeot, 2010).