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Farmland – an Elephant in the Room of Urban Green Infrastructure? Lessons learned from connectivity analysis in three German cities

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ABSTRACT

In recent years, Urban Green Infrastructure (UGI) has gained broad political support and has evolved to become a new research topic in the area of sustainable urban development. The focus has been largely on green urban structures, such as parks and urban forest. The role and contribution of farmland has often been neglected. This work wants to scrutinise the potential of farmland's contribution to the basic conception of UGI, in particular, with regard to connectivity. It reports on three case studies from Southern Germany, in the peri-urban regions of the three largest and expanding cities of Bavaria: Munich, Nuremberg and Augsburg. The spatial analysis we used is transparent, simple and repeatable. It is transferable to any European urban area. We use habitat suitability modelling to map the potential spatial distribution of low-intensity farmland, with emphasis on grassland systems. Based on these potential distributions, landscape indicators are used to analyse structural connectivity. Structural connectivity is used as a surrogate for functional connectivity, which supports ecological and abiotic processes and functions, but on the other hand characterises functional social connectivity, with respect to the accessibility of recreation. The results of this study suggest that farmland bears a great potential to contribute to UGI. The immediate surroundings of the cities do not just offer spatial potential but can enhance connectivity significantly. Based on these results some recommendations have been formulated to enable a better appreciation of farmland and farmers as partners for effectively developing strategies for UGI planning and sustainable urban development.

1. Introduction

1.1. Urban Green Infrastructure

In the past years Green Infrastructure (GI) evolved to a spatial planning strategy for landscape planning in Europe, reaching a broad political consensus. The development of GI belongs to one of the six main targets of the EU Biodiversity Strategy to 2020, to maintain, enhance, and restore ecosystems and their services (European Commission, 2011). To implement the EU Biodiversity Strategy to 2020 the European Commission adopted the GI Strategy, defining GI as "a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services." (European Commission, 2013). It is being supported by the European Economic and Social Committee (EESC) because of its aim of "linking environmental benefits with economic and social benefits" (EESC, 2013) and by the EU's Committee of the Regions (COR) as well, as it contributes to a sustainable urban model (COR, 2013). Although Urban Green Infrastructure (UGI) has matured in past decades as a spatial planning and design concept for sustainable urban development (e.g., Benedict and McMahon, 2002, 2006; Kambites and Owen, 2006; Walmsley, 2006; Ahern, 2007; Rouse and Bunster-Ossa, 2013; Mell, 2016) this political backup fostered new impulses for European research activities (e.g., Naumann et al., 2011; Davies et al., 2015).

Systematic overviews of different approaches, classification systems, and principles on GI planning are offered by Mell (2016), Young et al. (2014), and Bartesaghi et al. (2016). Although these can be very diverse – reflecting different objectives, contexts and disciplines, in which GI is considered – there is a general consensus that the basic conception in regard to multifunctionality and connectivity are fundamental requirements (Kambites and Owen, 2006; Pauleit et al., 2011). A comprehensive overview of different planning principles, which can take up urban challenges such as biodiversity, climate change adaptation, social cohesion and green economy, is given by Hansen et al. (2016). However, although elements such as public parks, green roofs,

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street trees, and urban forests are intensively considered and studied as essential components of UGI, it can be concluded that in comparison the role of farmland has been mostly neglected (c.f. Bartesaghi et al., 2016). The omission of farmland is surprising, given that agricultural land dominates many European urban areas (EEA, 2013). Urban and peri-urban farmland thus offers a considerable potential for developing the UGI. For instance in the Ruhr metropolitan region, the largest urban agglomeration in central Europe, nearly 40% is farmland, thus "the most important land user" (Pölling and Born, 2015).

1.2. Urban and peri-urban agriculture

(Mougeot 2000) defines urban and peri-urban agriculture (UPA) as "within (intra-urban) or on the fringe (peri-urban) of a town, a city, or metropolis that grows or raises, processes and distributes a diversity of food and non-food products, (re-)uses largely human and material resources, products and services found in and around that urban area, and in turn supplies human and material resources, products and services largely to that urban area". Although, boundaries a rather fuzzy this definition can be related to the understanding of functional urban areas according to (Piorr et al. 2011). Implications of UPA are manifold and have been discussed from various different ecological and socio-economical perspectives (e.g., Allen et al., 2003; Van Veenhuizen and Danso, 2007; Pearson et al., 2010; Zasada, 2011; Mok et al., 2013; Souse and Sales, 2013; Viljoen and Bohn, 2014; De Zeeuw and Drechsel, 2015; Rogus and Dimitri, 2015; Lohrberg et al., 2016).

Philips (2013), Viljoen and Bohn (2014) show how UPA can be considered in urban planning. In the last years too, UPA has been increasingly gained attention from researchers, stressing it in the context of UGI explicitly (e.g., Dunn, 2010; La Greca et al., 2011; La Rosa and Privitera, 2013; Timpe et al., 2015). Dunn (2010) for instance has pointed out positive effects of agricultural use as part of UGI, to stimulate local economy and create green collar jobs, such as organic farming. Furthermore it provides space for food production, lower food costs with benefits for city populations with low income. La Rosa et al. (2014) present a land use suitability strategy model for UGI development in which different forms of UPA play a vital role to enhance urban quality and to improve human health. Timpe et al. (2011) stresses the process of place making, using agriculture to improve life quality and for socio-emotional appropriation of the space. Furthermore there are some practical examples that show, how farmland can be implemented in UGI strategies. For instance the "Green Infrastructure and Biodiversity Plan 2020" of Barcelona, defines the goal "to promote agriculture in the city and outlying areas by applying a model of exploitation that provides social, economic and ecological benefits" (Barcelona City Council, 2013). The agricultural park in Barcelona – Baix Llobregat Agricultural Park – an area of about 3000 ha size, close to the city centre of Barcelona has its own development and management plan taking into account green space provision and landscape recreation (Consorci Parc Agrari Del Baix Llobregat, 2004). Also the City of Milan considers farmers as partners for the development of the green space network within the Regional Ecological Network – Rete Ecologica Regionale (RER) for the Lombardy region (Regione Lombardia, 2010). The "Parco Agricolo Sud Milano" a green belt adjacent to the City of Milan, covering an area of 47.000 ha, is playing and integral role for the development of the network, for protecting and enhancing urban green spaces both, at the city and regional level (Hansen et al., 2016).

Yet, it needs to be considered, that UPA is very diverse, and differs in regard to location, dimension, function, economic activity, motivation, purpose, and actors involved (e.g., Schulz et al., 2013; Mok et al., 2014; Lin et al., 2015; Aerts et al., 2016; Lohrberg et al., 2016). Roughly we can distinguish between small scale gardening activities and large scale, commercial farming activities, although there are many overlaps and hybrids. Farming models that are related to the maintenance of cultural heritage, conservation of agro-diversity and biodiversity, such as explicit environmental friendly production and/or landscape preservation, often linked with the marketing of high value products including the provision of other cultural and social values, are understood "as good examples of agriculture-based green infrastructure within metropolitan areas" (Lohrberg et al., 2016).

Fig. 1. In the designated "Grazing Town Augsburg", a coalition of farmers, nature conservationists and the city administration – the so called Landschaftspflegeverband Stadt Augsburg – promotes grazing management systems, such as traditional transhumance of shepherding, to maintain and develop low-intensity farmland in recreational areas. This serves as a good practice example of low-intensity farmland as part of UGI and its multifunctionality: management of recreation areas with high attractiveness and biodiversity, supporting cultural heritage and agro-diversity in combination with an explicit environmental friendly production of agricultural products (Photo: Liebig, 2002).

1.3. Low-Intensity Farmland and Urban Green Infrastructure

As such low-intensity farmland bears potentials for agriculture-based UGI (Fig. 1). In our means we understand low-intensity farmland as region-specific management practices with variances that is often reflecting prevailing environmental conditions i.e. geophysical factors like soil, climate and topography (cf. Baldock et al., 1993; Beaufoy et al., 1994; Van Velthuizen et al., 2007). This relates to the origins of the concept of "high-nature-value farmland" (HNVf). (Oppermann et al., 2012). Thus semi-natural pastures, meadows and orchards build an essential part of low-intensity farmland. However, because HNVf is primary understood as an indicator for European Union agricultural and environmental policies and Common Agricultural Policy (CAP) with legal implications (Andersen et al., 2003; Parachini et al., 2006), we rather use the term of low-intensity farmland in our work.

In rural areas low-intensity farmland has already been recognised as a useful component in GI strategies (EEA, 2011; ; Mazza et al., 2011), contributing to core zones (Fritz, 2013) or buffer zones (Benedict and McMahon, 2006). In central European human-dominated traditional cultural landscapes, it is widely accepted that low-input agricultural management practices have sustained biodiversity and ecosystem services over the last centuries (Jones-Walters, 2008; García-Llorente et al., 2012; Poschlod, 2015). Raudsepp-Hearne et al. (2010) show that low-intensity management can enhance multifunctionality, leading to higher regulating and cultural ecosystem services in *peri*-urban agricultural landscapes. Furthermore (Hector and Bagchi, 2007; Allan et al., 2015) proved linkages between land-use intensity, biodiversity, and multifunctionality of ecosystem services in several European grassland experiments. Hence, there is empirical evidence, suggesting that at least one of the two basic requirements, namely multifunctionality, can be met by low-intensity farmland, thus improving the quality of the UGI. But what about the second mentioned principle, connectivity? This relates to a second question: how large is the potential in the urban areas, for low-intensity farmland, and where are they?

This study explores the potential contribution of low-intensity farmland with special emphasis on grassland systems, for UGI development, focusing on connectivity. To address this question we use a