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Research paper

A bottom-up approach to map land covers as potential green infrastructure hubs for human well-being in rural settings: A case study from Sweden

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ABSTRACT

Green infrastructure (GI) policy encourages the spatial planning of natural and semi-natural areas to deliver biodiversity conservation and a wide range of ecosystem services (ES) important to human well-being. Much of the current literature relies on expert-led and top-down processes to investigate connections between landscapes' different land covers and ES. Little is known regarding the preferences of residents, and how they connect land covers with the delivery of ES important for their well-being. The aim of this study is to identify and locate such land cover types as GI that provide multiple ES important for human well-being in rural settings. First, we interviewed 400 urban and rural residents to identify ES important for personal well-being and the land covers that deliver multiple ES in three counties that best represent the existing rural-urban gradient in Sweden. Second, to support the inclusion of GI in spatial planning, we identified and located spatial concentrations of individual land covers providing multiple ES (GI hubs) and significant clusters of such land covers (GI hotspots). The majority of urban and rural respondents associated their well-being with lakes, mountains above the tree-line, old-growth forests, wooded-pastures, mature pine forests and rural farmsteads. The areal proportion of each type of hub was low, on average 3.5%. At least three land management strategies are needed to sustain GI hubs: maintenance of the composition, structure and function of natural ecosystems in protected areas; support for traditional agroforestry and villages as social-ecological systems; and diversification of the current intensive forest management approach.

1. Introduction

Green infrastructure (GI), a policy concept that highlights the importance of natural capital for human well-being, is identified as one of the key policy priorities for the European Union (EU) (European Commission, 2013). GI is expected to make a significant contribution to the provision of ecological, economic and social benefits to human society through natural solutions (European Commission, 2013). Similarly, scholars envision GI as a promising land management approach that is able to reconcile various interests of different stakeholder groups in obtaining multiple benefits from landscapes, whilst simultaneously maintaining biodiversity (Ewers, Kapos, Coomes, Lafortezza, & Didham, 2009; Davies, MacFarlane, McGloin, & Roe, 2006; Lafortezza, Carru, Sanesi, & Davies, 2009; Lafortezza, Davies, Sanesi, & Konijnendijk, 2013).

Conceptually, GI evolved more than a century ago in the United Kingdom and the USA along two paths. One approach views GI as the linking of urban parks and other green space into functional networks to benefit people, whilst the other approach sees GI primarily as a biodiversity conservation measure to counteract habitat degradation and fragmentation (Allen, 2014; McMahon, 2002, 2006; McMahon, 2002, 2006; Lafortezza et al., 2009). GI's long and diverse conceptual development trajectory has led to multiple definitions and interpretations (Benedict & McMahon, 2002; Wright, 2011 Weber, Sloan, & Wolf, 2006). In this paper we use the definition of GI provided by the EU (European Commission, 2013) as a 'strategically planned network of high quality natural and semi-natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings'. Thus, GI should fulfil two main functions; one related to

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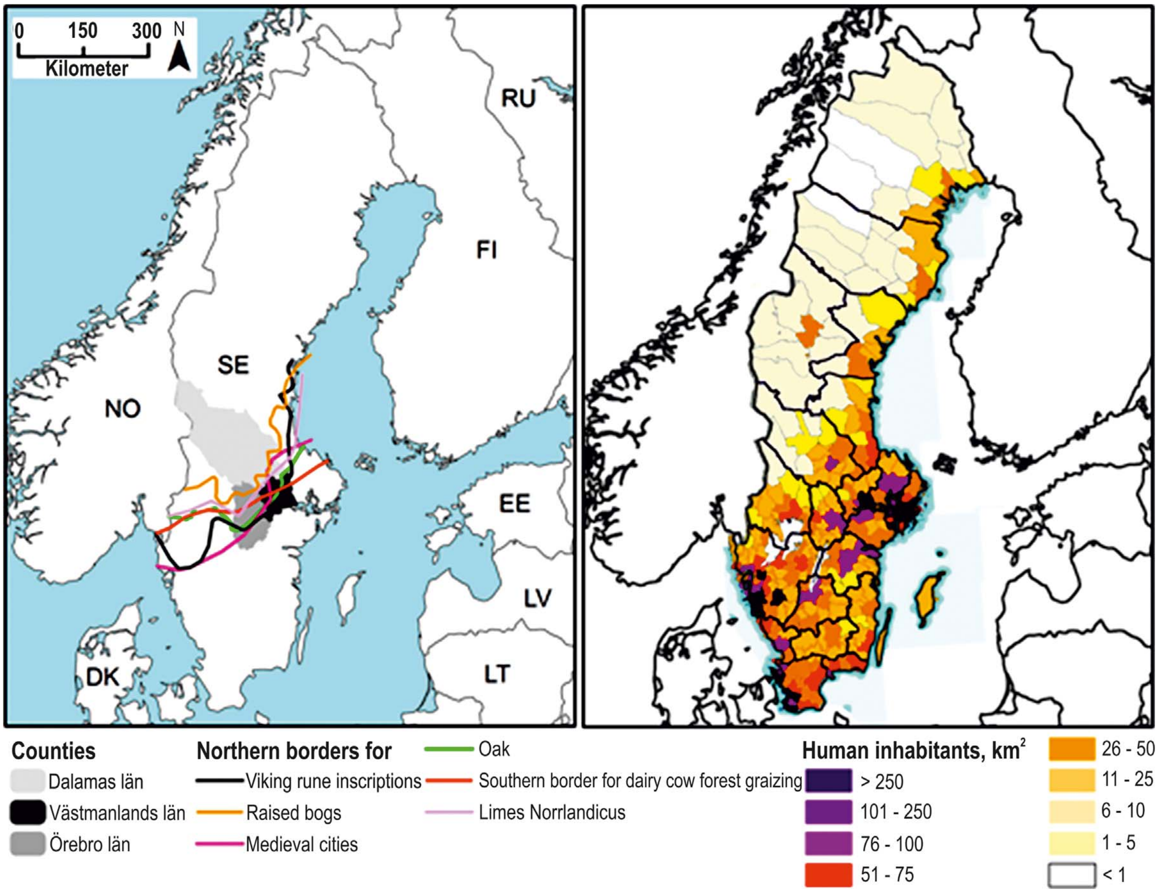

Fig. 1. Location of the three counties, Örebro, Västmanland and Dalarna that were chosen as a study area representing the rural-urban gradient in Sweden (left). The maps show the steep biogeographic and cultural transition zone (left), and the steep urban-rural gradient within the study area (right).

biodiversity conservation and the other to human well-being.

In this paper, we focus solely on human-related functions of GI that deliver 'a wide range of ecosystem services (ES) for human well-being (European Commission, 2013; Forest Research, 2010). ES are the benefits that people obtain, directly or indirectly, from ecosystems (Constanza et al., 1997; Daily, 1997; Lele et al., 2013; MA, 2005). These include provisioning, regulating, cultural and supporting ES (TEEB, 2010 MA, 2005). Ecosystem services research focuses primarily on the supply side of ES by mapping ecosystem properties as components of GI based on a quantification of ecological characteristics to provide a certain ES using spatial analyses of different land covers and other spatially explicit data. However, recent studies also demonstrate the importance of addressing the demand side of ES (Bagstad et al., 2014) in terms of the perspectives and interests of the public or diverse stakeholder groups regarding ES, and the consequences for their well-being (Colding, Lundberg, & Folke, 2006;Tuvendal & Elmqvist, 2011; Garrido, Elbakidze, & Angelstam, 2017; Garrido, Elbakidze, Angelstam, Plieninger et al., 2017). Following Huntsinger & Oviedo (2014), we also acknowledge that some ES are social-ecological services due to the considerable human past and present influence exerted on the composition, structure and functions of ecosystems (see also Lele, Springate-Baginski, Lakerveld, Deb, & Dash, 2013). As Díaz et al. (2011) specified, the various land use/management decisions (e.g., grazing, mowing, wood harvesting) that societal actors make, in order to obtain particular ES or a bundle of ES, have important impacts on ecosystems in terms of land covers, functional diversity and ecosystem properties. Although GI networks should include and connect both urban and rural areas (European Commission, 2013), most studies of GI for human well-being focus on urban contexts. Few studies have investigated the potential of GI to sustain and deliver multiple ES for human well-being in rural settings (Andersson, Angelstam, Elbakidze, Axelsson, & Degerman, 2013; Oteros-Rozas et al., 2014; Villamor, Palomo, Santiago, Oteros-Rozas, & Hill, 2014; Scholte, Teeffelen, & Verburg, 2015). Thus, there are still major gaps in GI research that are challenging for policy implementation.

From a spatial planning perspective, GI consists of hubs as structural components that contribute to maintaining a network of sites supporting ecological and social processes (e.g., Benedict & McMahon, 2002; Ortega-Álvarez & MacGregor-Fors, 2009). According to Ortega-Álvarez & MacGregor-Fors (2009), hubs provide multiple ES for people and serve as source habitats for species. These spatial elements have different sizes and shapes depending on the type and services being provided (Benedict & McMahon, 2002). Hubs refer to multifunctional terrestrial and aquatic land covers at a variety of spatial scales, from tree-lined streets and streams to woodlands, old-growth forests, and rivers and marine areas (Davies et al., 2006; Forest Research, 2010; European Commission, 2013). Thus, it is crucial to map key natural and semi-natural areas as potential spatial elements of GI networks, and to identify land management strategies that are important for sustaining the provision of demanded ES. Ideally, such knowledge should be available prior to grey infrastructure development or other planned changes in land use systems that might affect the long-term maintenance of multifunctional landscapes (Davies et al., 2006).

The aim of this study is to identify and map potential GI hubs that provide multiple ES important for human well-being with a focus on rural settings. The case study area, in central Sweden, is representative of an urban-rural gradient common to many West European countries where urbanization has accentuated a disconnect between people and natural resources, and where the intensification and modernization of natural resource use has resulted in depopulation of rural areas