# FOREST FACTS



Mountains above the tree-line, lakes, old-growth forests, wood-pastures, single rural farmsteads and mature pine forests are prioritised land covers by urban and rural inhabitants. Photos: Per Angelstam.

# Priority land covers of green infrastructure for human well-being in Central Sweden

Marine Elbakidze, Per Angelstam, Lucas Dawson, Taras Yamelynets, Mersha Gebrehiwot, Nataliya Stryamets, Karl-Erik Johansson, Pablo Garrido, Vladimir Naumov and Michael Manton

Green infrastructure is a strategically planned network of high quality natural and semi-natural areas designed and managed to **deliver a wide range of ecosystem services and conserve biodiversity** in both rural and urban settings.

To identify natural and semi-natural areas that provide important benefits for human well-being, or priority land covers, **we interviewed 400 rural and urban residents** in the three counties that best represent the existing rural–urban gradient in Sweden.

**Mountains above the tree-line, lakes, old-growth forests, wood-pastures, single rural farmsteads and mature pine forests were identified** by the majority of respondents as important for their well-being (see photographs above).

To support the inclusion of green infrastructure in spatial planning, **we identified places with high concentrations of priority land covers**. The area proportions of the preferred land covers were low.

**At least three management strategies are needed** to sustain green infrastructures for human well-being:
(1) to maintain composition, structure and function of natural ecosystems through the development of functional protected area networks;
(2) to maintain traditional agroforestry practices, and viable villages as social-ecological systems;
(3) to diversify forest management in order to retain attractive forests as a source of multiple ecosystem services.

According to EU and Swedish policy, green infrastructure is 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 conserve biodiversity in both rural and urban settings. Green infrastructure should fulfil two main functions: biodiversity conservation and human well-being. This study focused solely on human–related functions of green infrastructure that deliver a wide range of ecosystem services for well-being of both urban and rural residents.

From a spatial planning perspective, there is a need to identify and locate priority land covers that provide multiple

# Priority land covers of green infrastructure for human well-being in Central Sweden

ecosystem services for human well-being, which could be used as core elements of green infrastructure networks. Priority land covers might have different sizes and shapes depending on the type and the services being provided. Using a bottom-up approach we identified and located priority land covers of green infrastructure for human well-being in the three counties that best represent the existing rural-urban gradient in Sweden.

## Central Sweden as a case study

Three counties – Dalarna, Västmanland and Örebro – capture most of Sweden's biophysical and socio-economic diversity (Figure 1). Local landscapes range from urban and agricultural areas with scattered temperate forest remnants in the south to remote boreal forest regions and mountains above the tree line in the north. The selected counties are also representative of Sweden's land use history, beginning with the clearing of old-growth forests for agricultural and animal husbandry in the south more than 5000 years ago. The industrial production of metals began in parts of the region more than 2000 years ago. In contrast, the northernmost part was until recently relatively untouched by intensive land use – agriculture began there less than 200 years ago, and it remains on the logging frontier with a few remaining areas of near-natural forest close to the tree-line.

While wood, metal and water once served as the main basis for commodity production, immaterial values are becoming an increasingly important part of rural development in the study area. Natural and cultural landscape values are emerging as key providers of post-modern products for tourism and recreation and for attractive living.

## Interviews with urban and rural residents

In total, 400 interviews were conducted during the summer of 2015. Respondents ranked the importance of the tangible and intangible benefits of landscapes for their personal well-being. They also identified natural, semi-natural or built-up areas that provided the most important benefits for them. A total of 24 land cover types found in the study area were presented as photographs printed in A4 format. The photos mirrored the land covers in the Swedish urban-rural gradient from near-natural and managed forests to agroforestry areas, large-scale and small-scale agriculture, urban areas and roads, as well as lakes and mountains above the tree-line. Respondents were also asked to explain the benefits provided by each chosen land cover for their personal well-being. In addition, respondents provided relevant personal data, including country of origin, education, occupation, age, gender, length of residence in the county, and type of land/real estate that they owned in the study area (if any).

## Locating priority land covers

We analysed the interview data to identify those land covers that were desired by more than 50 % of the interviewees. Using publicly available spatial databases, we identified the location of these priority land covers within the study area. We then conducted geo-statistical analysis to map the most important areas with high concentrations of priority land covers, or hotspots of green infrastructure networks.

## Priority land covers of green infrastructure

Rural respondents identified lakes, mountains above the tree-line, old-growth forests, wood-pastures, rural farmsteads and mature pine forests as priority land covers for their personal well-being. Urban respondents, on the other hand, identified only the first three of these as being important. For both rural and urban respondents, each of these land cover types was associated with multiple ecosystem services. Our results suggest that, in the Swedish context, green infrastructure is expected to provide multiple ecological, economic, cultural and social functions with recreation/tourism (social); sense of place and inspiration (cultural); wild food, timber and food from subsistence farming (economic); and habitats for species (ecological) as those most frequently mentioned by respondents.

## Spatial distribution of priority land covers

Lakes and mature pine forests were evenly distributed, occupying 8 % and 7 % of the study area, respectively. Old-growth forests (2 % of the study area), although scattered throughout, were more common in the northernmost part of Dalarna, which was also the only location of mountains above the tree-line (2 %). Rural farmsteads and cultural wood-pastures (1 % of the study area) were more frequent in the south. As
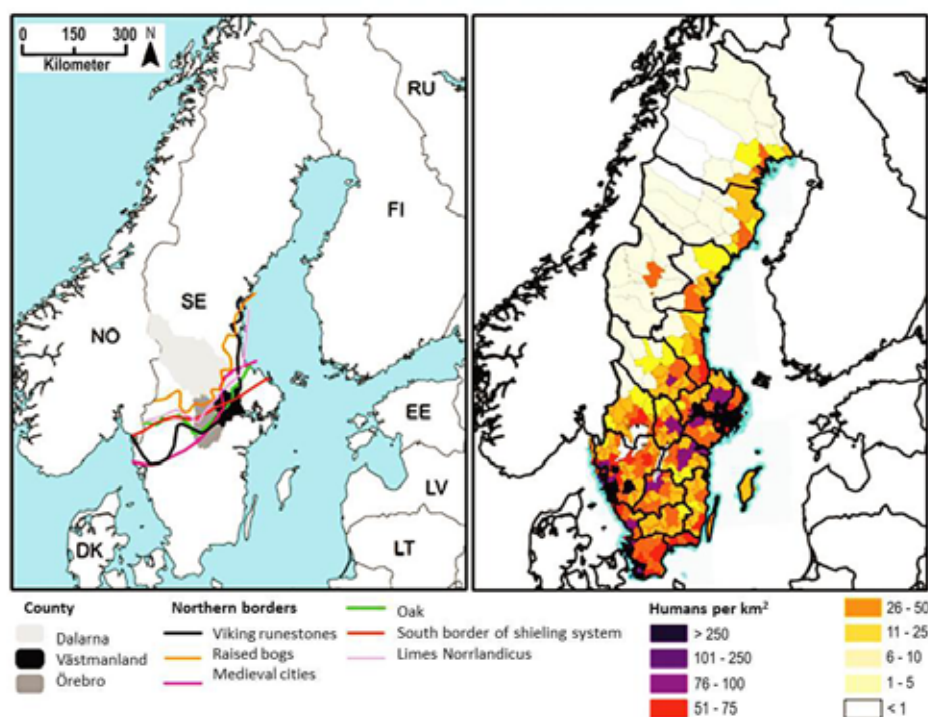


Figure 1. Location of the study area formed by the three counties Örebro, Västmanland and Dalarna (shaded areas), that together form Sweden's steepest biogeographic and cultural transition zone (left). Swedish municipal human population densities (right) illustrate the steep urban-rural gradient within the study area.

Figure 2 shows, priority land covers for human well-being are highly fragmented.

The highest proportions of all priority land covers were found in the municipalities of Älvdalen (28 % of total area), Arboga (27 %) and Askersund (26 %) for both urban and rural people (Figure 3). The lowest proportion (< 5 %) was in Kumla municipality. The highest area proportions of green infrastructure's hotspots were in Arboga and Laxå municipalities (24 % of total area), and the lowest proportion in Kumla (0 %) (Figure 4).

### Planning for green infrastructure in Sweden

Green infrastructure planning and development have to address a variety of social meanings and perceptions attached to natural and semi-natural areas, whilst continuing to provide multiple tangible services. The priority land covers identified provide similar sets of material and immaterial services. However, many ecosystem services important to human well-being are location-specific or otherwise not easily substitutable. For example, those who prefer old-growth forests for recreation may not be able to substitute their preferences by using lakes or mature pine forests. Substitution is even more difficult regarding sense of place, which is often connected to the personal identity of places. Thus, loss of priority land covers might lead to a decline of specific ecosystem services important for human well-being in a given area.

The bottom-up approach presented here could be adopted as a first step in the strategic spatial planning of green infrastructure networks that aims at local/regional identification and location of priority land covers and their main functions. For example, green infrastructure hotspots could be included in spatial planning for human well-being at the regional level, while single priority land covers of different sizes might be included into green infrastructure networks at the local level. Operational planning will be also useful to develop physical plans to design functional green infrastructure networks on-the-ground.

Discussions among relevant stakeholders, including input from the general public, can help to outline appropriate land management strategies for each specific area. In Sweden, one opportunity to legitimize priority land covers is to include these areas in municipal comprehensive plans.
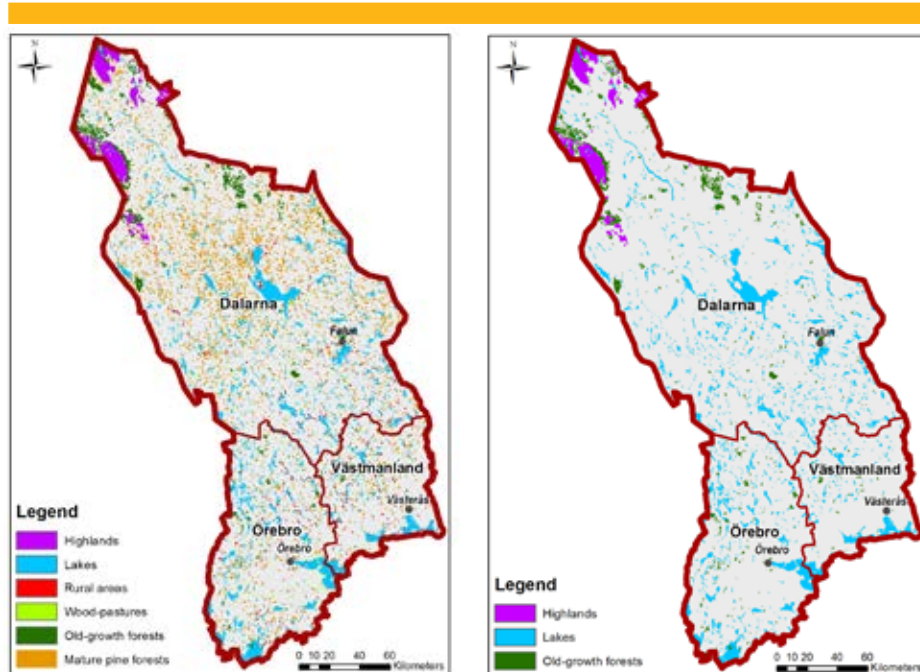


Figure 2. Spatial distribution of priority land covers for rural (left) and urban (right) respondents.

However, large differences remain among municipalities regarding the availability of financial resources, data, skills and knowledge required for spatial planning. Additionally, municipalities experience difficulties in coordinating complex issues regarding long-term planning to steer territorial development and to solve conflicts among competing interests. There is a strong need for arenas for landscape stewardship, which allow and promote stakeholder activity, participation and inclusion for green infrastructure development. This can, with appropriate promotion and extension services, support sustainable rural development.
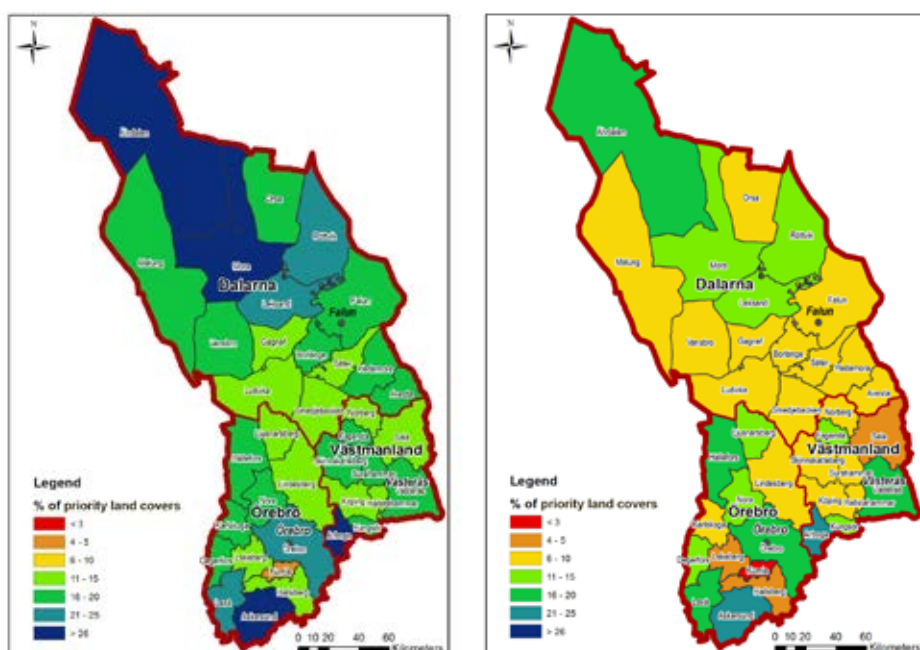


Figure 3. Area proportion (% of the total area of each respective municipality) of all priority land covers for rural people (left) and for urban people (right).
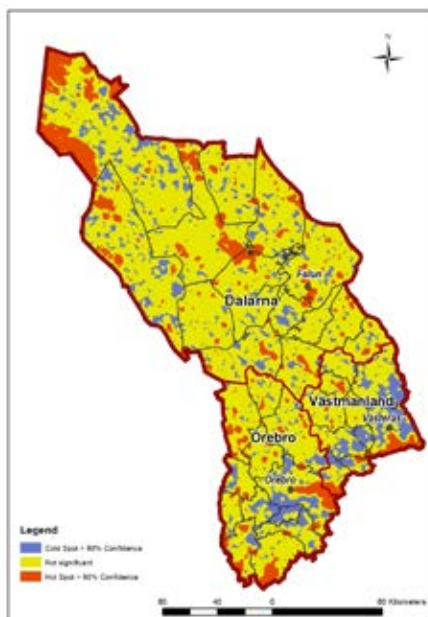
Figure 4. Location of green infrastructure hotspots as places of high concentration of priority land covers in rural settings.

**Three strategies and challenges towards functional green infrastructure for human well-being**

1. Maintenance of the composition, structure and function of natural ecosystems via the development of functional protected area networks, especially regarding old-growth forests. This is, however, challenged by existing protected areas and set-aside forests being scattered throughout the landscape, and having insufficient area and connectivity to satisfy current forest and environmental policy ambitions.

2. Maintenance of (1) traditional agro-forestry practices in wood-pastures, and (2) villages as social-ecological systems. However, traditional agricultural practices are currently of marginal profitability, which endangers traditional land-use systems and the resulting ecosystem services created by cultural landscapes as interconnected social and ecological systems.

3. Diversification of current forest management in order to retain attractive forests as a source of multiple ecosystem services for human well-being. However, in spite of increasing concerns among stakeholders about the negative impact of intensive forest management on forest landscapes, the contemporary focus on intensive forestry in terms of maximum sustained yield wood production is a challenge ■

> **"The bottom-up approach ... could be adopted as a first step in the strategic spatial planning of green infrastructure networks..."**

**Read more:**
▸**Angelstam, P. & Elbakidze, M. 2017.** Forest landscape stewardship for functional green infrastructures in Europe's West and East: diagnosing and treating social-ecological systems. In: Bieling, C. and Plieninger, T. (eds.) The Science and Practice of Landscape Stewardship. Cambridge University Press, pp 124–144.
▸**Elbakidze, M., Angelstam, P., Yamelynets, T., Dawson, L., Gebrehiwot, M., Stryamets, N., Johansson, K.-E., Garrido, P., Naumov, V. & Manton, M. 2017.** 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. Landscape and Urban Planning 168: 72–83.

▸**Elbakidze, M., Dawson, L., Andersson, K., Axelsson, R., Angelstam, P., Stjernquist, I., Teitelbaum, S., Schlyter, P. & Thellbro, C. 2015.** Is spatial planning a collaborative learning process? A case study from a rural–urban gradient in Sweden. Land Use Policy 48: 270–285.
▸**European Commission. 2013.** Green Infrastructure (GI) – Enhancing Europe's Natural Capital. COM 249.

**Authors:**
**School for Forest Management, SLU, SE-73921 Skinnskatteberg, Sweden:**
Marine Elbakidze – marine.elbakidze@slu.se
Per Angelstam – per.angelstam@slu.se
Pablo Garrido – pablo.garrido@slu.se
Mersha Gebrehiwot – mershagebrehiwot@gmail.com
Vladimir Naumov – vladimir.v.naumov@gmail.com

**Stockholm University, Sweden:**
Lucas Dawson – lucas.dawson@natgeo.su.se

**Lviv National University of Ivan Franko, Ukraine:**
Taras Yamelynets – taras.yamelynets@gmail.com

**Skinnskatteberg municipality, Sweden:**
Karl-Erik Johansson – karl-erik.johansson@skinnskatteberg.se

**Aleksandras Stulginskis University, Lithuania:**
Michael Manton – michael.manton@asu.lt

**Roztochya Nature reserve, Ukraine:**
Nataliya Stryamets – natastr@gmail.com

Figures 1–4 are reprinted from Elbakidze et al. (2017) with permission from Elsevier.