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GRETA - “GReen infrastructure: Enhancing biodiversity and ecosysTem services for territoriAl development”

Applied Research

Case Hämeenlinna

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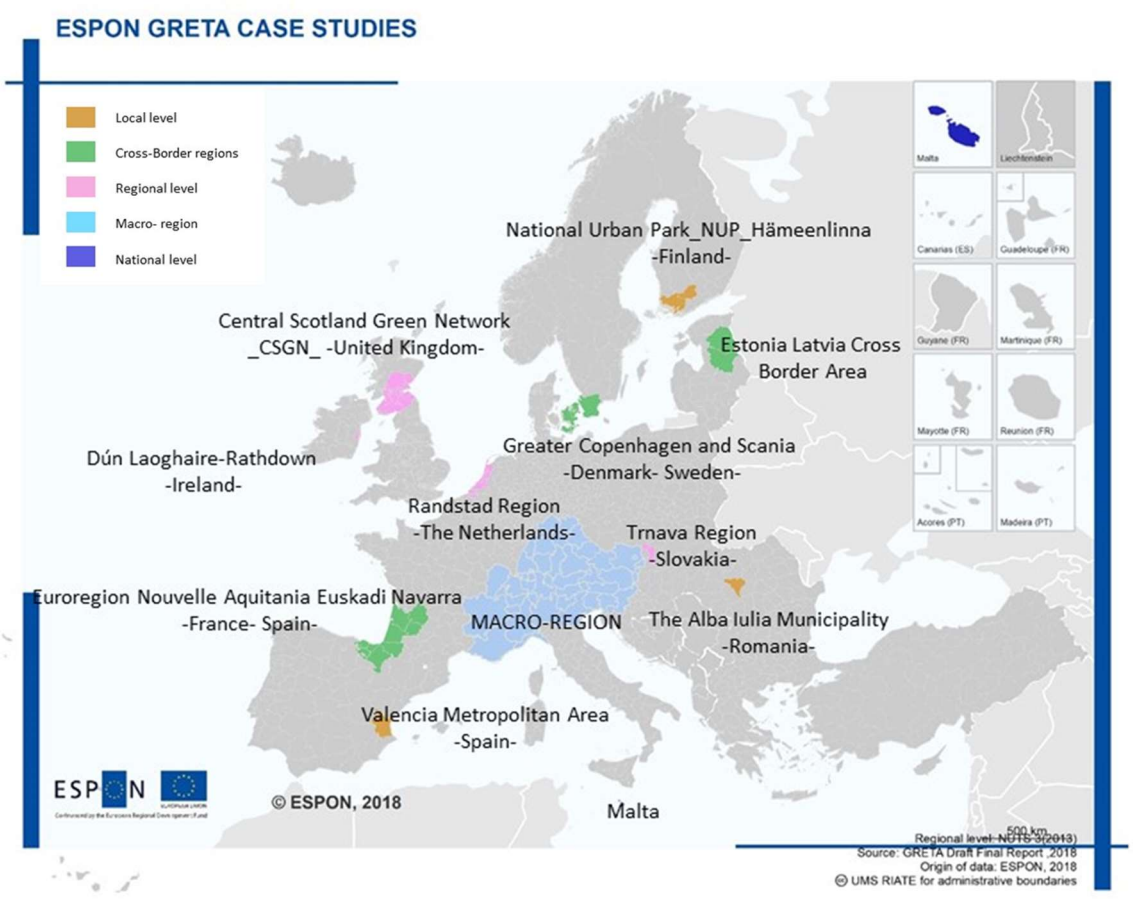
Abbreviations

EC	European Commission
ES	Ecosystem Services
ESPON	European Territorial Observatory Network
EU	European Union
GI	Green Infrastructure
NUP	National Urban Park
NUTS	Nomenclature of Territorial Units for Statistics
TEN	Trans-European Network

1 Introduction

GRETA investigated 12 case studies that represented different spatial, institutional and governance settings and that ranged from urban centres to rural countryside. The case studies served to:

i. gain knowledge on implementation factors, drivers and constraints in different planning systems and territorial realities;
ii. gain insights on the use and applicability of economic methods in decision making; and
iii. gather knowledge for policy and practice as input and inspiration for the policy recommendations.



Map 1. ESPON GRETA selected case studies

Method

The activities undertaken at the case study level incorporated a combination of desk-based analysis alongside online questionnaires and pre-structured interviews to key actors in each of the case study areas, including: (i) decision and policy making representatives; and (ii) those involved in designing, planning, implementing and managing green infrastructure (GI).

A series of three consultations were developed to gather relevant information from case studies on different aspects of GI spatial analysis, policies, planning and implementation. The consultation process was seen as a combined approach of an online survey and or a telephone interview (which used the survey questions as the basis) with stakeholders to facilitate getting good engagement and to address any clarifications needed.

Consultation A – Economic Valuation

The questionnaire included 20 questions structured in 2 main parts. The first part aimed at understanding the current use and awareness of valuation methods by respondents while the second part aimed at identifying their perceived barriers and interest of using such methods. We used a mix of open-ended and closed-ended questions to combine comparable results as well as qualitative material; respondents also had the possibility to comment on their responses. Analysis of Consultation A is described in Annex III-C.

Access to Consultation A

https://survey.tecnalia.com/limesurvey/index.php/214247?lang=en

Consultation B – Characterising green infrastructure and ecosystem services characterisation

The objective of this consultation was to identify good practice guidelines, opportunities and challenges that could be useful for a variety of regions and cities. Responses to Consultation B were used to assess the usefulness of the GRETA methodology, a methodology specifically developed to delineate and map the main green infrastructure (GI) elements and their multifunctionality, as well as identifying their capacity to support three main policy domains: Biodiversity, Climate Change and Disaster Risk Reduction, and Water Management. Questions in Consultation B were designed to help us gain further insight into the enabling factors that exist in different regions and cities. We also sought to gather information on the challenges and barriers that may compromise the implementation of GI. The final set of questions focused on identifying the general benefits and potential synergies and trade-offs associated with GI projects.

The maps produced for Consultation B in the GRETA project were intended to provide a starting point for discussion about the applicability of the GRETA methodology from European to local application. As such they did not aim to be a substitute for the maps or other planning material that already exist at local case study level nor were they aiming to characterize the GI on regional or local level. They were not developed to be used as an output from case study levels.

The landscape elements in the maps are produced based on standardized European data sets with a minimum mapping unit of 25ha (i.e. CORINE Land Cover 2012) – smaller geographical features are not depicted. The Consultation B aimed at finding the gaps between datasets produced at the European level and any other data sets produced at regional and local scales.

Access to Consultation B

https://survey.tecnalia.com/limesurvey/index.php/614564?lang=en

Consultation C - Analysis of governance, policy and financial frameworks

The successful implementation of green infrastructure (GI) projects requires a combination of governance structures, integrated policies and financial support. This consultation therefore aimed to investigate the governance systems in place in each case study area in order to determine how policies and policy makers enable the implementation of GI projects in the case study areas.

Responses to Consultation C aimed to help us identify: (i) how much funding (money and personnel) is currently used for GI in the case study regions; (ii) if this funding is sufficient for implementing and maintaining GI; and (iii) the main sources of funding (public tax-based funds, private investments, NGOs or others). Consultation C also examined whether policies compliment or conflict with GI and assesses policy makers' knowledge needs for making full use of GI development potential.

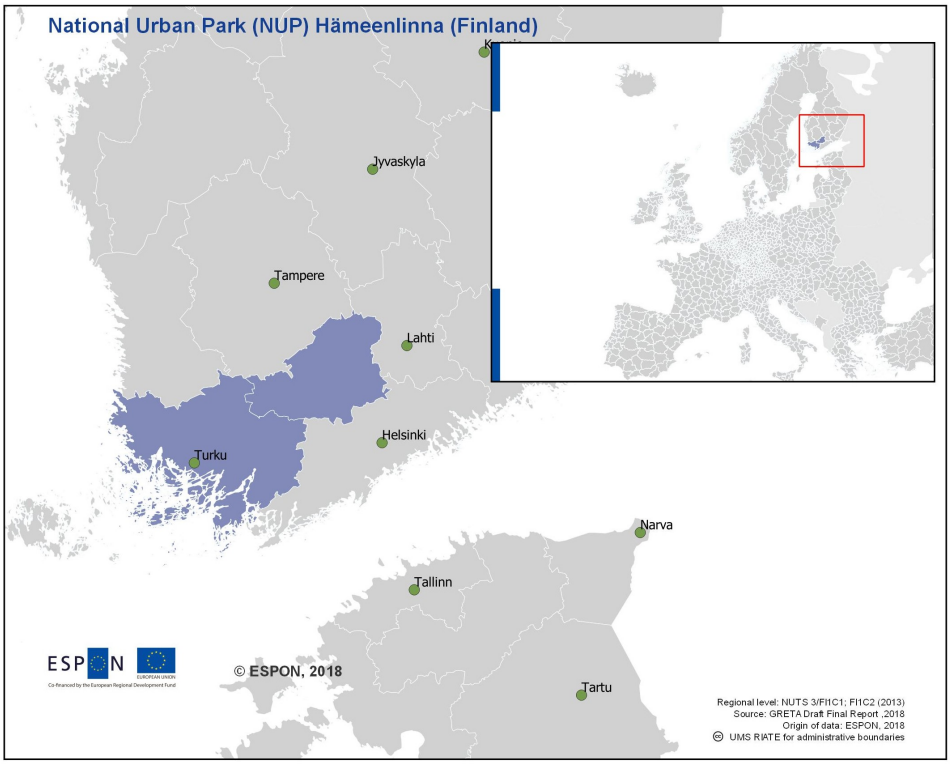
Access to Consultation C

https://survey.tecnalia.com/limesurvey/index.php/129674?lang=en

The content in this report is based on a mixed-method approach. The results presented are interpretations of semi-structured interviews, responses to a questionnaire on national policy and planning, responses to three consultations (Consultation A, B and C) via email, document analysis of plans and strategies (via desk-based analysis), and statistics.and spatial analysis using GIS resulting from the GRETA project. For all case studies, telephone conversations (and for some cases face-to-face meetings i.e. Copenhagen and Scania, Alpine region, Euroregion Aquitania- Euskadi-Navarra) allowed the completion of the consultations B and C.

The respondents who have contributed to this case study are people working in the public administration at different levels from the national Ministry of Environment to Kanta-Häme region Hämeenlinna municipality.

2 (Geographic) description of Hämeenlinna



Map 2. National Urban Park Hämeenlinna

Hämeenlinna is a culturally important historical medium-sized city located in the Kanta-Häme region in South Finland. The city is known for its medieval Tavastia Castle and its surrounding green and water areas (Vanajavesi Waterway) which are connected to the larger Aulanko nature reserve. The Vanajavesi waterway and Aulanko nature reserve are also the main areas for the first Finnish National Urban Park (NUP) established in Hämeenlinna in 2001.

Hämeenlinna has long traditions on urban park management. Compared to other Finnish cities they have relatively many urban parks. The first ones were established already in the 18th century. The urban centre is approx. 35km^2 of which 1,65 km^2 are built up urban parks and 4 km^2 nature conservation areas. The total area of the municipality is 1786 km^2 of which the NUP covers 7,38 km^2. NUP consists of two Natura 2000 areas and several nature conservation areas. One of the downtown's six other conservation area is the esker of Ahvenisto (1,3 km^2). Its central location and historic background make it culturally important recreational area with similar elements like the NUP. However, because of its vague ecological links with the NUP, located in the other side of the highway and the city centre, it is treated as a separate nature area with conservation actions.

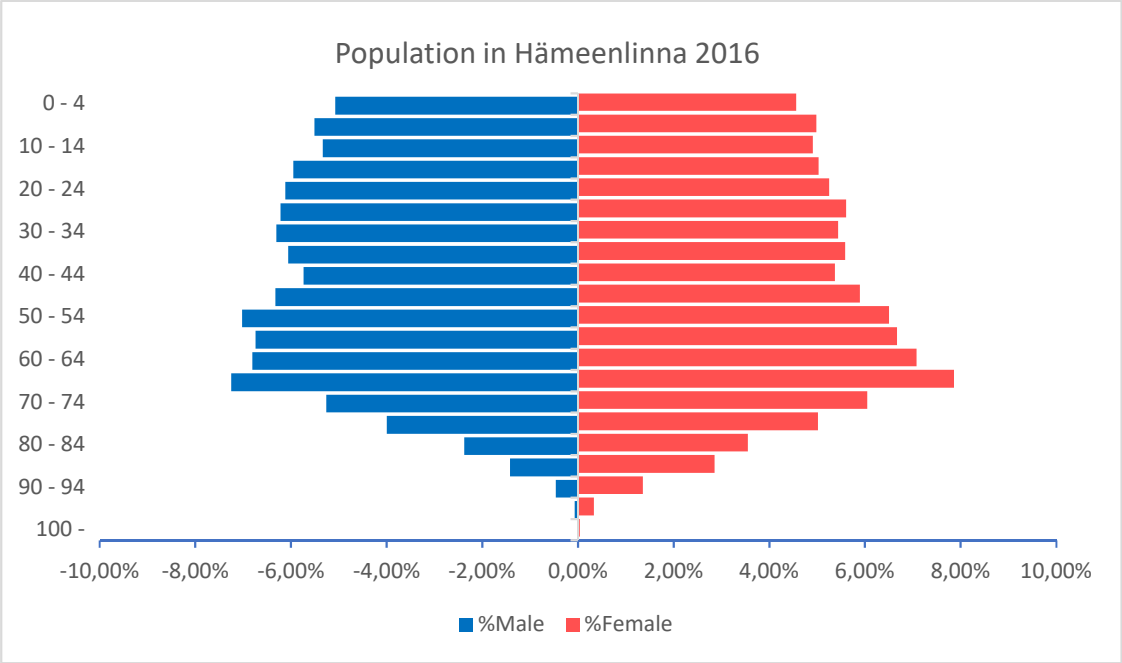
The green infrastructure planning in Hämeenlinna has a special emphasis on the ecological connectivity and biodiversity. Different initiatives show that the city has a strong interest to engage citizens into a dynamic planning process.

2.1 Case study outline

<table>
<tr><td colspan="2">Region/Area
(French: Nomenclature des unités territoriales statistiques (NUTS) Classification of Territorial Units for Statistics).</td><td colspan="3">City of Hämeenlinna (FI109) is one of the 11 municipalities in Kanta-Häme region in Finland.</td></tr>
<tr><td colspan="2">Geographical features in Hämeenlinna</td><td colspan="3">Land areas: 1786 km^2
Water areas: 246 km^2
Centre town area: 35 km^2 of which 1,65 km^2 is urban parks
National Urban Park: 7,38 km^2
Bioclimatic region: Boral</td></tr>
<tr><td colspan="2">Demographic figures</td><td colspan="3">Socio-economic characteristics</td></tr>
<tr><td>Total population in Hämeenlinna</td><td>67 850 (31.12.2016)

By age group and sex: See table below</td><td>Unemployment by sex and age - annual average</td><td colspan="2"><table><tr><td>Unemployment[1]</td><td>Total country (in 2015)</td><td>Hämeen-linna</td></tr><tr><td>All</td><td>14,3%</td><td>13,5 %</td></tr><tr><td>Males</td><td>16,1%</td><td>15,3%</td></tr><tr><td>Females</td><td>12,4%</td><td>11,7%</td></tr><tr><td>15-24</td><td>17,8%</td><td>20,2%</td></tr><tr><td>urban</td><td>n/a</td><td>n/a</td></tr><tr><td>rural</td><td>n/a</td><td>n/a</td></tr></table>[1] Register based employment in 2015 by gender, after place of living. All ages 15+. Source: Nordregio database</td></tr>
<tr><td>Population density-average in the case study area</td><td>38,01/km^2</td><td colspan="3">GDP per capita
GDP per capita (in PPP) in 2015 in Kanta-Häme (NUTS3) 26 266 (Source: Nordregio database)</td></tr>
<tr><td colspan="2">Self-perceived health by sex, age and degree of urbanisation</td><td colspan="3">Self-perceived heath 2016 in level of very good (16-year or over) in Finland:
Total:20,2%
Male:21,3%
Female:19,2%</td></tr>
<tr><td></td><td colspan="4">In Hämeenlinna 75,1 % of inhabitants live in the urban areas (29 % inner urban areas, 43% outer urban areas)</td></tr>
</table>

Figure 1.Population by age group and sex in Hämeenlinna, Finland (reference: Nordregio analyses based on Statistics Finland, 2018)



2.2 Territorial challenges

Hämeenlinna is located between two big and fast-growing cities in Finland, Helsinki and Tampere. The so-called growth corridor of Finland crosses the city of Hämeenlinna on its way from Helsinki via Tampere to Seinäjoki. Roughly one-third of Finnish population and about half of Finnish companies are located in this area.

The initiative 'Growth Corridor Finland' is aiming to develop mobility, accessibility and services in the area with sustainable and smart solutions. Hämeenlinna's location in this growth corridor is seen by the local authorities as opportunity to support the development of sustainable land use and harmonious regional structure.

Hämeenlinna has acknowledged the risk of green areas decrease in relation to compacting the urban structure. By focusing new housing and construction to the urban centre the short distances to the surrounding rural areas are easier to maintain. However, new housing or new densely build-up sites might happen at the expense of existing urban green space. This risk is particularly high in the residential areas with single family houses where currently the private yards are forming rather large green network. However, the spatial planners in Hämeenlinna are responding to this risk by conducting more elaborate green structure assessment in 2018-2019. The assessment is aiming to improve the city's possibilities to identify the most crucial ecological links in the urban areas and especially between residential built-up areas. Hämeenlinna's aim is to put higher priority to the quality and the accessibility of the downtown urban parks because the demand and their expected number of users are also expected to grow.

In a regional assessment for ecological network the highest risk for ecological connectivity was identified to the surrounding areas of the highway (E12) and the railway (national main line) crossing the region (Hyvinkää-Riihimäki-Hämeenlinna) as well as the city of Hämeenlinna. (Regional Council of Häme, 2016). Similar results were found in the GRETA analysis for GI potentials. The scale of GRETA analysis was broader, and it identified the danger of weakened GI connectivity between the same highway areas (Riihimäki-Hämeenlinna-Tampere). This fact has been considered in the most recent regional master plan 2040 which marked ecological network's links around the high-risk areas and core natural areas in urban centres with special attention. These findings are expected to steer future actions for the land use. However, the Finnish government is the owner of the highways and therefore the investments e.g. wild life crossing points, are depended on the national decisions to allocate their budgets.

3 The GI network and its potentialities for territorial development in Hämeenlinna

3.1 What is the approach to GI and Ecosystem Services in Hämeenlinna

Land use planning in Finland follows a formal hierarchical system from large scale regional plans that are steered by the national land use guidelines, into municipal plans and finally to more detailed local plans. Municipal and local master plans are drafted and approved by the municipalities (e.g. the local authorities). Regional councils are responsible to draft and approve the regional master plans. The master plans are aiming to create a strategic basis for the development of the functional urban/regional structure as well as its sustainable development. The Finnish Land Use and Building Act is the most important legislation controlling spatial planning (Ministry of the Environment, 2018). The Nature Conservation Act also ensures the conservation and management of nature and landscapes (Finlex, 1096/1996). In addition, one of the five key national land use goals are directly linked to green infrastructure management. The goal of 'vital natural and cultural environment and sustainable use of natural resources' includes preservation of ecological core areas and links for biodiversity and conservation of sufficient recreational areas and ecological network with solid natural areas. (Finnish government, 2017)

Drafting of the municipal master plan is a continuous process and a new official plan is conducted every six years with official democratic decision-making procedures. Right after completion of a new plan the municipality continues the preparations for the next one, which again consists of updated, additional and complementary assessments. Hämeenlinna's most recent downtown master plan 2035 became legally binding during the autumn 2018. As described above it is based on national and regional land use guidelines but also to cities' own strategic visions. Hämeenlinna does not have a direct green infrastructure plan but similar elements are covered thoroughly in this municipal master plan.

The priorities of the most recent master plan were to create a strategic basis for the development of the functional urban structure for services and transportation as well as sum up all the existing assessment related to the city's sustainable development. To guarantee Hämeenlinna's vital development the master plan emphasises the essence of services and their accessibility. From the green infrastructure's point of view this means a special emphasis to recreational services like access to green areas and maintaining the culturally and historically important urban parks. Hämeenlinna has 22 lakes in the vicinity of urban centre. The accessibility to water areas and nature trails also during the winter is taken into account in the local master plans.

The report describing the planning process of Hämeenlinna downtown master plan 2035 states that city's ecosystem services, including recreational services, are planned to be enforced (City of Hämeenlinna, 2016) One of the municipal land use planning priorities is to protect areas with defined high nature conservation or biodiversity values but also to put special attention to areas with this kind of characteristics. The local plans with new housing or new green areas will always consider the ecosystem services and their quality as well as various interest of green space by different users. Practically, this means for example local ecosystem service assessments or assessments about existing protected or threatened species. These are conducted either by an external consultant or by the planning authority. The assessments can also consider local knowledge on indication of the threatened species as part of the analysis. According to the city's water management strategy, the city is preferring nature-based solutions and natural methods for storm water management. The local master plans are completed with an open participatory process with local people or different interest groups. In Hämeenlinna, especially the Finnish Association for Nature Conservation has been actively advocating of coherent nature areas and preservation of areas with high biodiversity.

Hämeenlinna downtown master plan 2035 describes the green and recreational areas as a joint network that consists of few key zones. These are eskers that are typical landscape for Hämeenlinna nature with diverse flora and fauna, the Vanajavesi waterway and its surroundings and finally the joint zone of Aulanko National Park and its neighbouring Katuma lake and its surroundings. The master plan has an emphasis to enhance these areas and to improve the connectivity between them. However, this conventional approach to evaluate the city's ecological connectivity based on the zones marked as green is not exhaustive. The actual green or ecological network is wider and extends especially to residential area of single-family houses and other built-up areas with big gardens or similar natural areas.

Even though the municipal master plan addresses the joint network of green and recreational areas as key green space, there are also other categories with different kinds of green infrastructure. These are for example, all areas with high biodiversity (e.g. wetlands, land with threatened species, groves), nature protection areas or areas with special landscape values but also forest and agricultural areas of which some are identified to have important biodiversity.

Approx. 38 % of Hämeenlinna's downtown land is addressed as land for forestry and agriculture. Without direct linkage to GI policy instruments or strict land use restrictions these areas provide a remarkable share of Hämeenlinna's green infrastructure.

This indicates that the GI concept, in its cross-sectoral meaning, is not fully incorporated to the spatial planning. Hämeenlinna could find more possibilities to insert GI if ecological values and other GI principles would be considered and preferred more systematically, across the planning sectors. This fact, is also acknowledged by the manager of the spatial planning authority. According to him, more systematic approach of GI is their future objective, but the clear, actual and sufficient practises are still missing.

In 2002, Hämeenlinna was the first city in Finland who implemented the management and utilisation plan for the National Urban Park. Still today the National Urban Park of Hämeenlinna is the most important solid green space and large urban park of the city. At the moment, the spatial planning authority is planning to update its management plan and expand its solid green space according the updated visions. The park includes the most of Hämeenlinna's cultural and natural heritage sites.

In addition, the Regional Council of Häme has made an assessment studying the regional ecological network. This report was published in 2016 as part of the regional master plan process. It is an important overall assessment analysing regional green infrastructure jointly with its 11 municipalities and with Finnish Association for Nature Conservation involvement. It identified the core areas of ecological network but also took into account the most critical ecological corridors for regional ecological connectivity. These corridors are considered in the regional master plan which also obliges Hämeenlinna municipal master plan to include these areas to more final local plans. (Regional Council of Häme, 2016)

3.2 Benefits of GI and ecosystem services for smart, sustainable and inclusive territorial development;

The Finnish Land Use and Building Act obliges regions to consider ecological network that foster the biodiversity and other values of nature. (Land Use and Building Act, 5 §). This obligation as well as region's own interests to understand the most crucial ecological links on a regional level motivated Kanta-Häme to make an assessment for the ecological network. (Regional Council of Häme, 2016). The outcomes of the analysis emphasise the importance of regional biodiversity and water management. The report's spatial outcomes are similar with the spatial analyses of the GI in the GRETA-project. However, the final regional assessment was complemented by local knowledge. As part of the analysis Regional Council assembled land use planners from municipalities and representatives from the Finnish Association for Nature Conservation to a workshop to comment the preliminary results of the regional analysis. This part of the analysis helped regional planners to identify the most crucial bottle necks and ecological links that were found to be visible often only on the lower scale of spatial analysis. Therefore, the GRETA project maps might work as some basis for spatial planning process,

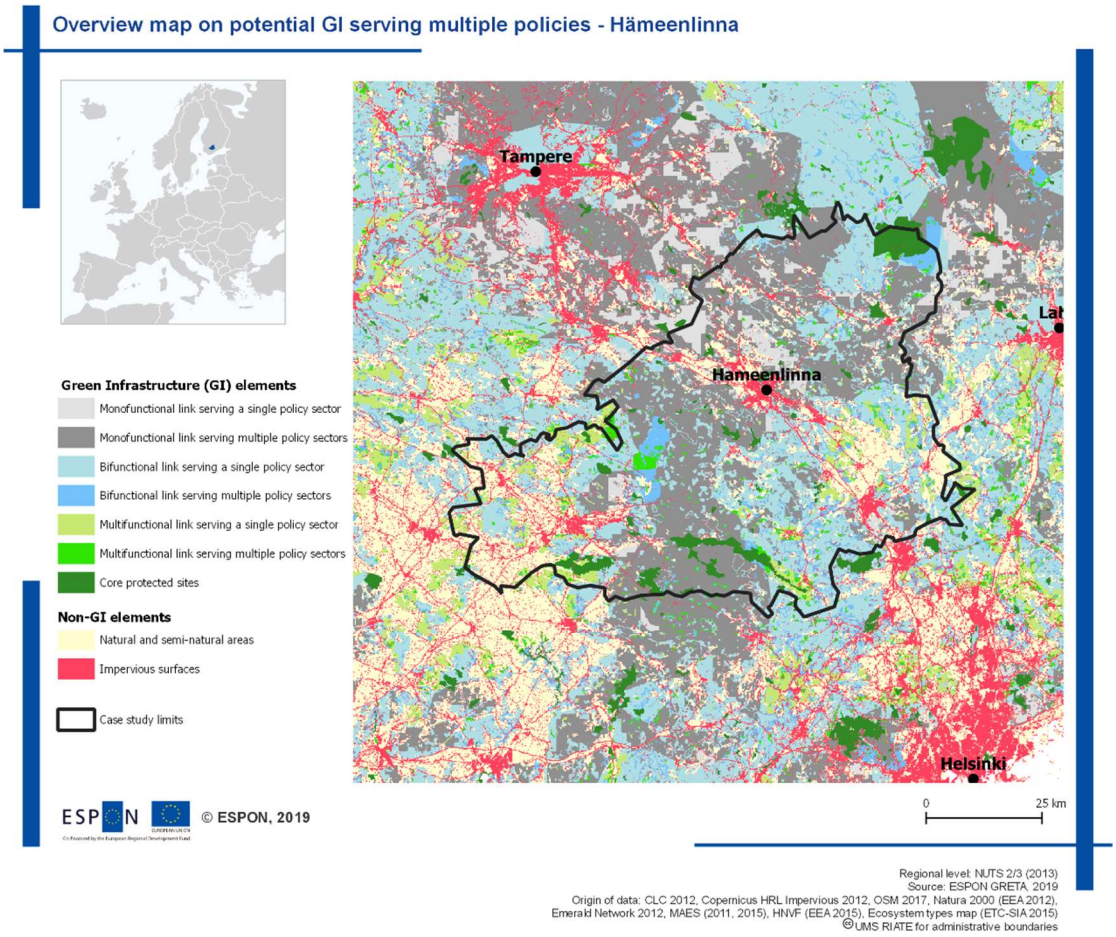
but they would need additional in-depth knowledge in order to exploit them in the decision-making purposes.

The maps about potential GI networks, produced in the GRETA-project were based on data sets that have European wide geographic coverage. As a combining factor, the CORINE Land Cover dataset was also used for the spatial analysis of the regional analyses. However, the Finnish Environment Institute provides more detailed, a national version of the Corine Land Cover inventory dataset and this version was used in the regional analysis conducted by the regional council. The national version of the data set is complemented by national topographic dataset. Therefore, the spatial resolution of the GRETA-maps might need some adjustment to apply in regional spatial planning activities.

3.3 Potentialities of the GI network in Hämeenlinna

The Hämeenlinna National Urban Park is located in the city of Hämeenlinna (FI109) and in the Kanta-Häme region (NUTS3, FI1C2). Because of the coarse scale of the GRETA maps the analysis for potential GI was made on the regional level.

There are two National Urban Parks in Kanta-Häme region, in Forssa and Hämeenlinna. Both urban parks are located in the vicinity of waterways and esker area. Region's typology is known for the extensive post-glacial ridge of Salpausselkä, which consists of three large formations. They form beautiful and culturally valuable landscapes and favourable environment to diverse biodiversity.



Map 3. Hämeenlinna GRETA case study. Overview map on potential GI serving multiple policies. (e.g. biodiversity policy, water management policies, climate change adaptation and mitigation policies) (reference: GRETA analyses by UAB and S4e).

Questions related to maps	**Description of phenomena in the case study**	**Implication for management**
Extent of GI	Potential GI covers about 70% of the region. The artificial areas (in red in the above map) connecting Tampere-Hämeenlinna-Riihimäki could be a threat to GI –specially increasing fragmentation.	Most of the region is well covered by GI, serving large part of the territory. However, special attention will require the axis Tampere- Hämeenlinna-Riihimäki to ensure the connectivity of the GI.
Integration of protected areas	All the protected areas are integrated on the potential GI. However, protected areas	Potential GI is well structured in the sense that it ensures connectivity of protected areas. Therefore, GI could be a valuable instrument to ensure connectivity in the whole region.

	contribute to less than 20% of the total GI. It should be noted that protected areas refer to Natura 2000 sites.	On the other hand, the share of protected areas inside GI is low. This suggests that about 80% of the potential network at the regional level is composed of unprotected landscape elements that deserve special attention. However, the framework of National Urban Park could be valuable to ensure this protection.
Support to policies for Biodiversity, Water management and Climate change adaptation and mitigation	This region provides limited support to different policies given the low provision of ecosystem services.	Most of the potential GI is monofunctional, with limited capacity to support all three policies simultaneously. More detailed information, at local level, would be required to confirm these limitations, and to identify where specific ecosystem services could be improved by appropriate management.
Synergies and trade-offs	Potential GI in this area has a high capacity for provision of the habitat quality and soil erosion ecosystem services. There is a strong trade-off between gross nutrient balance and soil erosion control, and gross nutrient balance with habitat quality.	Improvement of provision of ecosystem services could be counter-balanced by regional/local patterns of nitrogen deposition indicated by the trade-off linked to gross nutrient balance. Additional information will be required to evaluate the exact impact of nitrogen deposition and implications for other ES.
City level	No information available	

Table 1 Potentialities for GI network in Hämeenlinna based on GIS-analysis by UAB

Kanta-Häme region has good conditions to provide large GI. Moreover, the NUPs could be a strategic element to consolidate this GI. However, the major challenge is the limited capacity to support multiple policies, and the predominance of monofunctional GI. Additional information, at regional and local level, is needed to better understand the limitations on the provision of ecosystem services and options for improvement.

Economic valuation methods in urban planning

A policy maker respondent to online consultation (A) about economic valuation methods stated that cost-benefit analyses are not really used in the decision-making process when deciding about best ways to manage or invest in green infrastructure. However, there are some examples of usage of replacement cost and Hedonic pricing methods, but these are more of

experiments than the actual practises. The benefits of the green infrastructure, like recreational, health related, storm water management, biodiversity, are acknowledged benefit factors in decision-making process but without the monetary evaluation. This is reflected in the municipal reports describing the urban planning process.

According to the consultation's results, better know-how and planners' capacity to exploit economic-valuation methods in a planning and decision-making process would be helpful to inform the relevant target groups. Providing economic information could clarify the message of green infrastructure's benefits, like its potential to function as important attractive factor to invite new residents into the city.

4 Capacity of GI network in Hämeenlinna to meet the demand of ES

4.1 What do GRETA analysis on ES supply and demand reveal?

GRETA have explored the capacity of GI network to meet the demand of ES where:

ES supply is defined as the capacity of ecosystems to provide ES, irrespective of them being used.

ES demand can be defined as the amount of a service required or desired by society in a given location and time. This demand depends on several factors such as socio-economic conditions, cultural/behavioural norms, technological innovations, availability of alternatives, among others.

	ES Supply – benefits provided	ES Demand -specific definitions	Approaches to quantify Demand
Regulating services	Benefits are provided by maintaining desirable environmental conditions	Amount of regulation needed to meet target conditions	Reduction of risk
Cultural services	Benefits are provided by experiencing the natural environment	Desired total use (if rival service) or individual use (if nonrival service)	Preference and values // direct use
Provisioning services	Benefits are derived from consumption of final goods	Amount of goods obtained per unit of space and time or per capita	Direct use // Consumption

Table 2 Relation between benefits provided by ES supply and the corresponding ES demand definitions and operationalisation approaches. Adapted from: Villamagna et al., 2013 and Wolff et al., 2015.

Demand for **regulating services** can be defined as the amount of those environmental conditions that ensure the provision of a desired regulation level. A reduction of risk approach has been usually applied to quantify demands for these services. Vulnerability to potential changes in regulating services may provide valuable insight into society's needs capturing main linkages from the socio-ecological system.

Demand for **cultural services** has been mostly assessed by preferences and values for attributes of certain landscapes, ecosystems or heritage sites. Preferences may be either

quantified through stated preferences that relate to the desired level of services, or through revealed preferences (a proxy for the actual use of the service). Demand for cultural services has also been assessed by the direct use of a specific ecosystem, e.g. for recreation. This can be quantified by total visitor days per year or the number of fishing/hunting licenses, the presence of tourists or accounting the accessibility or proximity to recreational areas.

Demand for **provisioning services** has been quantified based on direct use and consumption of final. It is worthy to note that there is normally a spatial mismatch between the area where the service is provided and the area where the service is consumed, especially true for provisioning services. For this reason, interregional linkages have to be considered in order to properly identify faraway dependencies and assess magnitude of potential impacts

Following the proposed conceptual framework, we have combined demand and supply for each of the selected ES. The focus of this approach was to highlight those areas where there is a high demand and a low supply, i.e. those areas where GI is unable to cover the ES demand. It should be noted that these results are of a more exploratory nature in the whole GRETA project considering the following limitations:

- This is a research area still under development;
- There is need for a higher resolution of the data sources given the nature of the phenomena analysed;
- Balance between supply and demand is semiquantitative; and
- In some cases, a more sophisticated modelling would be required to have an appropriate quantitative balance.

Therefore, these results should be seen as illustration on how this demand and balance could be approached.

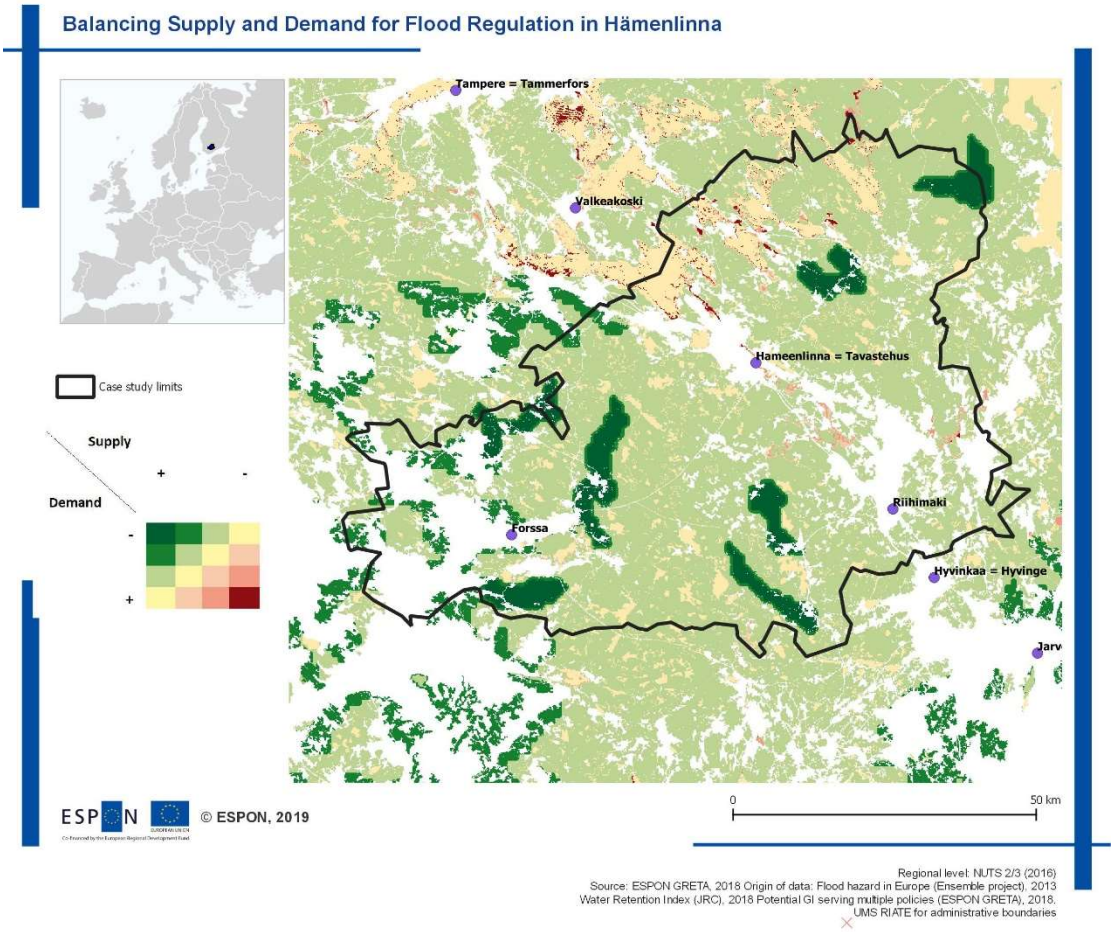
4.1.1 Analysis of supply and demand for Flood Regulation in Hämeenlinna

We have quantified demand for flood regulation based on the potential flood hazard. Exposure is described by the projected potential flooding risk[1]. On the other hand, benefits are provided by the water storage capacity of land to regulate floods. The supply for flood regulation is quantified by the Water Retention Index, which assesses the capacity of landscape to retain and regulate water passing through. This index is dimensionless and considers the role of interception by vegetation, the water-holding capacity of the soil, and the relative capacity of both the soil and the bedrock to allow percolation of water. The influence of soil sealing and slope gradient are additionally considered.

Map 4 presents a semi-quantitative analysis of the balance between supply and demand for flood regulation in Hämeenlinna. Dark green areas are those with maximum capacity of supply and demand is very low. These conditions are met in several areas within the case study area mainly but not necessarily linked with core protected areas. The other parts of Hämeenlinna

[1] for the period 2011-2044 that results after applying the LISFLOOD model from the ENSEMBLES project

that are still green could be considered areas where the balance tend to be positive, in the sense that the supply is slightly higher than the demand. In practical terms it would mean that improving or reinforcing GI with the objective of water retention will have a substantial benefit. In the northern part of Hämeenlinna the map shows that demand is not fully covered by supply, with some spots showing extreme deficit (low supply with high demand) in red. This could be partly explained due to the monofunctional character of the GI network in this northern area.



Map 4 Balancing Supply and Demand for Flood Regulation in Hämeenlinna.

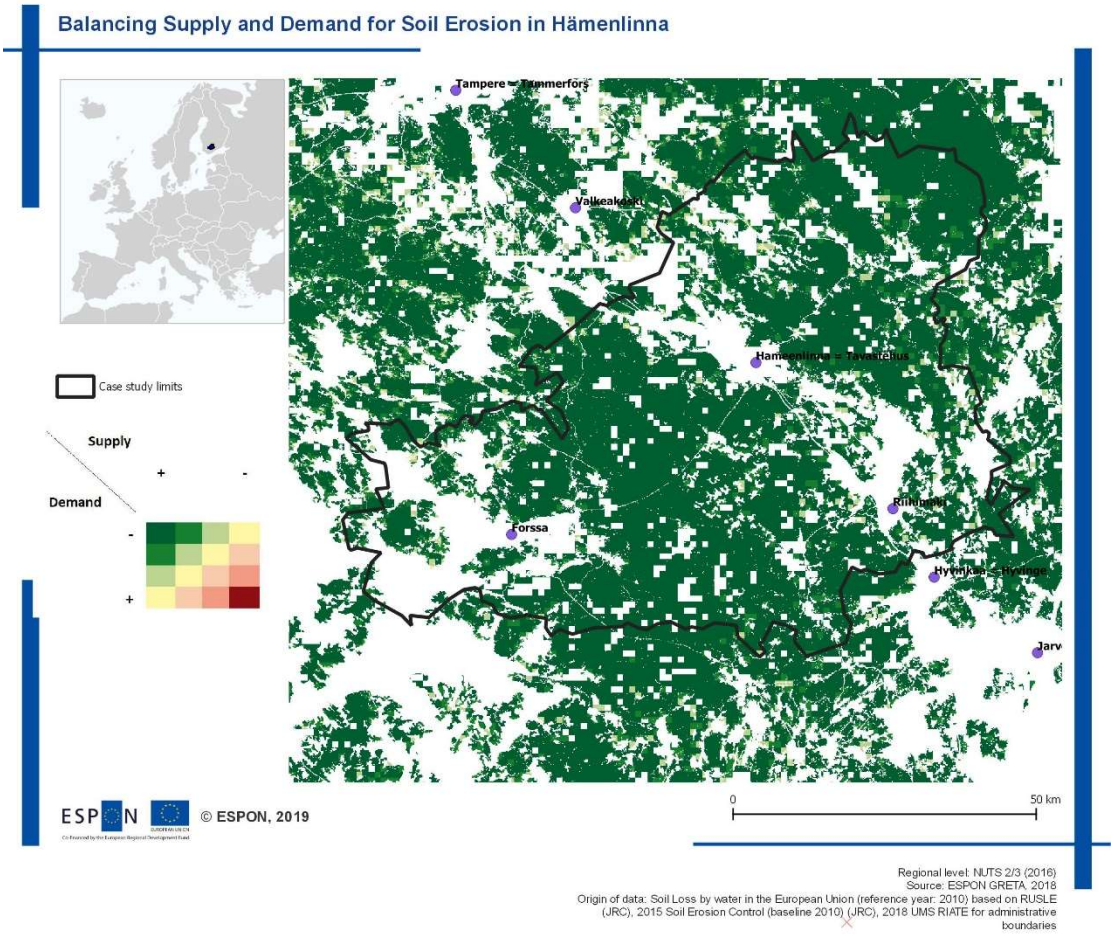
4.1.2 Analysis of supply and demand for Reducing Soil Erosion in Hämeenlinna

We have assessed the demand for the reduction of soil erosion by water producing a negative impact on several ES; in particular to the ones related to crop production, drinking water and carbon stocks. Soil erosion by water is mainly affected by precipitation, soil type, topography, land use and land management. Exposure is described by the soil loss rate[2] (t ha^{-1} yr^{-1}). Benefits are provided by the capacity of vegetation to control or reduce erosion rates. The

[2] as estimated by the modified version of the Revised Universal Soil Loss Equation (RUSLE) model

supply is quantified by the Soil Erosion Control dataset (JRC) that describes the capacity of ecosystems to avoid soil erosion.

From the resulting Map 5, we can observe that the GI network has the maximum capacity of supply and demand is very low, so no policy actions seems to be required to reinforce this particular aspect.



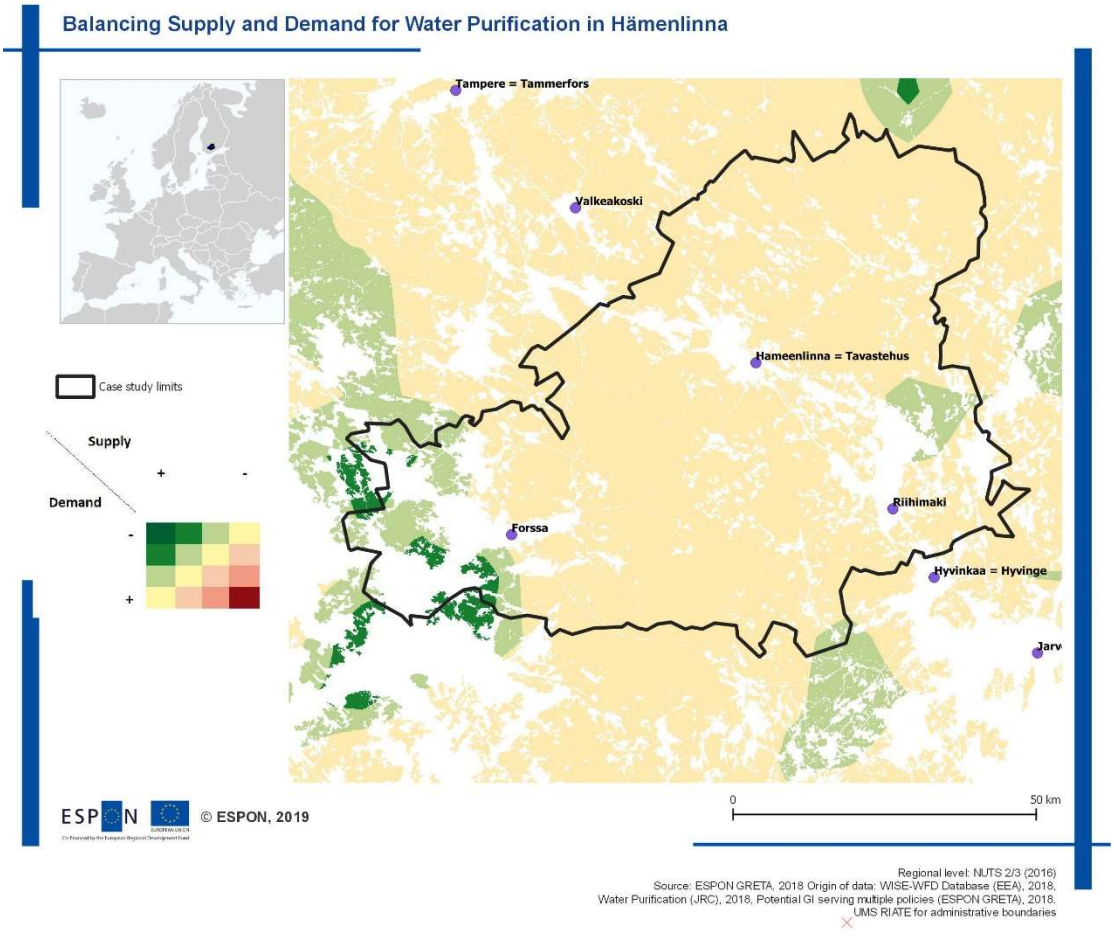
Map 5. Balancing Supply and Demand for Soil Erosion in Hämeenlinna

4.1.3 Analysis of supply and demand for Water Purification in Hämeenlinna

We have quantified demand for water purification based on the level of pollutants emitted to freshwater ecosystems by polluting sectors, primarily agriculture and waste water treatment discharges from industry and households. Exposure is described by mean annual concentration of nitrates in water [3](. The supply is quantified by the Water Purification dataset (JRC) that assesses the in-stream retention efficiency of ecosystems to dilute or degrade nutrients.

[3] tonne per year) captured in monitoring stations and aggregated by rivers (the WISE-WFD database)

Resulting Map 6 shows a well-balance situation, where supply of water purification by GI seems to meet the demand. The southwest of Forssa shows a positive pattern..

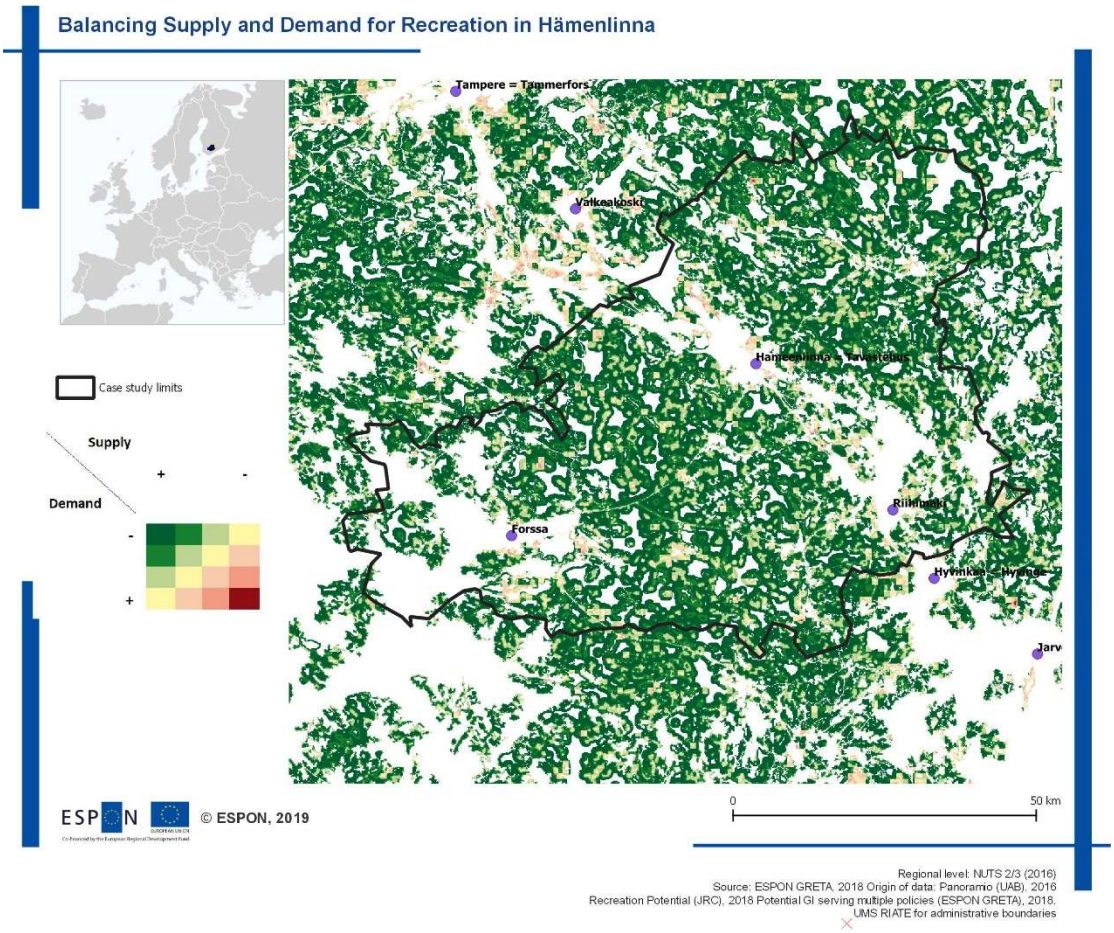


Map 6. Balancing Supply and Demand for Water Purification in Hämeenlinna

4.1.4 Analysis of supply and demand for Recreation in Hämeenlinna

We have described demand for recreation by means of a proxy for visitation. Recreation and tourism are important elements for national and local economies, that also contribute to other intangible benefits. Recreation directly depends on environmental attributes like species richness, diversity of habitats, and climate. The usability of crowd-sourced information by means of location photographs has already been shown to be as a reliable proxy for visitation rates to recreational sites. We have used the location of photographs in Panoramio as a proxy for landscape attractiveness for visitors. Demand is quantified by the number of pictures per square km. On the other hand, supply is described by the Recreation Potential dataset (JRC) that quantifies the potential for citizens for outdoor recreation.

The resulting Map 7 does show a predominant positive pattern where supply is higher than the demand. Some dispersed spots show areas in need for reinforcing supply that could be partly explained as direct link with population density.



Map 7. Balancing Supply and Demand for Recreation in Hämeenlinna

5 Governance practices, policy and planning instruments to implement GI and enhance ecosystem services in Hämeenlinna

5.1 National Urban Park of Hämeenlinna

The Finnish approach of National Urban Parks provides an example how conservation work for urban green infrastructure can be integrated into spatial planning policy in a consistent way. NUPs are established to preserve the beauty of a cultural and natural landscape and to maintain the ecological corridors, biodiversity, cultural and natural heritage in urban areas. The park must be a solid natural space with connections also to the neighbouring agricultural and forest land. Finnish Ministry for Environment coordinates the establishment process. In 2014 the national instrument was selected as part of the European Garden Heritage Network (EGHN).

The ministry has the criteria for the potential NUPs: First, the park must contain natural areas with valuable biodiversity, cultural elements relevant to the history of the city and parks and green areas with architectural or aesthetic significance. Second, the park should cover an area big enough to walk from one part of town to another through the park. Third, the park should

function as an ecological corridor allowing species to access and interact with green and blue nature areas outside the city. Finally, the park should be located in the city centre or the immediate surrounding area. The Finnish Land Use and Building Act chapter 9 includes legislation for establishing the NUPs.

The initiative to establish a new NUP always starts from the local level, starting the cooperation with the decision-maker, the Ministry of the Environment. The decision-making process is following the steps of municipal political democracy. The municipality approves the application, that is prepared in consultative cooperation with both the city council and the local government. A local municipal council submits the application and proposes the action plan to the Ministry of the Environment for decision making process.

Legally valid regional master plans (maakuntakaava), which take into account the region ecological network, are the base material for assessing the criteria for a new NUP establishment. This is to ensure that the areas within National Urban Parks are truly connected to each other and therefore they form a network of green space rather than few separate significant urban parks.

In 2001 Hämeenlinna became the pilot city for the national instrument. From the beginning the blue and green structure of Hämeenlinna was quite uniform. The extensive Aulanko nature reserve and its seamless links to the national rural cultural landscape were the good basis for fulfilling the national criteria of connectivity and continuity of green space. Besides, before the establishment, Hämeenlinna repaired some of the identified cut offs by transforming the former industrial area and the banks of the railway tracks into a park and a blossoming coastal green trail that connects the downtown to the Aulanko nature reserve.

At the moment all of the planned further actions to foster the ecological links within the NUP are completed. The action plan published right after the establishment process in 2002 has become fully implemented. After the completed actions Hämeenlinna is planning to update NUP's management plan and expand its solid green space according the updated visions. Action plan for NUP is always evaluated and accepted by the Ministry of the Environment.

The updated action plan for NUP is expected to address the land use expectations and limitations in an updated vision together with the ministry. The intention is to express the special cultural and ecological values of the park and to update the objectives of the future maintenance work. The actual process for conducting the new plan has not kicked-off yet but the more explicit land-use resilience analysis and better overview of the planned extensions are next steps. One of the planned extensions is south from the NUP. This by utilising a recently constructed recreational nature paths that goes along the Vanajavesi waterway. Another initiative is foster to connect the poor ecological link between east and west part of the natural areas, NUP and the esker of the Ahvenisto. The highway that crosses the city of Hämeenlinna and separates these two areas is however one of the major challenge that makes this work difficult. Planting

more vegetation and supporting natural species within these areas, however, might support some of the ecosystem services.

The NUP of Hämeenlinna is 6 km long and 5 km wide. Its coastal green ways are the most attractive recreational services with approximately 200 000 annual visitors. The park includes the most of Hämeenlinna's cultural and natural heritage sites and is therefore one of the most important attractive factor for the city. The most recent extension of the NUP was established in august 2018. This additional 97 ha conservation area 'Sibelius Forest' is named after famous Finnish composer Jean Sibelius, who is told to be inspired by the NUP landscapes during his youth.

At the moment there are nine NUPs in Finland. The cooperation between these cities is supported by a steering group that consist of each city's representatives. The steering group has regular meetings which recently have been focusing on communicative tasks. The group is aiming to create attractive profiles for each of the NUP to get more recognition and visitors to the cities with NUP.

5.2 Drivers and priorities for implementing green infrastructure

Biodiversity protection, coherent urban green network and enhancement of green area's recreational and cultural values appeared to be the dominant motivators for GI management in Hämeenlinna. These priorities are visible through local reports and they were pointed out during the GRETA case study interviews.

In addition to the National Urban Park extensions, the city is planning to improve its urban green space management practises. During the downtown master plan process 2014-2018 the city and the Häme University of Applied science identified the lack of a more comprehensive urban green infrastructure analysis. This means more detailed analysis of urban green areas that are not marked as "green" in the concrete municipal master plan. To improve the knowledge of these areas the city and the Häme University of Applied science have recently started a cooperation where at the first phase they are making an analysis about urban green spaces based on the aerial photographs and available GIS material. At the later phase their goal is to conduct the analysis at more local level in the different quarters of the town. This is planned to be a participatory process to plan more concrete actions for the protection of the biodiversity. These actions are planned to be for instance more nature-based solutions to storm water management or simply more systematic consideration on green space within the local infrastructure and street plans.

There are no final expected outcomes of the cooperation but the most important objective for the urban planners is to get a place-based analysis of the comprehensive urban ecological network and identify its most crucial links in order to preserve these connections in the denser urban structure. Based on the planned analyses urban planners are also willing to have better strategic vision for urban green infrastructure management or at least systematise the

guidelines for local plans to consider GI related solutions. The preliminary plan for the cooperation is three years. Furthermore, both actors are open and willing to foster the cooperation within potential international framework (e.g. international project). It is worth mentioning, however, that the concept of green infrastructure as such is not directly applied. The project defines the interest areas as urban green (kaupunkivihreä) which at least at the first phase focuses on the culturally valuable green areas and excludes areas for forestry and agriculture.

In 2017, Hämeenlinna used approx. 5.9 M€ to the infrastructural managements. The biggest share of this budget was allocated to the road maintenance (3.9 M€). 1.6M€ was used to manage and restore green areas and 0.5 M€ was used for forestry. In addition to the annual budget the investments for park and recreational area's constructions were 245 000€ including the annual investments to the maintenance of the NUP. Parks are managed in accordance with the principles approved by the Green Area Programme -2015 (Viheralueohjelma 2015). This was prepared in a participatory process with local inhabitants. It describes city's goals and actions for green areas and addresses practical principles for nature management. These are for example the preservation of the coastlines for the recreational use, sustainable use of water areas to maintain the beautiful landscapes and biodiversity, maintenance of the cultural value of the urban parks and maintaining the good accessibility to natural areas.

Citizens participation is not only within the planning processes but also in the actual maintenance work. From the beginning of 2010s different communities (e.g. NGO or housing cooperation) are invited to do voluntary work for maintenance of urban parks. By this opportunity citizens can affect to their own urban environment and foster the interaction with urban planners. The interaction has also been promoted by interactive online maps where citizens can share their views about favourable sites for new housing.

One of the hindering factor for Hämeenlinna's urban GI management is rather scarce resources. Despite the large number of urban green areas, the city has only one planner for the gardens and urban green spaces. This has slowed down and postponed some of the administrative work that relates to the GI management practises and communication.

Another hindering factor seems to be a halting political support for GI implementation. The different preferences of the changing municipal government indicate unsteady political commitment to GI management. More consistent usage of economic valuation methods for GI and better awareness of the GI concept across different planning sectors could be an opportunity to highlight the message to the decision-makers.

Finally, as mentioned in the chapter 1.2, the highway crossing the region of Kanta-Häme as well as the city of Hämeenlinna is acknowledged as a risk factor for green areas fragmentation. The regional and municipal master plans have preserved certain areas for wild life crossing points, but these investments are depended on the national decision-making processes.

6 Lessons learned and good practice examples from the Hämeenlinna case

The ecological connectivity and recreational values of green space have an emphasis in Hämeenlinna's municipal land use visions. The urban and regional planner's commitment to consider ecological connectivity is visible from the local reports and were also highlighted during the interviews. Hämeenlinna has a 'green city' image which the city wants to preserve. The city is surrounded by the NUP and other nature conservation areas which are easily accessible by pedestrians or bikers via coastal natural paths.

Even though Finland does not have a direct GI strategy on national level the case study shows multilevel governance examples for GI management. The regional ecological network, its hubs and links, is taken into account in a regional analysis that guides also the municipal master plan. Local actors' knowledge is included into this analysis as well as into the other spatial planning processes. Hämeenlinna has an innovative plan to conduct a new more detailed urban GI analysis together with the Häme University of Applied Sciences.

Another multilevel governance example is the national instrument of NUP. Nine cities with committed action plans, that are drawn up together with the Ministry of the Environment, indicates well-established instrument that enable long-term GI management practices. The Finnish well-acknowledged and clear concept of NUP has facilitated Hämeenlinna to frame important environmental values in their policy for urban green infrastructure management.

Despite of well-grounded work with NUP the concept of GI is not fully applied in Hämeenlinna's spatial planning. The planners of Hämeenlinna are aiming to integrate the cross-sectoral concept of GI into their management practices. This would mean more involvement of different planning sectors for GI management and more consistent consideration of GI within different infrastructural projects. However, this requires more awareness raising and communication between the different spatial planning sectors in the municipality. With possible new resources and targeted actions Hämeenlinna as a medium-sized city has good opportunities for achieving this goal.

7 Policy messages and recommendations in Hämeenlinna

In general, Finnish cities are rather green and often surrounded by large forest areas. Despite the lack of direct GI strategy on national level, the case study shows that there are some good multilevel governance practices for GI management. However, the GI as a cross sectoral concept is not comprehensively integrated into the spatial planning. Better awareness of GI principles and its multifunctional benefits could facilitate the integration of the concept into the local planning. By more systematic cross sectoral approach for GI management more synergies could be created. The synergies could foster the sustainable land use practises that harmonise the ecological, economical and socio-cultural objectives. By highlighting and communicating

the social aspects of GI and having special attention on the other environmental features, Hämeenlinna could enhance the attractiveness of the city.

Hämeenlinna has innovative ideas for GI management practices. The ideas have been raising especially form the recently started cooperation with regional University of Applied Sciences and from NUP management plans. By driving forward these ideas they could create transferable bottom-up examples for national policy level. This could be important to other Finnish municipalities and for the national policy level to learn what is going on and what needs further priority from national and regional level.

The need for wild life crossing to the highway, crossing the region of Kanta-Häme as well as the city of Hämeenlinna, is acknowledged by the Regional Council of Häme and by the local planning authorities. The risk for GI connectivity in the closure of the highway was also identified in the GRETA analysis for potential GI. Based on these considerations, the case study suggests active involvement of the Finnish Transport Agency to establish a wild life crossing to Kanta-Häme region.

Hämeenlinna as medium-sized city has rather small spatial planning authority. Nevertheless, stronger emphasise for the institutional memory of GI and NUP management practices would be recommendable. With stronger human resources, the planning authority could more effectively drive forward the innovative and ambitious initiatives for GI management and streamline their communication with citizens.

Also, the more consistent utilization of economic valuation methods for GI and better awareness of the GI concept across different planning sectors could be an opportunity to highlight the importance of GI management to the decision-makers.

8 Apendix

For the Hämeenlinna case the questionnaire for consultation A got one response on the online platform. The stakeholder was a policy/decision maker from the case study municipality.

For the questionnaire for consultation B got one response on the online platform. The stakeholder identified herself as other expert from the case study municipality.

In addition to this response the research team got information from regionally provided reports and via phone call (2018-09-24) with the regional planning authority in Kanta-Häme region.

For consultation C did not get response on the online platform. The consultation was conducted via phone call 2018-10-22 with stakeholder from the municipal planning authority.

Interviews via e-mail were undertaken with the environment counsellor at the Ministry of the Environment 2018-02-20-24

Phone interview with urban planner in the city of Hämeenlinna was held on the 22nd October 2018

Site visit was undertaken on the 2nd of November 2018 and interview with urban planner and urban gardener and green area planner from the city of Hämeenlinna.

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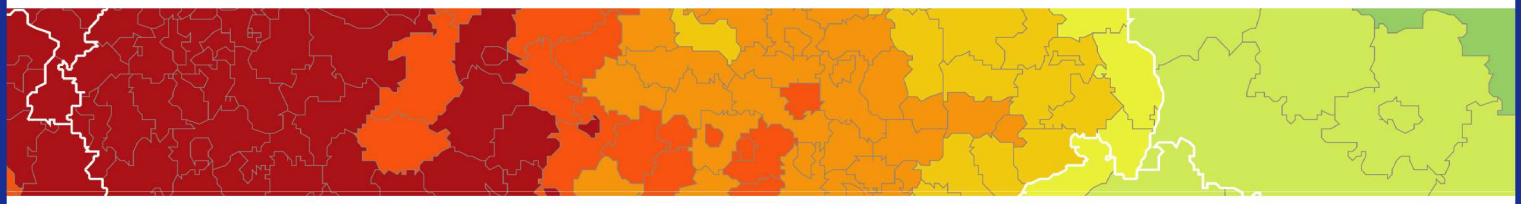

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