CASE STUDY BOOKLET

Green infrastructure and urban planning in the City of Järvenpää

June 2018

ESMERALDA partner: Finnish Environment Institute, SYKE

Case Study Coordinators: Arto Viinikka & Leena Kopperoinen

ESMERALDA

Enhancing ES mapping for policy and decision making

Suggested Citation: Viinikka, A., Kopperoinen, L., Adem Esmail, B., Geneletti, D., (2018). Case Study Booklet: GREEN INFRASTRUCTURE AND URBAN PLANNING IN THE CITY OF JÄRVENPÄÄ prepared for "WS 8 - Testing the final methods in policy- and decision-making (II): businesses and citizens" held in Eger, Hungary, 19-22 March 2018. ESMERALDA EC H2020 Grant Agreement no. 642007.

Acknowledgement: The research was funded by the City of Järvenpää and partly by the Finnish Ministry of the Environment and Finnish Transport Agency. The authors would like to thank Maija Tiitu who was working partly as a project coordinator and partly as a researcher during the project. We would also like to thank Pekka Itkonen participating data gathering and research designing in earlier stage of the project and the practitioners of the City of Järvenpää for a fruitful cooperation during the process, and for the wide variety of high quality GIS data to conduct the analyses".

Table of Content

CASE STUDY FACTSHEET

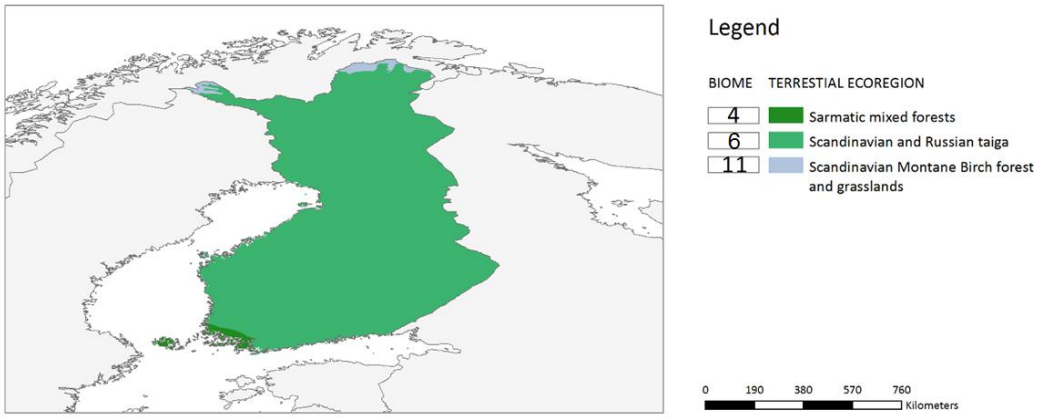
Mapping green infrastructures and their ES in Järvenpää

WS8_cs2a

NAME AND LOCATION OF STUDY AREA	City of Järvenpää
COUNTRY	Finland

STATUS OF MAES IMPLEMENTATION			
	Stage 1	Stage 2	**Stage 3**

BIOMES IN COUNTRY		
1 Tropical & Subtropical Moist Broadleaf Forests	**4 Temperate Broadleaf & Mixed Forests**	
5 Temperate Conifer Forests	**6 Boreal Forests/Taiga**	
8 Temperate Grasslands, Savannas & Shrublands	**11 Tundra**	
12 Mediterranean Forests, Woodlands & Scrub	13 Deserts and Xeric Shrublands	
14 Mangrove		



case study outline

SCALE	national	sub-national	**local**	
AREAL EXTENSION	**Ca. 40 km²**			

THEMES				
	nature conservation	climate, water and energy	marine policy	natural risk
	urban and spatial planning	**green infrastructures**	agriculture and forestry	business, industry and tourism
	health	ES mapping and assessment		

ECOSYSTEM TYPES				
	urban	**cropland**	grassland	**woodland and forest**
	heatland and shrub	sparsely vegetated land	wetlands	**rivers and lakes**
	marine inlets and transitional waters	coastal	shelf	open ocean

1. Overview of the study area

The City of Järvenpää is a compact city with tight boundaries in the Helsinki-Uusimaa Region (Figure 1). It is the fourth most densely populated city in Finland, with a population of around 42,000, and is predicted to grow significantly in the coming decades. It is a significant commercial and administrative centre in Central Helsinki-Uusimaa as well as part of the Helsinki Metropolitan Region economic and employment area due to its quick connections to Helsinki. City's compact structure means that new construction sites need to be found among the already built area, mainly in green space. Natural values come right into the city centre because the wetlands in the northern end of Lake Tuusulanjärvi belong to Natura 2000 network due to their importance for nesting and migratory birds.

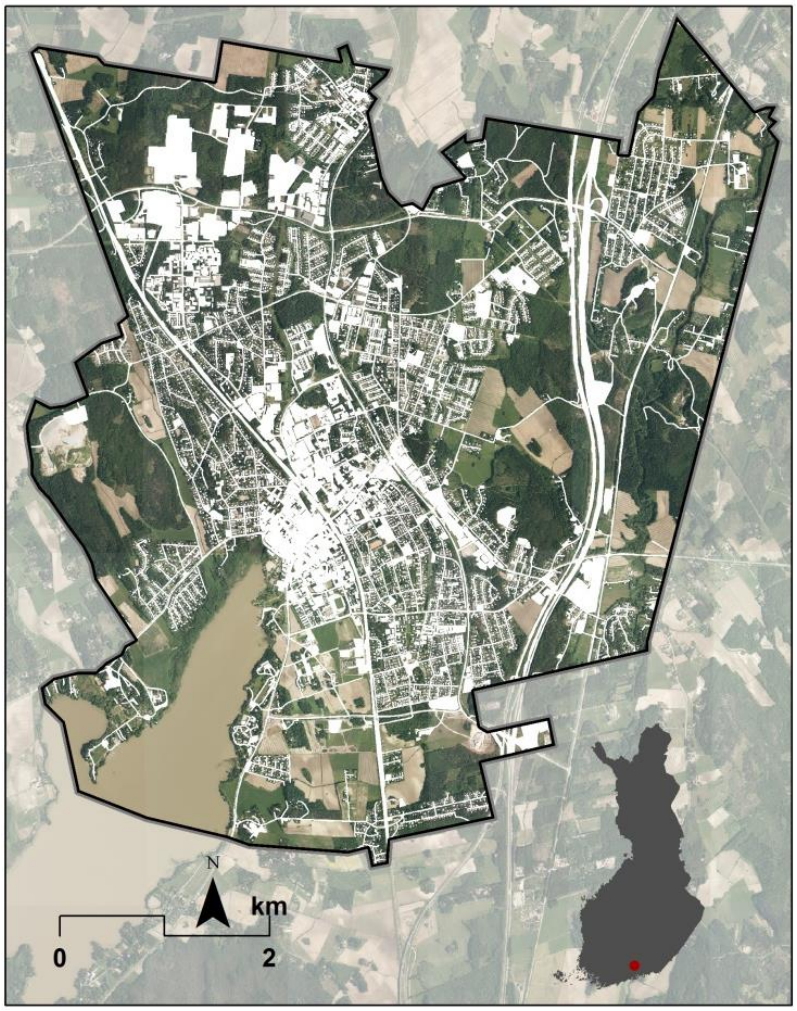


Figure 1. Map of the City of Järvenpää with impervious areas presented in white. Lake Tuusulanjärvi is seen in the south-western area.

2. Questions and Themes

The city of Järvenpää has an expected population growth of over 10 % by the year 2030. As a result, there is an exceptionally strong need for infill development to provide housing for new inhabitants as the master plan already covers the whole city and the neighbouring municipalities prevent the city to grow outside. Infill development and the fragmentation of the existing landscape structure require a more accurate assessment and development of the GI. The city's interest was to find the tools and criteria for valuing the

sites excluded from construction (i.e. GI) so that future urban planning could compress up and intensify the urban structure without losing the most valuable features of the GI.

The objective of this study was to evaluate the green infrastructure in the city by mapping and assessing the supply and demand of the most important ecosystem services (ES) and assess the connectivity on green infrastructure (GI). In the first phase of ES mapping and assessment, the perspective was policy driven aiming to support the city planners for sustainable development on natural values and ES provided by green and blue areas while simultaneously identifying land for future construction. Mapping and assessment was done in three phases concentrating to the questions of: 1) how the provision of ES related benefits provided by the green infrastructure were distributed in the area; 2) how and where the citizens use these benefits and; 3) how the ecological processes providing these services were connected.

According to the Finnish Land use and building act plans urban planning must be prepared in interaction with such persons and bodies on whose circumstances or benefits the plan may have substantial impact. The authority preparing plans must publicize planning information so that those concerned are able to follow and influence the planning process (see: Finnish Land use and building act 132/1999, amendment 222/2003 included). The citizen role was considered by arranging workshop, via online questionnaire and sending survey to schools and kindergartens to map their perceptions related to cultural ecosystem services.

This real-life planning example provided also a good opportunity to test the spatial multi-criteria analysis (SMCA) for engagement of practitioners in enhanced integration of urban greenspaces and residential infill development. The results from the first phase were used as input data for this scientific driven method testing. Here the focus was especially in the interaction and the underlying processes behind stakeholder role during planning process that can support the future planning.

3. Stakeholders' Involvement

The case study was initiated by the city planners of the City of Järvenpää. Researchers and planners co-operated from the very beginning of the process by identifying relevant ES to be mapped and reviewing the relevant background information and spatial data from the national and city archives. Citizens were involved in the case study in a citizen workshop where they were asked to provide information about their perceptions and values related to (mainly cultural) ecosystem services. The participants of the workshop scored different green infrastructure types and features based on how important they were for them from the ES point of view in general, and after that participants were asked to place the most important areas to which they attached cultural ES based values on a map. Moreover, the citizen knowledge had already earlier been collected by using an online participatory GIS survey and this information was reclassified to derive spatially-explicit cultural ES related values of green infrastructure using content analysis. To better comprehend educational values of green and blue infrastructure a map survey was mailed to schools and kindergartens.

In the second phase, this real-life planning-related case study provided a good opportunity to test spatial multi-criteria analysis (SMCA) in engaging practitioners in enhanced integration of urban green spaces and residential infill development. Here the focus was especially in the interaction and the underlying processes behind stakeholders' roles during planning process that can support the future planning. Experts from different sectors of the city had an essential role in the process as they provided input on the criteria and thereafter, weighting of the criteria to find the most optimal sites for infill development.

4. Initiating Mapping and Assessment

4.1. Identification and mapping of ecosystem type

Starting point for this mapping and assessment exercise was the identification and extraction of green and blue areas with sufficient spatial accuracy required for planning purposes. Aim was to create a typology of green infrastructure (e.g. Cvejić et al. 2015). To capture the most detailed features in the study area, we used the combination of currently available multiple different datasets that were complemented with digitization using temporally accurate high resolution aerial images with 0.5 m resolution. A key dataset was city owned local biotope data including areas of uniform environmental conditions that was used as a baseline for the delineation. As a complementary we used multiple datasets such as aerial images and environmental features from Finnish National Land Survey database.

The green typology was a prerequisite for the mapping and assessment, but it was also a result being the most accurate digital representation of the prevailing land cover in the area (Figure 2). This provided a possibility for the land use planners to have more accurate overview of the city green and blue areas to support planning and the importance, for example, of the private gardens to provide of multiple ES and maintain connectivity could be pointed out.

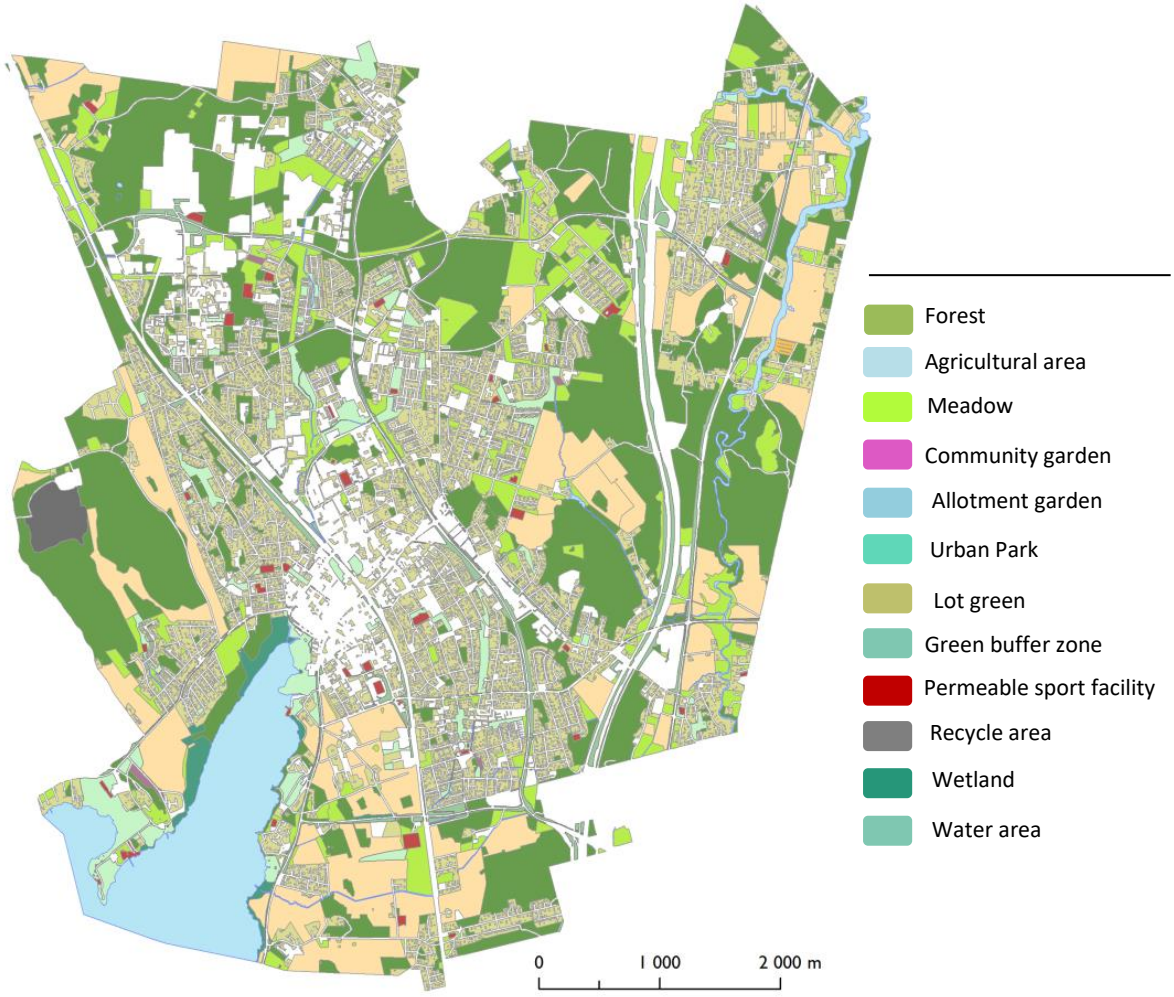


Figure 2. Järvenpää GI typology.

4.2. Assessing ecosystem conditions

Direct ecosystem condition assessment was not included in this study. However, ecosystem condition is directly linked to ecosystem relative service provision potential that was assessed in this study. Information about ecosystem conditions relevant for the case study were mostly related to structural analysis of urban green infrastructure components (e.g. connectivity) that is essential for the ecosystem sustainability and service provision.

4.3. Selecting Ecosystem Services

For the identification of relevant ES, we used the knowledge from previous mapping and assessment studies that were validated though a joint discussion with city planners. The objective of maintaining good opportunities for urban recreation and other cultural values supported the selection of all cultural ES according to CICES 4.3 to be mapped whereas provisioning and regulating and maintenance services consisted only the most relevant services in the area. **Errore. L'origine riferimento non è stata trovata.** includes the selected ES for the case study classified using the CICES v4.3 (2013) and the related assessment method categories where B = Biophysical, S = socio-cultural. Original CICES 4.3 was slightly modified by combining categories to fit better to the city needs. Economic assessment was not conducted in this study.

Table 1. Overview of the ES and related mapping and assessment methods in the city of Järvenpää

Ecosystem Service selected for mapping and assessment	B	S	E
1.1.1.1 Cultivated crops	X		
1.1.1.3 Wild plants, animals and their outputs + 1.1.1.4 Wild animals and their outputs	X		
1.1.2.2 Ground water for drinking	X		
2.2.2.1 Hydrological cycle and water flow maintenance + 2.2.2.2 Flood protection	X		
2.3.1.1 Pollination and seed dispersal	X		
2.3.1.2 Maintaining nursery populations and habitats	X		
2.3.5.2 Micro and regional climate regulation	X		
3.1.1.1 Experiential use of plants, animals and land-/seascapes in different environmental settings + 3.1.1.2 Physical use of plants, animals land-/seascapes in different environmental	X	X	
3.1.2.1 Scientific + 3.1.2.2 Educational	X	X	
3.1.2.5 aesthetic + 3.1.2.3 Cultural heritage	X	X	
3.2.3.1 Symbolic + 3.2.3.2 Sacred and/or religious	X	X	
3.2.3.2 Existence + 3.2.4.2 Bequest values	X	X	

* ES selected for further discussion during ESMERALDA workshops 8 in Eger, Hungary;
B = biophysical methods; S = socio-cultural methods; E = economic methods.

5. Methods for ES mapping and assessment

5.1. Biophysical methods for ES mapping and assessment

Total of three different biophysical methods were used to mapping and assessment. Spatial proxy method was applied to all ES listed in **Errore. L'origine riferimento non è stata trovata.**. The structural (potential) connectivity of GI was assessed using connectivity models and spatial multi criteria analysis was used to integration of urban greenspaces and residential infill development.

5.1.1. Mapping of provisioning, regulating and maintenance and cultural services

The potential provision of selected ES was assessed using Green Frame (GF) method that belongs to spatial proxy models (Kopperoinen et al.2014). GF is especially tailored for supporting planning processes due to its flexibility, transparency and operational possibilities. It provides an overview of the potential provision of ES in relative scale using spatial data and expert opinions. Analyses can be conducted in a short amount of time, which is usually a requirement in the planning process. Besides expert opinions, the method uses quantitative data when available, usually from provisioning ES such as timber volume (m^3) or ground water yield (m^3). The method uses multiple different datasets that were combined to themes and scored by the experts (Table 2). We utilized the results from the scoring workshop from previous year used for ES mapping and assessment in Uusimaa region as these were transferrable to local context. The scoring system for assessing the effect of each theme on the prerequisites for the provision potential of each ES group was:

3	2	1	0	-1	-2	-3
Very favourable	Favourable	Slightly favourable	No effect or neutral effect	Slightly harmful	Harmful	Very harmful

Table 2. Expert scoring applied into data themes

	Cultivated crops	Wild plants, animals and their outputs	Ground water for drinking	Hydrological cycle and water flow maintenance	Pollination and seed dispersal	Maintaining nursery populations and habitats	Micro and regional climate regulations	Recreation	Education	Aesthetic and cultural heriotage	Symbolic, Sacred and/or religious	Existence and bequest
Conseravtion areas	0	2	2	3	2	3	2,5	3	3	2	3	3
Valuable landscapes	3	1,5	1	1	2	2	1	2	2	3	2	2
Cultural heritage sites of built environments	2	1	0	1	2	1	1	3	1,5	3	2	2
Traditional biotopes	2	2	0	1	3	3	1	2	2	3	2	3
Areas of valuable environment according to Finnish forest act	0	2	1,5	2	2	3	1	2	3	2	2	3
Bogs	0	2	2	3	1	3	2	2	3	2	3	3
Important bird areas	0	1	0	1	1	3	1	2	3	2	2	3
Ground water formation areas	0	1	3	3	1	1	1	1	1	1	1	2
Agriculture areas with high nature values	3	1	0	1	2	2	1	2	2	2	2	2
Ekological condition of surface waters	0	2	3	2	0	3	0	3	3	2	2	3
Recreation areas	1	2	1	1	1	1	1	3	2	2	2	2

Respondents were advised to give a score of 0 if they saw no connection between the theme and the provision potential of the ES group in question. Scoring was also done to the Finnish national Corine Land Cover data to avoid empty areas in the mapping results. Although it is possible to map all the ES separately, the method reveals areas providing the multiple benefits (i.e. ES bundles) which are essential for comprehensive assessment of GI (Figure 4).

Figure 3. Provision of cultural ecosystem services in Järvenpää

Connectivity analyses

We used ecological connectivity models to evaluate the structural degree to which the GI facilitates potential movement of different ecological processes. Connectivity promotes the provision potential of many ES as connectivity is fundamentally linked to the ecological processes providing these services. In Järvenpää, assessment was conducted using two different approaches. Firstly, we applied Morphological Spatial Pattern Analysis (MSPA) that classified the green patches based to geometry, area and edge size (Vogt et al. 2007) (Figure 5).

Secondly, we used graph theory based Matrix Green and Conefor software's (Saura & Pascual-Hortal 2007) to quantify the theoretical importance of habitat to maintain the overall connectivity (Figure 4). Information of the attributes such as land cover and ES of GI were not included into the connectivity analyses, but rather all the GI habitats were handled equally.

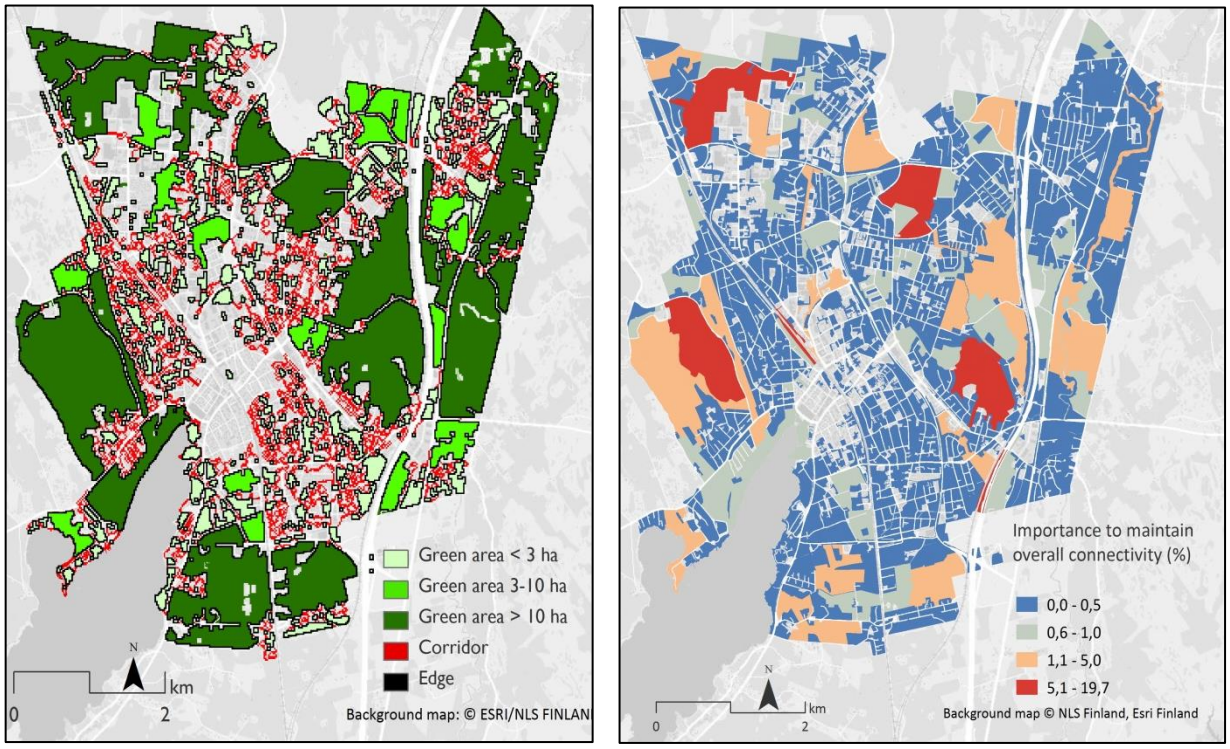


Figure 4. Structural connectivity of GI in Järvenpää.

Spatial Multi-Criteria Analysis

We tested the spatial multi-criteria analysis (SMCA) for engagement of practitioners aiming to enhance the integration of urban greenspaces and residential infill development. We applied a GIS-based Multi-Attribute Value Theory (MAVT) approach, which is a widely-used technique for supporting the decision making especially in the environmental field and urban planning (Ferretti and Comino, 2015, Huang et al., 2011).

Using the spatial assessment results from the ecosystem services and connectivity analyses integrated to the existing spatial knowledge of construction costs, transportation, accessibility to daily services and environmental nuisances and disturbance researchers drafted the initial version of the decision tree (Annex 1). The decision tree including the objectives and criteria was further discussed and altered on-the-fly according to the joint discussion based to the participant's expert knowledge on various sectors. Later, the stakeholders scored the criteria that were integrated to the spatial datasets to present the results on a map (Figure 6). Stakeholders participate in a follow-up table to discuss and validate the results of the ES mapping and assessment exercise.

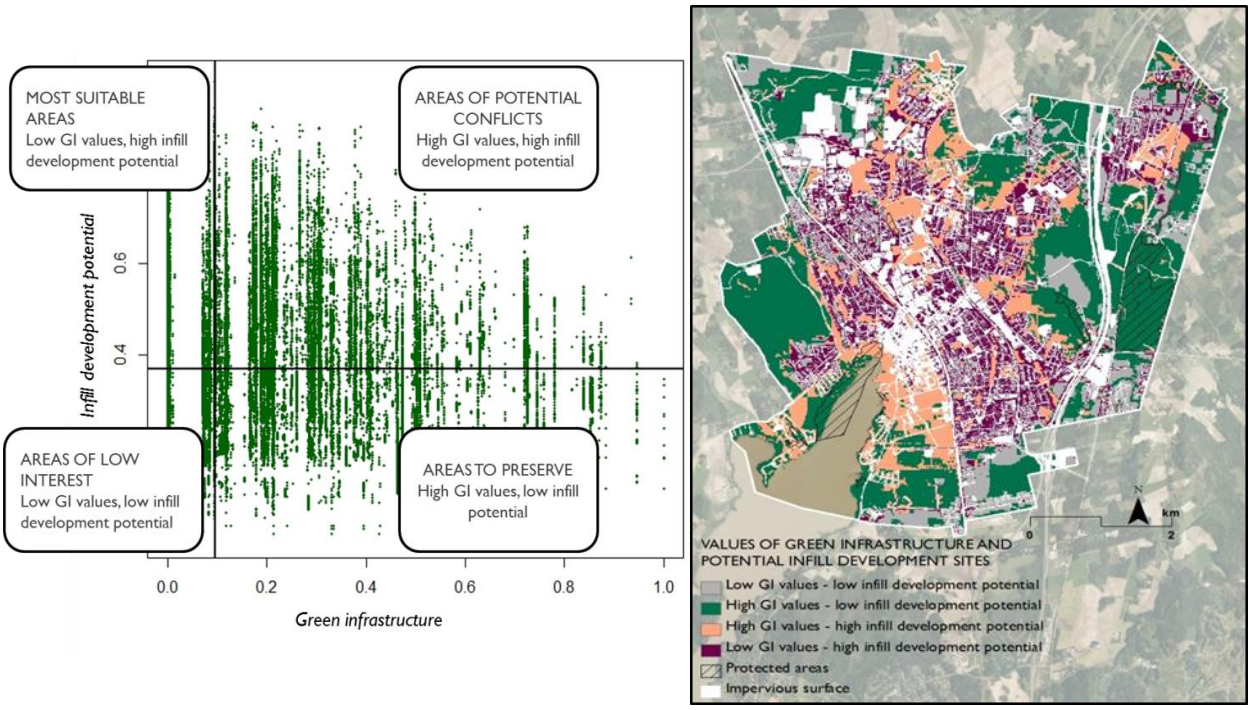


Figure 5. Normalized stakeholder median scores for each dataset pixels (left). Output map representing potential infill sites based to (right).

5.2. Socio-cultural methods for ES mapping and assessment

We used Participatory GIS to evaluates the spatial distribution of cultural ES (mainly) according to the perceptions and knowledge of citizens via workshop, surveys and online questionnaire (Figure 7). Citizen workshop was a twofold. In the first session participants scored green and blue areas according to the importance to provide ecosystem services (see: Annex 2). Method was highly subjective capturing respondent personal opinions. In the second phase, participants marked areas providing ES on a map.

Survey regarding the important educational sites was sent out to schools and kindergartens. In the survey the respondents were asked to mark on a map nature sites, routes or areas that are used for educational purposes. Respondents were also asked to mark areas that they would be willing to use with explanation why it is not possible.

We also utilized the results from the PGIS online survey from 2006 regarding the quality of environment in the area. Survey was not specifically tailored for ecosystem services, but by we were able to modify the results to fit our needs by classifying the answers into ES groups.

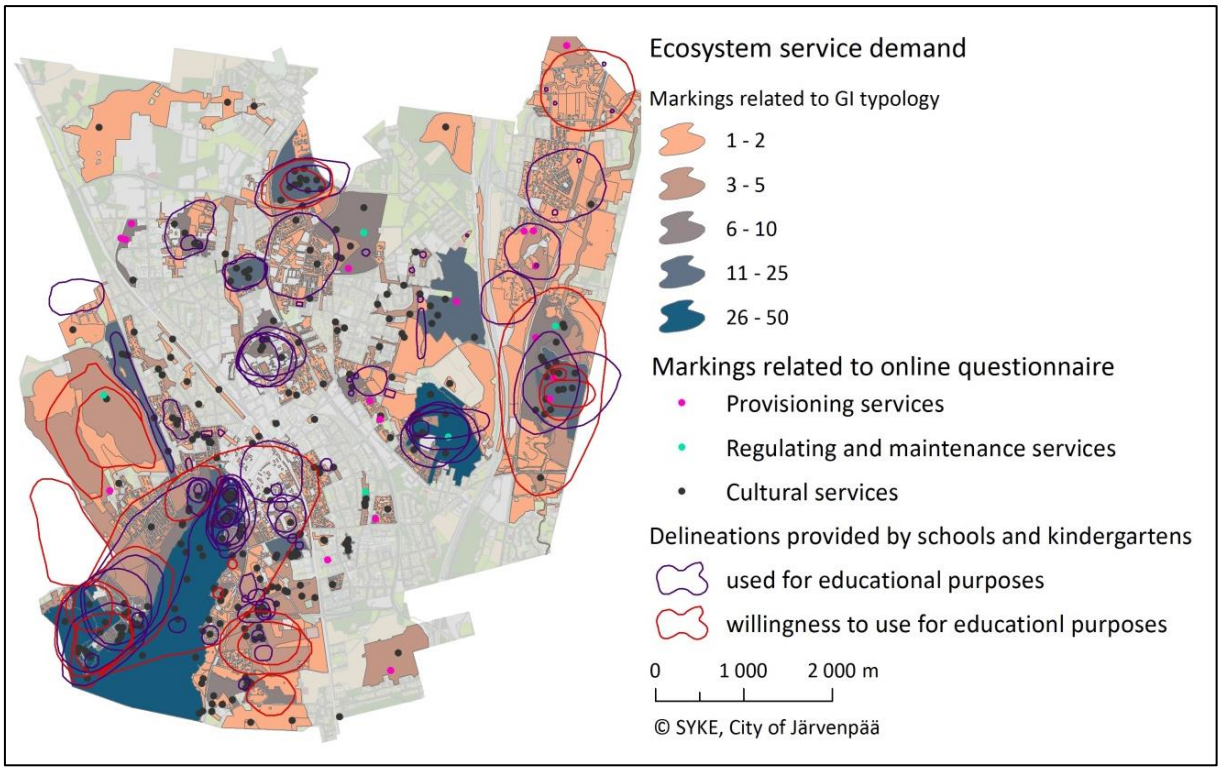


Figure 6. Compilation of the cultural ecosystem services demand in Järvenpää

5.3. Integration of ES mapping and assessment results

The mapping and assessment of ES in Järvenpää generated important information that helped to address the policy question on the better and more sustainable integration of GI and infill development. From a planning perspective, spatially explicit analysis results provided a way to compare potential ES supply, demand and connectivity between the planned infill development sites. Thus, the construction could be directed to areas not decreasing the quality of green and blue structure in the area.

Although each category of the ES was included, the main focus was in cultural ES. Provision potential combined to citizen preferences and values related to cultural benefits is directly linked to the wellbeing of the citizens, hence a useful tool to inform planning decisions in a way required in the Finnish land use and building act.

The SMCA mapping and assessment exercise allowed better engagement of the practitioners to the planning process. The decision tree was seen useful tool to structure the factors having impact to the infill development and provide a visual way to understand the challenge to weight different factors against each other. It provided also a way to include experts' knowledge and perceptions in equal manners.

6. Dissemination and communication

Communication and collaboration between planners and researcher were ongoing during the process through regular meetings and planners participation to the process. Analysis results including GIS-datasets and report (Kopperoinen et al. 2016 [in Finnish]) have been shared with municipal planners. The involvement of citizens, schools and kindergartens provided a way for a more effective policy-science-society interface and enhanced the knowledge exchange between participants in terms of cultural ES. The continuous collaboration along the entire process of mapping and assessment is expected to facilitate the introduction of the results into the ongoing urban planning process.

From the academic perspective, results obtained in this case study concerning the engagement of practitioners aiming to enhance the integration of urban greenspaces and residential infill development will be disseminated through scientific publications later this year (Tiitu et al. 2018). In addition, case study has been presented in international and various national conferences.

7. Implementation

The Järvenpää spatial planners employed the ES concept to value urban greenery in context of new infill development. A novelty, as active stakeholder involvement was ensured at each stage of the planning process, using PGIS methods in schools/kindergardens, an online survey and a citizen workshop, making sure that urban green stayed accessible by stakeholders. Combining municipal planning and research, also enabling citizens to co-shape new development plans enhanced the acceptance of new infill development and proves that the MAES, as applied in this case, bears great potential for upscaling, informing spatial urban developments at higher, regional levels

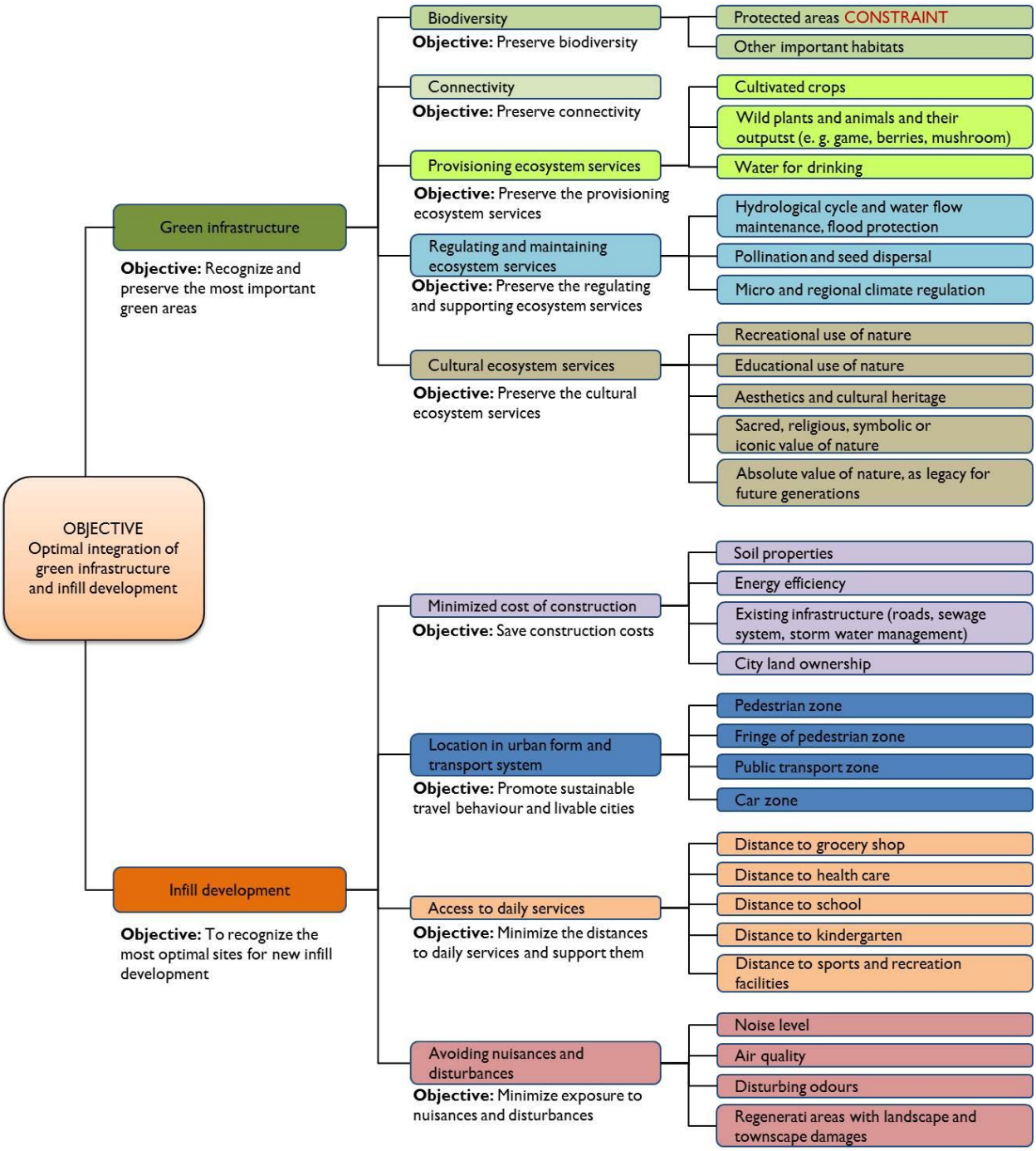
8. References & Annexes

References

Cvejić, R., Braquinho, C., Eler, K., Gonzales, P., Haase, D., Hansen, R., Kabisch, N., Lorance Rall, E., Niemela, J., Pauleit, S., Pintar, M., Lafortezza, R., Santos, A., Strohbach, M., Vierikko, K. & Železnikar, Š.
A typology of urban green spaces, ecosystem provisioning services and demands (2015). Report: D3.1. GREEN SURGE project (2013-2017)
Ferretti, V. & Comino, E. 2015. An integrated framework to assess complex cultural and natural heritage systems with Multi-Attribute Value Theory. Journal of Cultural Heritage, 16, 688-697.
Huang, I. B., Keisler, J. & Linkov, I. 2011. Multi-criteria decision analysis in environmental sciences: Ten years of applications and trends. Science of The Total Environment, 409, 3578-3594.
Kopperoinen, L., Tiitu, M., Viinikka, A., Itkonen, P. (2016). Järvenpään viherrakenteen arvot ja hyödyt. [Values and benefits of green and blue areas in Järvenpää]. Järvenpään kaupunki ja Suomen ympäristökeskus, Järvenpää. [City of Järvenpää and Finnish Environment Insitute] 102 s.
Saura, S. & L. Pascual-Hortal. 2007. A new habitat availability index to integrate connectivity in landscape conservation planning: comparison with existing indices and application to a case study. Landscape and Urban Planning 83 (2-3): 91-103
Vogt, P., Riitters, K. H., Iwanowski, M., Estreguil, C., Kozak, J. & Soille, P. 2007. Mapping landscape corridors. Ecological Indicators 7: 481-488

Annexes

Annex 1: Structure of the decision tree including objectives and criteria for the integration of green infrastructure (GI) and infill development.



Annex 2: Importance of green and blue areas as a provider of ecosystem services based to the respondents median scores from citizen workshop. Scale was from 0 to 2 (0= not important, 1= important, 2= very important).

	Forest	Agricultural area	Meadow	Community garden	Allotment garden	Urban park	Lot	Green buffer zone	Wetland	Lake	River	Stream
Recreation	2	0.8	1.4	0.8	0.6	1.9	1.9	1.3	1.3	2	1.8	1.1
Education	1.9	1.3	1.9	1	1	1.5	1.5	1.4	1.6	1.8	1.8	1.5
Aesthetic and cultural values	1.9	1.3	1.9	1.1	1.3	1.8	1.8	1.5	1.6	2	1.9	1.8
Artistic representation of nature	1.9	1.4	1.6	0.6	0.7	1.7	1.4	1.1	1.4	1.7	1.7	1.6
Symbolic meaning of nature	1.7	1	1.4	0.7	0.4	1.7	1.6	0.7	0.8	1.7	1.4	1.3
Spiritual values of nature	2	0.9	1.3	0.7	0.4	1.6	1.6	0.7	1	1.9	1.6	1.3
Sacred and/or religious	1.7	0.7	1.1	0.1	0.3	1	1	0.6	0.9	1.3	1.3	0.9
Existence and bequest	1.7	1	1.1	0.8	0.7	1.6	1.3	0.7	1.7	2	2	1.6
Cultivated crops	1.6	0.9	1.1	1	0.8	0.6	1.8	0.9	1.3	1	0.9	0.6
Micro and regional climate regulations	1.9	0.7	1	0.6	0.9	1.9	1.7	1.4	1.3	1.9	1.4	1.1