Integrating green infrastructure and ecosystem services in land use planning. Results from two Finnish case studies

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Abstract

Scientific advancements on Green Infrastructure (GI) and Ecosystem Services (ES) have been conducted by experts from several disciplines such as landscape ecology, landscape architecture and, more recently, regional and urban planning. However, there are still difficulties in defining and operationalizing GI and ES within planning. This paper explores the possibilities and obstacles in incorporating the GI and ES concepts into policy frameworks, planning strategies and planning practices by taking as case studies the Helsinki-Uusimaa Region and the City of Järvenpää in Finland. In both cases, several studies on GI and ES have been developed with the collaboration of academics, research institutes and planners. The literature review focuses on the understanding and integration of GI and ES within land use planning. A qualitative content analysis was conducted of policy and planning documents and interviews with regional and city planners. The results show that while the national policy has already embraced the two concepts, the planning strategies of the Helsinki-Uusimaa Region and the City of Järvenpää need to fully integrate GI and ES. A wider and more concrete picture about the difficulties in operationalising GI and ES is provided by the planning practitioners. Rigid regulatory framework and current planning tools still represent obstacles to the effective integration of GI and ES. More science-practice collaborations between experts, practitioners and policymakers should support the development of our cities and urban regions having GI and ES in mind.

Keywords: *green infrastructure*, *ecosystem services*, *urban densification*, *integration*, *understanding*, *planning practitioners*

1 Introduction

Over the last decade, the concepts of green infrastructure (GI) and ecosystem services (ES) have been studied in several disciplines such as landscape architecture, landscape ecology, geography, environmental and social sciences, economics, and more recently, urban and regional planning. The on-going collaborations between academics, policy makers and practitioners have aimed to transfer the scientific knowledge on GI and ES to different levels of policy and planning (Di Marino and Lapintie, 2018; Dick et al., 2018; Saarikoski et al., 2018; Davies et al., 2015). To this end, several studies have focused on the ways in which the concepts of GI and ES have been effectively integrated into land use planning (Bezák et al., 2017; Hansen et al., 2015; Lafortezza et al., 2013; von Haaren and Albert, 2011). However, planners still encounter difficulties in defining and operationalizing GI and ES within land use policy and planning practices (Brunet et al., 2018; Artmann et al., 2017; Lahde and Di Marino, 2018). In this context, it is important to realise that the introduction of GI and ES concepts in planning is not straightforward, but happens in complex environmental, professional, cultural and political contexts. In these contexts, the knowledge is also challenged by the status quo of regulatory framework, expertise and traditional planning practices (Lahde and Di Marino, 2018).

In addition to this, urban and regional planning needs to deal with a variety of knowledge, some of which is produced outside its main domains (such as in ecology, sociology, economics, political science and –philosophy), and some of which is created through its own planning practice, (such as communicative planning skills, visioning strategies and meaning-creation of planning concepts) (Polanyi, 1966; Lapintie, 2016). Therefore, major changes in the conceptual framework and the use of added knowledge of GI and ES require time and commitment, and this is often difficult in the hectic environment of contemporary planning. Thus, there is a need of further knowledge of the ways in which GI and ES can be embedded and developed within the new urban development by planners and policy-makers. More precisely, the aim of the paper is to explore possibilities and obstacles in incorporating the GI and ES concepts into land use planning.

Since the 2000s, several notions and interpretations of GI have been discussed within the scientific debate (Benedict and McMahon, 2001; Benedict and McMahon, 2006). GI is considered to be "an interconnected green space network (including natural areas and features, public and private conservation lands and other protected open spaces), that is planned and managed for its natural resources and values and for the associated benefits to the population" (Benedict and McMahon, 2012, p. 3). Considering the relevance of GI strengthening urban and regional development, GI is currently recognized as an "ecological and spatial concept for promoting ecosystem health and resilience, contributing to biodiversity conservation, and benefiting humans by promoting the delivery of ES" (European Environment Agency, 2014, p. 10). The ES can be categorised as provisioning services (for instance, the products obtained including food, fresh water, wood, fibre); regulating services (the benefits obtained from the regulation of ecosystem processes, such as climate regulation, natural hazard regulation, water purification and waste management); habitat services (which highlight the importance of

ecosystems to provide habitat for species) and cultural services (which include the non-material benefits that people obtain from ecosystems, such as spiritual enrichment, intellectual development, recreation and aesthetic values) (Millennium Ecosystem Assessment, 2005; TEEB, 2011). In this context, GI has also been conceived as a conceptual tool for strategically designing and managing a large variety of ES (Hansen and Pauleit, 2014).

Despite the increasing awareness of relevance and need for GI and ES amongst scholars and policy makers, we argue that the two concepts used by scholars do not automatically find their way to mainstream planning practices. Thus, the paper addresses the problems in integrating ES and GI in policies and planning practices. The study presents a literature review that, first, focuses on the understanding of ES and GI by planners, and secondly, on the effective integration of GI and ES in land-use planning (including the strategic roles of GI and ES, and related potential conflicts). In addition, the study explores the cases of the Helsinki-Uusimaa Region and the City of Järvenpää, Finland. The cases are used as methods to find some key problems and challenges that planners and policy makers face as they need to reconceptualise their work.

The reason for selecting these cases is that there is a growing interest among policy makers and practitioners of the city and the region to establish collaboration with research institutes and universities, in order to understand the new framework of GI and ES within planning. Most importantly, there are new processes of urban densification in which planners have tried to embed the new framework of GI and ES. Policy and planning documents as well as interviews of official planning practitioners from the two cases are used to analyse concepts in they argumentation. Through the two case studies the article focuses on the ways GI and ES were used as part of the land use policy and planning practice. The aim of the study is to develop planning. However, since this was a qualitative study of two cases, the results naturally cannot be generalized to all contexts, but can be used to find out where the key challenges in this integration are.

2 Literature Review

2.1. Understanding of GI and ES in land use planning

In the last decade, scholars have debated about the role that GI and ES can play in outlining long-term outcomes of planning on human well-being (Albert et al. 2014). Moreover, the analysis of ES trade-offs would support "the land-use or management choices that increase the delivery of one (or more) ecosystem service(s) at the expense of the delivery of other ecosystem services" (Turkelboom et al., 2018, p. 567).

However, several cities and urban regions have mostly embedded the concepts of GI and ES within the major arguments on biodiversity protection and non-statutory planning strategies, such as outdoor recreation plans and climate adaptation (Davies et al., 2015). Some of the ES

are more familiar to the planners, since they belong to typical urban issues, such as stormwater management and air pollution (Cortinovis and Genelotti, 2018). Thus, the understanding of GI and ES by planning practitioners is still limited for several reasons. For instance, the understanding of planners is not always supported by scientific studies but often by personal interactions with researchers (Albert et al., 2014). Moreover, established green concepts still permeate planning approaches in our urban regions and cities.

Referring to the five main principles of GI, which are 'connectivity', 'multi-functionality' 'integration', 'multi-scale' and 'multi-object', planners have mostly operationalized the principle of connectivity (Hansen and Pauleit, 2014). The connectivity of GI refers to "physical and functional connections between green spaces at different scales and from different perspectives" (Hansen and Pauleit, 2014, p. 517). Planners have been focusing on connectivity, since they probably have traditionally dealt with spatial issues of green (e.g., accessibility to green areas and ways to connect them).

Amongst planners, there is a tendency to consider one function of GI at a time without considering the multiple benefits of GI (such as ecological, social, economic and cultural) (Davies et al., 2015; Hansen and Pauleit, 2014) as well as the linkages to ES. Moreover, examples of combination of GI and grey infrastructures which operate together providing sustainable regional or urban structure are still limited in planning practices (Davies, 2015). For instance, experts are often called to solve conflicts between GI and grey infrastructures (see e.g., development of wildlife eco-dots and green bridges in response to new infrastructures) (Di Marino, 2016; Tiitu et al., 2018). Additionally, the 'multiple scale' of GI are treated differently according to the planning families around Europe. For instance, in the case of the Nordic countries, much more emphasis seems to be given to the city level when planning GI while the regional strategies have a little influence in the GI planning. Then, the 'multi-object' approach refers to all green and blue spaces (all dimensions, both private and public, natural and semi-natural areas) that can be included within GI (Davies et al., 2015). This approach still encounters several difficulties in land use planning when dealing with the variety of landowners. There is also a predominant knowledge on public green areas by planners, as well as the availability and usage of regional and local database on public green areas.

Furthermore, the linkages between GI and provision of ES have been mainly debated theoretically. "GI can deliver measurable ES and benefits that are fundamental to the concept of the sustainable city (Ahern et al., 2014, p. 255). GI can influence the capacity of ecosystems to provide services across different scales of landscape (Lafortezza et al., 2013). This occurs when GI mitigates risks from climate change by protecting urban regions against floods. Nonetheless, data about the links between GI and the provision of ES in our cities and urban regions are limited (Davies et al., 2015 referring to Kopperoinen et al., 2014). In this context, the most common linkage between GI and ES is understood by planners through the cultural ecosystem services (such as recreation opportunities, conservation of landscape aesthetics, scenery and cultural and historical heritage) (Davies et al., 2015; Andersson et al., 2014).

Therefore, it is evident that the understanding of GI and ES remains complicated due to a wide range of issues for which GI and ES can be employed in planning (Matthews et al., 2015). Some of the key issues are related to the dominance of existing discourses on recreational areas and protection of nature, and there is difficulty in designing appropriate policies for the emerging concepts of GI and ES. In the current planning practices, practitioners are still more familiar with established concepts of accessibility, recreation and protection of nature. The understanding of ES, which are provided by, for instance, urban green areas (e.g. psychological health, filtering pollutants and dust from air, providing shade and lower temperatures) is still vague. Therefore, the ways to transfer knowledge on GI and ES from research to practice are still complex and need further investigation.

2.2. Integration of GI and ES in land use planning and related conflicts

The incorporation of GI and ES can help to identify societal values and individual land use interests (von Haaren and Albert, 2011). So far, the integration has mainly been debated at theoretical level (Hansen and Pauleit, 2014). The effective integration of GI and ES in planning requires first the understanding of the urban context, and secondly, current planning tools (Albert et al., 2014).

Within the existing literature, the integration of the two concepts of GI and ES is recognized relevant to practitioners, policy-makers and citizens. ES are provided by GI and partly co-produced by people and nature (Kremer et al., 2015). This approach would help to further combine socio-ecological aspects into land use planning. Moreover, land use planning can play an important role in provision, regeneration and maintenance of ES in urban areas. In addition to cultural ecosystem services and supporting services, land use planning can help to acknowledge especially regulating ES more widely than before (Davies et al., 2015; Andersson et al., 2014). Scholars have also emphasized the relevance and need for a 'science-practice cooperation' when integrating GI and ES in planning (Albert et al., 2014). This would support, on one hand, the co-production of knowledge on GI and ES, and on the other hand, new collaborations between several actors at the different stages of the planning processes (Albert et al., 2014).

Lately, within the arena of scientific debate, there is an increasing awareness that the new framework of GI and ES enable to address or compare scenarios for densification (and infill of the urban structure) as well as understand the complexity of urban landscapes (Cortinovis and Geneletti, 2018; Artmann et al., 2017; Beery et al., 2016). To this end, the cities of Lahti (Finland) (Brunet et al., 2018) and Dresden (Germany) (Artmann et al., 2017) provide an interesting picture. In the City of Lahti, the ES approach was intended as a 'synthesising perspective on the data' (Brunet et al., 2018). The idea that nature provides benefits to people has helped local planners to understand and interpret the data on the ES considered most relevant (recreation and groundwater preservation). The ES were also discussed in the context of the densification of urban structure and related conflicts on non-urban areas, as well as the connectivity of GI.

Similarly to Lahti, the City of Dresden considered the integration of ES relevant to the model of compact and greener city as well as the assessment of urban ecosystems (Artmann et al., 2017). However, in addition to the cultural ecosystem services, findings show that the supply of other ES should be further incorporated in the plan (e.g., regulation of air pollution and temperature of water surfaces). Referring to the GI, the principle of connectivity is the most acknowledged in the plan (Artmann et al., 2017).

These two cases of Lahti and Dresden as well as other international examples, (see e.g., Berlin, Malmö and Barcelona, Davies et al., 2015) show that the effective ways of integrating ES and GI within planning practices is often related to disciplinary silos and professional skills, as well as socio-political forces amongst policymakers, developers, citizens and other stakeholders.

To this end, scholars have focused on the variety of conflicts amongst the stakeholders that planners encounter when integrating GI and ES (Cortinovis and Geneletti, 2018; Mell, 2013) Policymakers, planning practitioners and other stakeholders are often mostly interested in understanding 'where to develop' or 'where to build', and ask for spatial, temporal and operational solutions (Fürst et al., 2014). In this context, the integration of the ES trade-off analysis becomes relevant to the sustainable urban development. The ES trade-offs analyses are more complicated in the real life than theoretical studies (Turkelboom et al., 2018). Planners and decision-makers should understand causes and mechanisms for ES trade-offs and related impacts. This would help to "predict where and when trade-offs occur, as well as initiate a more sustainable decision-making process and urban development" (Turkelboom et al., 2018, p. 567).

It is evident that there are several well-known challenges in integrating GI and ES in situated planning contexts. The contextual application of knowledge on GI and ES and expertise are related to inevitable complex intents which characterize the different stage of the planning process from strategy to practices.

3 The study areas: Helsinki-Uusimaa Region and City of Järvenpää

The Helsinki-Uusimaa Region and the City of Järvenpää are presented as case studies. The Helsinki-Uusimaa Region, consists of 26 municipalities, including the City of Helsinki (the capital of Finland), and it is populated by 1.6 million inhabitants (Official Statistics of Finland, 2018). The City of Järvenpää is located in the Central Helsinki-Uusimaa Region, along the main railway corridor from the City of Helsinki, at a distance of 35 kilometers from it (Fig.1), and it is populated by 41,000 inhabitants. The Helsinki-Uusimaa Region covers a land area of 3,840 km^2. Nature reserves, protected areas and habitats of species under strict protection occupy 444 km^2. Forests and other nature areas represent 62% of the Helsinki-Uusimaa Region, while the agricultural areas form 23% of the regional land City of Järvenpää, covers a land area of 38 km^2 (Fig. 1). The population of Helsinki-Uusimaa Region is expected to grow by 16 % by 2040

(Official Statistics of Finland, 2018). Since the population is nationally concentrating in the Helsinki-Uusimaa Region, there is a continuous pressure to develop land for housing and other urban functions. The City of Järvenpää is also expected to increase its population by 11 % by 2040, and thus, the land conversion pressure is particularly high.

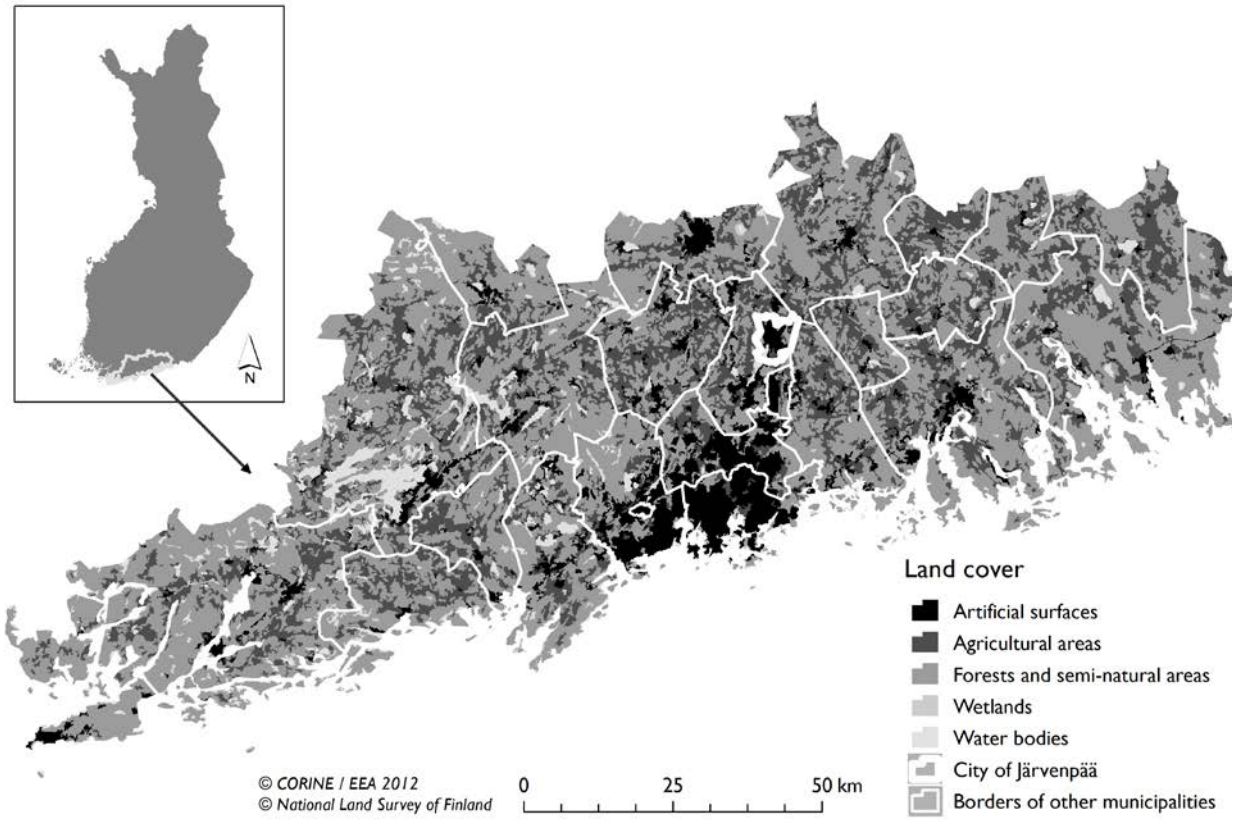

Figure 1: The geographical location and land cover of the Helsinki-Uusimaa Region and the City of Järvenpää.

These two cases were selected as both have recently challenged the traditional green space planning strategies. The urban developments from the past years and ongoing urban densification processes have affected the provision of green spaces and simultaneously limited access to the existing green areas. However, the regional and local policies are now currently more compact-city oriented (see e.g. the cities of Helsinki, Tampere, Vantaa and Jyväskylä, Lahde and Di Marino 2018; Di Marino and Lapintie, 2018). Thus, the intention of the planning practitioners is to encourage densification and more effective land use (e.g., diverse patterns, mixed-uses, and quality of green areas). The general aim is to create more sustainable cities and reduce traffic emissions. In this context, planning practitioners are currently trying to embed the new framework of GI and ES when discussing the new urban development. However, each context is characterized by planning practices as well as environmental, socio-political, economic and spatial pressures.

In addition, other reasons for the selection of the two case studies involve their introduction of new forms of science-practice collaboration that deal with the development of GI and ES. The Helsinki-Uusimaa Region is the first region in Finland to pioneer the development of GI and ES within its regional plan. Together with the Ministry of the Environment, the Regional Council has commissioned comprehensive studies from SYKE and the University of Helsinki. The City of Järvenpää is one of the first Finnish municipalities, (together with Tampere, Lahti, Oulu, Espoo, Vantaa, Helsinki, and Sipoo), to conduct a comprehensive analysis of ES and GI in collaborations with local experts from research institutes and Finnish universities.

Two parallel studies focusing on GI and ES were commissioned by the Helsinki-Uusimaa Regional Council as follows:

(1) The Finnish Environment Institute SYKE mapped and assessed the region's GI from the ES point of view (Kopperoinen et al., 2016a). The study included an analysis of spatial variation in the overall ES provision potential of GI using the GreenFrame method (Kopperoinen et al., 2014; Kopperoinen et al., 2016b). GreenFrame method is a semi-quantitative place-based method combining both quantitative and qualitative (i.e. expert scoring) data. Altogether 23 ES groups from all three CICES v.4.3 sections (provisioning, regulation and maintenance, and cultural ecosystem services) were included in the analysis. The workflow started by first identifying the most relevant sources of GIS data describing sustainable provision of the selected ES, and then collecting the identified GIS datasets. The collected GIS datasets were combined under mutual themes (e.g. various datasets of different types of protected areas were combined into one layer). After that, data themes were scored by experts and regional stakeholders according to the effect of each theme on the prerequisites for the potential provision of different ES. The scores varied from very favourable (3) to very harmful (-3). The median based on given individual scores was calculated and normalized into a common scale ranging from 0 to 1. The value 0 corresponds to the minimum value among the pixels of a particular dataset, while the value 1 corresponds to the maximum value (describing the higher ES provision potential). Finally, the different themes were overlaid in order to see the spatial differences in overall ES provision potential of GI, as well as categorically in CICES v.4.3 sections. ES provision potential maps were complemented with identification of the key areas of GI by roughly applying the methodology based on the European Environment Agency (2014) where the most valuable biodiversity areas constitute the core for the GI. This additional analysis was used to support the interpretation of results and planning decisions along the concept of ES that was first introduced into regional planning in Helsinki-Uusimaa region. ES mapping results revealed that using only the protected areas and other areas classified as valuable natural areas did not seem to capture all the regionally important green spaces belonging to the key areas. The analysis was complemented by including in key GI the areas having the highest 20% of the ecosystem service provision potential as well

as core nature areas and corridors based on connectivity analyses using Morphological Spatial Pattern Analysis (Soille and Vogt, 2009). In addition, demand for cultural ecosystem services was mapped using an online public participatory GIS survey. Finally, potential population pressure on GI was mapped as well as accessibility of each GI pixel in a number of timeframes along the road network.

(2) The University of Helsinki assessed the Helsinki-Uusimaa Region's GI based on biodiversity values and ecological functional connectivity of GI using the Zonation model. Zonation is a conservation planning framework and software (Di Minin et al., 2013). It produces a hierarchical prioritization of the landscape based on the occurrence levels of a variety of different ecological variables in sites (cells) by iteratively removing the least valuable remaining cell while accounting for connectivity and generalized complementarity. Habitat, habitat quality and animal species data is important in Zonation analysis; in the Helsinki-Uusimaa Region's analysis 18 animal species datasets and 21 habitat datasets were used (Kuusterä et al., 2015).

The parallel studies lasted about three years and produced both separate as well as joint comprehensive reports of the research results for the Regional Council (Kopperoinen et al., 2015; Kuusterä et al. 2015). The study process was very interactive between researchers and planners, as well as with regional sectoral experts through regular meetings and workshops between them.

In 2014, the city of Järvenpää commissioned a comprehensive analysis of ES and GI from SYKE. The study lasted two years consisting of a report encompassing a wide spectrum of GIS analyses, including a spatial classification of the green and blue areas, analysis of the ES provision potential of GI using the GreenFrame method (provisioning, regulation and maintenance and cultural ecosystem services).

In GreenFrame, scores given to data themes in the Helsinki-Uusimaa's regional study were combined with Järvenpää's data themes to conduct ES provision potential maps in a smaller city scale. This was seen appropriate as the City of Järvenpää is located in the Helsinki-Uusimaa Region. The different themes were overlaid in the same manner as in the regional study. This allowed to see the spatial differences in the overall ES provision potential of GI, as well as categorically in CICES v.4.3 sections (See Figures 2 and 3). The results were presented both as original raster data with a spatial resolution of 25 meters, and as maps where the data was aggregated into spatially classified green and blue areas. In addition, the structural connectivity of GI was assessed by applying a graph-theory-based method to quantify the importance of each habitat to maintain overall connectivity (Saura and Torné, 2009; Bodin and Zetterberg, 2010). Habitat size and distance to other habitats were used as parameters. In addition to the ES provision potential, an analysis of the demand for ES amongst the local community was carried out using a number of participatory GIS methods, as well as accessibility of GI.

Three of the five co-authors of this paper were involved in the study commissioned by the City of Järvenpää from 2014 to 2016, by collecting and analysing ES and GI data and by elaborating thematic maps. The results of the study were discussed with the city planners during the collaboration (from 2014 to 2016), and recommendations for new infill sites were given.

4 Research materials and methods

A qualitative content analysis was conducted to understand the ways ES and GI have been effectively integrated in the land use policy and planning strategies as well as planning practices. The qualitative content analysis was based on a textual analysis of policy and planning documents and practitioners' interviews.

For the qualitative content analysis, we have employed a number of strategic planning documents providing long-term strategies, visions and objectives for the future development of the Helsinki-Uusimaa Region and the strategic plan of the City of Järvenpää. A national report on the two emerging concepts of GI and ES was also selected for the document analysis. The analysis of the policy and strategic planning documents are based on the following reports:

1 Towards a Sustainable and Genuinely Green Economy. The value and social significance of ecosystem services in Finland, TEEB for Finland, (Ministry of Environment, 2015). The document aims to conduct a preliminary estimation on the economic and social importance of ES in Finland. The document focused on recognising regulating and cultural ecosystem services, but without neglecting traditional provisioning services. As a scoping study, it was based on separate case studies and did not provide a comprehensive nationwide assessment. The document is a product of a group of research institutes and researchers. Therefore, when citing the statements and related sources, within the qualitative content analysis, we referred to the authors of the chapters.
2 The Helsinki-Uusimaa Regional Programme, Vision and Strategy 2040, Strategic Priorities 2014–2017 (Helsinki-Uusimaa Regional Council, 2014). This programme has been formulated as a co-operation between the Helsinki-Uusimaa Region and the Centre for Economic Development, Transport and the Environment (ELY) of Helsinki-Uusimaa Region. The document aims to depict a sustainable growth considering opportunities for economic growth, practical everyday life and sustainable ecology. The strategic vision has helped to define the objectives of the regional land-use plan.
3 Where Does the City Grow? Review of alternative structural models for Järvenpää local master plan 2040 (City of Järvenpää, 2018). This is a strategic planning document prepared by the city planners, and it focuses on different structural models to support the new master plan 2040 that is under preparation (City of Järvenpää, 2018). The report provides some strategies relevant to the master planning, since it presents scenarios of urban growth.

Furthermore, the qualitative content analysis focused on the semi-structured interviews (in total N=7), with four official planning practitioners of the Helsinki-Uusimaa Region (from the Environmental, Housing and Tourism Divisions), and three city planners from the Land Use Division of the City of Järvenpää, respectively. The interviews dealt with several topics, such as the level of understanding of GI and ES as well as the awareness of the most predominant ES in the urban regions. Questions also referred to the transferring of GI and ES knowledge to regional and local plans, effective use of ES and GI data in planning strategies and practices, as well as difficulties that official planners have encountered in integrating the concepts of GI and ES (see the list of questions that were asked to the regional and city planners in the Appendix). During the interviews with the three planners of the City of Järvenpää, several GI and ES maps were also discussed. The maps were based on the analyses from the previous study commissioned by the City of Järvenpää mentioned in *Section 3*.

We analysed the contents of policy and planning documents and planners' interviews coding the statements in texts (see Table 1). The qualitative content analysis focuses on the three selected categories: 1) understanding of GI and ES; (2) integrating GI and ES as strategic components in the land use development and (3) identifying potential conflicts when developing GI and ES in planning. These three categories were considered relevant themes to explore further based on the findings from the literature review presented in this study.

Table 1 Selected content analysis of policy and planning documents and semi-structured interviews with the planning practitioners. Differences and similarities in integrating ES and GI in national and regional policy, as well as planning strategies and practices.

Category	Code	Excerpts from the policy and planning documents and practitioners' interviews	Preliminary argumentations
KNOWLEDGE OF GI AND ES	**KnESN**1	"Provisioning, regulating, supporting or maintenance, and cultural services of the natural environment are commonly included under the concept of ecosystem services (MA 2005, Kumar 2010, UKNEA 2011, see also www.cices.eu). Provisioning services and their material benefits for society have traditionally been considered adequately in decision-making, and generally an economic value for provisioning services in different markets has been formed." (Ministry of Environment, 2015, p. 11, referring to Jäppinen and Kettunen, 2015)	Regulating and cultural services are qualitatively identified, for instance, by establishing the recreational use of green spaces as a goal. However, the national policy stated that they are not generally evaluated using financial or other scales compared to other ES (e.g., provisioning services). This aspect should be considered when integrating ES in the regional and local land use planning.
KNOWLEDGE OF GI AND ES	**KnESR**1	"Ecosystem services are material and immaterial services that are derived from nature and necessary for people; safeguarding these services is essential for human well-being. Natural diversity is largely the foundation for any benefits that humans can derive from the ecosystem." (Helsinki Uusimaa Regional Council, 2014, p. 26)	ES are essential for people's well-being within a regional context. According to the regional strategy, the ES should be part of a new perspective in the regional land use development.
KNOWLEDGE OF GI AND ES	**KnGPS**1	"A mutual network of green infrastructure has been delineated for all the alternative structural models. The network consists of the key large green areas and green connections between them. The aim is to ensure the preservation of both locally and regionally important green connections in all the alternatives. These green areas and connections include the Natura2000 areas and other protected areas." (City of Järvenpää 2018, p. 9)	In the City of Järvenpää, the understanding of GI results into a sustainable perspective of urban growth. Moreover, there is a significant consideration of both level of planning, regional and local, when preserving natural areas.
KNOWLEDGE OF GI AND ES	**KnPP**1	"A planner needs more general outputs for elaborating a land use plan. Master plan needs to provide the future picture of the city. The ES can support more general strategies and future concrete action such as 'this is the most important green connection of the city centre, so save it'." (City planner from land use division, September 13, 2017)	The planning practitioner argued that planners are not researchers. They needs help to understand the ES and GI. It is necessary to integrate both concepts into more general questions of the master plan.
KNOWLEDGE OF GI AND ES	**KnPP**2	"The understanding of ES and GI can be improved through further knowledge and development of methods. People and practitioners from the regional divisions will use more and more the notions of GI and ES. Nature is very close to people in Finland, even in the metropolitan areas. However, we need to work at making concrete actions." (Regional planner' s interview, from the housing division, May 15, 2017)	People are aware of being surrounded by nature. However, according to the regional planner, the nature and its conservation needs to be further integrated into the regional land use planning.
GI AND ES AS STRATEGIC COMPONENTS	**StrN**1	"ES and related biodiversity in society can provide possibilities for new business models and employment activities which are based on the sustainable use of these assets. This kind of development activities should be encouraged and supported." (Ministry of Environment, 2015, referring to Jäppinen and Heliölä, 2015)	In addition to the public sector, this calls for a new collaboration with the private companies that should be able to embed the ES in their businesses.
GI AND ES AS STRATEGIC COMPONENTS	**StrR**1	"Natural diversity lays the foundation for services provided by the ecosystem. ES comprehensively highlight the benefits of green areas. Securing these areas is important for people's well-being. Our knowledge base on these topics must be complemented so that it can be used, for example, in urban planning and in the drafting of the region's green strategy that brings together regional objectives. National parks and the region's green belts are important for natural diversity and the recreation of residents." (Helsinki Uusimaa Regional Council, 2014, p. 22)	ES and green strategies are seen as strategic components when dealing with people's well-being, urban planning, nature diversity and recreational activities.

GI AND ES AS STRATEGIC COMPONENTS	**StrPS**1	"The new residential areas are located in the centre of the present green network, close to natural areas. The continuity of the green network is ensured by placing the new residential areas so that they do not considerably narrow the main green network. The accessibility is ensured by developing high-quality pedestrian and cycling routes from the residential areas to the recreation sites." (City of Järvenpää 2018, p. 21).	In the City of Järvenpää, the ongoing urban densification should not affect the provision of green spaces. The aim of the planning strategy is to encourage densification and simultaneously create a more sustainable city.
GI AND ES AS STRATEGIC COMPONENTS	**StrPP**1	"We cannot continue sprawling cities. We need different kind of green areas for reducing people's stress. We also want to make people more aware of the nature. Nature conservation needs to be further recognized and emphasized as priority within the master plan. This aspect should be more visible even in the current planning discourses on ES." (City planner from land use division, August 28, 2017)	According to the planning practitioner, the conservation of nature and habitats has not fully achieved within the master planning strategies. This use to happen also before the understanding of ES. The effective conservation of nature has been always challenging in the City of Järvenpää.
GI AND ES AS STRATEGIC COMPONENTS	**StrPP**2	"When developing the land use scenarios, we used the concepts of GI and ES. Amongst the principles of GI, the connectivity has been already integrated in the urban growth scenarios. The idea of a green network was based on the GI and ES data that has been collected in the last years (…). The thematic map on the GI connectivity was used very much to understand what green connections should be preserved. When developing the land use scenarios, we have simplified the concept of connectivity and its representation within maps and text. This has been a long process and is still on-going."(City planner from land use division, September 13, 2017).	The picture provided by one of the city planners of Järvenpää has confirmed that the GI and ES data are used to develop the planning strategies. However, when embedding GI and ES into the master plan, the data need to be simplified.
CONFLICTING VALUES AND INTERESTS	**CviN**1	"(…) even if plans were drawn up keeping ecosystem services in mind and utilizing an ecosystem service approach, the problem is that the links between planning law and laws regulating single decision-making processes, such as permit processes, are not always clear. For instance the effectiveness of water management plans ultimately depends on how authorities give due consideration to plans in their decision-making." (Ministry of Environment, 2015, p. 115, referring to Jäppinen and Heliölä, 2015)	The national policy has already recognized the fragmentation of administrative sectors, as well as the need of strengthening the current planning instruments.
CONFLICTING VALUES AND INTERESTS	**CviN**2	"These connections can be found for instance in the Land Use and Building Act, which provides key mechanisms for accommodating diverging land use interests. However, these connections are not made explicit and contemporary legislation does not provide clear authorization for consideration of ecosystem services in decision-making. However most of the norms do not directly block the consideration of ecosystem services in decision-making either."(Ministry of Environment, 2015, p. 114, referring to Jäppinen and Heliölä, 2015)	According to the national report, it is not necessary to change the legislation but only provide some guidance on where, when and how the concept of ES can be integrated in decision-making process.
CONFLICTING VALUES AND INTERESTS	**CviPS**1	"In some of the structural models, new land-uses overlap with the main network of green and recreation areas. This is to show that nowadays these areas belong to a larger green area network and that the preservation of the key green connections is important to ensure in planning." (City of Järvenpää 2018, p. 9)	The new land use is still dealing with some conflicts. The conflicts are between the strategic GI and other land use developments. The risk is that new urban developments might overrule the GI.
CONFLICTING VALUES AND INTERESTS	**CviPP**1	"There are difficulties in transferring the knowledge on GI and ES into detailed plans. The detailed planning focuses on how to recognize the natural values of urban areas, and where it is possible to build. Considering the GI and ES, there are often small areas for which it would be better to change the land use (e.g. from residential and office districts to green and recreational areas). However, often the detailed plans have been already approved." (City planner from land use division, September 13, 2017)	The regulatory framework and local zoning represent current obstacles for the effective integration of GI and ES.

List of codes used within the content analysis and number of examples for each code found
KnN Understanding of GI and ES, when they are discussed together, in the national policy =8. However, the two concepts of GI and ES were also discussed separately, and therefore, we used the sub code of KnESN when referring to ES, and the sub code of KnGN when referring to the GI. We found KnESN= 26 and KnGN=20.
KnR Understanding of GI and ES in the regional policy. We used the sub code of KnGR when referring to GI and KnER when referring to ES References to the GI were not found (KnGR= 0) while the concept of ES was discussed (KnER= 3).
KnPS Understanding of GI and ES in the planning strategies. We used the sub code of KnGPS when referring to GI and the sub code of KnESPS when referring to ES. The concept of GI was discussed (KnGPS =3), while references to the ES were not found (KnESPS= 0).
KnPP Understanding of GI and ES by the planning practitioners = 14.
StrN GI and ES as strategic components in the national policy =5.
StrR GI and ES as strategic components in the regional policy =3.
StrPS GI and ES as strategic components in the planning strategies =6.
StrPP GI and ES as strategic components in the planning practitioners' perspective =12.
CviN Conflicting values and interests in the national policy =16.
CviR Conflicting values and interests in the regional policy =0.
CviPS Conflicting values and interests in the planning strategies =3.
CviPP Conflicting values and interests in the planning practices =16.
In addition to the codes, the statements were numbered progressively. Therefore, the code is followed by a number (please see above)

5 Results

5.1. The Policy perspective

When discussing the urban growth, the TEEB report stated that a sustainable land use development should be based on the societal and ecological benefits of GI and ES (Jäppinen and Heliölä, 2015). TEEB report presents the Common International Classification of Ecosystem Services (CICES) as the backbone of the European Commission's work on ecosystem services (Vihervaara et al., 2015). First, the TEEB report emphasises the provisioning services provided by agriculture, forestry and fisheries. These services are relevant in Finland, but other ES can be identified at the regional and local level (such as wood-based bioenergy; non-timber forest products, such as berries and mushrooms; and recreation and nature-based tourism). Within the land use policy, however, regulating and cultural ecosystem services have received less attention so far, "because they remain more easily unrecognized in the planning process" (Jäppinen and Heliölä, 2015, p. 113). The cultural ecosystem services, for instance, are still too abstract or immaterial. In order to make the cultural ecosystem services more visible, the national policy recommends the use of participatory methods in land use planning. This would allow to integrate beliefs, views and values of local people in planning processes (Jäppinen and Heliölä, 2015). The understanding of ES in land use is supported by these arguments which were coded and interpreted as KnESN (n= 26) (see Table 1).

When introducing the notions of GI, the TEEB report refers to the European policy framework (e.g. European Commission, 2013) and the international scientific debate (see e.g., Naumann et al., 2011), emphasising the multi-functionality of GI in land use planning, and therefore, the possibility to offer several benefits at the same time (KnGN, n=20). "GI must be integrated into land use planning and decision-making at all levels" (Itkonen et al., 2015, p.46). In addition to this, the understanding of ES and GI needs to be supported by a wider comprehensive knowledge and thematic maps which embrace both concepts (KnN, n=8). The data from these spatial analyses and visualizations of GI and sites which provide ES (and where there is a

demand for ES) should be used not only in land use planning but also environmental impact assessment and further research.

Moreover, the idea of employing ES and GI as strategic components is mainly referred to in the conceptual framework of monetary and non-monetary values of ES (StrN, n=5). To this end, policy arguments stated that the current knowledge on the economic value of ES needs to be increased in further studies. Thus, it would be important to estimate the "damages and economic costs resulting from the loss of ecosystem services and related biodiversity that do not have a market-value" (Jäppinen and Heliölä, 2015, p. 118). In this context, the ES and related biodiversity are also recognised as part of business models enable a sustainable use of resources (Jäppinen and Heliölä, 2015).

Furthermore, amongst the arguments on potential conflicts in land use planning, several statements referred to the importance of understanding GI and ES amongst stakeholders (CviN, n=6). The learning outcomes of stakeholders, which refer, in particular, to the capability of recognizing ecosystem functions and related ES provided, allow to reconcile different points of views when discussing the urban development. Several statements on the fragmentation of administrative sectors and borders and limitation of the current regulatory frameworks were also interpreted as potential conflicts in land use planning (CviN, n=5). In fact, neither ecosystems nor the services they deliver follow administrative or sectoral boundaries. This calls for a new understanding of current and different planning strategies and instruments that support decision-making processes in Finland (Borgström and Similä, 2015). Existing regulations such as the Nature Conservation Act (1096/1996), "were not introduced with ecosystem services in mind" (Borgström and Similä, 2015, p. 73).

In this context, however, the main recommendation of the national policy is not to make legislative changes but rather understanding the ways in which ES can be considered within the framework of existing regulations on decision-making and highlighting them. Other statements referring to conflicting situations regard the demand and supply of ES (CviN, n=5). There are urban areas where the high demand for ES can meet high supply or low supply of ES. In the case of the Helsinki Uusimaa Region, there are areas with high potential supply of ES where there is an on-going process of densification (Itkonen et al., 2015). However, when discussing the urban growth, this ES approach is not yet acknowledged in the regional and local planning strategies.

In the regional planning document analysed, the concepts of GI and ES are not fully acknowledged. Several thematic maps on GI which have been commissioned to the research institutes are already available online within regional reports[1] (Kopperoinen et al., 2015; Kuusterä et al. 2015). However, when outlining strategies for the urban development, the regional policy is still embracing the concept of *green structure* instead of GI. "Nature in the

[1] The green structure and ecosystem services using new methods (in Finnish): https://www.uudenmaanliitto.fi/files/17240/Maakunnan_viherrakenne_ja_ekosysteemipalvelut_uusin_menetelmin_E158-2015.pdf

Helsinki-Uusimaa Region is highly diverse, and the cultural values associated with the built environment are great. The regional plan holds a crucial role in securing natural diversity; the region's green structure will be discussed as a whole in the regional planning process (Helsinki Uusimaa Regional Council, 2014, p. 25). The green structure is seen as a whole, "considering recreational services and housing, valuating cultural environments, strengthening the preconditions for business development, improving logistics, and looking into the use of renewable energy, e.g. wind power, in the region" (p. 36). However, this objective remains quite abstract even when the green network is further discussed: "In planning, it is important to discuss the green network and its impact on the well-being of citizens and the competitiveness of the region" (p. 41). It is evident that there is an emerging vision of the green structure often embedded within a regional green strategy. Therefore, explicit references to GI were not found (KnGR, n=0), while potential conflicts were mostly related to more established concepts such as ecological corridors, green structure and green networks and the impacts of urban densification.

Furthermore, few statements were found referring to ES concept (KnESR, n=3). This regional approach to the ES stated: "Ecosystem services are material and immaterial services that are derived from nature and necessary for people; safeguarding these services is essential for human well-being" (Helsinki Uusimaa Regional Council, 2014, p. 26). The regional vision, has also recognized the strategic role of ES for a sustainable living environment (StrR, n= 3). "When developing the management and valuation of ES important for people and society, as well as in every associated communication, one should emphasize, more than is being done currently, the socially beneficial regulating and cultural ecosystem services behind and alongside the provisioning services and supporting or maintenance services that enable ecosystems to function." (p. 11). However, the concept of ES is not further developed, and therefore, the ways to integrate the new framework of ES in the regional land use remains quite vague. Therefore, there were not found explicit references to potential conflicts that might occur when ES are effectively embedded in land use planning.

5.2 Integrating ES and GI: findings from the regional planners' interviews

There is a common understanding amongst the regional planners about the relevance and need for integrating GI and ES in land use planning (KnPP, n=7). Initially, the increasing awareness was facilitated by new professionals such as landscape architects who were hired amongst the official planning practitioners of the Helsinki-Uusimaa Region. One of the regional planners interviewed stated that "*The understanding of GI and ES happened for the first time ever in 2012, when we hired landscape architects in our offices. The GI represents an actual topic, and thus, we want to use the most modern methods."* Through the new collaborations with additional experts (e.g., from landscape ecology and urban ecology) from research institutes and universities, the regional planners realized the importance of people's well-being that can benefit from nature. "*The researchers helped us think from a new point of view of wellbeing, in addition to other traditional interests from the stakeholders.* Moreover, the planners are aware that the

integration of the new framework of GI and ES requires time and commitment, to this end one of them added: *"Bridging research and real world is not easy. While some topics are very well-known, such as transportation and housing research, ES is a new thing*."

In this context, however, the official practitioners remarked that the understanding of GI and ES within the municipalities can be really varied and it can depend, for instance, on the background of the city planners. Some of the municipalities do not have planners in-house with expertise on GI and ES. In this sense, the small municipalities, due to financial limitations, cannot even hire additional planners with a background in landscape architecture and related fields. In addition to this, one of the interviewees stated that: "*The Finnish name of ES is ekosysteemipalvelut. I think it is a very difficult word for the municipalities (…). We have tried to educate the municipalities about GI and ES as an entity, and from the points of view of human well-being and the value of nature*."

The concepts of GI and ES have been useful for understanding the different aspects of green areas (e.g. the largest forest areas and accessibility). However, a regional planner argued that "*It is not easy to mark the ES in land use maps, no one has done it before in Finland.*" According to the regional planners, the idea of delineating the potential areas that provide ES (that they called '*marking*') is not the most suited to the regional land use plan. Thus, the regional planners have decided to mention ES within the texts of the regional policy in a form of recommendations while the GI are represented in thematic maps.

On the one hand, the interviewees are aware of the relevance and need for using ES and GI approaches in the regional plan. On the other hand, they have also reflected on the potential conflicts that can be occur amongst the stakeholders involved in the decision-making process (CviPP, N=3). A regional planner argued: "*Several ES are provided within the forests, such as the provision of wood and recreational activities. Forest organizations, landowners and other stakeholders are key actors within the forest matters. I am wondering… is it more important to provide untouchable landscape for tourists? Or is it more important to understand who picks the berries or uses the trees for bio-energy within the Helsinki-Uusimaa Region?"* When applying the new framework of GI an ES in land use planning, regional practitioners have also dealt with conflicts related to the accessibility to green areas and landownership (CviPP, n=4). For instance, in the Helsinki-Uusimaa Region, the development of GI and ES is mostly based on the knowledge of public green areas. One of the interviewees said: *"We are still debating on how to go beyond the conflicts between private and public landowners. Noise and disturbance that might be created by the new recreational activities (e.g. picking berries) within private areas are not really welcome amongst the landowners. We are also focusing on what areas could provide ES and what areas actually provide ES*".

Furthermore, planners' statements focused on the strategic role of GI and ES, this mostly happened when discussing the idea of constructing a green belt around the urban region of Helsinki (StrPP, n=3). The idea is to define a green belt around the densest areas of the Helsinki-Uusimaa Region and take measures to counteract a further urban growth of the region.

According to the regional planners, the green belt can be a place where to further study the GI and ES.

5.3. Planning perspective of the City of Järvenpää

Within the strategic plan of the City of Järvenpää, the understanding of GI refers predominantly to the connectivity (KnGPS, n=3). The knowledge on GI is mainly supported by the GIS-based maps which visualize the main network of green and recreational areas that are also connected to the large green areas. Explicit references to ES were not found in the planning document while several benefits of GI were stated when describing the different structural models of the urban growth. Recreation, storm water management and landscape values are the most common themes mentioned. "Preserving the key green connections and need for planning the recreation routes (…) is emphasised. The field and cultural landscape support this recreation towards the lake and the planning of new residential areas in the densifying structure." (City of Järvenpää 2018, p. 15). However, the other benefits provided by GI are not discussed in the report.

Moreover, four different growth scenarios (so-called structural models) and related impacts on the built environment are described within the planning strategies (City of Järvenpää 2018). The impact assessment covers specific topics of the built environment, such as regional development, urban form, housing and population, mobility, livelihoods, services, cultural environment and townscape, land acquisition policy, and also GI. Within this overview, the GI is considered as one of the strategic components on which the impacts of the urban scenarios are assessed (StrPS, n=6). The impacts of the different structural models on GI were assessed with three criteria which are: 1) The continuity of green connections (qualitative: assessment based on map interpretation), 2) the urban biodiversity (quantitative and qualitative: proportion of green spaces of at least 3 ha of the city area and prevalence of conserved areas and species), and 3) the residents' access to recreation areas (quantitative: proportion of people having a recreational area of at least 1.5 ha within walking distance of 300 m). In addition to this, smaller green areas and green elements supplementing the GI, such as private gardens, are also recognised as a part of the GI. Concerning the relationship with GI and land development, the report states that GI is not a constraint that prohibits developing areas, but GI needs to be taken into account in detailed planning if the areas include GI.

Statements on contrasting interests in the document dealt with GI and development of land (CviPS, n=3). However, several statements refer to a sustainable urban development that aims to move beyond these conflicts by embracing the principle of GI connectivity and recreational services, such as: "The new residential areas are located in the centre of the green network, close to the natural areas. The continuity of the green network is ensured by placing the new residential areas so that they do not considerably narrow the main green network itself" (City of Järvenpää 2018, p. 21).

5.4 Integrating GI and ES: findings from the city planners' interviews

The official planning practitioners from the land use division of the City of Järvenpää presented an interesting picture about GI and ES. During the individual interviews, several thematic ES maps were shown to the city planner. This study reported practitioners' arguments when integrating the structural connectivity of the GI (Fig. 2) and dealing with potential ES provision represented by pixels (Fig. 3).

Figure 2 Structural connectivity of GI in the City of Järvenpää. The values (%) describe the importance of individual green patches for the overall structural connectivity of the whole green network of the city. The higher the value, the more important the patch is for overall connectivity (Kopperoinen et al., 2016a, p. 40)

Figure 3 Representation of all ES by pixels with spatial resolution of 25 meters. No aggregation into green and blue patches is done. The blank areas are built-up and other impermeable areas that were not included in the analysis (Kopperoinen et al., 2016a, p. 20)

The city planners were familiar with the emerging concepts of GI and ES (KnPP, n =7). However, one of the city planners, argued that, "*the ES and GI contents are new but not really new. In my opinion, already in 1960s, in the book 'Design with Nature', McHarg was pioneering some of the themes that nowadays are known within the GI and ES (e.g. nature conservation, storm water management, landscape scenery and recreational activities). Of course, at that time, those two conceptual frameworks were unknown as well as the ways to represent maps and collect data*".

According to the practitioners, however, the understanding of GI and ES in land use planning is still limited for several reasons. The existing planning tools and regulatory framework are too rigid according to one of the city planners: "*Planning is so… strict and full of borders (e.g., administrative and landownership). It is green or it is not green! We have still used the zoning for the green areas".* The planners argued that there is still a lack of knowledge about the relevance and need for green itself, especially at the level of the detailed planning. There is hard work to be done with colleagues from other divisions (e.g. transportation and housing) as well as real estate developers. When discussing the map of ES (Fig.3), one of the interviewees added: "*The*

maps show areas that provide ES, but as a planner, I do not understand how ES values are classified. Some of these areas are already zoned as residential areas. This is probably an old-fashioned way of thinking that I still have as well as other planners. We cannot probably change our way of thinking".

Amongst the conflicting interests and values, the city planners remarked that, although there is an awareness of the ES values, other values remain rather strong (see e.g. private and public investments in new urban developments). The planners identified other conflicts between the current zoning approach in use, GI and administrative borders. *"The green corridor which goes along the border (between Järvenpää and Tuusula) is not going to be fully preserved. There are areas already zoned as urban (e.g., residential and commercial)*" (CviPP, n=5). In addition to this, the neighbouring municipalities Mäntsälä, Sipoo and Tuusula would like to follow the example of Järvenpää by conducting the same ES and GI studies and link their own data with Järvenpää. However, at the moment, it seems that these studies cannot be conducted due to reasons of time and investment.

Other potential conflicts are related to the representation of the ES, current zoning and land ownership. As one of the interviewees argued: "*the areas which provide ES were really big, but portions of these areas belong to different landowners.*" In order to see the variety of the ES provision potential within individual green patches, the planners asked to have a map that shows ES values in individual pixels with a spatial resolution of 25 meters. The reasons for this additional map was that the green patches or polygons often cover quite large areas and the planners wanted to see the ways in which the values change within those large areas. This can help to plan functions more accurately in relation to the provision of ES and understand conflicts amongst landowners (CviPP, n=4).

Nonetheless, the planners understand that GI and ES can play a strategic role when outlining the new urban development (StrPP, n=9). The main aim is to provide a new master plan and detailed plans which embed the new conceptual framework of ES and as GI. To this end, the planners have recently used the two maps on connectivity of GI (Fig. 2) and combination of all ES (Fig. 3) to outline strategies for a green belt and connect the green corridors within it. In particular, the themes of spatial and ecological connections have been represented in the draft of the master plan and textual planning. One of the official practitioners specified that "*we simplified the concept of connectivity in the new master plan by including important areas to preserve and related connections between them. These analyses are relevant to the current zoning approach and regulations in the coming master plan (for example whether the green area is marked as a green connection within some other land use or as a green area itself)*." Thus, the data on the connectivity of GI was transferred into a report where ecological and recreational values were analysed separately and in a combination with the land use development.

However, the city planners asked to have more concrete suggestions on how to "mark" and regulate ES and GI (e.g., how to represent GI on land use maps and delineate potential areas that provide ES). "*We would need a short and simple summary that includes suggestions for the*

zoning approach. When embedding nature values and ES in the planning process, there are other parties that also asked for 'marking' ES and GI in the master and detailed plans". The planners thought that this would help the debate with the decision makers when commenting the drafts of the master plan. To this end, planners think that the so-called "marks" and current regulations should be further developed in collaboration with researchers.

6 Discussion

This paper explores possibilities and obstacles of integrating the concepts of GI and ES in the land use policy and planning strategies and practices in the Helsinki-Uusimaa Region and City of Järvenpää. Findings from the study show that incorporation of GI and ES in land use policy and planning requires time and commitment in contemporary planning. This was first confirmed when analysing the national policy and strategic planning documents at the regional and local level, and then, when conducting the interviews with the official planning practitioners.

First, the results highlight that, within the Finnish national policy, there is an increasing awareness that GI and ES are relevant to the sustainable land use development and can play a strategic role. On the other hand, the policy has also recognized potential conflicts that might be encountered when integrating GI and ES in land use planning (due e.g. to the administrative borders, the degree of understanding amongst the stakeholders). Although the national policies provide several insights and recommendations on the development of GI and ES within the regional and local land use planning, these two concepts are not fully acknowledged in the regional and local planning (see the Table 1). Results show that, while the notion of ES was embedded, the concept of GI was not yet introduced in the regional policy. GI is represented in dedicated reports and maps, but not yet within the regional vision of urban growth where the term "green structure" is the most mentioned. This probably happens because GI and ES are still "new things", as one of the regional planners argued. Moreover, a regional plan is a playground for several interests of stakeholders and politicians where the integration of new themes require a long process of negotiation and shared vision (Albert et al., 2014). Additionally, the findings from the analysis of the planning strategies of the City Järvenpää show that the concept of GI is embedded when developing the growth scenarios and impacts on the built environment while the ES are not explicitly mentioned. Although the storm water management and landscape values, recreational activities and green connections are quite predominant within the planning arguments are not explicitly under the ES framework.

Secondly, the planners' discourses provide a wider picture of possibilities and obstacles for integrating of GI and ES in land use planning practices. The two case studies of the Helsinki-Uusimaa Region and City of Järvenpää showed that there is an increasing understanding of GI and ES amongst both regional and city planners. 'Science-practice cooperation' with experts from research institutes and universities (Albert et al., 2014) is helping practitioners to identify

societal values and land use interests from the perspective of GI and ES (von Haaren and Albert, 2011). In both cases, a fast population growth is expected, resulting in densification to provide housing for new inhabitants. The aim of the collaboration between local policy-makers, practitioners, experts and other stakeholders was to find tools to enable a more compact urban structure without losing the most valuable features of the green areas by embedding GI and ES. Thus, this type of collaboration can be taken as example by urban regions and cities which address the model of compact city not only in Finland but also other European contexts with similar processes of urban densification.

Thirdly, in addition to this, the lesson learnt from the two cases is that the model of 'science-practice collaboration' can be further improved in light of the problems that planners still encounter in integrating the new knowledge of GI and ES. The findings from the two cases reveal that the disciplinary silos of planning practitioners (e.g. transportation and housing divisions) and limited expertise in-house on GI and ES represent current challenges as the planners remarked. Then, the understanding of GI amongst the regional and city practitioners is limited to certain principles such as the GI connectivity which also confirms the findings from the literature review (Davis et al., 2015; Hansen and Pauleit, 2014).

Fourthly, the two cases suggest that we would need a major focus on understanding the limits of existing planning tools and developing current regulatory frameworks to which planners still refer. The use of the two concepts by practitioners is not straightforward. On one hand, the approach of planning practitioners in Järvenpää aims to mark sites which provide ES by using a larger scale of representation. On the other hand, regional planners still work on thematic maps on GI, while ES are integrated in the planning documents in the form of text. Despite the planners' efforts, these two approaches might limit the understanding of the wide range of purposes of GI and ES. The difficulties of planners to operationalize the GI and ES in land use planning calls for further research. There are functions and objectives of ES and GI that cannot be spatialized and visualized in traditional representations such as maps. There are data and information that should perhaps remain in the form of recommendations and pictures (Brunet et al., 2018). It seems that the current zoning is not the most suitable tool to support the integration of ES and GI. This study suggests that, in order to move beyond these obstacles, planning tools as well as regulatory frameworks need to be revised having both GI and ES approaches in mind (Borgström and Similä, 2015).

Fifthly, findings from the literature (see e.g. the cities of Lahti and Dresden; Brunet et al. 2018, Artmann et al., 2017) and from the two case studies show that, so far, the possibilities of incorporating the new framework of GI and ES, occur mainly when discussing sustainable urban growth (e.g., the role of GI in the strategic scenario of the City of Järvenpää, and role of GI and ES in the future development of the green belt of Helsinki-Uusimaa Region). This aspect should help scholars to reflect whether there are particular phases of the planning process where the knowledge of GI and ES can play a key role. Also, this study suggests that further science-practice collaboration should focus on how to transfer the GI and ES to land use planning and whether there is a need to simplify the concepts when they are embedded in a

local master plan (*yleiskaava* in the Finnish planning system) as the city planners of Järvenpää are currently doing.

Furthermore, the study highlights the importance and the need for increasing new forms of science-practice collaboration seen as strategic components of the planning process, in the Finnish urban regions and municipalities, as well as international contexts. So far these types of collaborations are considered as ways of informing and training regional and city planners. Within these new forms of collaboration, an in-depth understanding by both experts and planners on the current urban contexts and existing planning tools is needed. The collaboration itself as fundamental pillar of the planning process can help policy-makers, planners, citizens and other stakeholders to understand how to plan and design cities with GI and ES in mind.

About the limitations of this study, the qualitative study was used to find problems that policy makers and planners are facing when they try to integrate the new concepts into the existing professional and policy framework. The study highlighted several challenges which are related to the 'application of new knowledge' in the professional and political context. Since the context around the world are different, we are not attempting to generalize but highlight problems that are real and can be met in several other contexts.

7 Conclusion

The study shows possibilities and obstacles of integrating GI and ES in current land use policy and planning. Despite several insights and recommendations within the national policy, there is still a fragmented understanding of the two concepts and related goals in the regional and local planning strategies. However, the current on-going collaborations among the official practitioners represent a fertile ground for future development of GI and ES at both regional and local level of planning strategies and practices. This type of collaboration can create new possibilities for discussing the urban growth having the concepts of GI and ES in mind.

This study also contributes to the international scientific debate by finding out the challenges and problems that planners and policymakers are facing when trying to integrate new scientific concepts such as GI and ES in a particular professional and political context. Since the contexts naturally vary according to local conditions and national legislation and governance frameworks, one should not over-generalize the results to different cities and nation states. However, the case studies are used as methods to find some of the key problems and that planners and policy makers face as they need to reconceptualise their work. These problems are related to traditional representations vs. lack of new representations or tools, the conflicts of interest that result in one-sided use, and the slow change in conceptual frameworks and even professional resistance (e.g. the predominant knowledge of GI connectivity and limited perspective due to more established concepts such as the recreational purposes of GI and ES

and nature protection). This opens further reflections on what kind of training and collaboration is needed among experts and planners to develop GI and ES, and what kind of planning strategies and tools would be needed to support knowledge on GI and ES.

Appendix (questions of the interviews conducted with planning practitioners from Helsinki-Uusimaa Region and City planning department of Järvenpää)

TOPIC 1 Understanding of ecosystem services (ES)

1. *What is your role in land use planning and decision-making?*
2. *Are you familiar with the concept of ES and green infrastructure (GI)? If so, what is your understanding of these concept?*
3. *Where did you learn about these concepts?*

TOPIC 2 Local/regional ES and related benefits

1. *What would you say is/are the most important/dominant ES in your city/region?*
2. *What kind of benefits do you see the local/regional green areas providing in your region?*

TOPIC 3 Effective use of data

1. *Are maps and spatial analyses of ES and GI useful for regional/local planning in general?*
2. *What kind of analysis of green infrastructure and ES have been made to support the regional planning?*
3. *Could the methodologies be improved in some way? In what way? What would be especially important for your needs?*

TOPIC 4 Transferring knowledge/data to the planning practices

1. *Have you already used the concepts of ES and GI within the regional policies and local plans?*
2. *If so, how did you transfer ES and GI knowledge/data to a regional/local plan?*
3. *How did the municipalities acknowledge the ES framework/concept?*
4. *What challenges have you encountered/ anticipated in applying the concepts of ES and GI into the planning process?*
5. *Have you used/ are you planning to use any traditional or web 'platform' to collect feedback from residents and other stakeholders concerning green infrastructure?*
6. *How have you utilized /are you planning to utilize the feedback from residents in the planning process?*

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