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THE CONCEPT AND PRACTICE OF GREEN-BLUE INFRASTRUCTURE IN NEW URBAN AREA OF MALMI AIRPORT

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Abstract

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A green-blue infrastructure increases and maintains plant and animal biotopes, connects and strengthens the green corridors in the urban areas. The scale of a green-blue infrastructure has direct impact on the quality of the space. If there are limitations on increasing the size of the space, enhancing the condition of the space, e.g. designing recreational opportunities can enrich the space. The green-blue infrastructure helps the integration of the urban areas by connecting the green space with its surrounding areas. They also enable strong stormwater management and offer diverse recreational opportunities and wellbeing for people. The plan for the city of Helsinki is to create a strong green-blue infrastructure by 2050. In the framework of this plan, a residential area with approximately 25,000 residents is designed for Malmi airport as a new urban area.

The aim of this thesis is to propose an optimal green-blue infrastructure for Malmi airport area. To simplify the plan, Malmi airport area is divided into six different subareas, each with specific potential. To propose optimal design solutions for each sub-area's green-blue infrastructure, the thesis selects ten different parks with characteristics similar to Malmi airport sub-areas. The thesis proposes a characteristics and similarity-based parks comparison (CSPC) as a practice for similarity comparison between parks and green spaces. The CSPC practice enables efficient and optimal planning of sub-areas in Malmi airport. This is conducted by comparing each sub-area with similar examples in different urban areas. Using the CSPC, the thesis compares each sub-area with two of selected parks and discusses the similarities between them. Based on the findings, the thesis proposes sustainable design solutions for each subarea. The results achieved from the CSPC practice state that Malmi airport area has a strong potential for implementing a sustainable green-blue infrastructure.

Keywords

Green-blue infrastructure, urban network, sustainability, stormwater management.

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Title Of Publication

Sini-vihreän infrastruktuurin käsite ja soveltaminen Malmin lentokentän uudella urbaanilla asuinalueella

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Abstract

Sini-vihreä infrastruktuuri lisää ja ylläpitää biotooppeja sekä yhdistää kaupunkialueiden viherkäytäviä. Sini-vihreän infran mittakaavalla on suora vaikutus viheralueiden laatuun. Mikäli yksittäisen alueen kokoa ei voida lisätä, voidaan alueen virkistysmahdollisuuksia rikastaa suunnittelulla. Sini-vihreän infrastruktuurin suunnittelu mahdollistaa viheryhteyksien muodostamisen ympäröiville alueille sekä hulevesien hallinnan ja virkistysmahdollisuuksien lisäämisen. Helsingin kaupungin tavoitteena on luoda vahva sini-vihreä infra vuoteen 2050 mennessä alueelleen. Malmin lentokentän alueelle on suunnitteltu uusi noin 25 000 asukkaan asuinalue.

Tämän opinnäytetyön tavoite on laatia ehdotus Malmin alueen optimaalisesta sini-vihreästä infrasta. Alue on jaettu kuuteen osa-alueeseen, joilla on erilainen kehityspotentiaali. Suunnitelmaratkaisujen työstämiseksi opinnäytetyössä on valittu kymmenen erilaista viheraluetta, jotka muistuttavat ominaisuuksiltaan Malmin viheralueiden osia. Opinnäytetyössä hyödynnetään puistojen ominaisuuksien ja samankaltaisuuden vertailua (CSPC), jonka avulla arvioidaan viheralueiden kehittämispotentiaalia. Tämä toimintatapa edistää osa-alueiden suunnittelua Malmin lentokenttäalueella. Jokaista osa-aluetta verrataan erikseen muodoltaan ja taustaltaan kahteen samankaltaiseen kaupunkiviheralueeseen ja puistoon. Havaintoihin perustuen opinnäytetyössä ehdotetaan soveltuvia suunnitteluratkaisuja jokaiselle osa-alueelle. Loppupäätelmänä todetaan, että sini-vihreän infrastruktuurin toteuttamiseen on hyvät mahdollisuudet Malmin lentokenttäalueella.

Keywords

Sini-vihrea infrastuktuuri, urbaani verkosto, kestävyys, hulevesien hallinta.

CONTENTS

1 INTRODUCTION

Green-blue infrastructure is the green spaces and water environment, which are fundamental factors for the quality of human life and the ecosystem. In fact, the green-blue infrastructure aims to recreate a natural cycle for the cities, using efficient water management and green infrastructure elements (Jaakkola et al. 2016). Green-blue infrastructure consists of natural and semi-natural landscape elements. These two elements together form a green-blue infrastructure. Examples of green infrastructure elements include any vegetation area such as organic, ecologic parks and forests and man-made courtyards and green streets.

The examples of blue infrastructure elements are any area with water resources such as ponds, rivers, lakes, wetlands, and seas (Perini & Sabbion 2017). In another definition by the Department of Architecture of the Municipality of Helsinki, the green-blue infrastructure is considered as an ecological and cultural network (Arkkitehtuuriosasto 2017). Because, the design and management of green-blue infrastructure is coordinated with urban, ecological and recreational objectives.

Green-urban infrastructure, due to its multi-purpose and multiple scale nature complicates the classification of services and benefits. Green-blue infrastructure is clarified as a combination of green spaces, water and construction systems such as forests, park, green walls, green roofs and wetland, sea, lakes, ponds watercourses. The green-blue infrastructure hasimportant role in urban areas. It has been planned to improve the quality of life of residents through stormwater management, creating sustainable environments, restoration of existing green-blue spaces, creating recreational spaces, and providing psychological and social services.

Parks are the outstanding examples of green-blue infrastructure. The parks are used and experienced in various ways by inhabitants, such as for wildlife experiences, such as birds watching and listening to nature (relaxation and enjoyment from nature). The use of parks has spiritual, social, and psychological effects on the inhabitants. On a larger scale, green-urban infrastructure is seen as promising facility to reduce the adverse impacts of climate change in urban areas.

For example, by balancing water flow to eliminate floods, providing thermal comfort for people through vegetation, supporting the coping capabilities, and improving water quality in forests and wetlands. Another benefit of green-blue infrastructure pertains to controlling the runoff in urban areas. In fact, runoff move faster in urban areas due to smooth saturation levels compared to rough natural surfaces. In fact, in urban areas 60 percent of rainwater becomes runoff in places without vegetation surface, instead in green areas only about 15 percent of the rainwater becomes runoff (Coutts 2007). Therefore, planting in urban areas helps the stormwater management.

In the city of Helsinki, Malmi airport area is an outstanding example that requires planning an optimal green-blue infrastructure (Figure 1). The airport is located in the district of Malmi, 10.5 km north-east of Helsinki city center. The project is in the planning phase and the plan covers an area of about 3.3 square km / 330 ha.

FIGURE 1. Location of the region in Helsinki (Helsinki map).

The topic of this thesis is defined by LOCI landscape architect company. This company is located in Helsinki city center and has long expertise in landscape architecture. Many successful projects in Finland have been planned, designed, and performed by the company. One of the important projects of the company is designing Malmi airport area as a new urban area, hence the topic of this thesis (Figure 2).

FIGURE 2. The planning area of Malmi airport (Helsinki aerial map 2018).

Therefore, in the design process of the project, the author involved the following activities. The author was the responsible person for collecting the materials for example technical

reports from the shared folders of the City of Helsinki and classifying those collected materials. These materials consisted of the technical reports, maps, figures, and statistical data about Malmi airport area.

In addition, the author worked on a hydrological map to which the author wrote a report to discuss and suggest some solutions for the stormwater management of Malmi airport area. Moreover, the author visited Malmi airport a few times to take photographs from the airport area. The author also met the airport area designers to discuss the design process and progress. Meanwhile, during the trainee time, the author was exchanging some ideas with the design experts of the company, which helped to modify the objectives and methodology of this thesis.

In fact, this thesis aims at studying the benefits of applying green-blue infrastructure for Malmi airport area and finding feasible design solutions for the area. For this reason, the thesis uses the airport elements, like forests as a basis and applies characteristics and similarity-based park comparisons (CSPC) between Malmi airport area and ten different parks selected from Helsinki and Berlin. In such a way, the thesis aims to define and suggest a new green-blue infrastructure for Malmi airport area.

It is worth noting that to the best of author's knowledge a prior method that considers various indicators for parks comparisons does not exist. Most of the methods in the literature use the scale comparison that is often described as the spatial, temporal, quantitative, or analytical dimensions used to measure different things (Gibson et al. 2000). Thus, in this thesis the author proposes the CSPC practice as an efficient method to compare the characteristics and finding similarities between two or more parks/areas using various indicators. The examples of these indicators pertain to the spatial extent of the parks, the geographic location of the parks, and the park structures and facilities.

Using the CSPC practice, this thesis proposes optimal design solutions that are effective for the future role and performance of Malmi region as part of Helsinki city, and as a living environment for the residents. This is performed by identifying the potentials of each subarea in Malmi airport and finding similar green-blue space/park example in a different urban

area and learning from the pros and cons of designs of the example park. This helps learning from other design examples and results in an efficient and optimal design of a green-blue infrastructure. The rest of this chapter reviews the history and the planning area of Malmi airport.

1.1 Planning Area

An area housing approximately 25,000 new residents is planned for Malmi Airport area. A master plan has been prepared for the area, which was approved by the City Planning Board (1.12.2015 and 13.12.2016). The area began the preparation of three city plans in 2016 (Tattarisilta intersection, airport buildings, the environment of the Fallkulla farm). In other respects, the city planning will proceed after the new Helsinki master plan comes into force (Figure 3).

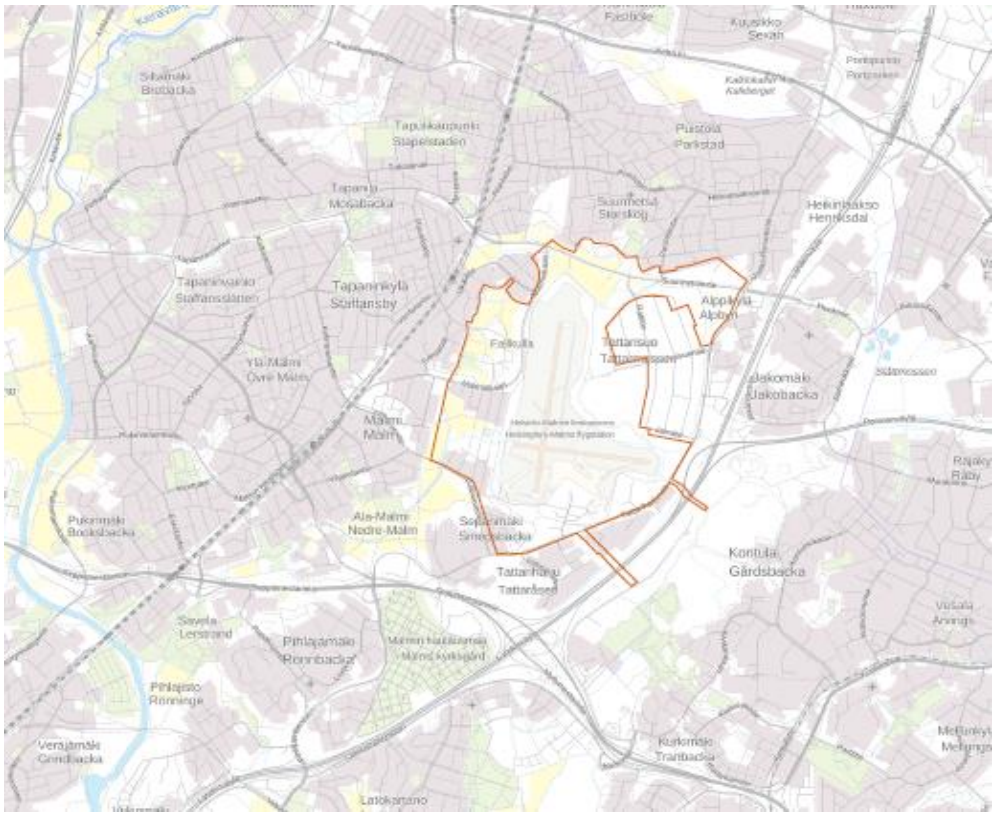

FIGURE 3. Location of the Design Area 1:20 000 (karttapaikka 2018).

1.2 History of Malmi airport

Malmi has experienced many changes during its history. It was the largest village in Helsinki at the end of the 19th century. In the 1900s, with the construction of the railway, Malmi and the associated (the current airport) areas were transformed from a rural area to industrial agglomerations in Finland and the population of the area began to grow rapidly. The statistics provided by the Helsinki regional website (Helsingin seudun aluesarjat) explains that currently, Malmi has 29,000 inhabitants and has a population area density of 2,600 km^2. In additions, the number of residents in the new airport area will be doubled and the demographic structure of the area will greatly change.

In the 1930´s, Malmi Airport was built, which gave a strong identity in Malmi region. After the expansion of the regional center in the 1980´s, it has become known as a social suburb complex. Therefore, the area became a residential place for people to live (Pirkkamaa 1989).

The construction of Malmi airport took a long time to complete, when it started in the early 1930s. In fact, in 1932, the government appointed a committee to propose a place for the Helsinki airport. However, finding a suitable area to start building the airport site was the major problem. The design characteristics, the previous use of the area, and the requirements of the shape and soil of the earth were the challenging issues to be considered. It was also important to be located at a certain distance from the city of Helsinki (Saarnisto 2016).

Therefore, after careful studies and numerous investigations, Tattarisuo was finally chosen to be the right area to start the construction site of the airport, since the ground structure and the groundwater of this area were suitable for the site construction. Then, the negotiations on the land transfer and financial issues were initiated between the city of Helsinki and the government, and the agreement for constructing Malmi airport was made on May 10th, 1935. The main plan of the airport was presented by Dag Englund in 1937.

In addition, the implementation of the plan was carried out by Dag Englund, Vera Rosendahl and Onni Ermala and the contractor Martti Välikangas. Eventually, the project work of the

airport was completed with the official inauguration being held on May 15th, 1938. Figure 6 shows the opening ceremony of Malmi Airport (Figure 4).

In the airport plans, the focus was on the terminal, since the architects' aim was to build an artwork that represents Finnish architecture. The airport was planned so that upon arrival, the passenger was supposed to see the yard with its gardens before entering the building.

FIGURE 4. Malmi airport on May 1938 (Freese & Schulman 2016).

There were also a few decorative huts planned for this purpose. From the old photograph taken from the airport in figure 8, it can be concluded that the water basin was completed gradually after the opening of the airport.

The airport plantations plan was also held between the years 1938-39. The shrubs and flowers were designed to be at the edges of the building and the water basin. The planned yard was supposed to emphasize the architectural values of the terminal environment. In addition, the yard was supposed to provide comforts for the passengers and demonstrate a picture of Finland (shown in Figure 5).

FIGURE 5. Courtyard area in 1951 (Freese & Schulman 2016).

2 LITERATURE REVIEW

In this chapter, a literature review is conducted to shape the background of the thesis. The literature review highlights the challenges, solutions, and suggestions for the planning of the green-blue infrastructure in urban areas. The keywords that are used for the literature review include “green-blue infractructure” and “green-blue network”.

The research by Wang aims to analyze the concept of accessibility with the goal of developing a new integrated framework for measuring the accessibility (Wang et al. 2013). To analyze the concept, this research performs a literature review and highlights that accessing urban public amenities such as parks and green spaces helps social welfare and developments of social capital. The analysis of this research also shows that while accessibility obtains a multi-dimensional structure, its measurement is limited to its physical and temporal dimensions. The other measurement factors such as social conditions and personal limitations that can be used to measure the accessibility have remained unknown. This research performs discussions for connecting the unknown measurement factors to assess whether it is possible to access the public urban facilities.

As the final outcome, the research presents an alternative integrated model for park accessibility using urban public parks. This model which includes the spatial and non-spatial dimensions facilitates understanding of accessibility dimensions and variables. The model consists of five dimensions which are spatial, transport, knowledge, social, and personal. The spatial and transport dimensions represent the geographic aspect of accessibility. Knowledge dimension represents an aspect of accessibility that associates with availability of information and people’s cognitive progress. Social and personal dimensions offer two socio-psychological dimensions for park accessibility. The research suggests employing the proposed model for public facility delivery.

The study by Coutts (2007) was performed to predict the use of greenways utilizing two variables of population density and opportunities (land-use mixture) (Coutts 2007). This prediction is an important concern, because the use of greenways has direct relation with human physical activities. In fact, a greenway is a linear open space established either along a natural corridor such as riverfront, stream valley, or ridgeline. This study employs the global positioning system (GPS) and the geographic information system (GIS) software tools as main method to test the variables. Then, the study come to the following conclusions:

- The smaller greenway scales like small walking and cycling routes are better factors to predict the physical activity behavior.
- Bringing the environmental support closer to the concentrated areas is not necessarily enough to increase the physical activity.
- The areas with increased population density correspondingly increase the levels of opportunities.

Another study by Barbosa aims to seek the benefits of accessing the green spaces (Barbosa et al. 2007). To find the benefits, the authors measured the distance along the transport network to public green space available for residents in Sheffield, UK. Then, they compared the distance with the distribution of private garden space. They also utilized a geodemographic data for testing the accessibility to the green space. The research concludes that green areas play an important role in supporting urban ecological and social system. The level of green area distribution and the ease of accessibility are two key factors for social and ecological developments in urban environments. In addition, green areas play an important role in supporting biodiversity and providing critical ecosystem services in urban areas.

In the literature, the behavioural intentions to use urban parks have been rarely investigated (Wang et al. 2015). In this regard, research was carried out by Wang et al., to conduct a comparison between perceived and geographic parks accessibilities. This comparison was made to predict the use of urban parks from psychological point of view. For the comparison, the expanded model of planned behavior was used. Note that the theory of planned behavior merges the perceived parks accessibility, geographic proximity and the past use behavior. A result of this research explains that precieved access has higher importance than geographic access in prediciting the park use. Another result indicates that however designing and constructing physical parks are essential but necessarily they do not encourage using the park.

Research by Yli-Pelkonen aims to address the importance, sufficiency and need of local recreational ecosystem services in urban areas (Yli-Pelkonen 2012). The research involved interviews with thirty key informants in the field from nineteen different associations in Helsinki with the focus on recreational ecosystem services. The results demonstrate that inhabitants regularly visited nature areas and spend considerable amount of time there. Meanwhile, during these visits people used the nature for recreational activities, like mostly for walking and sport-like activities. Based on these results the research

emphasizes ~~on~~ the importance of accessibility of the nature areas. Therefore, this research highlights the necessity of creating the recreational ecosystem services. The benefits of these services include enjoying the aesthetic aspects of landscape, recreation, education, psycho-physical and psycho-social health benefits. The research also concludes that in urban centers, small natural areas can be remarkable opportunities to design for recreational spaces. But the larger urban natural areas have more recreational value. In addition, the accessibility of urban residents to proper quality neighbourhood nature areas tends to promote dynamic lifestyle like physical activity in nature.

The study by Szulczewska aims to seek empirical evidences to establish minimal proportion of green spaces required for good environmental performance in neighbourhood (Szulczewska et al. 2013). For the study eighteen neighbourhood that characterized by an eco-spatial index called relative to biological vital area (RBVA) from Warsaw area were selected. Then, the relationship between the size of RBVA and the selected environment features (such as air temperature, humidity, floristic diversity, and butterfly species richness) was verified. The results obtained from this study indicate that eco-spatial indices are a useful planning tool for improvement of exisiting urban structures. In addition, the eco-spatial indices are not adequate for green space planning, since they do not respond the residents' needs like social interaction and recreation. The study concludes that in comparison to other eco-spatial indices, the RBVA can be described as the simplest and easiest index to implement in planning practices. Another conclusion states that when the size of RBVA is larger, the condition created for environmental performance in the area is better.

A study by Vierikko and Niemelä is conducted to identify socio-cultural values of ecosystem services in local blue-green infrastructure planning in Helsinki (Vierikko & Niemelä 2014). For this identification, the reseach studies a local environmental conflict related to a stormwater management plan in Helsinki, Finland. The research uses the following explanation to highlight the importance of the topic. In fact, the blue infrastructure has particularly important role in urban areas. The life of the residents can be improved with the help of water treatment, reduction of urban runoff and provision of psychological and social ecosystem services. Likewise, small size of water ecosystems such as ponds and watercourses are natural factor of the hydrological cycle. Literally, they provide special places for recreation, restoration, relaxation and enjoyment of nature for residents.

In addition, local people are more likely to use the park and the stream than other interest groups and value them, because they are likely to be aware of the use of the area and other activities in these areas. Usage values and perceived experiences can also be categorized as use-dependent locations that are assigned to a specific location. This refers to indirect communication with nature through specific activities that support the wishes of a person and the purposeful use and ability to provide a place of activity. Meanwhile, the park and watercourse are used and experienced in various ways for neighbourhood inhabitants, such as for wildlife experiences (like birds watching and listening to nature). The spiritual and social dependence can be described as elements of place identity. This refers to the psychological connection to the location and considers how the inhabitants deal with park and watercourse.

To perfrom the study, the research collects the techno-ecological values of the brook Kumpulanpuro from the official documents, publications, and archieves of the city of Helsinki. In addition, as a narrative research method, the research designs an interview for analyzing socio-cultural values. Then, the research studies socio-cultural values of key stakeholders towards the brook and the surrounding green area. The result of this study helps evaluating how these values can be considered at the early stage in green area planning.

This research shows interesting results. There were big differences between the interviewees, the stakeholders expressed negative values towards the parks while the locals commonly expressed symbolic values. The research reveals that it is crucial to make careful value mapping to identify socio-cultural velues of key stakeholders for defining ecosystem services. In fact, a clear outline of different value categories in a socio-ecological system is needed to explain the results collected from the interviews. The conclusion from this research is that, the integrated value mapping approach is an appropriate analytical tool in a green-blue infrastructure planning process. Since, this tool increases the knowledge and mutual understanding between actors on how the ecology and people are interlinked.

The research by Hansen and Pauleit is developed to investigate how multifunctionality in green infrastructure planning can be operationalized and tested in ecosystem services (Hansen & Pauleit, 2014). Green Infrastructure (GI) and Ecosystem Services (ES) are concepts for improving environmental planning in urban areas. These concepts are based on a comprehensive understanding of the complexity of communication and the

dynamics of socio-environmental systems. In GI planning, there are three spatial levels which should be mentioned:

- The first level: The foundation of GI that is identified by individual elements such as parks or rivers.
- The second level: The communication between the various elements of GI that create a network that makes plant and animal species movement possible and material circulation, for example rivers.
- The third level: The green infrastructure that consists of connected networks of green infrastructure elements in the regional level. This level uses multifunctionality for assessment that enables evaluating various types of of open and green space. Therefore, to investigate the multifunctionality in GI planning, the research explores the literature.

Furtheremore, the research proposes a conceptual framework to assess the multifunctionality from a social-ecological prespective. This framework establishes a strong link between the green infrastructure and ecosystem services. This research concludes that multifunctionality can be supported by a framework that integrated the ecological and social aspects. Then, the framework can be a trusted tool to apply in green infrastructure planning. The proposed framework also can provide a strong linkage between the green infrastructure and the ecosystem services.

In addition, the study by Demuzere was performed to explore the effect of green infrastructure and ecosystem services in mitigating and adapting to climate change (~~M.~~ Demuzere et al. 2014). This study suggests a green urban infrastructure assessment framework and quantifies some of the benefits and trade-offs of green infrastructure with regard to climate change mitigation and adaptation. Then, the study reviews the literature to address the production of the ecosystem services, benefits, and trade-offs at various spatial scales. As a result, the study highlights the knowledge gaps in the research objective domain.

The literature review conducted in this thesis covers different perspectives of planning the green-blue infrastructure. A study investigates the ecosystem services in mitigating and adapting to climate change. Other studies evaluate the recreational ecosystem services offered by green-blue infrastructure. For instance, the effect of using green space, e.g. parks from psychological point of view. For planning the green-blue infrastructure, a study introduces a method called relative to biological vital area (RBVA) as a planning

practice that considers environmental features such as air temperature, humidity, floristic diversity, and butterfly species richness. Another study takes into account the socio-demographic factors such as city of residence, age, gender, and income, while another study considers the distance, time, and frequency of moving objects in an area, e.g. boats. In addition, in a different study the population has been the main concern. The conclusion from these studies emphasizes that green and-blue infrastructure plays important roles in supporting biodiversity and providing ecosystem services in urban areas.

Based on the literature review performed in this thesis, and according to the author's knowledge a prior work does not exists for designing a green-blue infrastructure by comparing the characteristics and similarities between different green-blue infrastructure. Therefore, considering the characteristics and similarities between different parks, the author formulates research questions and methodologies to answer those questions in the next chapter.

3 THE THESIS OBJECTIVES AND METHODOLOGY

3.1 Objectives

Planning efficient green-blue infrastructure offers opportunities for strengthening the environment, e.g. by rainwater drainage, and provides services for the inhabitants, e.g. through creating recreational spaces. Planning a forceful green-blue infrastructure also provides vitality for the urban environment and for the people. A potential example where it is planned to apply the green-blue infrastructure is Malmi airport area in Helsinki, which is the case study of the thesis.

To apply such infrastructure, in Malmi airport planning area is divided into six subareas. This thesis aims to seek the opportunities of green-blue infrastructure for Malmi airport area. In fact, the objective of this thesis is to propose feasible design solutions for the six subareas in Malmi airport. This is performed by: i) exploring the ecological and recreational potential, and functional values of each subarea, and ii) comparing the characteristics and similarities of each subarea with ten different parks selected from Helsinki and Berlin. Thus, to propose optimal design solutions for the green-blue infrastructure of Malmi airport area, this thesis is based on these research questions:

A. What are the benefits of applying green-blue infrastructure in Malmi airport area?
B. What are the feasible design solutions for different subareas in Malmi airport?

To answer these research questions, the thesis utilizes the methodologies explained in next subchapter.

3.2 Methodolody

The methodology used in this thesis aim to find optimal solutions and propose effective designs to create a sustainable green-blue infrastructure in Malmi airport area. In fact, the aim of optimal design solutions for the area is to connect green and blue infrastructure to perform stormwater management, strengthen the environment, create new uban area for living, and to offer wellbeing and happiness for the residents. To propose such design solutions, in this thesis the following methodologies are employed:

i) A literature review regarding the green-blue infrastructure is performed. This review highlights the benefits of applying the green-blue infrastructure for creating new urban areas. The review assists in identifying the key factors in evaluation of the research questions and the approaches for the desired answers. These key factors include the scales, sizes, shapes of the green spaces, the location and pattern of the ground where the park is located, and the green space structure and facilities. It also demonstrates the challenges and requirements for creating an optimal green-blue infrastructure.

ii) In the planning process, Malmi airport area is divided into six different subareas based on their characteristics. These subareas were divided by the Loci's designers. Thus, according to the subareas similarities (in terms of indicators), ten different parks both domesic and foreign (nine from Helsinki and one from Berlin) are selected. These indicators include the spatial extent of the parks, location and pattern of the ground where the park is located, and the parks structures and their facilities. Then, according to their characteristics and similarities, each subarea is compared with one or two of selected parks. The comparison practice, the indicators for comparison, the airport subareas, and the selected parks are discussed in detail in chapter 5.

The research methods for this thesis are performed as theoretical studies, using books and scientific publications; and collecting information from the reports of real practical projects. The source of information of Malmi airport area project is provided by the company, i.e. Loci Oy.

4 RBAN STRUCTURE IN MALMI AIRPORT AREA

Malmi airport area is a big, open and flat place. It has a multi-dimensional structure due to its airport landscape, the potential of green and blue infrastructure, location in the city, and the current changing in the use. Since Malmi airport area has a multi-dimensional structure, then planning a new green-blue infrastructure for the area requires solving many challenges. One of the principles of sustainable development in Helsinki pertains to building the districts using their potentials and identities (Helsinki City Planning Department 2016).

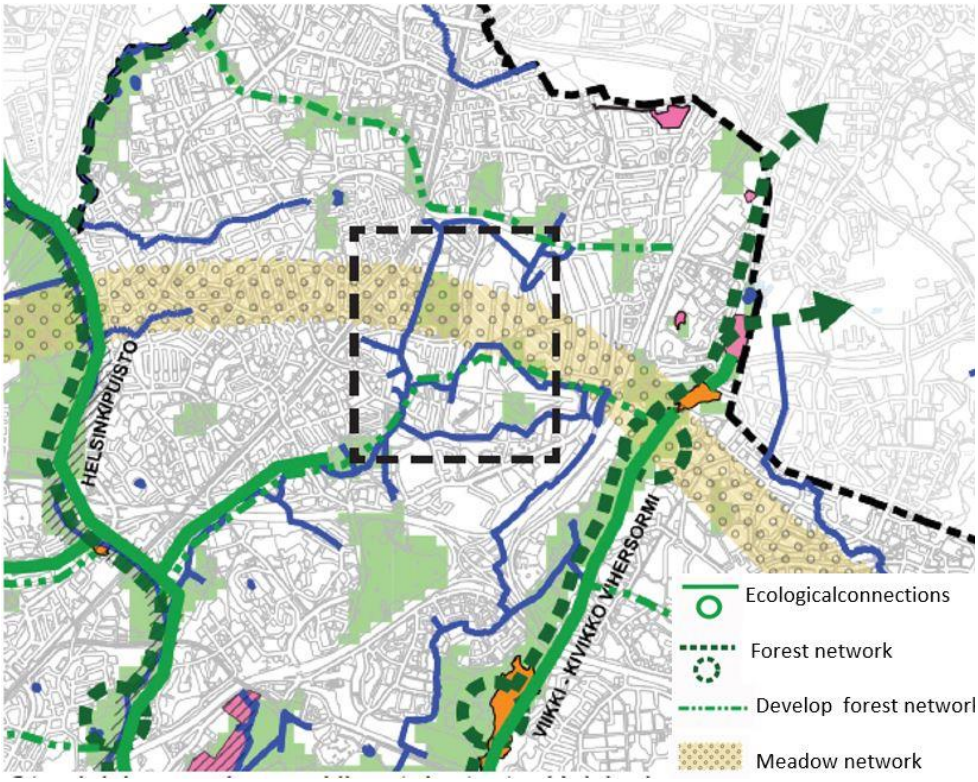

FIGURE 6. Helsinki recreation and green infrastructure for 2050 (Vistra II 2016).

The examples of these potentials include forests, meadows, lakes, and farms. Therefore, the principals of sustainable development must be applied when planning the new urban area for Malmi airport. This means that the current identity of Malmi airport area and green-blue infrastructure should be preserved in the planning and constructing phase. The recreation and green infrastructure plan for Helsinki 2050 is shown in Figure 6.

To this end, it is mandatory to study and evaluate the potential, opportunities, and challenges of Malmi airport area before starting the planning phase. During the planning and designing new residential areas in Malmi airport, the concept of green-blue infrastructure is the main concern to be taken into account. The plan for the area is to maintain the relationship between residents and their access to green spaces, create recreational opportunities, enrich the area's biotope and biodiversity, perform stormwater management, and integrate the blue and green infrastructure. The future plan for the area is shown in Figure 7.

In fact, the guidelines of Helsinki master plan for Malmi airport area have been explained in the Helsinki city plan 2017 and Vistra II. These guidelines are as follows (Helsinki city plan 2017):

- There will be tram lines planned to serve Malmi airport area.
- The area will also be a junction for the transverse Raide-Jokeri 2 (a light-rail line) and a line that goes from the city center north via Viikki and through the airport area.
- The planning of Malmi area takes into consideration the local strengths, e.g. open spaces and long distant views.
- The green infrastructure in the area is planned to be connected to the Kivikko recreational park by a bridge built over the Lahdenväylä main road.
- A continuous circular outdoor recreation trail is also part of the plans for the area.

FIGURE 7. The master plan (Helsinki City Planning Department 2016).

In the guidelines of Helsinki master plan for Malmi airport area (as a new residential area), the plan is to create green and recreational spaces as much as possible. The plan is to construct the residential buildings in combination with parks, and with a connection to Kivikko forest area and various green spaces. The connection between these areas will be through cycle routes, sidewalks, and pedestrian bridges. The other plan pertains to creating sport centers in the area. In addition, the plan is to integrate different green spaces to the forests to create a seamless green infrastructure, while preserving the natural values of the area (Vistra II 2016). In the next two sub-chapters the green and blue infrastructure for Malmi airport area are discussed separately.

4.1 Green infrastructure in Malmi Aiport area

The green structure of the new plan for the area is based on existing forest parks in the eastern, northern and southern part of Malmi area; the distributed meadow networks in the area are mainly the airport park; and the surrounding western and northen farms, e.g. Fallkulla farm. This green infrastructure is demonstrated in Figure 8.

FIGURE 8. Green infrastructure in Malmi (Loci 2018).

These forests that are known as forest parks are the backbone of green infrastructure in the area. The forest parks are covered by different species of trees, bushes, and shrubs. These

forest parks with their diversity of trees, host different species of birds. The meadow networks that are vegetated by grass, offer open views to the surrounding landscape while maintaining the biodiversity in the area. In addition, the farms increase the green spaces of the area while offering educational and recreational facilities for the people. For example, Fallkulla farm has become a place for education and recreation of children by familiarizing them with farming, i.e. cultivation and animal husbandry. The combination of these three types of green infrastructure shape and maintain the skyline of Malmi airport area.

Moreover, this green infrastructure is surrounded by green corridors, which connect the area to the surrounding green spaces, such as Longinoja valley, Kivikko and Puistola. In the new plan, this green infrastructure will be strengthened when designing the urban structure for Malmi airport area. In addition to designing the green landscape for the area, the other plans for the area are increasing and improving the ecological and recreational values for the area. In addition, a principle in planning new residential areas, e.g. Malmi airport area is that the residents should have easy and quick access to the surrounding green environemnts. Therfore, this concern should be considered when designing the green infrastructure for the area.

4.2 Blue infrastructure in Malmi Airport area

The blue infrastructure of Malmi airport area is composed of two water streams and a catchment area resulting from those streams. Actually, the Vantaa River is the largest waterway in the region. This river flows into Malmi airport area from west through Longinoja stream. Longinoja obtains high water resources and offers fishing and swimming to the local people.

The Longinoja valley that is located between the airport, Ala-Malmi, and Tapanila shapes the largest integrated green zone of Malmi region, and it is the main catchment area for runoff caused by Longinoja stream. The other catchment area for the runoff caused from Longinoja is inside Malmi airport area. In fact, the Longinoja stream is divided into two branches (i.e. those streams that shape the blue infrastructure of the airport area) and drain in the catchment area of Malmi airport. These two end streams cause runoff when there are heavy rainfall incidents during the year. The two streams in Malmi airport area shown in figure 9. These two streams drain high volume of water in the airport area and require the following solutions:

1. A water channel should be designed to delay the flow of water and prevent flooding. At the location (1) shown in Figure 8, a delay of $\frac{1}{10}$ is needed to control the volume of 13000 m^3, and a delay of $\frac{1}{100}$ is needed to control the volume of 19000 m^3.
2. At the location (2) illustrated in Figure 8, a delay of $\frac{1}{10}$ is required to control the volume of 7000 m^3, and a delay of $\frac{1}{100}$ is required to control the volume of 11000 m^3.
3. At the location (3) shown in Figure 8 which is an area around an open square and a pool, a delay of $\frac{1}{10}$ is needed to control the volume of 16000 m^3, and a delay of $\frac{1}{100}$ is needed to control the volume of 25000 m^3.

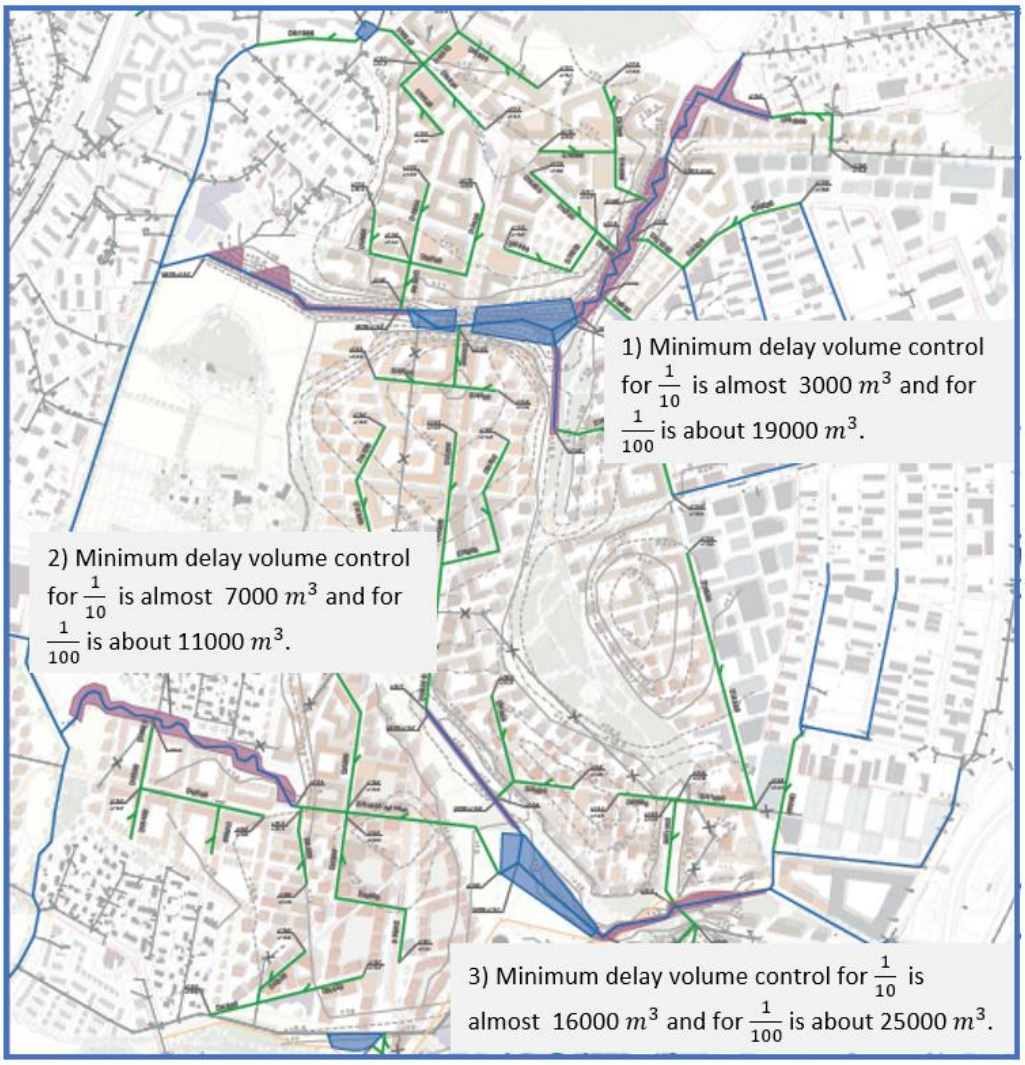

FIGURE 9. Water supply for Malmi aerodrome area (Sito Co. 2017).

As a matter of fact, planning new built-environment, e.g. residential areas in Malmi airport area will significantly increase the amount of stormwater loads. That is because in urban areas 60 percent of rainwater becomes runoff in places without a vegetation surface (SitoCo report 2017). Thus, an appropriate action is needed to be taken to avoid such runoff in the new Malmi airport's built-environments. In addition, making the right decisions and providing appropriate design solutions not only avoids the runoff in the area but also enables using the water collected from those runoff. Therefore, it is mandatory to perform stormwater management for Malmi airport area that provides many opportunities.

4.3 The Landscape Analysis

The utilization of Malmi airport area is changing by converting the area to a residential place. To design the new residential area, the landscape analysis enables describing and identifying the potentials and the landscape components such as the valuable forest areas, meadow patches and outstanding viewpoints. For example, an important landscape characteristic is the current spatial structure of Malmi airport which is very open and flat area. Another example is Malmi airport history that is identifiable by four runways lines.

Figure 10 shows the detailed landscape analysis of Malmi airport area. In the figure, the planning area is boarderd by the red line. The other colors in the legend of the figure describe different components of the area such as meadows and forest trees. The orange and green arrows show the locations with different viewpoints in the area. The orange arrows show the locations that offer wide and strong viewpoints to urban structure, and the green arrows show the places that offer views of green spaces for visitors. For example, the second and third runways that are presented with orange arrows offer a viewof the main street, surrounding areas, and the square. The fourth runway that is presented with green arrows provides a view of the eastern forest park and meadow network.

The views of various areas from different locations in the airport area are presented in Figure 10 in detail. The next chapter of the thesis is developed to propose solutions for designing optimal green and blue infrastructure

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FIGURE 10. Landscape analysis of Malmi airport area (made by author)

5 THE PLANNING PHASE

This chapter, i.e. the planning phase is developed to define a functional and ecological landscape design for the target design area. The planning phase defines ideas for further planning and suggests solutions to support the integrity of the area. For the planning phase, the thesis uses the master plan of Malmi airport area, considering the recreational activities, routes, ecological connections and water ecosystems. To this end, the thesis utilizes the method of Characteristics and Similarity-based Parks Comparison (CSPC) to compare the master plan of Malmi airport area with similar instances, mainly similar parks.

Using the CSPC practice, this thesis aims to propose optimal design solutions to improve the green-blue infrastructure of Malmi airport area. For instance, by determining the proportion scale of green space required for good environmental performance within an urban area. In fact, the CSPC refers to comparing the characteristics and finding similarities between two or more parks/areas. For example, one of these characteristics is the scales of the parks. In literature, the scale has been often described as the spatial, temporal, quantitative, or analytical dimensions used to measure (Gibson et al. 2000) different things. In addition, in area planning, the ratio of a distance to another distance, or one size to another size, is called the scale comparison. To perform comparisons using CSPC practice, between Malmi airport area with other similar parks, the thesis uses the following indicators:

- Spatial extent of the parks such as scale, size, shape, length and width.
- The location and pattern of the ground where the park is located.
- The park structures and facilities including buildings, services, routes, play areas, plants, water feature, tree-lined, green corridors, and sidewalks**.**

To apply the CSPC practice for comparing different sub-areas of Malmi airport area, the thesis divides Malmi airport area to six sub-areas and uses nine example parks selected from Helsinki in Finland and one example park selected from Berlin in Germany. Thus, the following comparisons for each sub-area are performed (Figure 11):

1. Lentokenttäpuisto (the airport park) CSPC with Toukolan rantapuisto and Park am Gleisdreieck in Berlin, Germany.
2. Muinaisjäännösmäki (the ancient monument hills) CSPC with Pikku Huopalahden puisto and Kaisaniemenpuisto.
3. Säilyvä metsäpuisto pohjonen (the northern forest park) CSPC with Hesperian puisto and Topeliuksen puisto.

4. Säilyvä metsäpuisto eteläinen (the eastern forest park) CSPC with Töölönlahden puisto and Sibeliuksen puisto.
5. Läntinen puropuisto (the western rain garden) CSPC with Hesperian esplanade.
6. Pohjoinen puropuisto (the northern rain garden) CSPC with Esplanadi and Topeliuksen puisto.

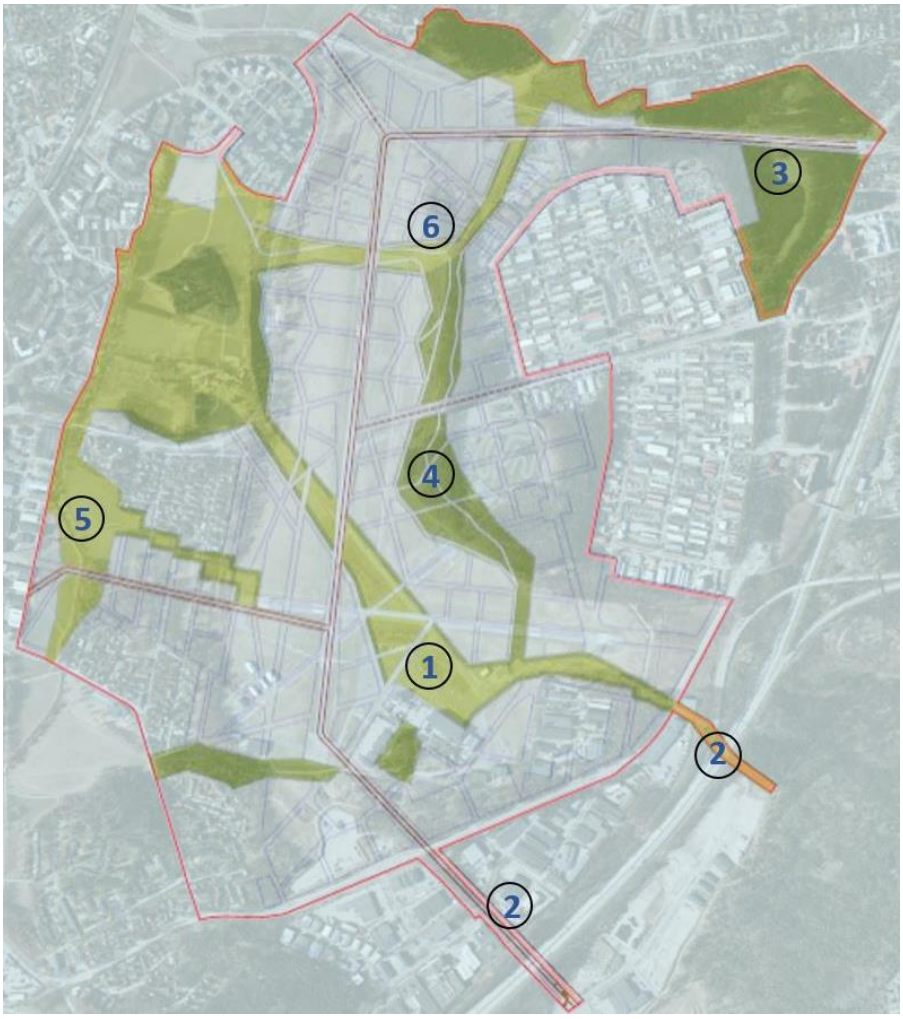

FIGURE 11. The six sub-areas (made by author)

In the rest of this chapter, for each sub-area of Malmi airport, one sub-chapter is developed to apply the CSPC with those selected park examples from Helsinki and Berlin. To apply CSPC, first, the characteristics of each of Malmi airport sub-areas and the selected examples for the comparisons are introduced. Then, the thesis explains the similarities achieved from CSPC and proposes the design changes for those Malmi airport sub-areas.

5.1 Lentokenttäpuisto CSPC with Toukolan rantapuisto and Park am Gleisdreieck in Berlin, Germany.

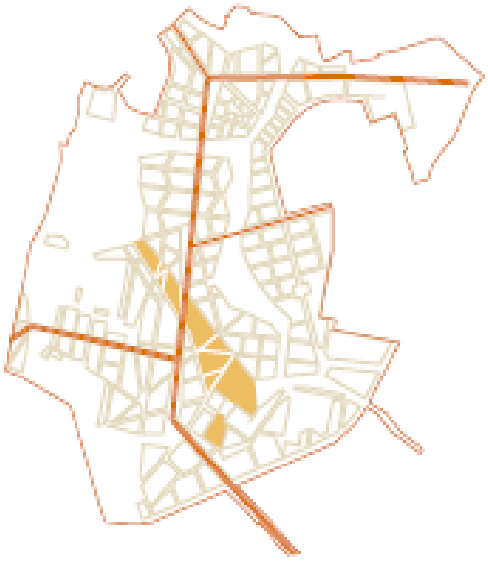

FIGURE 12. Airport park (Loci 2018).

Lentokenttäpuisto: This area is the airport park that is one of the main sub-areas that defines the identity in Malmi airport area. According to the soil map of Malmi airport area including the airport park, the area has unstable deep layers of clay. This airport park, which is a triangle shaped sub-area (as shown in figure 12), consists of four runways. These runways are planned to be a part of the green infrastructure.

The first runway is located at the northeast edge of the airport park. This runway is a functional zone with a width of 25-35 meters. In this area, there is the opportunity to design spaces for staying, sitting, enjoying space and playing. Furthermore, at the edge of the area, there is a massive passage for free walking. Along the street, there are squares with their own characteristics. In the future, the plan for this runway is to create an active place for people to gather and social interaction in what will be the central green area for the park.

The second and third runways pass through the first runaway, along the axis of the urban structure. These runways are in the form of streets, cross roads and parks. Despite the runways' various characteristics, they form identifiable elements in the area. In the future, the plan for these runways is to create comfortable urban village streets. The fourth runway

is the most important street in the area, since it has the longest runway line with a length more than 1.5 km. A historical element also included in this runway that there is uniform lighting that forms a straight line down the middle of the street. As another characteristic, this runway is surrounded by open spaces, i.e. different views and parks. For the future, this runway is planned to be the main street in the airport park.

Park am Gleisdreieck from Germany: This park is located in central Berlin. It is selected to be compared with Malmi airport park because it has an industrial history. Its area was a landfill in the 1940s. As one main characteristic, its nature is wild and intact. The park is designed to create an urban area in harmony with nature (Kowarik 2015).
It is spread widely (covering 26 hectares) over a triangular shaped area. This park is formed by the junction of railway lines. The park area is designed around a large central meadow. The design of the park is so that a walkway with concrete pavement crosses from east to west and from north to south. Considering the topography of the area the park has an integrated design, i.e. the landscape elements are connected. In the park, there are different types of landscapes in large scales. These landscapes are forest background, open meadow, sport trails, sports fields, the large terraces, community gardens and a central square.

Toukolan rantapuisto: Toukolan rantapuisto has an industrial history. One main characteristic of this park is its deep layers of clay. The park plays an important role in the green-blue infrastructure in Helsinki. The residential area around the park does not have straight access to the sea. A green space, which is part of the Toukolan rantapuisto, connects the residential area and the sea. This connection has improved the region’s condition. The Toukolan rantapuisto provides neighbourhood access to the sea for the central east part of Helsinki.

The park offers great opportunities for outdoor activities. The recreational areas of the park are linked to each other with multiple routes. In the planning process of this park, to improve the region’s condition, the main demand of residents was the size of the park to be larger than the residential area. Since, there was not enough size to answer the residents’ demand, therefore, the park planners and designers decided to improve the region's conditions by enhancing the quality of services and strengthening the existing green areas (Sairinen& Kumpulainen 2006).

The comparisons: To improve the green-blue infrastructure of Malmi airport area, the thesis applies the CSPC practice between Malmi airport park with Toukolan rantapuisto in Helsinki and Park am Gleisdreieck in Berlin, Germany (as shown in Figure 13).

FIGURE 13.Airport park comparison (Loci 2018).

The optimal planning for the Lentokenttäpuisto requires an accurate investigation. Hence, the thesis highlights some concerns for further investigations and then offers the following suggestions employing the characteristics and similarity-based parks comparison, i.e. CSPC. A major concern in the airport park relates to balancing the areas around the preserved airport building. That is because, the gradient leveling of the park areas are very low and the building's northern side is a part of the area's drainage basin. The thesis uses the CSPC between the airport park and the Gleisdreieck park to suggest a solution for balancing the areas around the airport building (the gradient leveling of the park). Considering the area's topography, the landscape elements of the airport park can be connected to balance the areas around the airport buildings. Therefore, the thesis suggests an integrated design for the airport park as in Gleisdreieck park.

The second concern pertains to height difference between the airport park and other parts of Malmi airport area. As a solution, the thesis proposes designing a support wall or a ramp between Malmi airport and the airport park. There may also be height differences between the marginal areas and the residential areas to be built later. Studying the topography of the Gleisdreieck park, the suggestion is to perform a special design considering the area alignments, stormwater management and foundation engineering for further construction.

The third concern relates to connecting the open meadow network in the airport park. The open meadow that is in the center of park is a part of the open green infrastructure. Learning from the Gleisdreieck park, for a solution, the thesis suggests continuation of the planning design of meadow areas. This will help the different areas to function as part of the meadow network.

The fourth concern relates to designing an open-air event square in front of the airport building. The goal is to create a large open space to hold outdoor events. Currently, there is a square in front of the airport building. In the northern end of the square, there is also a stormwater basin pool. This stormwater basin pool with a gradual slope continues toward the event square. Referring to the Toukolan rantapuisto characteristic, that connects the adjacent residential area to the sea by green spaces, the thesis proposes designing a green space between the square in front of the airport building and the stormwater pool. This eminently will emphasize the role of the square as an open-air event square. Moreover, creating a green space helps the bioretention of the stormwater in the area. This is highly effective treatment, since Malmi airport area has unstable deep layers of clay as similar characteristics to Toukolan rantapuisto.

5.2 Muinaisjäännösmäki CSPC with Pikku Huopalahden park and Kaisaniemenpuisto

FIGURE 14. The archeological sites (Loci 2018).

Muinaisjäännösmäki (The archeological sites**):** This area includes the ancient monument hills, i.e. the archeological sites that exist in forest parks. These monument hills are located at the end and in the east of southern runway. As a matter of fact, in the suburbs of Helsinki, the amount of forests gradually increases. In the past, Malmi district was a village with considerable number of farms. The district was surrounded by forests which were used by the residents. This utilization has reduced the natural forests in Malmi area. Today, a small amount of these natural forests remains in the area, while the forests around the airport are completely man-made i.e., they are forest parks. These forest parks together create a forest network in the area.

The most common types of trees in Malmi forest parks are birch, maple and mountain-ash. In the planned landscape for Malmi airport area, the surrounding nature still contains forest cover. One of the forest parks of the area is located at the southern end of the fourth runaway. This forest park has a view to the main street having two main features: i) the archeological sites and ii) the conservation of forest resources. The valuable characteristics of the forest park are the local corridors. These corridors connect the vegetated areas, small water channels and wetlands (Figure 14).

Pikku Huopalahti park: This urban area in Helsinki used to contain car repair shops and garbage lots. The area that was used to build this park included a shallow wetland and few meters from the garbage lots (9.7 hectares). The main characteristic of the park is the wide open and wave-like lawn. This lawn is in the southern part of the park. In addition, a small square beside the lawn acts as an outdoor terrace. This square is used to keep and irrigate the grass of the area. Along the street, there is a group of different species of trees that display magnificent colors in different seasons (Green heart 2018).

This park has the following characteristics. Most areas of the park are covered by green areas; different parts of the park are connected with green corridors that preserve the natural connections of the area; and multiple watercourses flow inside the park. Moreover, the park is located along the largest bay in the area. There is also a pond in the middle of the park that is used to collect the stormwater. Meanwhile, the park is designed to allow the stormwater to gradually move to the sea.

Kaisaniemi park: This is the oldest park in central Helsinki and since the early 1800s it was used as a public park, with a public walkway and a garden. In 1829, some areas from the park were given to the University of Helsinki for gardening purposes. Currently, this park is

known as the city park or city garden (4.43 hectares). It has several parts including a green-house, a rose garden, a winter garden and sports fields. The greenhouse was founded in 1889 and still is the most attractive part of the park. This park is suitable for outdoor and sports activities. The sport fields of the park include a football pitch, basketball and tennis courts (Green heart 2018).

The comparisons: To improve the green-blue infrastructure of Malmi airport area, here we compare Muinaisjäännösmäki of Malmi airport area with Pikku Huopalahden puisto and Kaisaniemenpuisto. These parks are shown in Figure 15.

In the southern forest park, there are separate corridors that preserve the landscape of the region. The separated corridors are the results of uncontrolled activities of humans that have disrupted the corridor connections. Meanwhile, learning from the characteristics of the Pikku Huopalahden park, the connected green corridors of this park have integrated the park space. Thus, applying connected corridors for the forest park also can improve its condition through the space integration. The connected corridors also can be used as a natural network connection to improve the green infrastructure. In the southern forest park, the highest location of the area is located behind the forest road, which offers different views to the forest. This thesis proposes the maintenance of these locations to preserve the views to the ancient monuments. This is a highly important concern, since these monuments have historic value. Utilizing the characteristics of Pikku Huopalahden park, in the southern forest park, it is possible to create open-air terraces on these high locations that can offer views to the beautiful landscape of the surroundings.

The eastern forest park is valuable for recreational use since it has an appropriate space for outdoor activities. Therefore, considering the areas in the example of Kaisaniemi park it is proposed to create spaces for sports activities. Moreover, for strengthening the forest network in Malmi airport area, it is suggested to create connections (through constructing bridges) between the different forest parks in the area. For example, constructing a bridge between the eastern forest park and the other forest parks will improve the forest network of the area. Besides, another feature of the eastern forest park is that there are several species of birds in this forest area. In order to improve the green infrastructure of Malmi airport area as a whole, this thesis suggests protecting and enhancing the different biotopes

including good living conditions for birds and other fauna in the area. In this way, the biodiversity in the region such as shrub, grassland, meadows, and fields will be preserved.

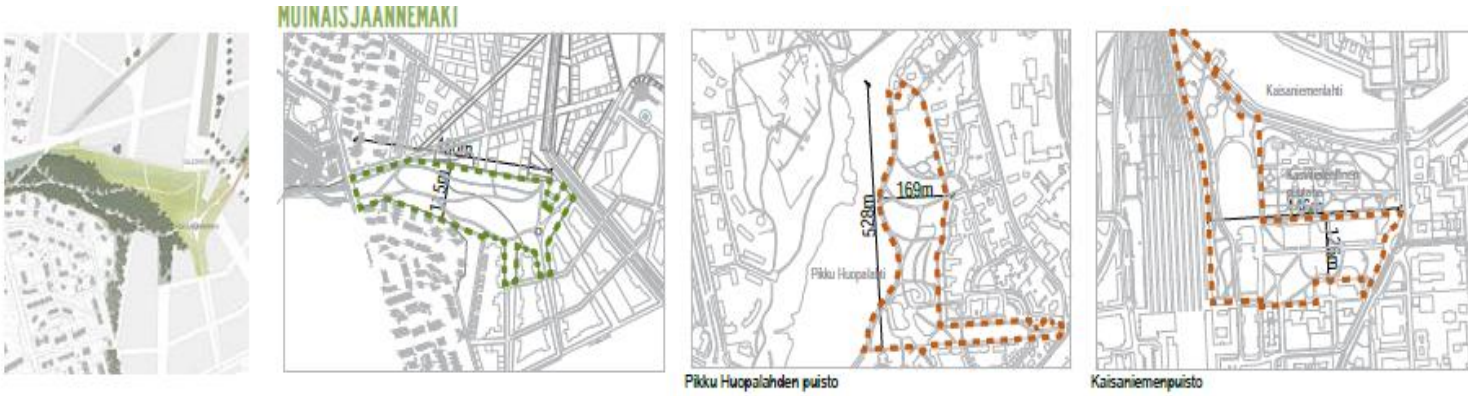

FIGURE 15. The archeological sites comparison (Loci 2018).

5.3 Säilyvä metsäpuisto pohjoinen (The northern forest park) CSPC with Hesperi park and Topelius park

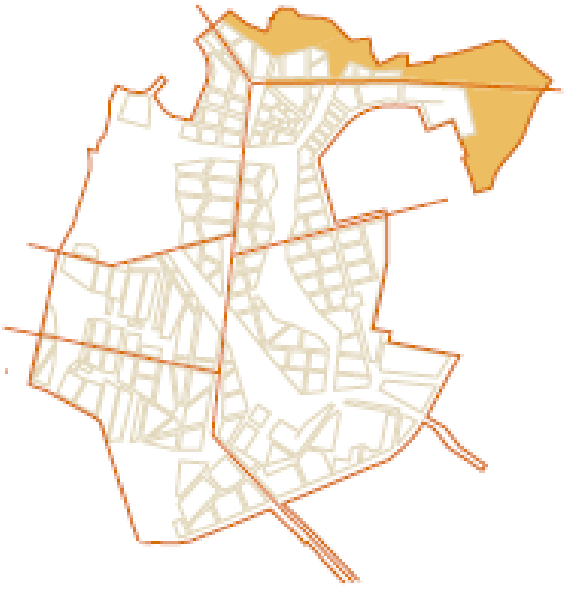

FIGURE 16. The northern forest park (Loci 2018).

Säilyvä metsäpuisto pohjoinen (The northern forest park)**:** This area is a forest park in the northern part of Malmi airport area, where the important road of Suurmetsantie crosses

from this forest park. Actually, this road connects Malmi airport area to different neighbourhoods in the city. These regions are Tapanila, Jakomäki and Puistola. Along the Suurmetsäntie road and in the adjacent of the northern forest park there is also a big farm that has created a vast and open space in the area. Another characteristic of the northern forest park is that, there are several routes in this forest. These routes create strong connections between different areas of the forest park and the surrounding areas in the region (Figure 16).

Hesperian park: This park is located at the Helsinki city center on the west of Töölönlahti Bay. From the south, this park is surrounded by Finlandia hall and in the north, the Finnish opera and ballet buildings are located. In the nineteenth century, the current location of the park was outside the urban area. In the location, there was a villa called Hesperia and one outdoor restaurant. In 1892, the use of that location changed by creating a city park under the same villa's name, i.e. Hesperia. There are several characteristics that define the identity of the Hesperia park.

For example, this park demonstrates a strong green-blue infrastructure through combination of various tree species and the Töölönlahti Bay. Inside the park, there is a sidewalk and cycling route next to the Töölönlahti beach. Along the cycling route, a long line of silver pear trees is planted. The park includes recreational trails (planned for sport activities) that surround the bay. In addition, the park contains many routes that these routes connect the park to adjacent areas. These routes also integrate the park with the surrounding areas (Green heart 2018).

Topeliuksen park: This park is in Helsinki city center in Töölö area. In 1906 the Topeliuksen puisto was designed for recreational use. The park offers spectacular views through its different plants; mainly species of trees and flowers, e.g. roses. The following are few of outstanding characteristics of this park. The park is designed into two styles, consisting of a natural park style and a formal park style. The natural park design relates to designing a park or a garden using natural elements as focal points, such as using natural hills and natural meadows. The formal design refers to designing a park or a garden with a clear structure, geometric shapes such as square flower beds, trimmed hedges and trees, and in most cases a symmetrical layout.

In fact, the Topeliuksen puisto has created a strong green infrastructure between two public buildings in the city. These buildings are Töölö Church and the Töölö library, where Töölö

church is located in the southern part of the park and decorated with poplar trees (Green heart 2018).

Another characteristic pertains to the large linden trees that are planted between the park and the Topeliuksenkatu that is the main road along the park. The advantage is that these lindens create a soft border between the park and the outer landscape of the park.

The comparison: To improve the area integration in Malmi airport area, here the thesis compares the Säilyvä metsäpuisto pohjoinen (northern forest park) with the Hesperian puisto and Topeliuksen puisto. These parks are shown in Figure 17.

In the planning of the northern forest park, the plan is to create a new branch (a street) that crosses from the surrounding residential area and returns to the Suurmetsäntie road. The plan is also to transform the Suurmetsäntie road from a roadway to a scenic street. Learning from the Topeliuksen Puisto, the author suggests planting linear trees along the Suurmetsäntie road. Because, a scenic street can be created and different spaces such as the forest park, the farm, and the street itself can be integrated. Therefore, through planting such a line of trees, a magnificent view over the landscape of the area will be created.

Another plan for the northern forest park is to maintain the connection with Malmi airport area and the surrounding regions which are Tapanila, Jakomäki and Puistola. Using the model of Hespari park, the author recommends using the existing forest routes for creating sidewalks and cycling routes. In this fashion, these new routes can: i) connect different parts of the forest to adjacent areas, ii) integrate the park with the surrounding areas, and iii) create a sustainable connection with the forest network as a whole.

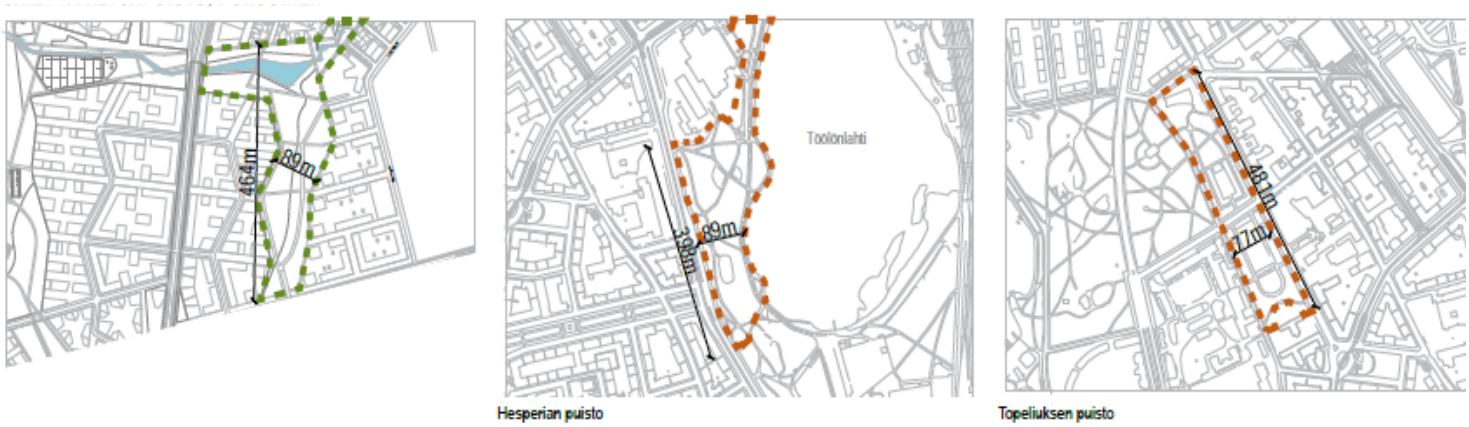

FIGURE 17. The northern forest park comparison (Loci 2018).

5.4 Säilyvä metsäpuisto itäinen (The eastern forest park) CSPC with Töölönlahti park and Sibelius park

FIGURE 18. The eastern forest park (Loci 2018).

Säilyvä metsäpuisto itäinen (The eastern forest park): This area is the forest park in the eastern part of Malmi airport area. The eastern forest park includes the Tattarisuo area, which is a natural forest and considered as a sustainable and valuable forest resource. The eastern forest park includes the Tattarisuontie road, that is located in the south of the eastern forest park. For the future use, the plan is to preserve this road. That is because any change in this road may damage the natural ecosystem of the forest area. Furthermore, in this forest park, there are valuable meadows and shrubs, where some species of birds live. This has created rich biotopes and has added values to the Tattarisuo natural forest (Figure 18).

Töölönlahti park: This park is in Helsinki and it is located on the south of Töölönlahti Bay. In the late 1800s, there was a need to create recreational areas and a sports center for the inhabitants of the south of Töölönlahti bay. To this end, Töölönlahti park was designed and created. The followings are some of the prominent characteristics of the Töölönlahti puisto park. The park was created for recreational use and as a place to rest, therefore people quickly adopted to it. In the park, there are white willows that are planted along the beach

of the Töölönlahti bay. There is also a sidewalk that is divided into separate lanes for pedestrians and cyclists. In addition, the urban planners have performed a study to identify the existing plants species of the park area. This study has helped to protectthe ecosystem of the area through preserving the plant species. Thus, today the natural landscape of the park has remained almost intact. In 2016, a playground that includes climbing facilities and modern sport equipment was constructed in the center of the Töölönlahti park. The playground has created an environment full of child-friendly activities. Moreover, currently a library is under construction in this park that is aimed to bring a cultural environment to the park (Green heart 2018).

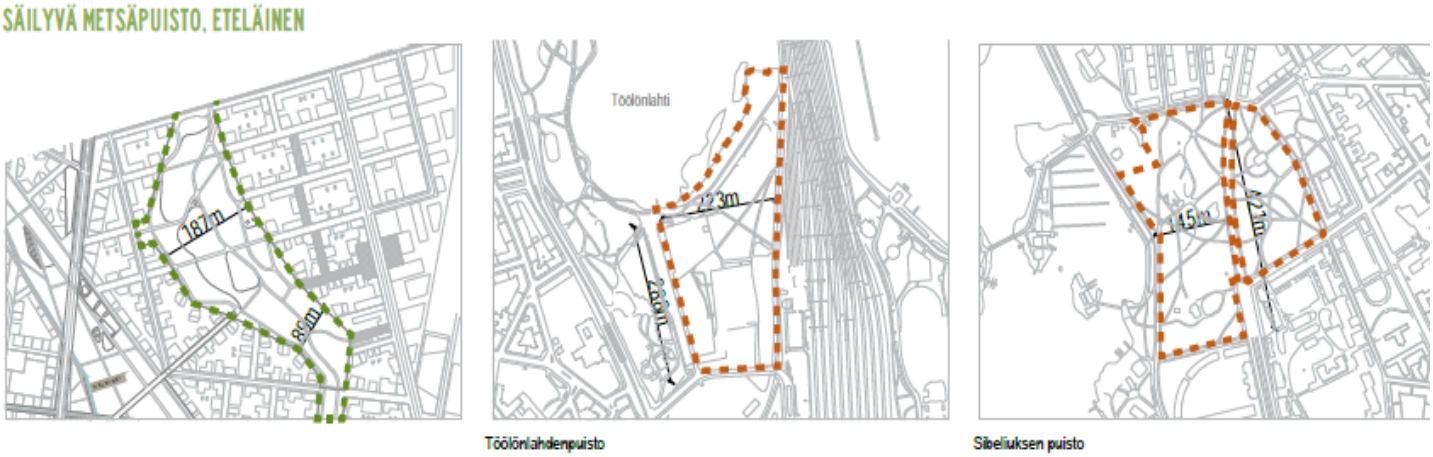

FIGURE 19. The eastern forest park comparison (Loci 2018).

Sibelius park: This park is in Helsinki city center in Töölö region, that was completed in 1916 (9.65 hectares). The following are some of the characteristics of the Sibelius park: i) the park is mainly planned for recreational use, and ii) it is designed as a natural park. The natural park design means that a park is designed based on natural elements as focal points. In Sibelius park, using natural lawns, natural ponds, and natural style of the park has made it to be compatible with the Finnish coastal environment. In addition, birch trees are widely planted that emphasize on the natural design of the park (Green heart 2018).

The comparison: To preserve the green infrastructure in Malmi airport area, the thesis compares the Säilyvä metsäpuisto itäinen (the eastern forest park) with the Töölönlahti puisto and the Sibelius park.

For the future, in the eastern forest park, the plan is to preserve the Tattarisuontie road. Thus, to preserve the road, learning from the Sibelius park, the thesis suggests following a

natural design style for the eastern forest park. In such way, the natural elements of the area will be protected.

Another plan for the eastern forest park is to create places for recreational use. Therefore, to minimize the damage to the natural ecosystem of the forest area and learning from the example of Töölönlahti puisto, this thesis suggests adding open spaces like a playground and a dog park in that area (Figure 19). In this way, the natural ecosystem of the forest area will remain intact. Moreover, an important concern relates to preserving the rich biotopes of the eastern forest park. Considering the natural design in the example of Sibelius park, the thesis suggests using the natural design for the eastern forts park. Furthermore, inspiring from the Töölönlahti puisto, the thesis also suggests performing a study and an investigation about the biotopes (species of plants and animals) of the forest park. This definitely will help in recognizing the biotopes of the area and preserving the ecosystem of the eastern forest park in the future.

5.5 Läntinen puropuisto (The west raingarden) CSPC with Hesperian esplanade

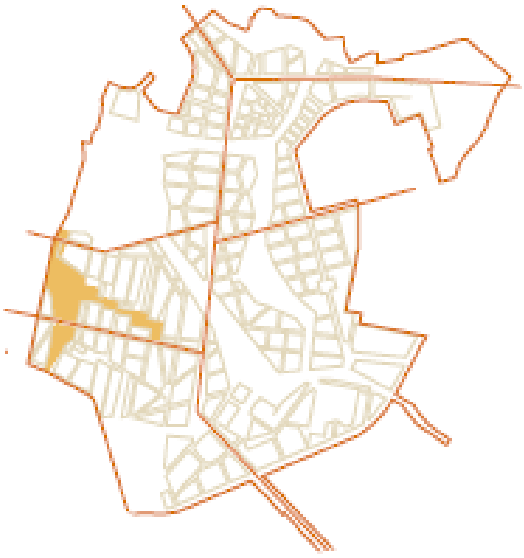

FIGURE 20. The west raingarden (Loci 2018).

Läntinen puropuisto (The west raingarden): This area is planned to be the western rain garden in the western part of Malmi airport area. In fact, the largest waterway in the region

is the Vantaa river. This river enters Malmi airport area from the west through its largest stream called Longinoja. A branch of this stream enters to the west and another branch continues to the north of Malmi airport area. The catchment area of Longinoja stream in Malmi airport area has an area of 12.24 square kilometers. An important concern regarding the Longinoja relates to the drainage of this stream in the western part of Malmi airport area. The drainage of the stream converts the area to a flood zone whenever there is heavy rainfall (Figure 20).

Hesperia esplanade park: This green area, which is a city boulevard in Helsinki city center in the district of Töölö. Hesperia Esplanade park consists of different species of plants. The horse chestnuts trees, oak trees, elm trees, hawthorn bushes, lilac shrubs, various flowers are the example of these plants.

The Hesperia Esplanade park has a geometric shape that is divided into two sections by a city street. This division has formed two new shapes with two different sizes and scales. Therefore, the urban planners have defined a special function for each of these park sections. The section with the narrow rectangular shape is designed to become a place for resting and enjoying the place. This place is full of splendid perennials and summer flowers that attract the visitors. The other section of the Hesperia Esplanade park that is a wider rectangular shaped area is designed with three elements: i) a playing field, ii) a playground, and iii) a small water pool. These elements have defined a recreational aspect to this park section and attract people for activities throughout the year. Furthermore, as an important characteristic, the surrounding of Hesperia Esplanade park is covered by narrow sidewalks that have integrated the two sections of the park (Green heart 2018).

The comparisons: To manage the stormwater in the western part of Malmi airport area, in this section the thesis compares the Läntinen puropuisto (the west rain garden) with the Hesperia Esplanade park.

A significant problem pertains to drainage of Longinoja stream in the western part of Malmi airport area. This is a critical concern, because the drainage of the stream in the area leads to flooding at the times of heavy rainfalls. Considering the area (sizes and the scale) of the rain garden in the west part of Malmi airport, we observe that the scale of the rain garden is equal to the scale of the Hesperia Esplanade park. Therefore, the thesis recommends designing a rain garden using the sizes and the scale of the Hesperia Esplanade park. In a way that the design for the rain garden follows the structure of the Hesperia Esplanade park by having two different sections, one section to be a narrow rectangular shape and the other section to be wider.

Currently, the area of the narrow rectangle type shape includes the Longinoja stream and the area of the other section includes few farms, the residential area and some part of the Longinoja stream. The recommended design is shown in figure 21. To manage the storm-water, the thesis recommends planting wildflowers, sedges, rushes, ferns, bushes, shrubs, and small trees in the rain garden. In this way, the roots of these plants absorb and filter the sotrmwater and prevent flooding when there is heavy rainfall.

Moreover, the thesis recommends designing two elements for the rain garden: i) designing a playground and playfield in the wider section of the rain garden to create a place for rec-reational activities similar to the wider section of the Hesperia Esplanade park. ii) designing a sidewalk and around the raingarden similar to the sidewalk of Hesperia Esplanade park to integrate the rain garden and at the same time to increase the facilities for people's ac-tivities.

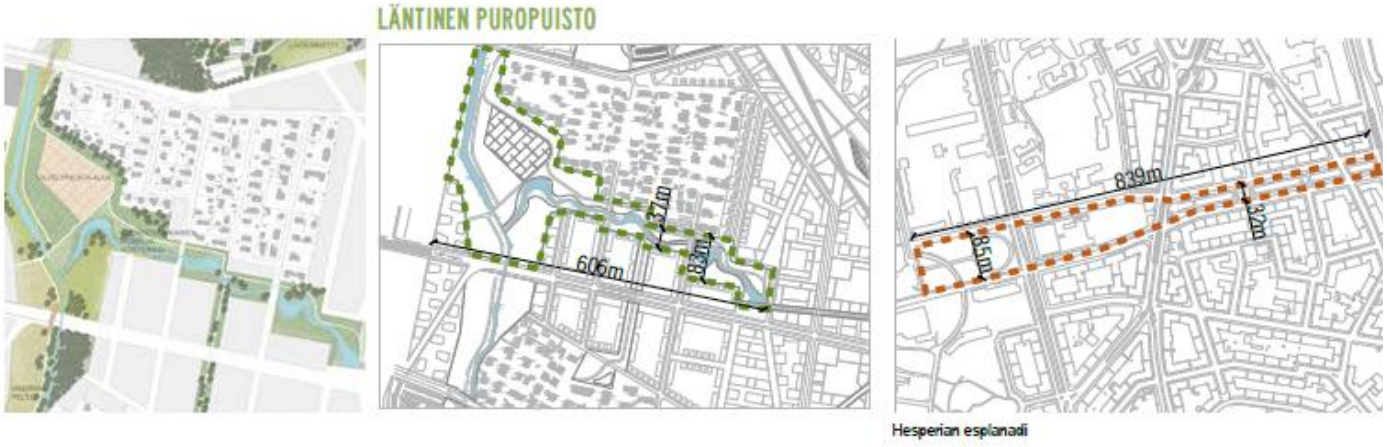

FIGURE 21. The west raingarden comparison (Loci 2018)

5.6 Pohjoinen puropuisto (The northern raingarden) CSPC with Esplanadi and Topeliuksen puisto

FIGURE 22. The northern raingarden (Loci 2018).

Pohjoinen uomapuisto: This area is planned to be the north rain garden in the northern part of Malmi airport area. As we mentioned in the subchapter 5, one of the Longinoja streams continues toward the north of Malmi airport area. As we also explained in the previous subchapter, the drainage of the Longinoja stream in the airport area is a significant concern. Since, any massive rainfall may cause flooding and damages in this area. Therefore, planning new designs and structures for this area will definitely help to avoid hazards and damage (Figure 22).

Esplanadi park: This park is located in Helsinki city center and it was built in 1850. The Esplanadi park known as the green heart of Helsinki city.

The followings are the characteristics of the park. The park is designed as a greenway for walking purposes. The straight lines of trees and flowerbeds define the identity of the park. There are many species of plants in the park. For example, the tree species include linden, crab apple, aspen, and horse chestnut; and the types of bushes include the laburnum, rose, and cotoneaster. There are also different types of flowers, e.g. summer flowers. Actually, these varieties of plants have created a park with lots of attraction so that this park attracts

people to perform social interaction and enjoy the atmosphere. In addition, one main characteristic of the Esplanadi park is its geometric rectangular shape. This is illustrated in figure 16. The rectangular shape of the park that is bordered by a continuous sidewalk has integrated the park space (Green heart 2018).

The comparisons: To manage the stormwater in the northern part of Malmi airport area, here the thesis compares the Pohjoinen puropuisto (the north rain garden) with the Esplanadi park.

FIGURE 23. The northern raingarden comparison (Loci 2018).

As was mentioned earlier, one main challenge is to plan new designs and structures for the northern rain garden to avoid any hazards caused by the heavy rainfall. That is because the drainage of the stream in the north of the airport area causes flooding when there is intense precipitation. Considering the geometry and the rectangular shape of the Esplanadi park, we can find similar rectangular shapes in the northern branch of Longinoja stream area in Malmi airport. Thus, the thesis proposes designing a rain garden using a rectangular shape. To identify the rectangular shapes, the thesis proposes designing sidewalks around these shapes. In addition to the defined identity, designing the sidewalks offers accessibility to different places in the area. They also provide an opportunity for recreational activities such as walking and cycling (Figure 23).

It is also proposed to design a stormwater pool and a water channel to collect the water accumulated from heavyrainfall and to gradually direct it to the farms at the northern edge of Malmi airport area. In this fashion, the stormwater can be effectively controlled. Furthermore, inspiring from the diversity of the plants in Esplanadi park, the author suggests planting various kinds of trees, bushes, and flowers. Especially, planting the trees on both sides

of the water channel will define the channel shape and identity. Therefore, planting in the northern rain garden enables absorbing and filtering the stormwater through the plants and avoiding water runoff. Meanwhile, the open spaces around the water channel can be used to design a place for playground, a playing field and a fitness site. In such a way a place for recreation and sports can be created that brings wellbeing and happiness for the inhabitants.

6 FINDINGS AND RESULTS

Urban developments and population increase in cities threatens the water resources and green spaces. To avoid such threats, in urban planning ecosystem services should be implemented in cities. The examples of these ecosystem services include implementing green-blue infrastructure and managing the stormwater.

This thesis explored the opportunities of green-blue infrastructure for Malmi airport. Regarding the green-blue infrastructure, the study performed in this thesis has selected ten example parks from Finland and Germany. These parks are selected to conduct characteristics and similarity-based comparisons between Malmi airport area and each of the parks. This comparison is performed to find feasible design solutions for six different parts of Malmi Airport area.

The results obtained from the comparisons are important for the future role and performance of Malmi region as part of Helsinki city and as a living environment for the residents. The findings and results achieved in this thesis include: ‘’

1. Design projects like Malmi airport area create an opportunity to implement the green-blue infrastructure. These opportunities help the optimization of ecosystems, recalibration and refurbishment of existing infrastructure. In addition, these projects allow systematic integration of natural areas and constructions. For example, in Malmi airport, the meadow network in the airport park, the forest parks in the south and in the east provide great opportunities for green areas.

2. In the urban planning and design process, it is an effective approach to select similar examples of urban areas, e.g. parks for comparing the similarities between the selected areas. This comparison will help in identifying the potentials of the target plan area through studying similar examples. This identification illustrates the feasibility and practicality of the planned design for the target area.

3. Using the characteristics and similarity-based park comparison (CSPC) is an efficient practice to perform comparisons between two areas/parks. The CSPC is a comprehensive practice that employs different indicators for comparisons like spatial extent, the location and pattern, the structures and facilities of the areas/parks.

4. The linkage between the green and blue infrastructure can offer several advantages. In practice, the green infrastructure is essential for stormwater management and flood control. The blue infrastructure also contributes to increasing the value of green areas and strengthening the environment. These have been clearly discussed during the comparisons in this thesis. For example, Malmi airport area is surrounded by Falkulla farm, the forest and meadow networks that form the green infrastructure in the area. In addition, through designing rain gardens in the north and west parts of Malmi airport area, blue infrastructure can be strengthened. As the result from the green-blue infrastructure perspective, the Falkulla farm can connect to the meadow network and the forest to function as recreational and educational areas, while the rain gardens can be designed to manage the stormwater.

5. The design of green-blue infrastructure in Malmi airport area provisions the ecosystem services at various spatial scales. As result, defining and designing the green-blue infrastructure for Malmi airport increases and maintains biotopes, and connects and strengthens the green corridors.

6. The identity of Malmi area can be supported by the green-blue infrastructure. However, the airport park is the most important part in the planning area but implementing the green-blue infrastructure for Malmi airport does not change some features of the airport area. Because, the main elements in the airport park that define the identity of the airport are the old building and the long runway. These identity signs are preserved that are reminiscent of the former Malmi airport.

7. For optimal green-blue infrastructure design, it is necessary to define an optimal scale for the target plan area. Defining optimal scales for the area offers diverse ecology and ecosystem services. In fact, the scale of green spaces has significant impacts on the quality of environmental conditions. The larger the size of a green space, the higher the quality of the space in terms of ecology and ecosystem services. For example, the effect of sizes and scales are particularly visible through the botanical and biotopes diversities.

8. When there are limitations on increasing the size of a green space, enhancing the quality of environmental conditions can enrich that space. For example, according to CSPC

performed for Säilyvä metsäpuisto pohjonen area, this area is in shortage of green spaces. The green space in this area is very narrow and requires improvements to reach for an optimal size. It is worth noting that based on ecological definitions; the optimal size of a “forest feel” is approximately 3 hectares with at least 100 meters wide (Hamberg et al. 2012). Therefore, as solution for the areas with a shortage of spaces, the thesis proposes preserving the green areas in their current shapes (using the natural design concept) and designing new spaces like a playground, playfield or a dog park for that area. In such way, the shortage of green spaces can be compensated through enrichment of the area.

9. Adaptation of the green-blue infrastructure adds value to green space and urban environment. This can be performed by creating walkways, sidewalks, cycling routes or by strengthening and connecting the existing routes in the area. In addition, by creating links between the new routes, different parts of the green space can be connected to adjacent areas and the green space can be integrated with the surrounding areas.

10. The urban planning and development similar to Malmi airport area offers opportunities for strengthening the environment and services for the inhabitants. For instance, to strengthen the environment, the green and blue infrastructure can be connected, and stormwater can be managed. In addition, through creating recreational spaces and places for sport and social activities, the level of wellbeing and happiness can be enhanced for all ages. In fact, the urban planning and development can convert the areas into a better place to live.

7 CONCLUSIONS

Implementing green-blue infrastructure in urban areas offers opportunities for strengthening the environment and provides ecosystem services for the inhabitants. This creates sustainable and livable urban spaces and offers vitality for the people. To study the concept of green-blue infrastructure and to understand the benefits of applying such concept, this thesis evaluates Malmi airport area as the case study. The objective of this thesis is to study the benefits of applying green-blue infrastructure in Malmi airport area and proposing feasible design solutions for the six subareas of Malmi airport by comparison with other parks with similar characteristics.

Therefore, to find appropriate answers to the thesis objectives, ecological and recreational potentials and functional needs of each sub area in Malmi airport are explored. In addition, the thesis uses ten different green spaces/parks selected from Helsinki and Berlin. Then the author finds the similarities between the six subareas of Malmi airport and the selected parks. Then for each subarea, the author selects an example park and performs the characteristics and similarity-based park comparison (CSPC). The CSPC is a comprehensive practice that utilizes various indicators for comparisons. For example, the spatial extent, the location and pattern, the structures and facilities of the areas/parks.

The CSPC practice is defined based on various indicators including the spatial extent, the location and pattern, the structures and facilities of the areas/parks. The indicators of CSPC practice can be utilized as tools for planning a green-blue infrastructure in urban areas. The CSPC practice enables improving the environmental conditions for the target green-blue spaces, e.g. parks. In fact, applying the CSPC practice allows learning from similar example parks and it enables planning efficient and optimal green-blue infrastructure. However, since this practice does not consider the socio-demographic characteristics and environmental factors, e.g. weather conditions may not be an absolute method for planning a green-blue infrastructure.

This thesis uses ten different green spaces/parks selected from Helsinki and Berlin and applies the CSPC method to find the similarities between the six subareas of Malmi airport and those ten parks. The results obtained from these comparisons showed that the CSPC is an efficient method to apply when planning an area. Because, area planning based on

this method in Malmi airport area i) preserves the ecosystem, ii) increases the biotope diversities, iii) manages the water runoff, i.e. enables the stormwater management, iv) integrates the green spaces of the area, v) offers diverse social services, and vi) and creates a sustainable environment.

The major challenge when performing the research was that the author did not find a similar method to the CSPC for planning a green-blue infrastructure. Whereas, learning from similar methods, the author could learn and consider their findings in the thesis. The other challenge was the limited information about the selected parks for the comparisons. Thus, the author had to depend on the information provided in Wikipedia and other online resources found using google search. Another challenge was the language of the accessed documents of Malmi airport area. In fact, the language of the documents was in Finnish and it was a challenge for the author to translate them into English.

Indeed, through this thesis helped the author to deepen her knowledge of green-blue infrastructure planning and sustainable urban development concept. Conducting this thesis helped her to understand the main challenges and considerations for planning a green-blue infrastructure. The author also learned the different ways of controlling water runoff and management of stormwater in an urban area.

As the final word, the area planning and employing green-blue infrastructure for Malmi airport area can create a sustainable environment. Because, based on the literature review performed in this thesis, the scale of an optimal urban area depends on the amount of vegetation in that area. In addition, since the sizes and dimensions of green spaces in Malmi airport area are big, therefore, a better environmental condition will be provided by employing such a green-blue infrastructure. Considering the potentials and features offered by the green-blue infrastructure, this thesis confirms the functionality of planning such infrastructure for the future green-blue areas. However, it is important to receive users' feedback and survey the people's mind through questionaries' about the usage and functionality of the space after creating the green-blue infrastructure. This enables ensuring the functions of the space and improving the next urban area design.

This thesis has proposed the CSPC method for the first time. This method uses the spatial extents, the location and pattern, the structures and facilities of the areas for the comparison. As the future work, in addition to the indicators of CSPC, this thesis proposes defining a method for the area comparisons that considers the socio-demographic characteristics and environmental factors of the region where the area is located. In this fashion, an efficient method for comparing different urban areas can be defined and it can be used as a tool for a sustainable urban development.

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