LUND UNIVERSITY

Bachelor Thesis in Human Geography

Decision Support for Urban Regeneration

Using Multi Criteria Evaluation for Urban Green Space Development in Helsingborg

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SGEK03 / Fall 2017
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ABSTRACT

Urbanization and densification are two noticeable trends that imposes many challenges for urban planners. Fast growing cities comes with the need for incorporating publicly accessible green spaces to ensure public health and for creating an attractive city. Urban regeneration provides the possibilities of restructuring the urban environment according to desired needs. Helsingborg municipality did, in 2017, initiate one of the biggest renewal projects recorded in the municipality´s history. The H+ project, even though in an early stage, makes up a good example of how resource efficiency is growing in importance. Making the most out of limited resources implies demand for well-suiting planning strategies to base decisions on. Tools and methods for achieving this could be found in geographic information systems (GIS). More specifically for this study, the practicality of using multi criteria evaluation (MCE) for decision making is examined. In addition, an MCE is applied to find potentially suitable locations for new public green space within the H+ project area.

Key words: Urban Development; Urbanization; Decision Support; Multi Criteria Evaluation; Public Green Space

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1. INTRODUCTION

The urbanization process is becoming more and more evident in the world. Year 2030 the total urban area is expected to have tripled from year 2000 by an increase in total population from 2,84 to 4,9 billion people (Secretariat of CBD, 2012). Planning policies must therefore be well-designed and adapted to preconditions and future challenges in order to withstand the test of time. Since we live in an everchanging world, continuing adaptation and efforts in understanding our surroundings is crucial. Not only for keeping up with changes but for the maintenance of our close and immediate landscape. Additionally, for our environment as well, since the urbanization put heavy pressure on natural resources (Secretariat of CBD, 2012).

Urban growth expectancy come with the need of sustainable thinking that addresses the problematics of urban compactness and density, managing and achieving a diverse land use, and at the same time incorporate public green spaces in the urban environment (Jabareen, 2006; Littke, 2016). Being located in one of Scandinavia's most populated regions and being one of the most fast-growing cities, Helsingborg is dealing with the problematics of developing the city in a sustainable manner (Helsingborg Stad a, 2014; Helsingborg Stad, 2016). Today, approximately 140 000 people live in Helsingborg. By 2035 Helsingborg is estimated to reach 160 000 residents, and heavier demand and need for green spaces within the city is expected (Helsingborg Stad a, 2014). Therefore, the challenge for Helsingborg is to combine the elements of densification alongside preserving and incorporating public green spaces in the urban area (Helsingborg Stad a, 2014).

Helsingborg, like many other municipalities, struggles with limited resources such as actual physical space. Intensifying urbanization is often followed by worsening conditions of air pollutions and high noise levels as an effect of increased density (Douglas et al, 2017; Jabareen, 2006). Thus, the relationship of limited space and consequences caused by densification are interesting and important to investigate further. It gives incentives that the problematic relationship between densification and green space in an urban environment needs addressing. Making the most out of existing space and resources in an efficient manner is consequently significant.

In order to be efficient and make well founded assessments on different planning perspectives different tools such as geographic information systems (GIS) can be of assistance. The usage of geographic data and GIS has increased, and its practices are reaching outside the realm of the field of geography (Schuurman, 2004:1). Still, optimal land usage, where geographic relationships are essential, is one of the main objectives addressed. Therefore, the most substantial field of its operating is within planning on local, regional and national levels (Harrie & Eklundh, 2013:22).

1.1 Identifying the Research Problem

In 2017, Helsingborg initiated one of the city´s largest city renewal projects called H+. The project is to be completed in 2035. The H+ area is located in the central parts of Helsingborg (see figure 1). A more detailed image of the area can be seen in the map in figure 2. The main objective is to renew the industrial areas – *Södra Hamnen-Oceanhamnen*, *Södra Hamnen-Knutpunkten*, *Universitetsområdet*, *Husarområdet*, and *Gåsebäck* – located in the southern parts of the more central city. The areas addressed in the project are to be transformed into attractive, functional neighborhoods, and business environments with close proximity to everyday services. While at the same time becoming more incorporated in the city as a whole (Helsingborg Stad, 2016).[1]

This kind of immense project provides great opportunity for the municipality, since renewal and re-usage of old industrial spaces adds another dimension to the urbanization process. Instead of only focusing on new development regeneration becomes an alternative. Hence, already developed land can be given new meaning and be transformed to meet the need for housing as well as space for business developments. Thus, with a long-term perspective this transformation process has economic growth incentives. Development in dense areas is difficult due to the lack of space. Therefore, the H+ areas central location in Helsingborg provides great opportunity (Öhrström, 2001:96).

Transformation and regeneration of old industrial areas could then be viewed as one approach to sustainable development of a city. Nevertheless, municipal planning authorities still have many factors to account for when designing development plans, and with the case of industrial area renewal the potential environmental hazards must also be recognized (Nyström, 2001:118). This becomes important since the placement of certain features, such as green spaces, could be affected. Contaminated land can give rise to future problems if a public green space was to be placed on that location without proper precaution.

Consequently, environmental aspects when renewing old urban industrial areas are vital pieces when structuring municipal planning policies. It is supposed to contribute in achieving the national and local environmental goals. In Helsingborg, the importance and values of urban green spaces has been addressed in their green structure program, *Grönstrukturprogram för Helsingborg*, that was accepted in the municipality council in 2014. Though, the program does not bring forth specific and detailed plans for green development. It can instead be viewed as an umbrella of guidelines covering the spectrum of city development, highlighting the values of green in the urban environment (Helsingborg Stad a, 2014). The program has been incorporated into the comprehensive plan for the H+ project where the main ideas for public green space development are represented with an additional description of environmental consequences (Helsingborg Stad, 2011).

[1] More information about H+ Renewal Project and the five areas can be found on www.hplus.helsingborg.se.

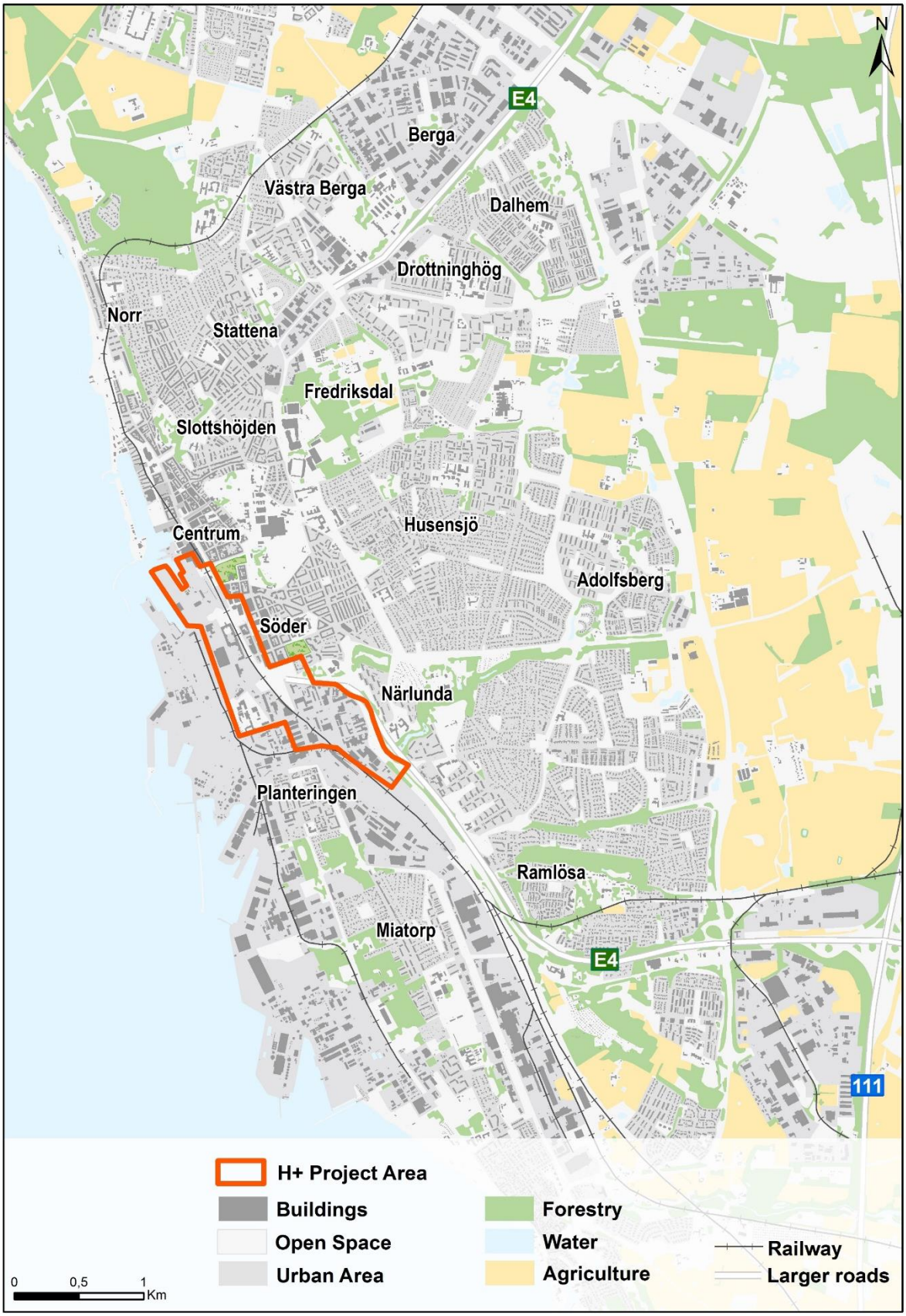

Figure 1 *Overview of the H+ project location within Helsingborg urban area.*
Map layout: Nina Sandberg (2017)
Map data: © Land Survey Sweden & © National Road database (2017)

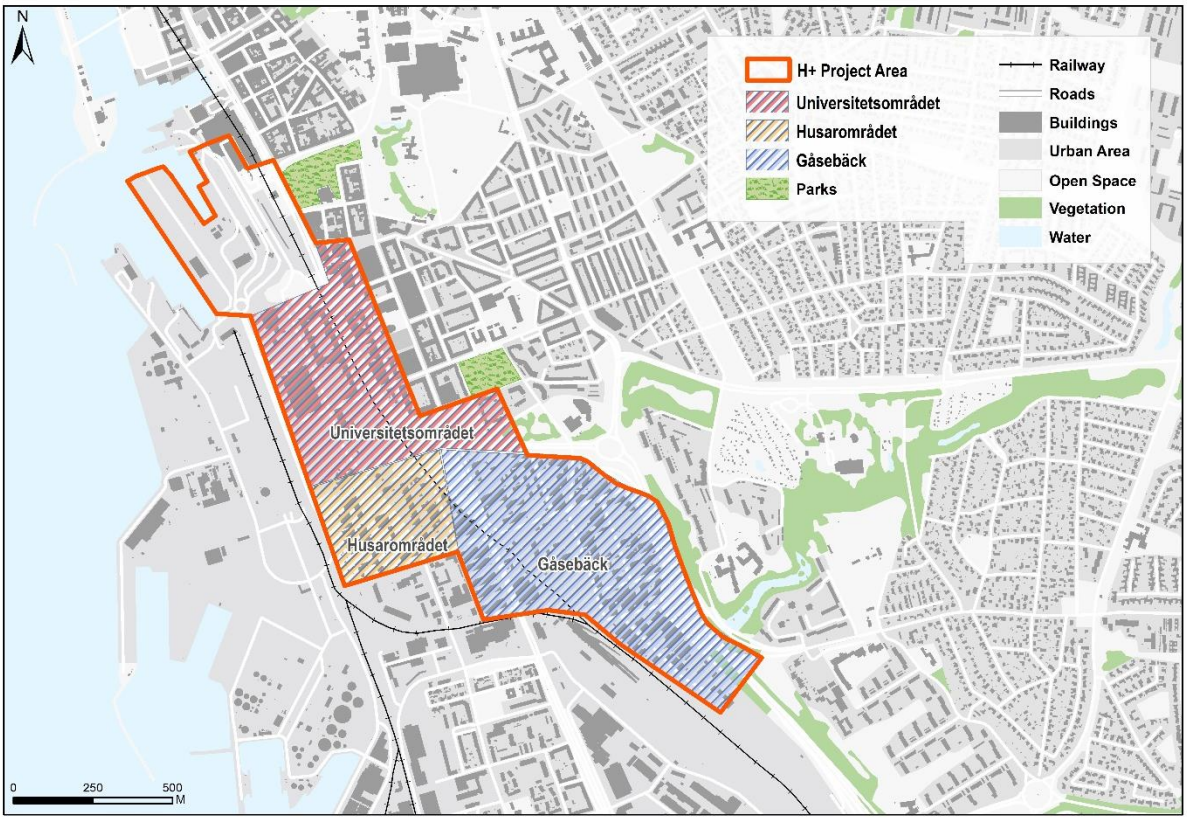

Figure 2 *The three focus areas (Universitetsområdet, Husaområdet & Gåsebäck) within the H+ area.*
Map layout: Nina Sandberg (2017)
Map data: © Land Survey Sweden & © National Road Database (2017)

By combining different kind of geographical information when conducting an analysis of the incorporation of public green space in the H+ project one might find placement alternatives. Similarly, important factors that has not been considered in previous revisions but affects the output of the analysis could be noticed. An multi criteria evaluation (MCE) for suitable location analysis, performed in GIS, allows for the combining of many different factors. Examples of factors could be distance or proximity to certain objects like roads, railway, or parks for instance. Those three examples along with urban noise levels and distance to potentially hazardous properties will be used a criterion for investigating green space development and placement in Helsingborg. Combining factors in this way makes it possible to visually display possible placement alternatives of a public green space depending on chosen criteria (Pilesjö & Eklundh, 2013:247-255).

1.2 Research Aim & Research Questions

The objective of this paper is formed by the complex relationship between urban development, densification, and public green spaces. Combined with the difficult task of balancing urban and green elements in the city, the overarching aims are to:

1) critically examine plans of urban green space in Helsingborg´s city renewal plans for H+ project and;
2) investigate how GIS and more specifically an multi criteria evaluation (MCE) method can be used for decisions concerning urban green space development in Helsingborg.

To investigate and operationalize the aims, following research questions are formulated:

- What are the directives for public green spaces in the areas of *Universitetsområdet*, *Husarområdet* & *Gåsebäck* according to the deepened comprehensive plan FÖP H+ and the green structure program?
- In what ways could MCE be supportive for urban developmental decisions?
- What locations would be suitable for public green space development?

1.3 Why is This Research Important?

It has become noticeable that more and more people tend to enjoy spending time in nature. The physical and mental health benefits that derives from this trend is finding support in several studies and is a frequently reoccurring theme in different forms (Douglas et al, 2017; Lake & Townshend, 2006; Littke, 2016; Naturvårdsverket b, 2017). Improved access to green spaces in urban areas are becoming more important because of more people, especially in more densely populated (urban) areas, wants to spend time in nature (Naturvårdsverket b, 2017). If more people want to use public green space, various use desire and wishes need addressing. Developing urban public green spaces with regard to these wishes exemplifies the complexity that urban development faces. Nevertheless, it puts the relation between urban planning and the urban environment´s health impacts on everyday life on the agenda (Douglas et al, 2017; Littke, 2016).

Besides the health implications, that green spaces in the urban environment provides, an environmental aspect is also present. In a rapid pace, severe loss of biodiversity is noticeable across the globe (Secretariat of CBD, 2012). Preservation of green spaces are consequently not only important for human well-being but a necessity for biological diversity. Since physical space is limited, as mentioned above, preserving and forming green spaces in urban environment could be one possible direction to take in order to prevent species extinction in a foreseeable future (Alvey, 2006). Nevertheless, preservation of green spaces in an urban setting consequently has both societal and nature values, since it has impact on urban residents' health as well on the biodiversity that can be found in the urban environment (Alvey, 2006; Littke, 2016).

The challenges with limited resources means that efficiency in existing resource usage becomes vital. Thus, the examining and continuous assessments of development plans and search for alternative directional decision support is crucial for fostering sustainable development in cities (Jabareen, 2006; Secretariat of CBD, 2012). Helsingborg´s major city renewal project H+ gives the opportunity to investigate the development of the southern city districts with diverse perspectives in order to make both a broad and more

in-depth analysis possible. The usage of decisions supportive softwares and methods, like MCE, is a way to add a geospatial dimension to the analysis (Harrie & Eklundh, 2013:22-23). MCE is, in this case, about finding the most suitable location (place) for public green spaces according to five different factors; distance to the existing parks Stadsparken and Furutorpsplatsen, distance to the heavy trafficked road Malmöleden, distance to the railway, distance from potentially hazardous properties, and noise levels within the city. Effects of these factors will then be analyzed.

1.4 Delimitations & Clarifications

To make some clarifications this section will address some concepts that reoccur and give some more explanatory comments on the delimitations of the research field. Since the time frame, in which this research is to be completed within, is limited the extent of the investigation field must be adjusted. The focus and geographical limitation will be on three out of the five areas that are included in the renewal plans of H+. These are *Universitetsområdet, Husarområdet* & *Gåsebäck* (Helsingborg Stad, 2011) (see figure 2). Husarområdet stretches outside of the H+ project borders and this part will be excluded from the multi criteria evaluation since the focus of this investigation is solely on the H+ renewal project. Additionally, the reason for not including *Södra Hamnen-Oceanhamnen* and *Södra Hamnen-Knutpunkten* (the unmarked area in north parts of the H+ area, see figure 2) is simply because the developing process has been initiated unlike for the other three where detailed development plans still has to be formed and accepted.

Furthermore, *public urban green space* is a key concept, and in this context, refers to space that is accessible to the public. Private gardens, places that requires admittances fees, and other closed of areas are not included (Littke, 2016; Helsingborg Stad a, 2014). Urban green spaces and public green spaces are consequently referred to having identical meaning in this paper, since a requirement is that green space must be publicly accessible. An additionally important aspect that will not be addressed here is the residential perception of accessibility. Variations of peoples´ perception of accessibility, along with their mobility options, would be interesting if mobility and accessibility was studied. But for this investigation the presence of green space is the main interest.

Sustainable development is a term often used in planning context even though the term itself can be viewed as evasive. In the context of this paper its refers to development and growth that takes public green spaces into account in planning along with urban densification (Haq, 2011; Jabareen, 2006). Societal and ecological benefits arise if an integrated position towards nature and green spaces in the urban environment are held. (Alvey, 2006; Littke, 2016). These benefits are viewed as contributes to a sustainable urban development.

The matter of urbanization and preserving important biodiversity in urban area was discussed in section 1.3. This field could itself be studied from many different perspectives and form a research focus of its own. However, since the main objective for this paper is to investigate the future plans for green space in Helsingborg city´s green

structure program and deepened comprehensive plans for H+, and the potential gains/negatives of using GIS based analysis methods for decision making no further discussion will be made on the theme of biodiversity and its implications in the urban environment.

The brief discussion in section 1.1, on the relation and problematics between regeneration of old industrial space and urbanization, could also be extensively investigated. In the case of Helsingborg city´s renewal project H+, old industrial space is an important factor that must be recognized. It will most likely have impact on decision making regarding placement of a green space. The potential problematics with pollutions in the ground affects usage possibilities. Therefore, this will be considered among the criterions that will be used for the MCE. But due to time restrictions cost efficiency will not be further assessed even though this can affect decision making. Removing contaminated soil could be viewed as one example were cost would be an important factor.

2. APPROACHES TO PUBLIC GREEN SPACE, RELATIONAL SPACE & URBAN PLANNING DECISION SUPPORT

Approach to Public Green Space

In order to examine and analyze the existence or absence of public green space in urban areas a review and discussion of what constitutes green space is necessary. Firstly, there is a need to create an understanding of what constitutes a public green space, so that an analytical discussion on the issue can be conducted. Secondly, a recognized understanding of green space is necessary for the investigation of green space plans in the case study of Helsingborg and H+. What does Helsingborg localities bring forth and include in their vision of public green spaces?

The following quote contains an attempt to define green spaces in a way that that could be useful for understanding public green spaces in this investigation.

> "*The definition of urban green spaces which is agreed on by ecologists, economists, social scientists and planners is public and private open spaces in urban areas, primarily covered by vegetation, which are directly (e.g., active or passive recreation) or indirectly (e.g., positive influence on the urban environment) available for the users*" (Tuzin et al., 2002 in Haq, 2011:601)

The green aspect, vegetation, and for it to be open space could be considered requirements for it to be labeled as a green space. Furthermore, the private sphere, and indirect availability in the cited definition, is being overlooked in this study simply because limitations are needed. However, these spaces also contribute to the greening of urban areas and for the well-being of residents. Privately owned properties, with open green gardens for example, could give a sense of green in the urban environment, just like the citation from Tuzin et al (2002) in Haq (2011) implies. Due to changes in development structures the private sector is becoming more and more visible in both the production

and management of public space (Littke, 2016). But since these are not open to the public in the same sense as publicly owned spaces they have been excluded. Otherwise the definition sums up the main objectives for urban green spaces in accordance with the same objectives of this enquiry; accessible, urban spaces where the green element is primarily from vegetation.

Helsingborg authorities put their focus on green infrastructure which is also addressed in their green infrastructure program[2]. The concept contains all the elements that in the review above was given as explanation for green spaces. Green space is hence a part the concept green infrastructure. The problematics of having an evasive concept like this is that the field for investigation becomes extensive.

> "*Green infrastructure is in this document represented by both formal green spaces – e.g. parks and nature reserves – and informal green spaces e.g. villa gardens, development districts, allotments, and cemeteries.*" (Helsingborg Stad a, 2014:11, author´s own translation)

The informal aspect includes the private sphere of space in the urban environment. This by itself makes up an investigation area that becomes much larger and to complex. It reflects reality better since that kind of green space is also experienced by the urban residents and visible in the urban environment. But it makes the analysis more difficult due to additional factors, such as private properties containing green space, and it complicates the decisions process of what to include and not in an analysis. Limitations of what to include and not becomes more complicated, since private properties often not follow same regulations as municipalities. These problematics are acknowledged in the sense that they make the final result extensive. However, conducting a more restricted analysis, using MCE for new green space placement, still adds value. The results can be helpful as a guide and bring forth new perspectives on suitable locations for parks.

Finally, the quality of a green space has not been addressed. This relates to the relational approach that will be presented next.

Relational Aspects on Urban Planning

The second approach that will be addressed concerns the relational conception of space and place and time. Places inherit substantial meaning in a never-ending process of formation, implying that places can be created, changed, and destroyed endlessly. A place is given meaning both from the people found in that place but also from its surroundings (Gren & Hallin, 2016:156-159). This becomes important in planning since placement of certain amenities is affected both on their intended purpose and users as well as their surroundings.

Addressing this relational aspect could then bring forth a deeper discussion and awareness of possible factors that needs to be accounted for in planning processes. The quality of a green space is one factor that is significant, since it will have effects on the usage of a place, in this case public urban green spaces like parks for instance. If Helsingborg wants

[2] See Helsingborg Stad 2014 in reference list.

to develop and increase public green space accessibility within the city the quality of these envisioned spaces needs to be evaluated for better understanding the surroundings effects on a place´s quality.

Understanding the context based reality the H+ project area is situated in, is necessary for a better understanding of the development possibilities the area holds. The relational aspect of an urban environment, if focused on perception and expectations of a place, can limit the innovativeness in planning (Graham & Healey, 1999). The physical structure of an area, let's say a grey, concrete dominated industrial area, does not induce the same perceived experience as an area with colors and lots of greenery for instance. We are affected by our physical surroundings, and at the same time the very same surroundings are formed, transformed, and ultimately given a meaning by us. Thus, visions of development reflect innovating ideas that simultaneously contain prejudice based on the knowledge of a place current situation.

The urban environment, and the city, is not a homogenous entity. The subareas and neighborhoods have almost as many meanings and traits as there are people residing there (Amin, 2011). A park for one citizen can imply a place for recovery and serenity, and for another the complete opposite. Consequently, planning decisions must incorporate not only the physical factors of a place in a deliberate manner but also the more relational aspects of the city (Amin, 2011; Graham & Healey, 1999). And there is no straightforward and established way to do this.

A relational approach to H+ project will add a historical aspect into account, since this is visually present in the physical structures. Ranging from actual buildings to the structures of road network, traces of the past can be seen in the present landscape. This historical aspect adds another relational understanding to H+, besides the socially constructed one given by people who has alleged connection to the area. The historical context in which H+ finds itself will affect the future plans since our surrounding is affecting us in the same manner as we are altering and re-creating our surroundings.

Planning Decision Support Approach

Various aspects and factors relating to accessibility, mobility, and preservation must be recognized on many levels and scales of society when it comes to urban development. The interrelated work processes within a municipality´s management encourage good cooperation between local authorities for better facilitating the developmental aims and stated goals. "*GIS ends up somewhere between detailed development plans and the political decisions*" (Harrie & Eklundh, 2013:22, author´s own translation). Thus, there is a need to consider institutional influences, for example guidelines, missions, and policies, that affects the urban development processes (Nyerges & Jankowski, 2010:273).

From a broad perspective, decision support is faced with the complexity within the structural process were guidelines and development plans are designed and revised. As stated above municipal work is highly interrelated not only within the internal institutions but also with external forces that indirect affect decision making. The local business

environment and various organizations can be considered as being different types of these external actors (Nyerges & Jankowski, 2010:274).

So, decisions are continually being made between various actors on an everyday basis. The basis for the decisions depends on what is to be decided and this can be based on expertise among the decision makers for instance. But often some kind of data analysis is required to be used as a foundation and this could be called data driven decision making. Data driven decision making can be applied in many different context and for various purposes, there is consequently not one single method to follow (Rasmussen et al, 2017:6).

Therefore, the processes of municipal development need an integrative approach, and this demands tools supporting that approach. GIS software and technology supports the need due to its possibilities of incorporating many factors and aspects (Nyerges & Jankowski, 2010). It is possible to esteem economical, judicial, cultural, environmental, and other societal features were the geographical notion is of key importance, in planning for instance (Harrie & Eklundh, 2013:22-23). GIS offers enhanced possibilities of data storage, that exceeds human capacity, various spatial analysis functions with opportunities for graphic visualization (Nyerges & Jankowski, 2010).

Besides this more contextual aspect of GIS one must consider the implications that this data driven type of tool can have on decisions processes. Decisions based on geodata will only be as good as the data input. There are potential shortcomings of data provision even though we live in an era of excessive information flows thanks to social media and technological advances (Rasmussen et al, 2017). The variety of data sources and the variety of methodological aspects these data have been derived from is also potentially problematic, not to mention when trying to integrate data originating from several sources. These are some issues that researcher have to position themselves for and try to overcome by clarifying methods and usage (Janelle & Goodchild, 2011).

The critique regarding data inadequacies is probably the most problematic for the development and incorporation of GIS methods in the decision-making processes. As mentioned above, the GIS results will only be as good as the input data. If there is a lack in transparency about possible deficiencies within the datasets this will give misleading results. Development of accepted metadata structures might be helpful in overcoming the more practical issues regarding data. Clear structures, over the collecting process or missing values for instance, could help informing what metadata that would be required to accompany datasets in order to increase transparency and decrease potential deficiencies. This development is becoming more and more evident when looking at growing numbers of open data sources, cooperation between data collectors, and common geodata portals. Geodata is easier traceable and more accessible than ever for the individual user. But large quantity of data is not necessarily good; the quality is still most important.

Some other aspects of GIS usage should also be recognized in the context of planning. Any kind of modelling requires simplification of reality to become feasible. Even though

the GIS technology has the possibility to incorporate various analytical factors it still has its limitations. Two examples could be the need for compatible data and more general the need for some generalization in order to analyze a complex reality. These limitations must of course be acknowledged in a debate on GIS. There has been some raised critique towards the more positivistic approach GIS comprises. This critique is directed on the limitations of including social aspects in society. Perception and human behavior does not follow sets of rules and is therefore hard to incorporate. However, if used properly, by city planners for instance, in combination with complementing participatory approaches the more rational planning perspective from GIS methods could be useful (Nyerges & Jankowski, 2010), and the many functions could be used for risk assessments, various resource evaluations, and spatial analyses to give some examples.

Finally, discussion about spatial analysis and social research must be addressed. GIS, as a planning tool, has become more common over the years for various practices, within municipal work as well within private companies. Nevertheless, there are still one issue that needs to be considered in urban planning and spatial analysis. Investigations of a social nature does not follow one set of methodological rules guiding the enquiry. Planning the urban environment, which is a social environment of human interaction, subsequently becomes difficult. The reason why is because the conceptualization of space comes in many dimensions and not in one linear shape. Thus, locating and distinguish the social aspect in research and in extension trying to incorporate this in GIS becomes somewhat of an issue. Integrating data driven GIS with more socially directed theories on planning and policy-making might be a suitable solution (Baur et al, 2014). Knowledge about and paying attention to the possible limitations that GIS has to adjust to will create more conscious planning.

3. METHOD & MATERIAL

The methods for the analysis will in great degree rely on GIS. However, there is still a need for some complementary data collection in order to fully investigate the aims of this paper; examining how GIS can be useful for urban development decisions. This supplementing data will be in the form of planning documents. More specifically Helsingborg´s green structure program from 2014 and the deepened comprehensive plan for H+ area, FÖP H+. This section presents and explain the different material used for the analysis and more thoroughly the methodological foundations of the performed MCE analysis.

3.1 Material

Firstly, the material that has been used for executing the analysis consist of official documents from Helsingborg municipality. Additionally, geographical data has been collected from Helsingborg municipality´s open data online, Land Survey Sweden

(Lantmäteriet) through the Geodata extraction tool (GET), and the National Road Database (NVDB). The County Administrative Board of Skåne has provided the investigation with datafiles over potentially hazardous industries in Helsingborg urban area. The geographical data has been processed by the software ArcGIS provided by ESRI, and the same software is used for performing the multi criteria evaluation. More information about the different data providers will be presented below.

3.1.1 Data Sources

County Administrative Board of Skåne
The County Administrative Board of Skåne has provided this analysis with point data of potentially polluted properties. The industrial points, that are classified as dangerous and posing a high environmental risk by County Administrative Board of Skåne, where extracted from the dataset. The distance of 200 have been used to minimize the investigation area but still include potentially polluted properties that are close to the H+ project area. The reason behind the 200-meter distance is because it is often used as a safe distance measurement. The ones extracted have been given a 2 in the risk classification given by the Swedish Environmental Protection Agency. The classification stretches from 1-4 where 1 is very high risk and 4 low risk (Naturvårdsverket a, 2017). There are no properties within a 200-meter proximity to the H+ area with a classification of 1, consequently the second classification has been extracted. The data has some deficiencies since not all objects have been classified and there is a lack of metadata about whether old industrial sites are included in the dataset. The metadata is thus somewhat deficit, but it does explain the properties´ attributes, and adds another dimension for the analysis.

Helsingborg municipality
Helsingborg municipality has contributed with planning documents and guidelines in form of green structure program and the deepened comprehensive plan for H+ project. The green structure program contains over-arching guidelines and information on currently existing green spaces within the municipality. It also comprises strategies on future development, and therefore this document has been chosen as material for this investigation. The deepened comprehensive plan FÖP H+ is directed towards the development of the H+ project and gives directives for the development of the three focus areas Universitetsområdet, Husarområdet, and Gåsebäck.

Specific and detailed plans for those three sub-areas has not yet been agreed upon. Otherwise these would also have been used as foundation for the document analysis. Besides these documents the municipal has a policy about open data. The policy specifies the municipality´s desire to make geographic data available to the public. The data on the city´s latest road and railroad noise investigation has been collected from the municipality´s website containing open geodata. High noise levels are a factor that potentially can cause livability issues if levels exceed established benchmark values that are stated in the constitutional regulation 2004:675 regarding ambient noise.

There is a lack of descriptive information about collection method and potential accuracy deficit of the data. Since extensive metadata is lacking, thorough examination of the data throughout the work process has been essential in order to identify potential issues in early stage. Furthermore, the file has been transformed into the coordinate system SWEREF99_TM from WGS_1984 to make everything cohesive. Transforming the projection does have possible implications on the geodetic references resulting in non-matching data. However, for this investigation these potential issues have not had any effect on the analysis.

Land Survey Sweden
Land use and property data have been collected for this specific investigation. The data have an overall high accuracy with extensive and transparent metadata. The metadata specifies the assembly process and explains the potential problems of complementing the datasets throughout the years using various methods. However, the data used for this study have an overall high accuracy. Nevertheless, it is still important to pay attention to potential errors, such as missing data, in the material.

National Road Database
The data contain comprehensive road and railway networks and is the result of cooperative work between the Swedish Transport Administration, Land Survey, Swedish Association of Local Authorities and Regions (SKL), Swedish Forest Industries Association, and Swedish Transport Agency. The guidelines and extensive collection requirements are stated in the metadata[3]. Information about different roads are important since one of the problems with the H+ area is road barriers. For instance, highway E4 creates a barrier in the south parts of Helsingborg (Helsingborg Stad, 2011).

General Information
The material used for this investigation is mainly in the form of secondary data. By using secondary data, one can get hold on extensive and often high-quality material within a fraction of the time it would take to perform the collecting-process. By decreasing the often very time-consuming process of collecting primary data, more time and focus can be put on the actual analysis instead (Bryman, 2016:310-312).

However, one of the risks with secondary data is that one does not have same familiarity with the material. Since the secondary data is collected by someone else for their purpose there is a chance that some aspects/factors might be missing in the analysis. This is a potential risk when using secondary data (Bryman, 2016:312-313). But in this context and for this investigation the potential risks are outweighed by the advantaged stated above. The material for this study comes from official authorities which follows transparency guidelines for collection, processing and distribution of information.

One last remark on the material is that some digitalization was required of the H+ project area and the three sub-areas – Gåsebäck, Husarområdet, and Universitetsområdet – within the larger area. Additionally, the closest parks, Stadsparken and Furutorpsplatsen have

[3] Metadata can be found on National Road Database (NVDB) website, https://nvdb2012.trafikverket.se/.

also been manually digitalized, by the author, because they could not be accessed as already existing detached data files from the land use. All manually digitalized objects can be viewed in figure 3.

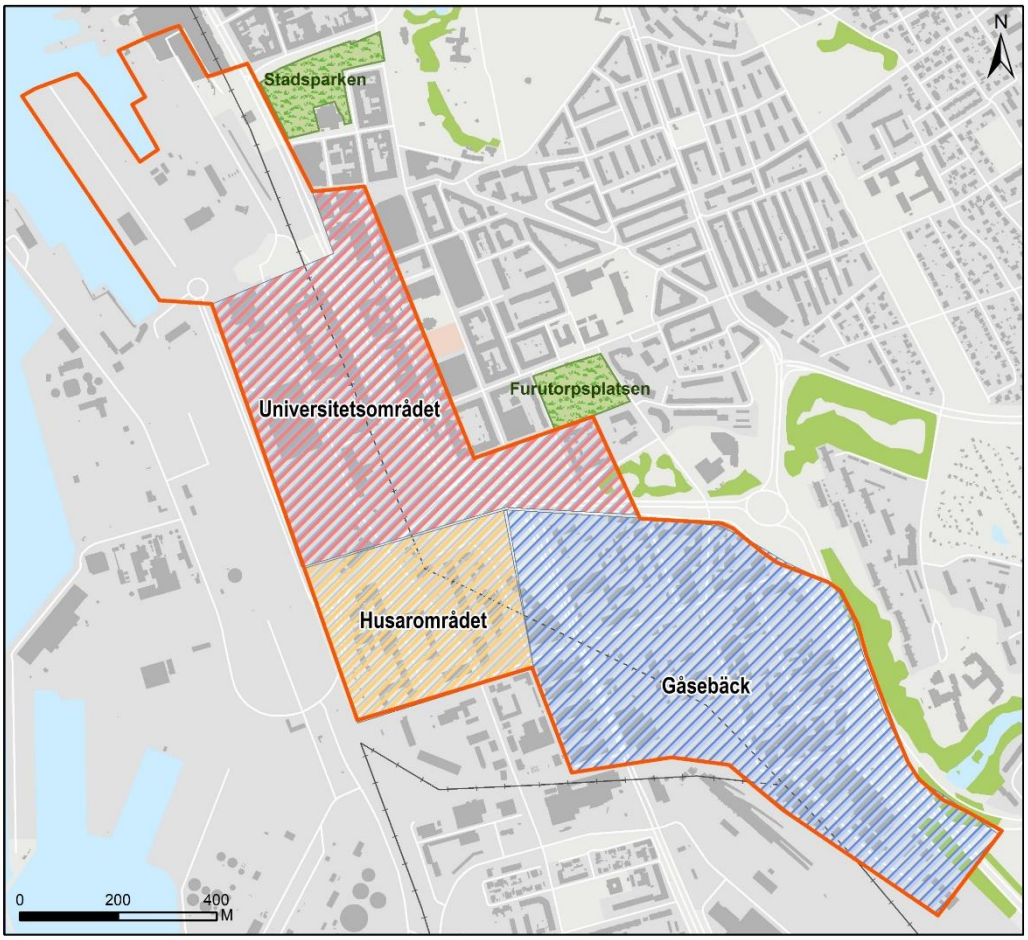

Figure 3 *Manually digitalized objects (the borders of H+ focus area, the three sub-areas, and the two existing parks Stadsparken and Furutorpsplatsen)*
Map layout: Nina Sandberg (2017)
Map data: © Land Survey Sweden & © National Road Database (2017)

3.2 Mixed Method Approach

The approach used for this investigation is somewhat of a qualitative and quantitative mix, and divided into two methodological processes; MCE and document review. GIS represent a data and digital driven approach to planning, but applying it in the specific contexts of this case study and due to its place specific data it becomes more qualitative. To fully understand the preconditions of Helsingborg´s renewal project H+ one must additionally look at the foundations whereas the current planning incentives and guidelines originate from. To do this the document review will be used. Furthermore, a deductive reasoning between theory and empirical findings will be kept. The theory sets up the conditions from which the empirical findings are collected and analyzed (Bryman, 2016:21). In this case the approaches on public green space, GIS as decision tool, and relational space.

Since the objection of this paper is to investigate and analyze GIS as a potential planning tool both the MCE and document analysis are equally important. To investigate how GIS can be helpful for decision making, an understanding of current public green space plans is necessary. This will affect the starting position for the GIS analysis. Therefore, a convergent parallel approach has been taken. This means that the collection of material has been done simultaneously and the results has been analyzed as a whole (Bryman, 2016:638-639).

Planning decisions are commonly stated from policy statements or similar. Combining the two methods therefore helps giving a deeper understanding of the complex relationship of conforming to guiding policies and developing the urban environment accordingly. Reflection of GIS as decision support in combination with the reviewing of planning document consequently becomes significant in trying to understand the complex reality of the urban environment (Nyerges & Jankowski, 2010:4). In order to perform the multi criteria evaluation, in a manner that meets the actual goals of the renewal plans, an understanding of current plans and guidelines for public green spaces are is important. Aims and criterions needs to be accounted for and identified in the documents, and then implemented in the MCE in order to better represent reality. The methodological process of the MCE can be found in section 3.2.2. But before the multi criteria evaluation, a review of the document analysis will be presented.

3.2.1 Document Review

The two documents, green structure program and FÖP H+, are studied according to a qualitative content analysis. This entails a theme based approach in reviewing the documents contents (Bryman, 2016:563). Meaning that key concepts, such as urban public green space, arguments relating to locational preconditions, and placement/location of green spaces in the H+ renewal project first will be identified in the texts. Secondly, the result deriving from the first step is then assessed to examine what affects these features might have on the MCE analysis. This assessment considers in what context public green space, locational preconditions, and location is mentioned in the plans.

The documents will be assessed and presented one at the time in order to avoid confusion between statements within the plans. The content relating to the key concepts above have been extracted from the plans as citations (own translation). This is done in order to get a clearer thematic overview, and to highlight potential factors guiding urban green space placement (Bryman, 2016:563). From Helsingborg´s green structure program a more overall view on public green space have been taken. This is the overall green space development guide for Helsingborg municipal, and is therefore valid for the focus areas of this investigation. The deepened comprehensive plan, on the other hand, have been viewed more in direct relation to the H+ project area itself and of the sub-areas Gåsebäck, Husarområdet and Universitetsområdet. The analysis has been done by continually looking for directives for green space according to the green space approach explained in

section 2. Key words such as public green space, goals, prerequisites, and location was used as guiding factors. The analysis of the empirical findings will then clarify whether the factors have direct effects on green space placement or if they might have potential impact.

Being secondary data, the planning documents used for this analysis derive from official authorities. It is important to be attuned to the contextual circumstance documents are derived from in order to be able to interpret the contents of them (Bryman, 2016:562). There are possible biases that needs to be recognized. Consequently, there is a need for critical reflection over the likely representativeness of the material, since it most likely is constructed in a specific context for a specific reason (Bryman, 2016:552-553). Separating the city´s more abstract visions from more clearly outspoken goals will be somewhat problematic since the language in the documents are very much highlighting the potential that Helsingborg possess. Nevertheless, written goals along with publicly accessible urban green space, preconditions, and public green space placement relating to the focus area will be guiding the document review.

3.2.2 Multi Criteria Evaluation

A multi criteria evaluation (MCE) is a type of geographic analysis method used in GIS, where multiple data are studied simultaneously. An MCE method could be useful for location analysis since placement of an element (e.g. a park) often has some requirements and criteria's that needs to be accounted for. These possible requirements could then have possible implications on the final location suitability (Pilesjö & Eklundh, 2013:247-248). By using this method planners and others can combine multiple factors/requirements that potentially will have effect on placement decisions, for example distance to roads, bus stops, and proximity to already existing parks. The most suitable location can then be derived from the chosen criterions which, in an overlay, possibly adds another perspective on the planning process by taking preconditional factors into account. The method can be helpful to sort, rank, and select from different decision options (Nyerges & Jankowski, 2010:136). The method consequently requires a selection process of factors that will become the multi criteria evaluations basis.

Explaining MCE

For a better understanding of the possible technological aspects of MCE as a research method, and in extension, the methodological decisions made for this paper, a more practical explanation follows. The method can be approached from three major angles; with a *logical Boolean operation*, a *ranked/weighted operation*, and finally a *fuzzy operation*. These different operations affect the way in which the factors are classified and how the divide of suitable versus non-suitable locations are categorized in order to locate best possible placement. Figure 4 gives an example of how the Boolean, ranked and fuzzy classifications would divide values in a dataset according to suitability. In the MCE, different criterions are thereafter overlayered or weighted together to find the most suitable location, meeting the several categories at the same time.

It is however possible to combine the different operations in mixed ways (Pilesjö & Eklundh, 2013:248-255). To give one example, it is possible to use Boolean classification of a variable together with a fuzzy classified variable in a weighted overlay. Consequently, the preparatory steps of the data are important for a better understanding of the input data´s overall processing.

The first option with a logical Boolean operation uses a sharp divide between suitable and non-suitable areas by giving the values in the attribute table values 0 (false) for non-suitable and 1 (true) for suitable (see figure 4). The divide is decided depending on given criteria. For instance, we have a distance from an object and less than 10 meters is considered unsuitable. Accordingly, the values reaching the given criterion (>10m) are given 1 and the others a 0 (<10m). This simple divide makes an overlay of all factors easy using the operators intersect (AND) where all criterions must be met, or union (OR) where at least one criterion must be met. The intersect (AND) operation could be good for minimizing risks since all criterions must be fulfilled, and the union (OR) for when one wants to maximize possibilities since location becomes more optional depending on the factors. However, the result and possible outcomes can be affected by a particular factor (Pilesjö & Eklundh, 2013:248-250).

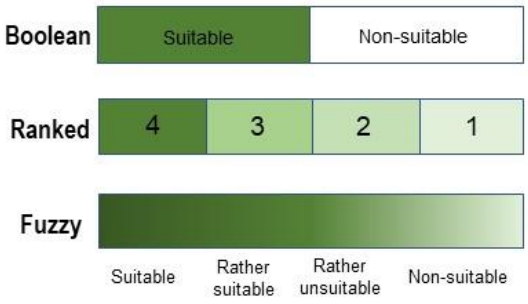

Figure 4 *Visual example of the transition between classes using the different operations.*

The fuzzy operation, allows for gradual transitions amongst the factors. The divide between variables are considered "fuzzy", in comparison to the sharper divide derived by the Boolean operation or defined categories used by the ranked operation (see figure 4). By using fuzzy operation, the divisions instead give a range of values, either linear or in the form of an Gauss- or S-curve[4] (see figure 5), giving a more ambiguous transition amongst the suitability levels. The values are calculated using membership functions in the GIS software and the original values are transformed into the range between 0 to 1.

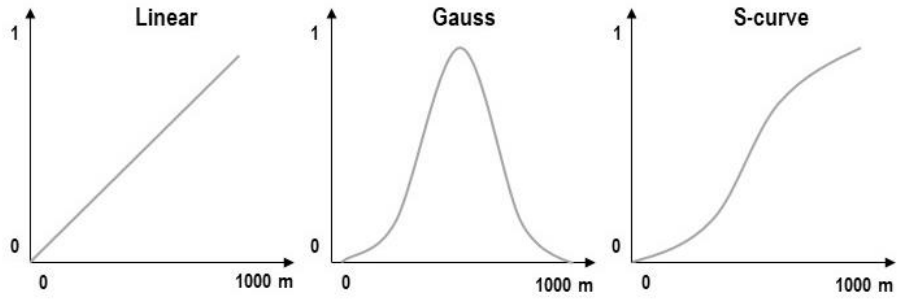

Figure 5 *Visual example of a value range in a linear, Gauss-, and S-curve.*

[4] For a Gauss-curve the values of a variable are closely located around the mean, and large deviations are rare. An S-curve shows the changes in a variables values depending on another variable.

The values can then be combined in different ways with the equivalents of the logical operations; fuzzy intersect (AND) and fuzzy union (OR). This is done in the same manner as with the Boolean operation; the fuzzy intersect (AND) is used when all criterions must be fulfilled, and the fuzzy union (OR) when it is enough with one. This operation results in scheme of values/percentage giving indication on where potential placement should be suitable (Pilesjö & Eklundh, 2013:253-255).

In comparison with the Boolean logic, the ranked/weighted operation provides a less sharp categorizing of the variables, making the classification more flexible. The ranking stands more for the preparation of the data, and the weighing for the final combination of all the variables. A variable is ranked using an ordinal scale, for example 1-4 where 1 is non-suitable, 2 is somewhat suitable, 3 is suitable, and 4 is very suitable (see figure 4). The categories represent different values, e.g. distance from a major road. If the criteria states that the optional choice of location is for example as far away from a major road, then the higher class would be considered more suitable. A high ranking indicates a more suitable location, and the ranking system could be used on data that is either on a nominal scale (e.g. land use) or an interval scale (e.g. distance) (Pilesjö & Eklundh, 2013:250-252).

Weighted sum is used to perform the overlay, because this adds all the criterions together according to importance. Each criterion will be weighted according to importance measured in percentage, and the datasets used for weighted sum must be in raster format[5]. So, for example if one is working with five criterions and they all have the same importance they will be given the weight 0.2, representing 20 percent for each criterion. The result will display the suitable location based on the chosen variables, and in extension the chosen rankings and weighting of the criterions, which also is important to remember. One of the problems that must be addressed when using this operation is the different measurement scales that criteria can have. This imposes some potential issues when combining various criterions (Nyerges & Jankowski, 2010:137). Therefore, all criterions used must also be classified to the same common measurement, such as 0-1, if the weighted overlay is to be possible.

MCE Criterions

The operation being used for this investigation is a combination of a fuzzy linear classification and simple Boolean classification, which are combined through a weighted sum operation. Before the classification can be done, transformation of the data into raster format is required. This is done by calculating Euclidian distance. An exception is the noise level dataset because it keeps the original integer values stretching from 35 to 75 decibel (dB). A maximum distance of 500 meters have been set for the dataset for potential polluted properties, covering the entire focus area. Similar for the road and railway data. The reason behind choosing 500 meters is simply because this is the minimum distance required for getting values covering the entire focus area. Full coverage is necessary for the final overlay. If values are missing for some parts of the

[5] For more information go to ArcGIS for Desktop, http://desktop.arcgis.com/en/.

geographical area, these areas will consequently be excluded from the result. The outcome could therefore be misleading, and suitable locations might be overlooked.

The five criterions that are being used for the MCE have been chosen on the basis of their possible effects on urban development. To increase accessibility, new green space development should be placed so that it increases the catchment area to a maximum. Prerequisites also have to be acknowledge, and therefore trying to keep distance to unwanted disturbances from major roads and railways could be considered rational choices. Other prerequisites, like polluted properties for instance, are another example of potential factors that can affect urban development and should, if significant, be included. The five criterions can be read in a summarized version in table 1.

Criteria summary for the MCE	Equal Weight	Mixed Weight
Linear relationship of distance from Stadsparken & Furutorpsplatsen (0-1000 meters) & locations within 200-meters from the existing parks are unsuitable (=0), and the ones outside are suitable (=1).	**20 %**	**30 %**
Linear relationship of distance from the larger road Malmöleden (0-500 meters) – Further away from the road the better.	**20 %**	**20 %**
Linear relationship of distance from the railway crossing through the H+ area (0-500 meters) – Further away from the railway the better.	**20 %**	**10 %**
Noise levels in the city has to be less than 50 dB. Everything above is unsuitable (=0) and below suitable (=1).	**20 %**	**30 %**
Linear relationship from potentially polluted old industrial properties (0-500 meters) – Further away from polluted properties the better.	**20 %**	**10 %**

Table 1 *Summary of criterions and their importance in the weighted overlay.*

Technical Approach

Next step is to transform the data into the same measurement scale which range from 0-1. This is done by using the fuzzy membership function in ArcMap for all criterions besides the noise dataset. The procedure re-calculates the original floating-point values into values between 0 and 1, where the values closer to 1 better meets the criterions. Since distance away from the major road, railway, and hazardous properties is considered better, the higher values (longer distance) will be closer to 1. There is a matter of cost-efficiency connected to the hazardous properties criterion that is not addressed and incorporated in the analysis. The municipality could decontaminate properties if economically profitable. But in order to incorporate this the analysis must take another direction that does not follow the set premises for this paper. Thus, the criterion is approached in a linear manner stating that the further away from a potentially polluted property the more suitable green space placement would be.

Proximity to existing parks have been processed differently which will be explained further, since there are some methodological difficulties when including this criterion. Two classifications have been made; one with a linear relationship and one with simple Boolean logic. Both will be used as input data in the final analysis. This will result in one evaluation with the Boolean classified data, and one result with the fuzzy classification. The result can then be examined to see which one produces the most reasonable result. All other criterions will remain the same.

The deepened comprehensive plan for H+ state that residents should not have more than 200 meters to a public green space. A 200-meter concentric buffer zone around Stadsparken and Furutorpsplatsen has been created to display the already existing catchment area. Next, the values within the 200-meter-zone has been reclassified as not suitable (=0), and the values outside as in the need of green space (=1). By using this Boolean logic, the methodological issue was solved in simplistic manner covering the entire investigation area. But it makes a strict division and does not include flexibility. The linear fuzzy membership function does not take the 200-meter distance into account but instead provides with more flexible options for green space placement. The maximum distance was set to 1000 meters, in order to get values covering the entire investigation area. If a shorter distance had been used some areas within the H+ borders would have been missed out, and a longer distance would just add unnecessary values for an area beyond the H+ project. Higher value – locations with longer distance away from the two existing parks – will be closer to 1 when classifying the variable with the fuzzy membership. These are considered being more suitable options, because green space placement further away from existing parks will increase the catchment area. However, this solution does not account for the areas already having a 200-meter proximity to parks. These locations do not have the same need for a new one.

The noise level dataset has instead been recalculated manually using Boolean logic with 1 and 0 for the values below and above the breaking point value of 50 dB. The breaking point originate from Helsingborg municipality's city noise evaluation in the green structure program where 50 dB was considered being the maximum level which a majority still does not feel disturbed by noise. The values below are given 1 representing suitable green space locations, and the values above are given 0 being non-suitable locations for a new green space. Placing green space in an area that have lower noise levels consequently have health implications as well as increasing green space quality (Helsingborg Stad b, 2014:30). Areas with a dB lower than 40, also called silent places, are very rare and should be preserved (Helsingborg Stad b, 2014:27). However, since these levels are rare in the urban environment and due to the H+ project area´s central location within the city, the breaking point value is set to 50 dB in order to maximize possible suitable locations.

The following step is to perform the actual weighted summary to get the result of the most suitable location for a public green space in the H+ area. In this MCE analysis the importance of each criterion has been divided equally resulting in 20 percent for each.

But to display the possible impact the actual weighing has for the MCE analysis another second analysis is made with different weights (see table 1 for mixed weights).

The criteria noise levels and distance from already existing parks have, in the second weighing, increased importance. The reasoning behind this weighing is based on directives from the green structure plan and deepened comprehensive plan for H+. FÖP H+ states the goal of having an overall 200-meter accessibility of green space in the urban environment, and the green structure plan brings forth the importance of keeping disturbing noise levels low and preserving areas which generally have low noise disturbance. Therefore, noise is considered more important, and efforts of trying to increase accessibility for more residents. Distance from Malmöleden remains with the same weight since restructuring of traffic to and from the harbor hopefully will make this road less busy, diminishing it as a barrier somewhat. The railway is intended to be rebuilt underground and would therefore not have much effect on green space placement besides during the phase before its removal. Hence, its lower importance in the second MCE-analysis. Old industrial properties also have a lower importance in the second analysis. This is based on the possibilities of decontaminating the soil making this criterion less significant.

For making the visual analysis easier the result has been transformed back into vector format. This process requires a reclassification of the values from the MCE-results, and these have been made turned into 10 classes with an equal interval. The classification choices were made in order to preserve the value gradations of suitability within the area and to be able to make comparisons between the MCE-results, which the classification method equal intervals appropriate for.

4. ANALYSIS

4.1 Document Review – Directives for Public Green Space

Followingly, the two planning documents, containing Helsingborg municipality´s overall urban green strategies within the green structure program along with the deepened comprehensive plan for H+ project area, will be reviewed. The empirical evidence of the city´s public green space directives will be specified and presented followingly as illustrative writing.

4.1.1 Grönstrukturprogram för Helsingborg (2014)

The purpose of the green structure program is to bring forth the values of green space within the realm of the municipality, and is doing so by evaluating Helsingborg´s current state, framing strategies, and looking closer at five different topics; cultural environments and landscape, recreation, green teaching, biodiversity, and climate, air and water. The content of the green structure program is trying to highlight the many values of including

greenery in municipal development. Its intention is to act as guide for more detailed development planning within the municipality, helping the many different institutions within the municipality with decisions relating to greenery. "*[…] the green structure program should be used as a fact and planning basis making up the foundations for new land use decisions.*" (p. 9) and it is "*part of the city´s current comprehensive planning and will be used as a foundation for the actualization and preparation of a new comprehensive plan.*" (p. 10).[6]

From this document, contents connected to planning goals of new green space/parks placement in the areas of Gåsebäck, Universitetsområdet, and Husarområdet have been identified. Also, preconditions affecting green space placement have been acknowledged in accordance to the public green space approach discussed in section 2. What constitutes a green space will have effects on both what to in include in the concept but also for the structuring of this kind of document.

The program addresses urbanization in relation to exploiting municipal resources.

> "*The ambition is to grow resource efficient through densification. So far, focus has been on development for residential accommodation and businesses. Other functions and values needs densification, for example green spaces, parks, and recreational opportunities.*" and "*[T]he shares of green spaces in the urban areas are proposed to be maintained and increased in some places for example H+ area […].*" (p. 7)
>
> "*The main strategy for development of Helsingborg is to densify within existing settlements, […] in order to spare agricultural land. This imposes an increased exploitation-pressure on the green spaces. Loosing green spaces entails a risk for future costs because of negative effects on recreational and cultural values, local climate, storm water delay, and biodiversity.*" (p. 14)

However, the increased importance of public green space in the urban environment simultaneously comes with the conflict of needing the same restricted space for densification (Helsingborg Stad a, 2014:25). "*In a growing city with ambitions of densification, creating new green spaces is difficult.*" (p. 58). The problematics of the urbanization versus green space development are somewhat the reasons why decision support in different ways, like GIS for instance, can be valuable. Structuring the urban environment should be done with the best possible preconditional knowledge possible in order to make well-suitable decision that will have positive long-term effects. Because if not, development projects, like the H+ project, might have to be remade and restructured within a short time frame to fix problems that has occurred from fast and/or un-suiting choices.

The green structure program is to be considered a help for the municipal comprehensive planning, and if incorporated in "*[d]etail planning it can help assuring existing green spaces and reserve space for new developments.*" (p. 23). It might be that some currently

[6] The citations, and all following, have been translated by the author.

existing green spaces have been planned for something else besides urban greening and therefore valid, but latent, detailed development plans impose a risk of exploitation. "*It can be detailed development plans or old city plans, that has not been actualized, where land is reserved for roads or railway, housing, industry or other kind of establishments.*" (p. 23). This can be viewed as an example of how the green structure program stretches over the work of municipal instances, and is intended to be a helpful document for decision making wherever it is relevant. In this case the program wants to highlight the need for overviewing older detailed develop plans so that existing green spaces are not exploited on the basis of urbanization.

Green spaces within the urban environment has many functions and with an increasing population Helsingborg city needs to meet future demands. Public health is a reoccurring topic in public debate and it reoccurs in relation to the challenges of physical barriers and high noise levels within the city. "*Barriers like buildings, roads, railway, and agricultural land prevents people from reaching the green spaces.*" (p. 15). For a green space and park to be used on a regular basis they should be accessible for all kind of citizens. "*Walking distance should be less than 300 meters without solid barriers.*" (p. 16). The program states that possible solutions to overcome the barrier that the trafficked road Malmöleden constitutes must be studied further (Helsingborg Stad a, 2014:56).

> "*Approximately three out of ten citizens have good access to parks and nature. The meaning of this is that they have access to a park at least 1 hectare and a larger nature area within the recommended walking distances of 300 respectively 1000 meters.*" (p. 54)

"*Many areas in the city, in particular the southwest parts, are lacking parks as well as larger nature areas within the recommended distances*" (p. 54). The distances used for these measurements can be found in table 2. "*[…] currently the area of H+ has a longer distance than 3 kilometers to a recreational area.*" (p. 50). The present accessibility can be seen in figure 6. The accessility to different parks are displayed, showing a lack of parks in the southwest parts of the city. The H+ project is within this area with low accessibility.

Area Type	Size	Walking Distance
Close Park	≥ 1 hectare (ha)	≤ 300 meters
Area Park	≥ 5 ha	≤ 500 meters
Large Nature Area	≥ 15 ha	≤ 1 km
Recreational Area	≥ 200 ha	≤ 3 km

Table 2 *Recommended walking distance for different types of parks.*
Source: Helsingborg Stad (2014)

Additionally, the noise levels are causing problems, such as disturbance and overall decrease in public health, in the urban environment. "*In many areas the noise level is above the recommended level.*" (p. 64). "*[…] In particular the city's south parts are the green spaces disturbed by high noise levels.*" (p. 40). The levels that is required for providing a pleasant experience to the larger majority should be a maximum of 50 dB in parks (Helsingborg Stad a, 2014:64).

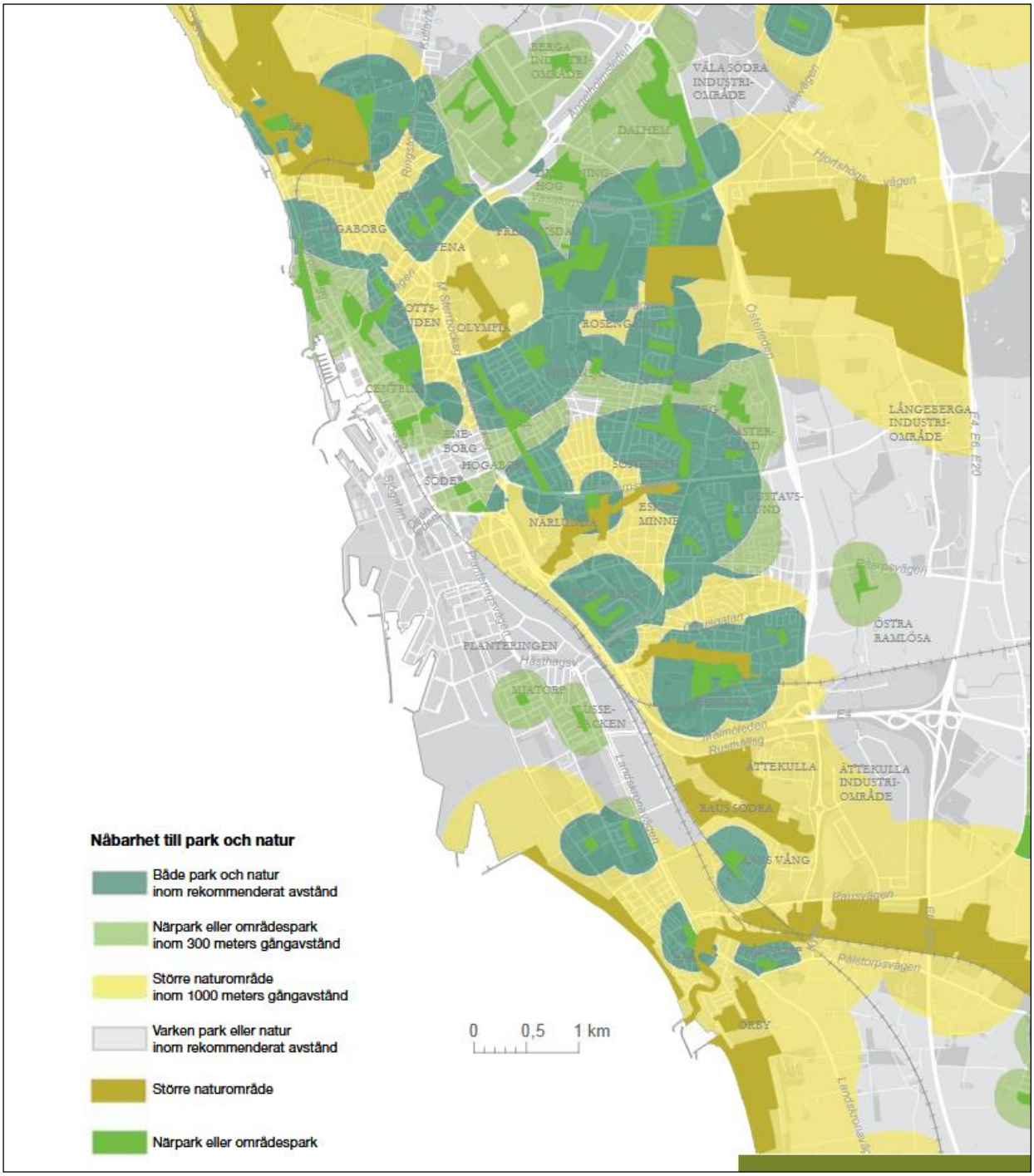

Figure 6 *Accessibility to different sized parks and recreational areas within Helsingborg urban area.*
Map layout & data: Helsingborg Stad (2014), p. 55.

The examples of accessibility and noise disturbances are two examples of factors that the program brings forth that has implications on municipal development in Helsingborg. The assessments of accessibility to parks, that can be seen in table 2 and in figure 6, shows how the matter of accessibility is being approached from different angles to enhance the program´s objectives; green spaces are necessary and important in the urban environment.

Further, the program makes some clarifications regarding the structure types within the city stating the characteristics of each area. H+ is classified as being an industrial/business area with a structure characterized by rigid surfaces. Parking spaces, industrial buildings, and larger business localities are some examples of structures to be found here. The prerequisites for water drainage, air cleansing, and biodiversity are low in these places. Therefore, these areas are in need of renewal, due to low level of adaptive abilities that the hard, industrial surfaces possess (Helsingborg Stad a, 2014:33)

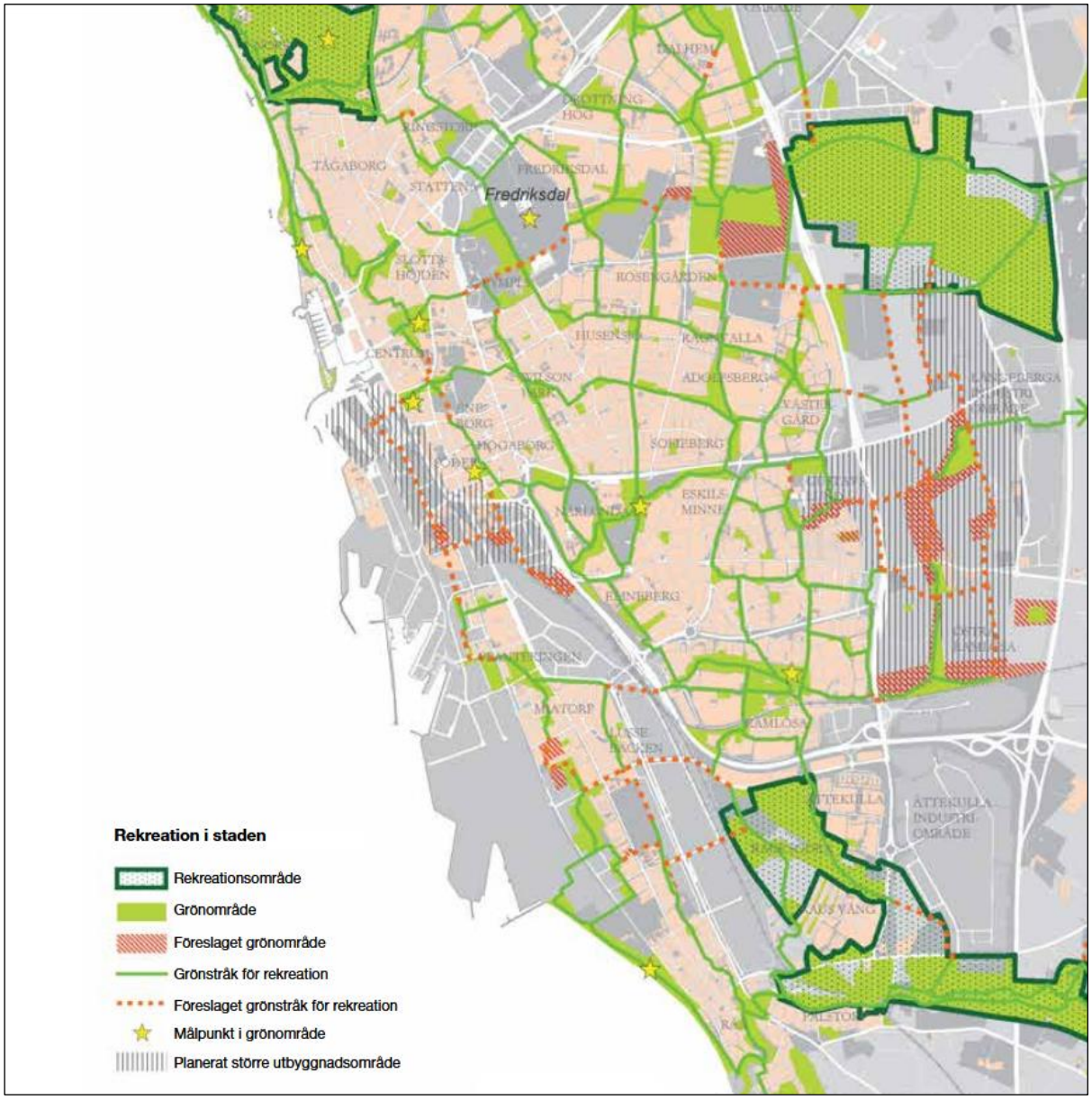

Figure 7 *Display of existing green space and proposals of new green space creation in Helsingborg urban area.*
Map layout & data: Helsingborg Stad (2014), p. 43.

"*It can be difficult creating new green spaces in the build environment. In connection to city renewal projects, the possibility to construct a park and incorporate nature, where it is needed, should be tested […]*" (p. 17)

The current state of the H+ area consequently has effects on the future development requirements to transform the space into a livable and welcoming area for residents and visitors. Forgetting the context in which the H+ project is situated in, an area characterized by various industries and harbor, can have unpredictable consequences. But so, could any type of development decision have since people does not always react in a predicable manner. People's perception of the area might not change even though the area is transformed. The surroundings, especially the harbor to the west, does put an imprint on the H+ area by it being characterized by heavy traffic and industrial activities. This relational problematic, objects meaning in relation to the surrounding objects according to human perception, is a tedious matter to tackle for urban planners. Especially when trying to include this in a decision-making process since perception and potential problematics are hard to incorporate in GIS for instance. Complementary data, in the form of participatory investigations or citizens dialogues, might be necessary to better incorporate the more relational aspect of the H+ area.

Finally, being one of the largest city renewal projects for Helsingborg municipality in modern time comes with both difficulties and opportunities. Green space evaluations and accessibility investigations in the city show that "*[n]ew parks and recreational possibilities needs to be created in the southwest parts of the city.*" (p. 41). The map in figure 7 gives a visual image of existing green space along with proposals for new ones within the city. Tree proposal are within the H+ area. All are in the south part of the H+ area. One is placed in the central parts of the area Husarområdet, one at the border between Husarområdet and Gåsebäck, and the last one in the south part of Gåsebäck. However, any clear reason for these specific placement does not come forth, but it can be used for comparison to the multi criteria evaluation.

4.1.2 FÖP H+ (2011)

> "*This detailed comprehensive plan of the H+ area suggests an overall building structure for the long-term development in the southern part of Helsingborg. […] The vision for the H+ area is about being a tolerant city which also infuses the proposal for the entire plan area. It will be a dynamic place where the future citizens of the Öresund region will want to work, live, study and spend their time off. […] The starting point of the proposal is to develop the central part of Helsingborg into a dense and attractive inner city with integrated city districts. […] This proposal means that the city of Helsingborg will start a transformation process in former industrial areas in order to develop a diverse city with a mixture of residences, businesses and offices among other things."* (p. 7)[7]

The deepened comprehensive plan covers a large field of different aspects regarding urban development, and presents nine themes which has been brought forth to act as knowledge and planning support for the renewal project. Besides the theme on greening

[7] The citation, and all following, have been translated by the author.

and recreation, there are also themes covering traffic and its implications, cultural heritage, and public services to mention a few (Helsingborg Stad, 2011:7). Breaking down a large field into a number of fields can be useful for a better overview, since details easier can be included when having a clearer focus.

The deepened comprehensive plan "*forms a framework for continual work with the development of H+ area*." (p. 12). This means that FÖP H+ is the guiding material for the area´s development. "*A precondition for the entire H+ project is that Södertunneln will be built, meaning the railway from Knutpunkten and south stretching through Gåsebäck will be put in a tunnel.*" (p. 9). Today the area mostly consists of different kinds of industries, many connected to the proximate harbor, and large-scale infrastructure. Therefore,

> "*H+ greatest challenge is to combine the city both physically and mentally. By building away the existing barriers that complicates people mobility between north and south, east and west, and between the H+ area and the surrounding city districts the city´s physical structure can heal.*" (p. 10).

The plan, indirectly, addresses the relational problem of perception and surroundings. The physical barriers make up the surrounding objects that directly affects the H+ area. While the mental part can be viewed as the problematics of perception. If people still feel like barriers are making the H+ area inaccessible, then the physical structures, even if changed and removed, does not reach the intended goal.

The development of H+ project is facing the difficulties and controversies of wanting to densify the urban environment, and at the same time generate high accessibility to recreational space. A strategy that both tries to be resource and space efficient. "*The demand of quality in the public spaces, light conditions, and the residential housings access to greenery increases with density.*" (p. 10). The preconditions of the area today state that "*[t]he northern parts of H+ area […] have no green spaces at present.*" (p. 94). This reasoning within the plan relates to that of the green structure program. Understanding the prerequisites of an area is necessary for making suitable development choices. Because, if well-founded decisions had been made in the first place, choices will not have to be altered within a short time period, resulting in more development costs that could have been avoided. Therefore, combining information from many sources and having clearly stated development goals within the municipality the possibility of making good planning decisions should increase.

The close presence of the harbor has, besides the more structural effects, also indirect effects on the project area that will affect development plans. The businesses environment in the harbor results in noise disturbance created from the heavy traffic flow (Helsingborg Stad, 2011:139). The land use can be traced back to the detailed development plans covering the area. Half of the detailed development plans covering the H+ area was created before the establishment of the 1987 plan and building convention. Overall the plans are dominated by the land use description industry. Even though some spaces have been assigned for general land use, the actual usage of those spaces has been characterized

by industries of different kinds (Helsingborg Stad, 2011:21). Possibilities of incorporating green space in these places have consequently not been further assessed. Instead the current plans have been following the same developmental trajectory that the surrounding area has uphold.

> "*Proposed land use within the H+ area, with the development of a mixed city, indicates that a majority of the city plans and detailed development plans will have to be altered in order to be able to carry through the planning proposal.*" (p. 21).

Overviewing the current detailed development plans could be helpful in establishing if there are any existing plans that supports the development of public green space, but is being currently used for something else. Or simply to see if there are any direct places that would be suitable for green space development. This kind of assessment could then potentially be combined with GIS to make spatial evaluations for further assessments, as later step in the process of forming developmental plans.

"*City renewal such as the H+ project comprises a long process of transforming and developing the different sub-areas in southern Helsingborg.*" (p. 32). The stages of development have been divided into three major phases. The first, starting at 2010 and continuing until 2020, contains the creation of the railway tunnel Södertunneln. Space, currently occupied by the railway will then be exposed and give way for restructuring and densification. Densification development of the area Universitetsområdet will most likely be a part of this first phase. The second phase, stretching over the years between 2020-2030, will transform and renew the area Husarområdet. A restructuring of the major traffic flow to the harbor will revised, creating Hamnleden. Making Malmöleden less affected by heavy traffic, consequently making it less of a mobility barrier. The third phase, between the years 2030-2035, includes some more extensive establishment of housing combined with non-disturbing businesses, offices, and services within the area Gåsebäck. (Helsingborg Stad, 2011:32).

> "*To make the H+ area attractive, already in an early stage, establishing greenery should be prioritized in the development phases of the area. By starting planting trees, plants, and at the same time creating activities such as sports and play areas along the blue-green passage, the H+ area can be activated before the buildings are in place. Focus will be put on the places where existing structures and/or temporary greenery and activity spaces can be made permanent.*" (p. 36)

The blue-green passage, stretching inlands from Jordbodalen to the coast of Öresund, is intended to incorporate green space within the H+ sub-areas, since they are insufficient at the current state. Some smaller parks will be developed in connection to the passage, assuring residents in the area accessibility to green spaces. "*Distance to a green space should never be further than 200 meters.*" (p. 96). "*The blue-green passage shall offer recreative spaces of varying character and size, stretching from being more but smaller in the north to being bigger but less in the south*" (p. 98).

In the northern area, Universitetsområdet, the blue-green passage will be established at an early stage in order to raise the status and attraction for further development. "*The area today is characterized by large scale traffic and low accessibility.*" (p. 52). Connections and enter points to the area are few due to the heavy barrier Malmöleden. There are no green spaces at presence but the plan states that:

> "*Smaller parks of different character need to be founded with connection to the canal passage, in order to support the city-district with green qualities, and to create meeting points for the university and business sector. The green space factor will be implemented in the area to give a green stamp on the neighborhoods.*" (p. 52)

The second area, Husarområdet, will have culture environment as the driving factor for development. The area holds buildings with historical importance that requires preservation. The characteristic barrack yard in the area will be restored to its original form and be further "*[…] developed to a city park with a water passage supporting the neighboring city districts with larger green space and open space for spontaneous and organized sports.*" (p. 57).

Similar to Universitetsområdet the street structure in Husarområdet is adapted to large scale traffic and there is "*an overall shortage of green space besides the open space at Husarregementet that is in current use by the school Rönnowska.*" (p. 58). The goal is to initiate the development plans for the area within the second phase (2020-2030) of developmental process of the H+ project. However,

> "*[b]efore any stage concerning residential building can be performed there is a need to re-examine the permissions of the environmental hazardous businesses located south of Husarområdet, to add potential impact areas limitations or see if businesses have been dissolved.*" (p. 59)

The third and final area, Gåsebäck, is "*split in two by parts of the railway and a road bridge.*" (p. 62). Despite being centrally located in the city the area becomes isolated from the surrounding city. As with the other focus areas Gåsebäck does neither have any public green space access at present. "*A larger park is suggested to be placed centrally within the area […] to offer a place for different activities etc.*" (p. 64). But,

> "*[a] larger transformation and densification of Gåsebäck is first planned for within 15-20 years, and the pace for this transformation from a commerce area into a mixed residential area will be governed by the real estate owners interest of change.*" (p. 64)

4.2 Multi Criteria Evaluation – Results

In this section the result of the applied MCE will be presented along with maps showing the results of potentially suitable locations for new green space development. After the

result is presented an evaluation of the different criterions will be given. Finally, some general discussion on MCE as decision support is brought forth.

The MCE-analysis have been performed four times resulting in four different schemes of values on the scale from 0 to 1 representing location suitability, where values closer to 1 represents areas that better meet all the criterions. 1 indicates that the criterions are meet to 100 percent. The multiple analysis performances were due to two major reasons. First, the testing of the two classification variations – fuzzy and Boolean – of the criterion proximity to existing parks. Secondly, to the change of importance and weight of the criterions (see table 1).

The attained results from the multi criteria evaluation can be viewed in map compilations in figure 8 and 9. The maps display the locations with the highest suitability rate. In figure 8 the weights for the different criterions were equal at 20 percent. The map to the left uses the fuzzy categorization of the criterions; distance to already existing parks, Malmöleden,

Figure 8 *MCE results with equal weighing. Suitable locations for new green space development. Map layout: Nina Sandberg (2017)*
Map data: © County Administrative Board of Skåne, © Helsingborg municipality, © Land Survey Sweden, & © National Road Database (2017)

railway, and potentially hazardous properties. These fuzzy classified criterions were combined with the binary classification of noise levels in the city. Having the same importance of 20 percent each, the result gave suitable locations ranging up to

approximately 57 percent. This means that the criterions requirements for new green space location was reached to a 57 percent level. The largest area is found within the borders of Husarområdet. Some small areas in the area of Gåsebäck can also be noticed, as well a small area in Universitetsområdet proximate to the already existing park Furutorpsplatsen. This location might not be as suitable since it is neighboring an existing park. The municipal aim to increase accessibility to public green space will not be achieved since the catchment area would remain similar to the current one.

The map to the right uses the binary (Boolean) classification for distance to the parks Stadsparken and Furutorpsplatsen. The result shows an increase in the number of locations in comparison to the first MCE (map to the left in figure 8). There is also a higher level of suitability on the locations. The pink color represents locations with a suitability range between 55-63 percent. But there are some locations that has a higher suitability rate stretching up to 71 percent. These are the ones represented by the blue color. The south parts of Husarområdet still has large area of suitable locations for public green space placement according to the second multi criteria evaluation. For Gåsebäck a different result can be seen compared to the previous MCE. A large area of suitable locations can be found in the northern parts of the area. A couple of suitable locations, with a suitability rate up to 63 percent, are found in the northern parts of Universitetsområdet.

The results from the MCE, when using a mixed weighing, is displayed in figure 9. The map to the left has the fuzzy classified input data on distance to parks. Location suitability stretches from 56-70 percent. Similar to the left map in figure 8, the left map in figure 9 shows that suitable locations are located mostly in the south part of Husarområdet. The MCE displayed in the right map in figure 9, has the Boolean classified distance to existing parks-criterion as input, and generates locations with the highest suitability range compared to the other results. Majority of the locations in the areas of Gåsebäck and Universitetsområdet has a suitability rate between 66-75 percent. In Husarområdet the rate is even higher stretching between 75-83 percent of location suitability.

The four different multi criteria evaluations gives a good example on how GIS, in this case, can be used for spatial analysis. However, the challenges with modelling reality, so that it becomes manageable for GIS, is also visible. The four different results are all based on the same raw data. But data processing and preparation, as can be seen in this case, has effects on the result. Possible variations in data preperation consequently shows the importance of transparecy in data management. The outcome of the MCE in this investigation shows variations of locational options as a consequence of changes in data preparation.

Nevertheless, the criterions that has been used all relate to important urban development challenges, such as barriers, high noise levels, and trying to increase accessibility to certain services (e.g. parks). But there are other possible factors that could have been used in various ways, like population distribution or biodiversity of certain areas. But for this investigations specific purpose those criterions would most likely not add significance to

Figure 9 *MCE results with mixed weighing. Suitable locations for new green space development.*
Map layout: Nina Sandberg (2017)
Map data: © County Administrative Board of Skåne, © Helsingborg municipality, © Land Survey Sweden, & © National Road Database (2017)

the result. Especially when it comes to population since the H+ area currently is not densly populated.

Since there were five criterions in use for the analysis, and due to the lack of clearly outspoken ranking between the different factors, the equal weight seemed a rational choice. But to show the potential impact weight can have on the final result another mixed weighing was necessary. The chosen weights for the second analysis could have been done differently. It all depends on how and if variables are considered more important than the others. In this case, since Helsingborg wants to increase accessibility, already existing parks and the barrier that Malmöleden creates where considered more significant than the railway and polluted properties. Disturbing noise levels was also considered more important due to its direct affect on peoples health situation. This was the reasoning behind the mixed weighing, but it could as mentioned been done differently.

This does not necessarily mean that the method is unsuitable to support decision making. As stated above, the results show a variation of locational options. These options can then be further evaluated in combination with other complementary data, such as investigations or plans for instance. The result follows somewhat the proposals that was

laid forward by Helsingborg municipality in figure 7. The south part of Husarområdet is also proposed by the municipal along with the area in the central parts of the area Gåsebäck. However, there is also a proposed area for new green space, made by the municipality which is located in the south parts of Gåsebäck (see figure 7). This area does not come forth as a suitable location according to the applied MCE, no matter the combination of classifications of variables and weight.

MCE could consequently be a helping piece for urban development in the planning process. If a given area, for example the H+ project area, is to have a park developed, an MCE could be useful for narrowing down the potentially suitable locations. Or it could hint what locations that, according to chosen criteria (distance to roads or specific properties for instance), would be more suitable.

5. DISCUSSION

The directives for public green space in the areas of Universitetsområdet, Husarområdet & Gåsebäck has been examined, and in addition, the usefulness of a MCE for developmental decisions has been explored. For a broader view, a MCE was applied to find suitable locations for green space development within the three focus areas. Followingly, the results from the investigation will be discussed in the same order as the posed questions. Starting with discussing the green structure program and the deepened comprehensive plan FÖP H+, then discussing the usefulness of GIS, and in particular MCE, and summarizing it all with the conclusions that has been derived from the applied MCE.

What could be considered the most noticeable from the deepened comprehensive plan FÖP H+ and the green structure program is the awareness of the increased need for greenery and recreational space within a growing and densified urban environment. From both guiding documents this need is proclaimed clearly and extensively. However, by being more informative in character for planning, more precisely detailed development planning, these documents do perhaps not give clear way for green space development in the H+ project area. Detailed development plans will be designed in a later planning stage, and even though these have not been available for this investigation there are still some interesting aspects, derived from the documents, that can be brought forth.

First, the extent in which green will be present in the urban environment stretches beyond the more old-fashioned and obvious ways of incorporating greenery with parks for example. This, partly being a direct consequence of the struggle with resource efficiency and limited space in the city, and partly to the desire of being innovative and creating a more vibrant city with various characteristic traits. For instance, creating green meeting spaces for all citizens, and at the same time offer an attractive business environment in the central parts of the city. A lot of focus is put on green structures around the H+ area.

The main idea for increasing green space is to develop the green structure around the blue-green passage, stretching from Jordbodalen to the coast of Öresund. This passage is intended to pass through the H+ area. These green structures are to be viewed as a mean to include urban greenery and assuring citizens publicly available green spaces. The positive effects from including greenery in the urban environment in this way can perhaps be enough for not reserving land for the creation of parks no matter the size. Being centrally located in a somewhat already dense area, large parks would realistically not be suitable or even thinkable since there are many other objects in need of developing in the city, such as housing and other public services to mention a few.

Therefore, the current lack of green space within the H+ area and the difficulties balancing urbanization, densification, and distribution of land use for different development projects become tedious. Especially since the developmental strategy for Helsingborg municipal, if one looks at the green structure program and FÖP H+, focuses on densification. The complex reality indicates a need for breaking existing barriers and followingly opening up mobility from the H+ area to the rest of the city, making it easier to use surrounding green spaces.

Majority of the development plans that can be found in FÖP H+ depends on the re-drawing of the railway crossing through the area and trying to decrease the impact of traffic, both noise levels and as barriers, to make the area more inviting for pedestrians and increasing their mobility. If the railway is placed underground this also changes the possible solutions for a new green space/park in the area. Disturbing noise levels, caused by the railway, will decrease making it a less significant criterion to include for spatial analysis.

Secondly, there are some differences in the green structure program and in FÖP H+. Most relevant for this investigation would be the variation when it comes to optimal walking distances for pedestrians. The green structure program states that a maximum of 300 meters should be the goal for green space creation, while FÖP H+ instead has the more constrained distance of 200 meters. This shows once again that the two documents have a guiding character for the municipal operation as a whole, and does not have the binding effects that for example detailed development plans has. However, having guiding documents stating different requirements, for example optimal walking distance to a park, makes the decision process more diffuse as opposed to having clear and consistent strategies for urban greenery.

Thirdly, H+ project close proximity to the harbor, and the activities currently taking place, will have implications on the planning of the sub-areas and on the H+ project as a whole. Not only does it origin from a safety perspective, creating a safe urban environment, but also a more relational perspective based on the perception of the area overall. Existing activities and physical structures will create its own limitations for what possibilities that arise and what ideas that will be further assessed. Having a strong historical industrial connection does imply some restrictions in what possible development that can/should be placed there. There is the question of preserving the areas characteristics as well introducing new elements in the planning process. Balancing the two can be challenging

since the municipal aim is to transform the area into an attractive and vibrant part of the city. Keeping characteristic traits, such as specific buildings with historical and cultural values attached to it, can affect the overall look of an area. If the area does not develop in an inviting style for citizens, the result will not be successful, and the aim will not be achieved.

Furthermore, to broaden the view on development from the two documents a relational approach has been incorporated. Having a relational approach to urban planning somewhat becomes a counter reaction to the more linear, positivistic, and straightforward decisions processes that GIS and multi criteria evaluation represents. The physical aspect of a city can quite simply be visualized with GIS tools. However, the result of the MCE will solely be the result of the input factors used and nothing else. There is consequently a lack of connection between the physical dimension of the city with the streets, parks, buildings etcetera, and the more liquid dimension relating to the human perception of space and place (Amin, 2011; Graham & Healey, 1999).

The MCE results in different placement possibilities depending on the variables being used, therefore it is important to include the relational aspect of these places. Meaning that a location suggestion in the area Gåsebäck does not have to be equal to a suggested location in Husarområdet even though both were derived from the same input variables in the MCE. The surroundings of the suggested location, for example if it is surrounded by residential housing or only industries, will affect the planning decision whether a place is suitable for a public green space or not. These changing dynamics of space and place over time then becomes an essential aspect needed in planning decisions in order to create a vigorous and sustainable city (Amin, 2011). Striving for long-term lasting decisions is what is considered sustainable in this case. But, including a relational view, on the H+ area for instance, is not easy since perception vary and no straight forward strategies for incorporating a relational assessment in spatial analysis exist.

Nevertheless, combining the information from the document review with the more straightforward and result oriented MCE analysis has resulted in direct placement suggestions of where to locate a public green space within the H+ focus area Universitetsområdet, Husarområdet, and Gåsebäck. As mentioned previously "*GIS ends up somewhere between the detailed development plans and the political decisions*" (Harrie & Eklundh, 2013:22, author´s own translation). By incorporating guiding directives for publicly accessible urban green space development, from the green structure program and FÖP H+, the result of the MCE has become more incorporative in nature. If only one method had been used the result would most likely be narrower in its applicability to reality. But, since the investigation is case specific, the results are not generalizable and applicable for other cases besides this one. However, it can still be enlightening.

To draw any direct conclusions from the applied MCE would perhaps not be possible, since the evaluation is restricted to the input criterions. However, the results do give some implications on a suitable area that repeatedly came up at the top of the result score of suitability. The score of the area in question, the south parts of Husarområdet, has a range

from 50 percent up to 83 percent of suitability. The score variation depends on the weighing and what type of classification that has been used for the criterions (see figure 8 and 9). The municipality´s proposals for new green space within H+ area (see figure 7) also somewhat follows the MCE results (see figure 8 and 9). The south parts of Husarområdet is marked as being a potential development location for green space. Due to the proposed area´s location in the outskirts of the H+ area, a more central location would perhaps be better suiting since the total catchment area would increase. However, placing a park in the south parts of Husarområdet could be a good idea for decreasing impact from the neighboring harbor located west of the area.

Finally, modelling a complex reality is difficult. As discussed in section 2 the analysis will only be as good as the input data that is being used. Deciding what criteria to use and which ones not to use will have effects on the final results. If other additional criterions were to be included, for example preservation of historical buildings or socio-economic distribution of the population, the final result could become different. These are the difficulties in trying to model and create a method process when there are few if any substantial criterions to follow. This relates to what was previously discussed about guiding documents and strategies states different goals. This problematic can only be overcome if decision-making adapts an integrative approach. Cooperation and informative exchange between municipal agencies is crucial for well based assessments to base decisions on.

6. CONCLUSION

This section will conclude the derived results, and to try to answer the given questions in the beginning of this investigation. Starting with the municipal directives for public green space, the intention is to increase publicly accessible green space. Both documents that has been reviewed states that there is a need for incorporating green spaces in the urban environment and in the three focus areas of Universitetsområdet, Husraområdet, and Gåsebäck.

The municipal goal is to give citizens a walking distance of a maximum 200 meters to a green space according to the deepened comprehensive plan. The green structure program states a distance of 300 meters instead. This could be explained by the nature of the documents. The green structure program is meant to be a developmental guide for green space within the entire municipality while the deepened comprehensive plan has adapted requirements after the prerequisites for the specific area of H+. Furthermore, the municipality has three proposed locations for new green space development within the H+ project area. The locations are in two of the three focus areas; Husarområdet and Gåsebäck (see figure 7).

The question on the possible support a multi criteria evaluation can have for urban developmental decision follows next. A MCE makes spatial analysis of many different

factors possible to do simultaneously by overlay operations. Some possible shortages, that needs to be addressed with GIS methods, comes with the heavy reliance on data that potentially can be deficient. And often generalizations must be made in order to model a complex reality. However, one can also argue that a complex reality is an argument for the usage of MCE and a planning decision support approach. More structured aggregation of input factors in the decisions process can be clarifying and give better overview. Thus, the geographic analysis adds another dimension to the decision-making process.

Finally, the results from the applied MCE shows a reoccurring tendency of suitable green space placement in the south parts of the area Husarområdet. This can be seen in all four test runs of the MCE (see figure 8 and 9). The result does, to some extent, display the same location as suitable for new green space development as Helsingborg municipality´s proposal in the green structure program (see figure 7). The MCE result can be used as informative material in the decision-making process and for further placement assessments.

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