Climate in Mind – Climate-adapted neighborhood design.

A case study from Nyhamnen in Malmö, Sweden

Anna-Lena Sauer

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Abstract

Cities affected by the impacts of climate change have to find new ways to adapt to the variability in weather patterns, such as heavy rainfalls and storms. The coastal city Malmö, a former industrial city, aims to be carbon neutral by 2020 and provided by 100 percent renewable energies in 2030. However, Malmö is facing many environmental and socio-economic challenges. One of these challenges is to answer the following question: How can a newly planned neighborhood be spatially designed so that it balances social, environmental, and economic needs of sustainable urban planning and thrives for a climate-adapted design through urban green spaces?

This thesis presents an analysis, through the lens of the SymbioCity approach, of the new urban development project Nyhamnen in Malmö. On the basis of this conceptual framework, Nyhamnen and its potential of becoming a climate-adapted neighborhood is analyzed.

To achieve sustainable urban development, an approach integrating spatial planning, water resources management, energy, landscape planning, climate change adaptation and mitigation is necessary. A case study research design and a mixed method approach are applied through 17 semi-structured interviews with urban planning professionals, field visits as well as quantitative data analysis.

This thesis concludes that mitigation and adaption measures should be linked through a mix of different urban green spaces and multifunctional space use. This thesis recommends to ensure a social mix and to welcome all inhabitants in Nyhamnen to decrease social tensions. In order to achieve economic sustainability of urban green spaces, citizens should be incorporated into the planning, design, implementation, and maintenance of urban green spaces. It is recommended that Nyhamnen adopts its streets system for a car-free future and narrows the widths of the streets. Another important area is the shadow effects of buildings, and adjusting housing typology for wind and precipitation events. The historical foundation of Nyhamnen as a leading ship-yard industry needs to be taken into account.

It is recommended to enhance the scope of the SymbioCity Approach through the inclusion of microclimatic parameters. This thesis advances the discussion about integrating urban climatology and urban design through a system perspective. Sectoral approaches in urban planning are not successful, and a transdisciplinary approach is needed which looks at the water, energy, soil, and climate nexus.

Keywords: Nyhamnen, Malmö, SymbioCity Approach, sustainability, urban green spaces, multifunctional space

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This thesis is dedicated to my brother.

For all the displaced and deported people who had to experience war and start all over again, especially my grandparents.

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Preface

“In a garden you realize that you have a purpose.” (Ron Finley, 2016)

The formulation of this topic has evolved throughout time: During my bachelor studies, I have been working at the Research Institute for Regional and Urban Development (ILS) on the EU Interreg IVB project VALUE (Valuing Attractive Landscapes in the Urban Economy). I wrote my bachelor thesis on the topic of *Enhancing Pluvial Flood Risk Management through Green Measures – How can Urban Planners Contribute to a Comprehensive and Effective Pluvial Flood Risk Reduction.* My hometown, Oldenburg, was hit by pluvial flooding and a strong storm event in the summer of 2015. The city of Malmö was hit by pluvial flooding in summer 2014, when I started my master program and I experienced the forces of storm *Urd* in December 2016. During my LUMES studies, I wrote three papers on the topic of urban flood risk management and urban green spaces. I got inspired by the international conference in Lund in 2015, organized by the school of architecture at Lund University, on “*Making climate performative places – urban design that makes a difference*” and the statement in one of their magazines that “the future is the places we create”.

Lund, 16th of January 2017.

Anna-Lena Sauer, Engineer (B.Sc. Spatial Planning)

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List of Abbreviations and Acronyms

BEST	Boverket och EkoSystemTjänsterna (Ecosystem Services in Planning)
Bo01	European Housing Expo in 2001 (City of Tomorrow)
BREEAM	Building Research Establishment Environmental Assessment Method
CCA	Climate Change Adaptation
CCAM	Climate Change Adaptation and Mitigation
CMP	Copenhagen Malmö Port
$C0_2$	Carbon Dioxide
ES	Ecosystem Services
EU	European Union
Et al.	Et alia
IPCC	The Intergovernmental Panel on Climate Change
km	Kilometers
m^2	Square Meters
mm	Millimeter
MKB	MKB Fastighets AB (Housing company owned my Malmö City)
OECD	The Organization for Economic Cooperation and Development
PBL	Swedish Planning and Building Act
s	Second
SCA	SymbiCity Approach
SEK	Swedish Kronor
SMHI	The Swedish Meteorological and Hydrological Institute
SGU	The Geological Survey of Sweden
UGS	Urban Green Space
UHI	Urban Heat Islands
UN	United Nations
WH	Western Harbor, Malmö, Sweden

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1 Introduction

Climate change adaptation and mitigation (CCAM) measures in cities have received much attention in recent years due to negative environmental, social, and economic climate change impacts for citizens (Becker, 2014; Campbell, 1996). Cities are facing heat waves and strong rainfall events, but cities also contribute to climate change, e.g. through greenhouse gas emissions (EEA, 2012, p. 13).

However, there is a lack in urban planning literature about the combination and relationship of mitigation and adaptation measures for climate change impacts in cities (Davoudi, Crawford & Mehmood, 2009). Mostly, these measures are treated separately (Wamsler & Pauleit, 2016; Davoudi, Crawford & Mehmood, 2009). While in recent decades scientific research on climate change has been growing rapidly, less attention has been given to the role of spatial planning in it (Davoudi, Crawford & Mehmood, 2009).

In Sweden, municipalities have mainly focused on mitigation measures in the energy sector. Adaption measures are urgent, but most communities cannot take the necessary steps (Davoudi, Crawford & Mehmood, 2009). According to Davoudi (2009), municipal responsibilities for climate change are diffuse and municipalities are not obliged to do any particular action. There is a gap on how to integrate climate change into daily spatial planning practices.

One way to combine CCAM measures is seen in urban green spaces (UGSs), but the climatic benefits of UGS are barely incorporated into urban planning and there is a knowledge gap of climatic effects of different types of vegetation and how they behave under a changing climate (Mathey et al., 2010, p. 480; James et al., 2009, p. 72).

This thesis presents an analysis, through the lens of the SymbioCity approach (SCA), of the new urban development project Nyhamnen in the Swedish city Malmö. On the basis of this conceptual framework, Nyhamnen and its potential of becoming a climate-adapted neighborhood is analyzed.

1.1 Research problem and aim

Urban planners have to re-think how to shape cities (Davoudi, Crawford & Mehmood, 2009). This thesis focuses on UGSs for CCAM. More precisely, it looks at how ecosystem services (ES) and benefits of UGSs can be integrated into urban planning practices (Jansson, 2014, p. 139). Langemeyer (2015) points out that the value of UGS is often overlooked in urban policy and planning. Jim (2004, p. 312) promotes higher attention and resources support of UGS to strengthen policies and practices. Wamsler and Pauleit (2016) conclude that adaptation measures disconnect with climate mitigation policies. They call for more research on the role of climate policy integration to assure sustainable planning and transformation through research and practice. Urban climate is rarely a theme in urban design and policy, and Lenzholzer (2015, p. 111) calls for a design for multiple microclimate factors, such as albedo, sun, wind, and daylight.

Sustainable urban planning is here defined as outline by the SCA, including social, economic, and environmental dimension (Ranhagen & Groth, 2012). There is a lack of scientific articles on the practical application of the SCA in cities (see Table 1).

Table 1. Literature overview on the SCA (Author, 2017).

Mejía-Dugand, Santiago (2016). The Evolution of Sweden's Urban Sustainability Marketing Tool: A Comparative Study of Two Major International Events. In: Journal of Urban Technology., Vol. 23 Issue 2, p. 65-80.
Ramirez, J., I., Qi, K., Xiaobo, L. (2016). Sustainable stormwater management in Yinchuan New Town. In: Water Practice & Technology. Vol. 11, No. 2. p. 469 – 479.
Hult, A. (2015). The circulation of Swedish urban sustainability practices: to China and back. In: Environment and Planning A. Vol. 47, p. 537-553.

This thesis tries to address this research gap and advocates the combination of CCAM measures through UGSs into urban planning practices. The thesis looks at urban planners in Malmö, defined as people working for the municipality, deciding about the land-use through land-use plans (Condon et al., 2009, p. 2).

It is the aim of this thesis to increase the understanding in adapting neighborhoods to climate change impacts, mainly weather-related events such as precipitation and storms, through the help of UGS. The results hope to inform the discourse on sustainable urban planning. A more integrated, transdisciplinary, and sustainability science-oriented approach to UGS planning and urban microclimatology is needed. Research on this topic seeks to help urban planners communicate CCAM benefits of UGSs to the public (Byrne, Lo & Jianjun, 2015, p. 133). This thesis hopes to promote and strengthen public UGSs for CCAM. It identifies further research areas such as urban microclimate modelling and establishment of climatope maps.

1.2 Research questions

The following overall research question can be formulated: *How can a newly planned neighborhood be spatially designed so that it balances socio-cultural, environmental, and economic needs of sustainable urban planning and thrives for a climate-adapted urban design through UGSs in times of climate change?*

The following sub-research questions operationalize the above mentioned question:

Specific RQ1: How is the relationship between socio-cultural, environmental, economic, and spatial dimensions and urban systems synergies of sustainable urban development in Nyhamnen?

Specific RQ2: How do institutional factors, such as frameworks, settings, legislation, and urban planning practices, interplay with the design and implementation of UGSs?

Specific RQ3: What are potential guidelines for practical and integrated system solutions in terms of UGS design, ensuring social benefits and reducing municipal costs for UGSs?

1.3 Contribution to sustainability science and structure of the thesis

Sustainability Science is described as an emerging field of research looking at nature and society interactions through different disciplines and collaborations, avoiding a sectoral approach for sustainability problems (Clark & Dickson, 2006; Kates, 2011; Wiek et al., 2011). Through sustainability science, new synergies across social and natural science can be created, and it tries to bridge the gap between critical research and problem-solving approaches (Jerneck et al., 2011, p. 69; Lang et al., 2012, p. 40). This thesis uses a problem-solving approach (Clark & Dickson, 2006). It looks at a socio-ecological system, the interactions between the human induced system, the urban area of Nyhamnen and its institutional set-up through urban planning, and the ecological system of the climate and UGSs. To manage and plan new urban areas is a complex task and involves many stakeholders and different disciplines on various scales and levels (Haley, 2007). System-thinking enables holistic urban planning practices (Da Silva, Kernaghan, Luque, 2012). Therefore, this problem can be solved with the help of sustainability science (Clark & Dickson, 2006; Lang et al., 2012).

Most often, urban planning faces the problem of sectoral and fragmented approaches and silo-thinking in the field of water, energy, waste, and transport planning. Different departments and disciplines are not integrated and looked at from a holistic point of view. Collaborative and just decision-making between affected stakeholders and citizens not always come into force. This creates short-comings in terms of sustainable urban planning. Taking a sustainability science perspective in urban planning, moves away from this sectoral approach of looking, e.g. only at the water management in a city or only focusing on the physical built environment. The SCA tries to bring together different systems and subjects in urban planning, such as the governance system of a city, its resources flow as well as its interconnection with the rural area. It covers subjects of social justice, environmental well-being, and economic vitality. It looks at interlinkages and interdependencies between those systems and subjects and hopes to prevent environmental degradation and social exclusion. Through this, a holistic picture of the problems and potentials in the new urban planning

area can be created. This enables the opportunity to fulfill goal 11 of the sustainable development goals of making inclusive, safe, resilient, and sustainable cities. The SCA uses different methods from sustainability science. It is described as a multidisciplinary, interdisciplinary, and transdisciplinary sustainable urban planning tool (Ranhagen & Groth, 2012). It looks at urban systems, functions, and synergies between the systems. According to Lang et al. (2012), transdisciplinary, community-based and participatory approaches fulfil the criteria of sustainability science. Sustainability science tries to connect natural and social science in order to find creative solutions to complex challenges and to strengthen the dialog between science and society (Jerneck et al., 2011, p. 69). According to Sioen, Terada, and Yokohari (2016), sustainability science is the next step in urban planning and design.

The structure of this thesis is as follows: the first chapter entails the introduction; the second chapter contains important background information. The SCA is introduced in the third chapter. In the methodology chapter, the case study research design is explained. The results are presented according to the SCA in chapter 5. The results are being discussed in chapter 6 and chapter 7 entails the conclusion.

2 Background

This background chapter introduces the topic of climate change impacts in cities and their contribution to it. Next, ES and benefits of UGSs, their municipal planning in the Swedish context, and climate-adapted neighborhood design are explained. Finally, the case study area of Nyhamnen is introduced.

2.1 Climate change and cities – perceived impacts and cities´ contribution to it

More than 50 percent of the world´s population lives in cities, and this number is expected to rise to 70 percent by 2050 (UN, 2014). Cities are facing multiple challenges in regard to sustainability, including social, environmental, economic, and climate-related challenges (Becker, 2014; Campbell, 1996), and European cities are no exception (Carter, 2011, p. 193).

Due to the built environment cities are facing urban heat islands (UHI) as a result of their warmer temperatures in comparison to rural areas (Carter, 2011, p. 193). It is estimated that UHI will increase (Mathey, Rössler, Lehmann & Bräuer, 2010, p. 479). This has an impact on the quality of life and increases health problems (Mathey et al., 2010, p. 479; Lenzholzer, 2015, p. 13). Urban pluvial flood risk increases through the amount of impermeable surfaces which increases the velocity of urban stormwater (Carter, 2011, p. 193). Cities are using resources such as water, energy, and land for different purposes and through urban development the natural vegetation is substituted by new buildings and paved surfaces (Breuste, 2013, p. 17). As a result, these materials have different thermal and hydrological characteristics than the natural environment (Breuste, 2013, p. 17). The land is limited in cities and there is space competition over this scarce resource due to different needs such as housing, recreational, and commercial areas (Campbell, 1996). Cities contribute to climate change by releasing greenhouse gas emissions (IEA, 2008, p. 179). The energy use of a city is linked to its design and layout, e.g. of the transport infrastructure and energy use of buildings (Lenzholzer, 2015). The concentrated number of urban residents, infrastructure and its economic assets make cities vulnerable (EEA, 2012, p. 10). These characteristics of urban areas itself will increase climate change impacts (Carter, 2011, p. 193).

Despite - or perhaps because of - their role in contributing to climate change, cities play an important role for CCAM (Rosenzweig, 2011, p. 4). They are seen as places which can tackle climate change (Lenzholzer, 2015). Due to international agreements and European directives, European cities have to find local CCAM options (Wamsler, Lüderitz, Brink, 2014). The Intergovernmental Panel on Climate Change (IPCC) report (2014) emphasizes the urgency for effective CCAM measures due to the negative impacts of climate change in cities. IPCC defines climate change adaptation (CCA) as “an adjustment in natural or human systems in response to actual or expected climatic stimuli or their

effects, which moderates harm or exploits beneficial opportunities" (IPCC, 2001, p. 365). Mitigation is defined as "an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases" (IPCC, 2001, p. 379). At the UN Habitat III conference, the New Urban Agenda was adopted (UN, 2016). This agenda thrives for safe, inclusive, and resilient cities, as outlined in the Sustainable Development Goal 11. Among the main focus areas of this agenda are the design and local implementation in urban planning. In the EU Strategy on Adaptation to Climate Change (2013), the EU Commission aims at promoting urban adaptation strategies through UGS.

2.2 Ecosystem services and benefits of UGSs

In this thesis, UGSs are physical structures and include public parks, pocket parks, green roofs, green facades, street trees, urban forests, allotments and blue (water) spaces (Cameron et al., 2012, p. 129). After a review of central planning documents of the city of Malmö, this definition has been chosen.

There is a consensus that UGSs are important for cities (Heidt & Neef, 2008, p. 84; Littke, 2016, p. 1) and fulfill important functions: social, ecological, economic, cultural, aesthetical and psychological (Littke, 2015, p. 11307; Kabisch & Haase, 2014, p. 129). Figure 1 points out the most important ESs and benefits of UGSs for this thesis. According to Demuzere et al. (2014, p. 108), there is the need for integrated approaches, analyzing physical and social benefits of urban ecosystems and CCAM. They display ESs and different benefits of UGSs such as physical, psychological, and social (Demuzere et al., 2014, p. 108). ESs are the benefits people receive from ecosystems, including provisioning, regulating, cultural, and supporting services (MA, 2005, p. 39).

Physical benefits

Through photosynthesis, UGS removes CO_2 from the atmosphere during the day and through respiration CO_2 is released during the night (Demuzere et al., 2014, p. 108). Urban soils and biomass contribute to carbon uptake and storage (Demuzere et al., 2014, p. 109; Strohbach et al., 2012, p. 220). Gill et al. (2007, p. 129) confirm that UGSs reduce greenhouse gas emissions. Large-scale green roofs reduce energy consumption and CO_2 concentration in the atmosphere (Peng & Yim, 2015, p. 554).

In regard to CCA, UGSs can lead to temperature reduction of the air and surface through shading and evapotranspiration (Demuzere et al., 2014, p. 109). UGSs regulate and reduce urban temperature and therefore heat stress and UHI (Voskamp & Van de Ven, 2015, p. 161; Taylor and Hochuli, 2014, p. 751). This results in an improved thermal comfort and reduced energy use (Demuzere et al., 2014, p. 109). UGSs reduce flooding and drought problems through water flow regulation and runoff mitigation (Voskamp & Van de Ven, 2015, p. 161; Gill et al., 2007, p. 116).

UGS can absorb pollutants, such as particulate matter, and through this improve air quality (Demuzere et al., 2014, p. 110; Haq, 2011, p. 602). In regard to climate change mitigation benefits, vegetation can absorb black carbon which is a component of particulate matter and classified as a short-lived climate pollutant (Demuzere et al., 2014, p. 110).

Psychological and social benefits

Demuzere et al. (2014, p. 110) differentiate between health and restorative benefits, social and individual coping capacities, and education.

UGS contribute to wellbeing, health, and recreation (Haq, 2011, p. 603). Relaxation, comfort, and satisfaction are achieved through participation in physical, leisure, and social activities (Demuzere et al., 2014, p. 110). UGS invite walking and cycling and therefore improve health conditions and contribute to reducing carbon emissions (Demuzere et al., 2014, p. 110). Access to UGS is associated with higher physical activities levels. In case of weather extremes, negative health factors such as illness and impairment hamper measures for adaptation (Demuzere et al., 2014, p. 110).

Social and individual coping capacities are increased through UGS (Demuzere et al., 2014, p. 110). UGSs are proven to establish a greater sense of community and combat social exclusion and isolation (Demuzere et al., 2014, p. 110). UGS foster responsibility, ownership, and place attachment, through being active in a community garden, and increase “climate-positive behavior” as people are more likely to act carefully in a place they value (Demuzere et al., 2014, p. 110). UGSs play an important role for biodiversity and nature conservation (Haq, 2011, p. 602; Demuzere et al., 2014, p. 108; Byrne & Jinjin, 2009, p. 36).

Community resilience in times of environmental extremes can increase through UGS, promoting social interaction, satisfaction, and “community bonding” (Demuzere et al., 2014, p. 110). Socializing is especially important for vulnerable groups, such as the elderly, young children, and people with poor health (Demuzere et al., 2014, p. 110). Due to an increased interest in urban agriculture and community gardening, the provisioning services of UGS such as food production have received increased attention (Haaland & Konijnendijk, 2015, p. 4).

Reasons for not taking action for CCAM measures are seen in ignorance, uncertainty, denial, and habit (Swim et al., 2009, p. 45). The relationship between the urban environment and individual action are best understood through hands-on and practical learning experiences rather than factual knowledge (Demuzere et al., 2014, p. 110). Therefore, education and learning are important attributes of UGSs (Demuzere et al., 2014, p. 110).

UGS

↓ Provides

Climate Change Mitigation and Adaption

Ecosystem Services	Results in → Benefits	
	Physical	Psychological and Social
Carbon Storage & Sequestration Regulation of Climate Regulation of Water Flows Purification of Stormwater Purification of Air Spiritual & intellectual Interactions	Reduced CO_2 Thermal Comfort, Reduced Energy Use Reduced Problems with Flooding, Peak Flows, Drought Improved Water Quality Improved Air Quality	Health & Restorative Benefits Social & Individual Coping Capacities Education

Figure 1. Ecosystem services and benefits of UGSs for this thesis (Adapted from Demuzere et al., 2014, p.108).

2.3 Challenges in UGS planning in densified cities

The long-term provisioning of ES in dense cities depends on how UGS are designed, managed, and protected through urban spatial planning (Haq, 2011, p. 606). Well managed and developed UGSs have a positive impact on the social, economic, and ecological value of a city and its inhabitants (Varese, 2001, p. 3). UGSs planning relates to municipal urban planning procedures and policies which provide, design, and manage UGSs (Littke, 2016, p. 10).

Densification and urban sprawl are the prevailing urban planning schemes of the 21st century (Stahle, 2009, p. 2). No coherent definition of a compact or dense city exists (Neumann, 2005, p. 11). The main aim of a compact city is to decrease urban sprawl and urban expansion (Haaland & Konijnendijk, 2015, p. 6). Negative impacts of compact city development are traffic congestion, air pollution, housing affordability, decreased quality of life, UHIs, high energy demand in densely built-up areas and loss of open and recreational space (OECD, 2012).

According to Haaland and Konijnendijk (2015, p. 1), Jim (2004, p. 311), and Byrne and Sipe (2010), the implementation of the compact and dense city approach leads to the following challenges and problems for UGSs:

- UGS provision in areas undergoing densification,
- counteracting social inequalities,
- and institutional constraints related to urban planning.

Due to scarcity of space, public UGS compete with other land-uses such as residential or commercial areas (Breed, Cilliers, & Fisher, 2015, p. 349). Due to land-use changes, land is a finite and shrinking resources in Europe and these changes are evident through land consumption, rising urbanisation trend, urban sprawl, and the sealing of soil (Bringezu et al. 2014, p. 50). Schicklinski (2015, p. 1) and Campbell (1996, p. 296) elaborate that due to this trend the use of urban space is highly controversial and has to deal with diverging interests and yielding a high conflict potential. Dense city planning, in-fill development, and consolidation due to new housing development pose a threat on UGS (Beer, Delshammar, Schildwacht, 2003, p. 132; Pauleit & Breuste, 2013, p. 28).

The planning of UGS is connected to social and environmental justice and ecological gentrification issues (Littke, 2016, p. 23). New UGS can contribute to healthier and more attractive neighbourhoods and they can increase housing costs and property values (Wolch, Byrne, Newell, 2014, p. 235; Haq, 2011, p. 602). Wolch, Byrne and Newell (2015, p. 235) stress the paradoxical problem that this can lead to gentrification and displacement of the residents the UGS were designed to benefit.

Planning of UGS is influenced by political strategy and policy context (Gulsrud, 2015, p. 10). According to Buizer (2015, p. 8), a shift from government to governance can be witnessed in UGS planning. Traditionally, local authorities were responsible for UGS planning and management (Gill et al., 2007; James et al., 2009, p. 72). Today, local communities, enterprises, and other non-governmental stakeholders are involved. Different forms of how UGS are managed exist (Buizer, 2015). New innovative participatory governance arrangements for UGSs are emerging, such as new forms of small-scale urban gardening practices (Buizer, 2015, p. 5; Nikolaïdou et al., 2016, p. 5). Rymsa-Fitschen et al. (2014) highlight the need for participation in UGS planning in order to link top-down and bottom-up approaches for resilient communities (p. 664). The multiple functions of UGSs are barely incorporated into urban planning, design, and management (James et al., 2009, p. 66). Most often, municipal budget for UGS planning is under pressure (Zoest & Hopman, 2014, p. 107; Gulsrud, 2015, p. 14).

2.4 Climate-adapted neighborhood design

Climate-adapted neighbourhood design is defined as combining urban design on a neighbourhood level with urban climatology.

Urban design can be described as a discipline and field between urban planning and architecture (Frick, 2012). Since its establishment, its goal has been to design our environment in a sustainable,

functional, just, and aesthetical way (Reicher, 2010). Urban design is defined according to the definition by Reicher (2010), as the ability to develop a product and simultaneously creating a process for more urban quality (see Table 2). In relation to this, it analyzes spaces structures and its filling, its organization, and activation (Reicher, 2010).
According to Barnett (2003), there are five important features of urban design: fostering a sense of community, creating livable neighborhoods and workplace, reducing traffic congestion, encouraging social equity and achieving sustainability by preserving and restoring the natural environment.

Urban areas have a special urban climate defined by the topography of a city and its surrounding region (Heidt & Neef, 2008, p. 84; Lenzholzer, 2015, p. 13). The urban climate directly impacts people´s quality of life (Lenzholzer, 2015, p. 13). Important parameters are precipitation, cloud cover, wind speed, air temperature, and solar radiation (Heidt & Neef, 2008, p. 84). Urban density, shade of buildings, and quantity and type of urban vegetation are factors that affect the urban climate (Heidt & Neef, 2008, p. 84). Urban radiation and heat budget are responsible for temperature and wind (Parlow, 2013, p. 31). Every urban design intervention changes the microclimate, the climate for a small-scale urban area, of the built environment (Lenzholzer, 2015, p. 28).

Table 2. Urban design as a product and a process (Reicher, 2010).

Product		Process	
A	B	C	D
Space Structure	Space Filling	Space Organization	Space Activation
Buildings, Open Space (Private or Public), Streets	Use, Program	Land-use Planning, Formal and Informal Standards and Regulations, Connections	Branding Events, Participation, Images

In Copenhagen, Saint Kjeld's Quarter in Østerbro is the first climate-adapted neighbourhood against cloudbursts (Copenhagen, 2013). Climate change is used as a catalyst for urban renewal through innovative green infrastructure and drainage projects. Among the measures are green street corners, areas of wild vegetation, and front gardens (Copenhagen, 2013). In Malmö, the Bo01 tried to combine urban design with climate design, mainly focussing on climate change mitigation through reducing energy consumption (Holgerson, 2015).

2.5 Introduction to case study area Nyhamnen in Malmö, Sweden

The coastal city of Malmö (see Figure 2) is located in the Southern part of Sweden in the county of Skåne and is with its 317,930 inhabitants (Malmö Stad, 2015) the third largest city (Delshammar, 2015, p. 3). A new urban area (700,000 m^2), called Nyhamnen, is planned for 6.000 new apartments, 13.000 new jobs, and 100,000 m^2 of UGS. Nyhamnen, a former industrial area of the ship-yard industry, is located North of the central station and bounds with the coast (the Öresund) to the West, the Copenhagen Malmö Port (CMP) area in the North (see Figure 3). The estimated planning time is set to be 40 years (2015- 2055) and will be conducted in different planning stages. The urban planning objective for this site, as outlined by the municipality, is to ensure an attractive and sustainable city which balances social, economic, and environmental needs. The urban development process is described as being inclusive, innovative, and unique (Malmö Stad, 2015).

Figure 2. The city of Malmö 2015 (Author, 2017). The case study area of Nyhamnen is marked in red.

Figure 3. Overview of Nyhamnen (Author, 2017).

3 Conceptual Framework – The SymbioCity Approach

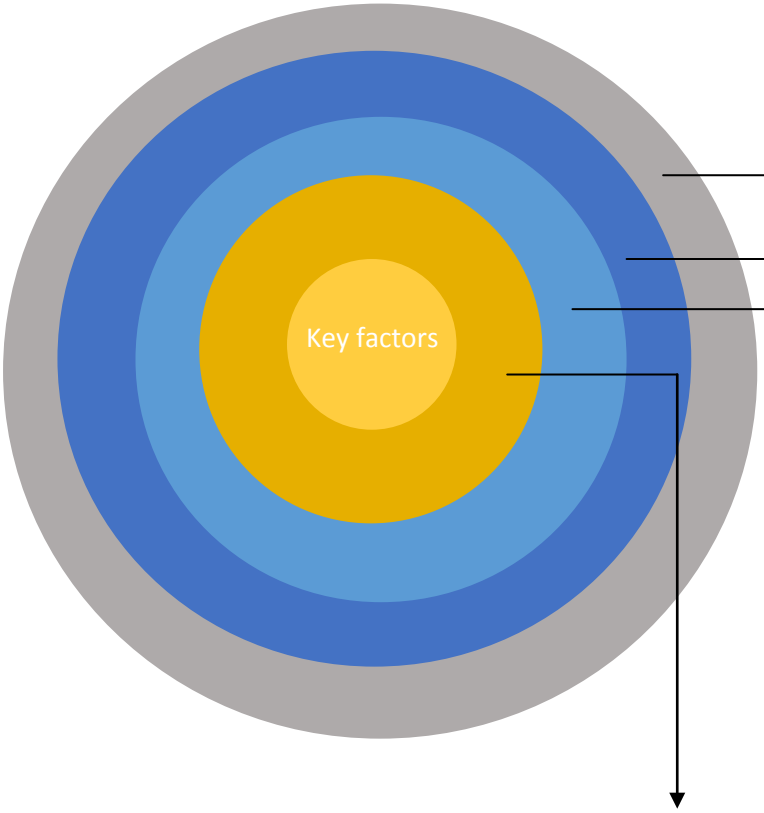
Green Cities, Ecocities, Smart City, low carbon cities, resilient cities, and sustainable urbanism - In recent years there has been an increase in new terms, methods, and tools for the so-called sustainable urban planning field. Evaluations, rankings, and branding of cities are in trend. Buizer (2015, p. 7) and Gill (2007) state that in times of urbanization the question, how to develop attractive, livable, sustainable, and healthy urban environments is increasing in focus.

3.1 Purpose and Scope

The SCA, initiated by the Swedish Government in 2008 and revised in 2010, uses an integrated, holistic, and multidisciplinary approach for sustainable urban development (Ranhagen & Groth, 2012). The aim of the approach is to build sustainable and resilient cities for all inhabitants, ensuring better quality of life, efficient resource use, synergies, and links between urban systems (Ranhagen & Groth, 2012). The approach is a generic and flexible concept which can be applied on different scales, such as regional or local context. It includes guidelines, methods, and tools, and advocates practical and integrated system solutions. Sustainable urban planning is described as a complex and dynamic field, including systems, services, and relationships. The focus lies on environmental, spatial, and system dimension of urban sustainability (Ranhagen & Groth, 2012). The SCA can be used for sustainability reviews at different levels and evaluating urban development strategies. It looks at urban and rural interlinkages as well as international and national contexts. The approach has been applied in Sweden, South Africa, India, China, and Macedonia (Ranhagen & Groth, 2012).

3.2 The SymbioCity Approach

The SCA is built on three interconnected core areas (see figure 4) – the Conceptual Model, Institutional Factors, and Urban Systems (Ranhagen & Groth, 2012). The Conceptual Model looks at the relationship between socio-cultural, environmental, economic, and spatial dimensions. Institutional factors encompass institutional frameworks and settings, legislation, and urban planning practices (see table 4). Urban systems fulfil different functions and services, such as water or energy supply (Ranhagen & Groth, 2012). The six steps in the circular process are organising the process, diagnosing the current situation, identifying key issues and setting objectives, developing proposals, assessing the impacts of proposals, and developing an implementation strategy (Ranhagen & Groth, 2012).



Key factors	The Conceptual Model			Urban Systems	Institutional Factors	Spatial Dimensions
	Environment	Economic	Socio-cultural			
Health	Climate Change	Innovation	Justice	Urban Functions & Structures	Urban Planning	Regional Connections
Comfort	Risk hazards	Urban Wealth	Social Inclusion	Buildings & Architecture	Urban Governance	Urban & Rural Linkages
Safety	Noise & Pollution	Consumption & Production	Culture & Tradition	Energy	Public Participation	Density
Life Quality	Contamination	Economic Growth	Human Development	Waste	Legislation and Policy	Size
	Harmful Substances		Tolerance	Water	Finance	Configuration
	Air Pollution		Demography	Landscape & Social Space	Training & Education	Topography
	Radiation			Traffic and Transport	Technology	
				ICT	Public-Private Participation	

Figure 4. SymbioCity Approach with core areas (After Ranhagen and Groth, 2012, p. 7). Description: The inner circle entails the key factors of the approach. The second circle describes urban sustainability with its environmental, socio-cultural and economic aspects. The third circle displays urban systems. Institutional and spatial factors are described in the last two circles. The table lists the different components of the SCA.

4 Methodology

The thesis involves a case study research design and a mixed methods approach (see Table 3). Expert interviews, analysis of important urban planning documents published by Malmö municipality, field visits for the case study area of Nyhamnen, as well as quantitative data analysis were used to find answers to the research questions. The collected data is analyzed through the lens of the sustainable urban planning tool, the SCA (see chapter 3).

Table 3. Research design (Author, 2017).

Case Study Research Design		
Data Collection	Qualitative Data	Quantitative Data
	17 expert interviews (2 questionnaires)	SMHI
	Urban planning documents published by Malmö municipality (2003-2016)	SGU
	Field visits and participation in conferences (Stadsbyggnadsdag 2015 and 2016)	Miljöbarometern
	Documents for Nyhamnen (Comprehensive Plan 2015, Pictures from 1914, *Strukturplan*, Miljökonsekvensbeskriving (2016), Maps).	
Data Analysis	SCA	

If the research question tries to explain present circumstances and asks for the "how" and "why", the case study method is appropriate as it produces detailed and context-based knowledge (Flyvbjerg, 2011, p. 303; Yin, 2014, p. 4). As the case study is about researching different aspects of complicated, real-time events, different kinds of qualitative and quantitative sources and methods are consulted (Holgersen, 2016; Yin, 2012, p. 10).

A single-case and descriptive case study design is chosen (Yin, 2014, p. 25). The case of this thesis can be formulated as *how to achieve climate-adapted neighborhood design.* The main units of analysis correspond to the three specific research questions. This thesis builds on several propositions such as climate change is happening, UGSs bring benefits for cities, and urban population growth in Malmö. There is no blueprint of the research design for case studies (Yin, 2014, p. 25). Criteria to increase research quality are construct validity (finding correct operational measures), external validity (in how far can this study be generalized), and reliability (operations of the study can be repeated with the same results) (Yin, 2014, p. 130).

Nyhamnen was selected from Malmö municipality, which is located in the Southern part of Sweden and has been mentioned as one of the leading cities for sustainable urban development worldwide since the building exhibition Bo01 (Delshammer, 2014, p. 164; Frederiksson, Lundström & Witzell,

2013, p. 223). Nyhamnen is considered to be the next large urban development project (Malmö Stad, 2016).

A total of 17 experts-interviews were conducted and analysed. 16 planning documents were analysed (see Appendix D) and 10 field visits were undertaken in the neighbourhood of Western Harbour (WH), Rosengård, Hyllie, and Nyhamnen (see Appendix C). Expert interviews are a useful research method for reconstructing social situations and processes of involved actors (Przyborski & Wohlrab-Sahr, 2008, p. 133; Gläser & Laudel, 2009, p. 13). For the semi-structured expert interviews, a set of questions (see Appendix A) were formulated which served as a guideline for the interview, but the questions were changed according to the expertise of the expert. Experts were chosen by means of the following criteria: profession (urban planning, UGS planning and CCAM), years of experience, and availability. They were asked by emails (36 persons) whether they were interested in participating in a personal interview. The interview questions were emailed to the interviewees in advance. Each expert interview lasted approximately 1 ½ hours. Due to ethical consideration, the names of the experts are replaced by the affiliated institution. These interviews increase the construct validity of the case study, but they could pose the risk of personal bias of the information given through the interview or how the questions were asked. This data bias is limited through literature analysis and analysis of relevant planning documents, programmes, and projects by the municipality, as well as historical books about urban development in Malmö (see Appendix D and Figure 7) (Bryman, 2008, p. 515). The author participated in *Stadsbyggnadsdag* 2015 and 2016. An important strength of the data collected is that it comes from different sources which increases its validity.

For the data analysis, the interviews were transcribed and then analyzed through the lens of the SCA. The result section is organized according to the main components of the approach (see Figure 4). Components, the interviewees did not refer to were not included into the analysis, such as ICT, tolerance, and human development. The data is enriched through quantitative data such as rainfall data during flooding events, collected from SMHI and SGU, to support and validate the interview statements. This triangulation increases the validity of results. The data collected would have benefited from more quantitative data analysis in the field of urban microclimatology, such as wind speed, average monthly and daily rainfall, as well as buildings heights.

5 Results

This chapter introduces results for the case study area of Nyhamnen through the lens of the SCA (see chapter 3).

5.1 Environmental Dimensions

5.1.1 Observed Climate Change Impacts and Risk Hazards

Climate change impacts can be seen in Europe (IPCC, 2003, p. 543), including an increase in temperature and a change in precipitation patterns (EEAb, 2012, p. 16). For Sweden it is estimated that the average temperature will increase by 3 to 5 Celsius degrees by 2080 in contrast to the values from 1960-1990 (SOU, 2007: 60). Sweden will face an increase in precipitation, especially in spring, autumn, and winter (Hall, 2015). Southern Sweden has to face warmer and drier summers and sea level rise is expected (Hall, 2015).

The same is estimated for Malmö: an increase in precipitation, local flood risk, sea level rise, and temperature, resulting in heat waves (Malmö Stad, 2012, p. 4). Malmö´s climate is classified as an oceanic climate (SMHI, 2015). The risk for pluvial flooding has been prevalent during July until September. Urban planners have not dealt with UHI yet (Interviewee D). Malmö was hit by strong rainfall and storm event resulting in flooding in August in 2014 (Interviewee E). 100,1 mm of rain fell within 24 hours. A new record for the city, whereas the yearly precipitation average is 618 mm. Damage to houses, garages, cars and busses, which were trapped in water masses, resulted in hundreds of millions of SEK (Malmö Stad, 2015). Expected climate threats in Nyhamnen are sea-level rise, flooding, and UHI (Interviewee E). If the sea-level rises above 3 m, the whole area of Nyhamnen will be flooded (Interviewee E). Urban flooding is described as new experience for Malmö and Sweden (Interviewee E and Q).

Sweden lies in the so-called west wind belt (SMHI, 2015), this means that normally most of the undisturbed wind comes from West or Southwest direction. Storm events are normally frequent from October until December. During storm events there is a higher chance of coastal flooding. Hurricane-force winds were measured of the Southern West coast at 33.8 m/s during storm *Urd* in December 2016 (SMHI, 2016).

5.1.2 Air Pollution and Noise

Several Swedish towns and cities have problems with air pollution, despite lower emissions. New research at SMHI (2016) shows that it may be difficult to fully achieve clean air objectives in the future. The results confirm that it is primarily local emissions caused by road traffic that need to be restricted (SMHI, 2016). Traffic noise and traffic emissions are expected to decrease the attractiveness of Nyhamnen, due to daily traffic from Västkustvägen and Stockholmsvägen through

Nyhamnen (Malmö Stad, 2015). Noise levels from port activities are a problem for Nyhamnen, whereas levels of 57 dB during the day and night have been accepted (Malmö Stad, 2015).

5.1.3 Contamination

There are many brownfield redevelopment projects in Malmö and plans for soil contamination treatment, such as for the former brownfield site WH (25 ha). Nyhamnen, a coastal brownfield site, faces the problem of soil contamination, it is artificially filled and the ground is porous (SGU, 2016). Different remedial techniques are envisioned; such as soil exchange. Problematic is the limited knowledge on what kind of harmful substances are in the ground. Nyhamnen is very old and massive extension projects were conducted in the mid of the 19th century. Problematic is that part of the toxins are washed out into the water. Water pollution through heavy metals is seen in WH (Interviewee E).

5.2 Socio-Cultural Dimensions

5.2.1 Social Inclusion and Justice

Malmö municipality wants to include the social dimension into long-term urban planning (Malmö Stad, 2015). According to one Interviewee, social sustainability is an important topic, but has not received a lot of attention in urban planning (Interviewee E). One of the main socio-cultural challenges the city is facing is segregation which has developed over 100-150 years (Malmö Stad, 2013, p. 4; Interviewee E). As stated by Interviewee E, the city cannot deal with segregation because this is not in their hands. He mentions that social problems scare private investors away (Interviewee E).

There is a housing shortage in Malmö. The city is in need of 53.000 new homes, 13900 preschool and 23700 new school places and kindergartens (Malmö Stad, 2016, p. 3, Interviewee A, B, and D). More than 3000 homes per year over the next ten years have to be built in order to meet the housing needs (Malmö Stad, 2016, p. 6). It is expected that 1800 homes will be finished by 2016 (Malmö Stad, 2016, p. 3).

Interviewee B states that it is more important to have houses than UGSs, so no one is homeless. In addition to this, Interviewee E concludes that housing should be financially feasible for all sorts of income populations but this is not the city´s responsibility. The city cannot say that there should be social housing in a certain area (Interviewee E). Sweden does not have social housing, as for example Germany, but they are discussing the topic today (Interviewee E and B). The city, if they own the land, can rent flats from private housing companies or the real estate department can sell the land to someone and then rent flats (Interviewee B). However, the real estate department is under pressure

from politics to sell the land profit-oriented. In urban plans there is the possibility to state that private housing, rental apartments, and integration is preferred (Interviewee E).

According to Interviewee J, the economic system in place does not provide the type of affordable housing Malmö needs. Rent has to be according to market conditions, otherwise apartments are rented out at a higher price, people will buy it cheap and then sell it (Interviewee J). The municipality is the only instance to give building permissions on the land. They have the power to decide who is going to be the owner of the site. Therefore, Interviewee J advises the municipality to take this responsibility seriously and to provide cheaper sides. Further, he calls for a rethinking in order to provide social and affordable housing (Interviewee J).

Interviewee E describes that gentrification has different dimensions. With every more m^2 of UGS, living becomes more attractive and expensive. Therefore, some UGSs will lead to gentrification. Nyhamnen can be described as Malmö in small: you have an attractive Western part and a less attractive Eastern part. Thus, urban planners are planning to put UGSs in the Eastern part, so that a social mix can be ensured and that Nyhamnen will not be separated between the poor and the rich. But the problem is that through UGSs the Eastern part will become more expensive (Interviewee E). Another Interviewee pointed out that from a social and ecological point of view, it would make sense to densify large villas areas of private property owners and their private gardens, rather than densification of public UGSs in poorer areas (Interviewee C).
In relation to the question if UGSs could decrease the social divide in Malmö, Interviewee C states that the usage of UGS in WH in the summer, *Folkets Park,* and *Pildamsparken* has brought the city together. In how far this can contribute to lower income differences is questionable (Interviewee C). In his opinion, the municipality can use its power to create large UGSs on municipal owned land as it is done in WH. In contrast to private developers, the municipality has other ideas than merely profit making, such as branding the city as a green city rather than making money from every single m^2 (Interviewee C).

5.2.2 Demography

Malmö has a very high population growth rate, and is considered to be the fastest growing city in Sweden and one of the fastest growing European cities (OECD, 2012, p. 272; Interviewee A). For 28 years the population has been increasing and it is estimated that Malmö will have 357.000 inhabitants by 2019 (MKB, 2016, p.11). Malmö is described as a young city with an average age of 38, 5 (Malmö Stad, 2016b).

5.2.3 Culture and Tradition

For Nyhamnen, four identities have been chosen due to its use and function in the past: food and drinks, diversity and migration, water and greenery, and culture and venues (Malmö Stad, 2015). Nyhamnen used to be a port area which exported and imported food products and handled immigration to the United States (Malmö Stad, 2015).

5.3 Economic Dimensions

5.3.1 Urban Wealth and Economic Growth

Malmö had to face two economic crises: economic problems in the 1990s when the ship building industry collapsed and closed down, and the financial crisis of 2008 (Holgersen, 2014, p. 286). In 1993, the unemployment rate was over 16 percent and the municipality had a one billion SEK deficit in 1994 (Holgersen, 2014, p. 290). During this time, a huge suburbanisation process was happening (Holgersen, 2014, p. 236). One of the biggest challenges Malmö is facing is a high unemployment rate and high costs for social welfare (Interviewee A and B). There has been combined efforts by the municipality and construction companies to create income opportunities for the unemployed, e.g. through a neighborhood café (Interviewee B).

5.3.2 Innovation

In the last decade, the city has won many international prizes and awards due to its environmental friendly practice (Holgerson, 2014, p. 232). In Augustenborg, the city has implemented UGS as CCA measures. According to Interviewee C, UGS is used in Malmö's profile and city branding and is linked to their broader economic strategy, especially the green roofs in WH (Interviewee C). In his opinion, it seems more important to gain international recognition and attention, than actually reducing emissions and fulfilling CCAM in WH. Further, he questions the usefulness of green roofs in WH due to its proximity to the sea. He advises to implement green roofs anywhere else in the city, but it is in WH that it goes into the discourse on green and city branding (Interviewee C). Opposed to that, an urban planner said that UGS are not used as a branding strategy (Interviewee D).

To implement a sustainable and climate-adapted neighborhood, it is important to look at the whole city and at existing and newly planned development sites. Nine districts in the city are characterized by housing typologies from the Million Program (1965 -1974), such as in Rosengård. Here, the city is discussing new place making models for these areas to improve the neighborhoods. Rosengård has been negatively portrayed in the media as a problematic district, but in relation to UGS, Rosengård is a green neighborhood (Interviewee B, field visit). According to interviewee J, the housing typology in Rosengård is a failure and there is no ownership of UGS.

5.3.3 Consumption and Production

In Nyhamnen, there is the potential to rethink current urban consumption and production patterns, especially in relation to food. Instead of planning more commercial supermarkets, it is advisable to create smaller shops close-by (Interviewee J). In the city's policy for sustainable development and food, it is stated that Malmö aims for 100 % sustainable purchasing and served food shall be organic certified until 2020 (Malmö Stad, 2010). An increase in urban agriculture areas and local markets selling local farming products can be witnessed in Malmö (field visit). There are 1700 allotment garden plots in 22 different places, ranging from 20 to 200 m^2 (Malmö, n.d.).

5.4 Urban Systems Synergies

5.4.1 Urban Functions, Structures, Water and Energy

The outer ring and inner ring road is creating a structure in Malmö (see Figure 2). The railway tracks are an interruption in the urban fabric and are separating the city into different areas (Interviewee J). Nyhamnen is separated from the city center through the railway tracks (Malmö Stad, 2016).
For the new design of Nyhamnen, Interviewee J suggests not to change too much in the existing urban structure and rather support it and to create a continuous urban fabric. Malmö is fortunate, because it has edges such as the water front, and water channels which are positive interruptions. These structures increase quality of space. He mentions that how people want their cities to be and look like varies on different scales (Interviewee J).

Malmö faces the problem of contaminated groundwater due to past industrial activities (Malmö Stad, 2016). There are traces of chlorinated hydrocarbons in the water in the city center and port areas. Soil remediation to improve the groundwater is needed. The groundwater is also threatened by saltwater intrusion through sea-level rise. Soil and rock layers are built of different geological layers, mainly limestone (SGU, 2016). Due to these problems, most of the drinking water is distributed from the lakes *Bolmensjön, Vombsjön*, and *Ringsjön*. 15 % of the drinking water comes from the *Alnarp* aquifer. Three water towers help to regulate water distribution in the city. Currently, Nyhamnen has a combined and separate sewer system in place (SGU, 2016).

In relation to energy production, there is an offshore wind park 10 km of the South coast of Malmö. The largest photovoltaic plant in Sweden stands in Sege Park (1250 m^2 of solar cells with a peak power of 166 kW) and electric vehicles are operated in Malmö. Malmö wants to become Sweden´s first climate neutral city by 2020 and aims to run 100 % renewable energy by 2030 (Malmö Stad, 2009, p. 7). Energy-efficiency, through e.g. zero energy or passive plus houses, of old and new buildings is envisioned in Nyhamnen (Malmö Stad, 2016). The city is investigating potentials for solar

energy on roofs, as well as a heating system that uses salt water as an energy source (Malmö Stad, 2016).

5.4.2 Landscape & Social Space

Historically, Malmö has been called the city of parks. Today, it is said to be a myth. Malmö is not a city of parks and has, compared to other Swedish cities, less UGS per inhabitant due to its topography and the surrounding agricultural land (Interviewee D and L; Windgren et al., 2015, p. 93). There is a decline in the total amount of UGS (Miljobarometern, 2005). In 2000, there were 3.834 ha and in 2010 3.564 ha of public and private UGS (Miljobarometern, 2005). Public green structures are described in the Green Plan from 2003 (Green plan, 2003, p.31). There are 15 public parks, whereas *Kungsparken* is the oldest park (1872), next to *Pildammsparken* (1914), and *Slottsträdgard* (1998). New public UGS are constructed by the Street and Park Department (Delhammar, 2015, p. 5).

The city center is facing compact urban development and a lack of UGS (Interviewee H). Existing UGSs in the city center are described as highly managed areas (the grass is cut) and a deficiency in biodiversity (Interviewee D and I). In parks, exotic plants are predominant which are not beneficial for native pollinators (Interviewee I). UGSs should be managed more ecologically, stimulate biodiversity, especially for bumble bees, and contribute to a rich environment, and should be beneficial for urban citizens (Interviewee I). According to Interviewee B, one problem UGSs are facing is that they are not accessible and squares should be made greener (Interviewee B).

To ensure sufficient UGS, the city is planning a new botanical garden outside the ring road. Pildammsparken from 1914 was built outside the city´s boundaries at that time (Interviewee A). The future aim of UGS in Malmö is to improve existing UGS and to ensure that they are connected through *ekostråket* (green stripes) (Interviewee A).

Figure 3 shows the envisioned UGS for Nyhamnen. The planned six urban parks will have an urban character. The street *Jörgen Kocksgatan* will be transformed into a central green route (Malmö Stad, 2015; Interviewee E). UGS in Nyhamnen are planned for heavy precipitation events in order to release pressure on other areas. UGS should be used as reserve or buffer zone areas for temporary urban and coastal flooding and cloudbursts (Interviewee E and D). The most important function of UGS is to reduce volume and velocity of rainfall and stormwater and to guide this water to places where it should be (Interviewee D).

There is a need for more UGS because the Eastern part of the city center has too few. Nyhamnen hopes to even this out (Interviewee E and D). Interviewee E points out the difficulty of building new UGSs in existing places. Therefore, Nyhamnen offers great potential because most of the area belong

to the city (Interviewee E). Concerning the ratio of UGS and other land-uses, there could be more UGSs in Nyhamnen, according to Interviewee E. The actual m^2 size of UGSs is small. Besides this, two schools and a kindergarten have to be added to one park which decreases the UGS area (Interviewee E). Interviewee J suggests to preserve 10 % of Nyhamnen for UGS. Interviewee E raises the question, how UGS can contribute to a good climate and how UGS can be attractive. In his opinion, this is an ambivalent story and has to do with urban design (Interviewee E).

For Nyhamnen, a mix of UGS measures is needed, such as gardens, street trees, pocket parks, and green roofs to ensure the ES and benefits of UGS as pointed out in chapter 2.2., especially in relation to ecological and recreational needs and CCA (Interviewee E and D). During pluvial flooding, green roofs cannot cope with all the water because they saturate quickly (Interviewee D and Q). Interviewee D prefers street trees over green roofs for rainwater collection and favors the planning of more street trees. He points out a knowledge gap in the field of suitable tree species due to a changing climate. In the past, too many non-native trees were planted which did not attract native insects and too little native trees (Interviewee D). In 2015, the Street and Park Department was responsible for 60.000 trees. Since 1984, 40.000 elm trees had to be taken down in Malmö, because they were affected by the Dutch Elm Disease. Recently serious diseases are affecting the trees, such as bleeding crashers on horse chestnut, chalara dieback of ash and phytophthora in beech (Malmö Stad, 2016). In Nyhamnen, native and climate change adapted trees are envisioned. There is a focus in nature protection and species diversity. Landscape planners and the Streets and Park Department will publish a guide and an action plan for the landscape design of Nyhamnen (Interviewee E).

Interviewee G mentions that the discussion of compact city development and its pressure on UGS can be used to redevelop how we think about UGS. Due to CCAM strategies, there is an interesting development in new types of UGSs, such as pocket parks and multifunctional space use. A green roof becomes a place for urban gardening and a social meeting place or a skate park is collecting stormwater. This stimulates a creative and positive process in developing, redeveloping, and engaging people in UGS planning (Interviewee G). Multifunctional use of space is an important topic in city planning in Malmö (Interviewee B, D, and E). In relation to this, public spaces should be better combined with schools and kindergartens (Interviewee B). Existing places could be retrofitted to become a multifunctional space (Interviewee D). The main problem for more multifunctional spaces is the financing of those measures (Interviewee D). Another option is temporary use of space, where the area is used for another purpose, such as food production, before housing construction starts (Interviewee D). According to Interviewee D, Malmö is in need of places where larger amount of water can be collected. He describes this as one of the biggest challenge for Malmö. Alternatively,

urban planners have to locate places, such as rain streets, where the rain can be directed to (Interviewee D).

Interviewee J calls for a rethinking in urban design. Different biotopes should be connected to buildings. Shading could solve many problems together, such as UHI, reducing energy costs, and increase comfort. The biological systems of vegetation and their needs should decide how we design UGSs, e.g. some vegetation needs sand or stones. He describes this as an upcoming area for landscape architects how biotopes can be more natural than a garden or a park (Interviewee J).

Information on implemented UGSs could increase their acceptance by the public (Interviewee D). Interviewee D believes that it is possible to implement different kind of innovative UGS measures, if people receive information why this is done, such as not cutting the grass for increasing biodiversity or the aesthetics of rain gardens when there is no rain (Interviewee D).

5.4.3 Building & Architecture

Today, Malmö is described as a stereotypical version of a post-industrial city, with a focus on business, education, green architecture and planning, waterfront developments, various events, and shopping malls (Holgersen, 2014, p. 232). Before the construction of WH, the Eco-city Augustenborg was built in the 1950s for the housing company MKB. A major reconstruction process was going on in the 1990s to better deal with pluvial flood risk (Holgersen, 2014, p. 232).

The existing buildings in Nyhamnen represent different architectural styles and the industrial character is still present (see Figure 6 for the old character of Nyhamnen (1914-1922). It can be classified as a mix-use area, consisting of different retailers, sports facilities, and different businesses, such as an architecture company and a hotel. Currently, there are 80 people living or working there. There are different property owners, such as the municipality, *Jernhusen*, *Trafikverken* and private property owners (Interviewee E). Most of the area of Nyhamnen belongs to the city and the city will sell land (Interviewee E).

Glasvasen, BREEAM excellent certified, is one of the first projects being implemented in Nyhamnen (Interviewee E). The development area, South Nyhamnen, owned by *Jernhusen* and *Trafikverken* received building permission (Interviewee E). Interviewee E stresses a building problem here due to the surrounding traffic. A noise protection wall will be implemented, oriented at the High-Line Park in New York. This new green promenade (*Bangårdsterrassen)* shall invite for walking (Interviewee E; Malmö Stad, 2016, p. 11).

The building, street, and public space design in Nyhamnen has to be adapted to coastal and pluvial flood risks. New construction should be adopted to a 3 m sea-level rise (Malmö Stad, 2016;

Interviewee Q). An idea is to increase the elevation of the area or leaving the first level of houses free. New urban water designs in Malmö are the *Paulibron,* and the rain street, *Monbijougatan*, and multifunctional skate parks (field visits).

There has been an increase in pluvial and coastal flooding events in the last five years in Malmö. Those events are hard to predict (Interviewee Q). Green and blue infrastructures, such as green roofs, are not sufficient to mitigate pluvial flood risks (Interviewee Q). For Nyhamnen a mixture of coastal flood defense and adapted housing design is recommended (Interviewee Q). Nyhamnen is supposed to be a national show-case for flood-proof design, e.g. through different types of floating housing systems (Interviewee Q; Malmö Stad, 2015). Interviewee Q mentions the difficulty of designing housing, streets, and open space for coastal and pluvial flooding at the same time. It is advised that houses should not have basements. For Nyhamnen it is important to have safe waterways where the water can go to. The municipality should ensure that people are aware that they are living in a flood-prone area. Nyhamnen should be designed in a way that it protects the city center from flooding. As a design measure, part of the harbor could be transformed into a collection basin, where the stormwater could be directed to. This basin could clean the water and remove heavy metals through sedimentation processes. Interviewee Q calls for more detailed measures for flood defense and adaptation in the detailed plan for private developers. If there will be a coastal protection barrier, there is no need for an increase of the land to 3 m (Interviewee Q).

Urban design measures should preserve existing flora and fauna. Building materials should be chosen which last a long time (100 - 150 years) and are of good quality. The housing typology needs to enable long-term flexibility and adaptability. This ensures long-term sustainability and affordability. Social mix can be achieved through a different and diversified distribution of m^2 of the apartments (Interviewee J). Interviewee J advises to be open for experiments in cities because they create different results and discussions. He advises against following rigid aesthetic urban design rules. He concludes that *"there are various ways of a good future and not only one. We need to question ourselves, private and as a society, what we really like and what we are fond of, instead of promoting what we have"* (Interviewee J).

5.4.4 Traffic & Transport

Many urban planning problems in Malmö are due to the traffic system because the main objective of the last century was to make space for cars and this made the city less green. Therefore, a change in the traffic system, and in attitudes, is needed. Cars of the future will be different (Interviewee D and G). For Nyhamnen, it is recommended to move away from the standard streets widths which are oriented on today´s car use and adapt it to future transport systems by narrowing the streets widths

(Interviewee A, D and G). There is a need to equalize the transport conditions in the whole city. Every part in Malmö is equal reachable with cars and bikes but not with the train (Interviewee J). Cycling and walking are the preferred transport modes because buses and cars cut people off from the urban life, according to Interviewee J.

5.5 Institutional Factors

5.5.1 Urban Planning, Urban Governance, Legislation & Policy

The Planning and Building Act (PBL) regulates the Swedish planning system (Delshammar, 2015, p. 5). According to this act, municipalities are the main planning unit for urban and rural areas (Delshammar, 2015, p. 5; OECD, 2012, p. 272). Each municipality needs to have a comprehensive plan which is not judicially binding and has covers the whole municipality and a detailed development plan which is binding for authorities and individuals (Interviewee A; Delshammar, 2015, p. 5). The Swedish Parliament has decided on 16 environmental goals (*Miljöbalken*) that municipalities should work on (Malmö Stad, 2012). One of the targets is to create a good urban environment. City planners work with detailed plans and the Streets and Park Department tries to ensure that the measures proposed by city planners work in practice (Interviewee A).

The Comprehensive Plan for Nyhamnen is to be adopted in late 2017. It serves as a strategic guideline and has to be followed up by decisions of politicians and concrete actions plans. The municipality does not create detailed plans unless the property owner asks the planning department (Interviewee D). In Sweden, the rights and responsibilities of private property owners are strong in comparison to the municipality. Interviewee D describes this as more freedom and responsibilities of the private owners and less support of municipal urban planning (Interviewee D). Malmö owns half of the city (Interviewee B and L). The municipality is in need for more support for CCA and improved laws. Implementing the environmental law as a municipality is difficult, because it does not enforce the implementation of specific measures. Only the owner of the land can do that. According to Interviewee D, there is a thinking in Sweden that the private sector will be more ambitious than the public sector (Interviewee D).

The PBL does not account for ES. It is the city´s responsibility (Interviewee B)**.** There is no guideline for how to incorporate ES into planning, but urban planners have a huge interest in this. It is good to have tangible effects of ES to support new projects (Interviewee A).

Important plans and projects which influence UGS today are the Green Plan (2003), the Environmental Building Programme South (2009 - 2016), BiodiverCity (2012), Project MEST_Plan (2014), BEST, and the Water Plan (2016) (Interviewee B).

The Miljöbyggprogram Syd, introduced during the European Housing Expo in 2001, was not primarily used for UGS but for including green initiatives in new housing areas for the building companies to follow. But there was a change in the national planning law with the aim to plan housing areas faster. This resulted in the close-down of the program (Interviewee A). A new and better strategy, as a checklist for green and as a tool for dialog to help the builders, is in the planning stage. It is not binding but the dialog is obligatory. Through this, the city can choose the "best" developer (Interviewee B).

For ten years, urban planners have been working on long-term planning for flood risk management. It is important to show stakeholders possible measures and explaining action steps (Interviewee E). Urban planners are aware of the impacts of heavy rainfalls for the city but it takes time until guidelines or strategies are put into action. Even though Copenhagen had to deal with pluvial flooding in 2011 and 2012, no politician asked what would have been the effects for Malmö. It is not until it happens in our backyard (flooding 2014) the politicians woke up and said we have to do a cloudburst plan (Interviewee A). *Anna Lindhs* square close to the train station was flooded and the water almost went into the city tunnel (Interviewee E). The Streets and Park Department together with city planning and the sewage department (VA Syd) are currently preparing a cloudburst plan in order to better deal with climate change impacts due to heavy rainfall, combining flood risk modeling with GIS (Interviewee A and E).

The city is preparing a new report on blue and green qualities which replaces the old Green Plan. An important question in this regard is where does the money come from for those initiatives (Interviewee A). One theme of the New Green Plan is the role of UGS for pluvial flood risk mitigation (Interviewee B). In the new Green plan, the most important measure should be an action plan for reducing hard surfaces especially in the areas the municipality has control over and for more street trees. Recently created UGS have too little green and too many stones according to Interviewee D. He votes for a replacement of impermeable surfaces through UGSs (Interviewee D). Interviewee B states that all municipal plans are connected somehow and that urban planners want to make Malmö a green city (Interviewee B).

The Streets and Park Department has to fight to get space for UGS due to the limited available space in the city (Interviewee A). As stated by Interviewee E, everybody says that UGS are important, but in the land-use plan there are too few UGS, but this is a problem almost every city is facing. He further states, that urban planners have to fight for the implementation of UGS, because the comprehensive plan it is not legally binding, and is not concrete enough. Therefore, the workshops for Nyhamnen are essential in order to establish a consensus early on (Interviewee E).

The planning of Nyhamnen was a short but very intensive process. A round table with other departments, such as the environment, street and park, traffic, planning, building and real estate department was implemented. They formed a working group together with an additional reference group, consisting of representatives from schools, kindergartens, cultural departments, association, different city districts, and VA SYD. Different workshops were held in order to receive a fast result. The comprehensive plan is a result from those workshops (Interviewee E and J). Before this plan comes into force, there are two hearings. There is the project *Uppstart Nyhamnen,* where two student teams and three architecture firms presented different ideas for Nyhamnen (Interviewee E, J). According to Interviewee J, involved actors were thinking outside the box and ensured a good dialogue. Malmö city understood to create temporal solutions, such as temporal usage of industrial buildings (Interviewee J).

5.5.2 Finance

Malmö is facing financial challenges (Interviewee D). This affects the implementation of the planning in Nyhamnen. Therefore, some areas will be developed first. Later, the money can be used for UGSs. It is not perfect, but the real estate department sets the framework for it (Interviewee E). The need for money is driving the urge for development (Interviewee G). Nyhamnen is a very attractive place due to its proximity to the water and the central station from Sweden´s third biggest city (Interviewee E).

There is a high maintenance cost of existing UGS which is problematic (Interviewee A and B). The investments of the Streets and Park Department are decreasing (Interviewee A). Outsourcing of maintenance (cutting the grass, cleaning) of UGS is a common practice in Malmö (Interviewee G). The municipality is by law not responsible for protecting private housing from flooding but most inhabitants expect that. They changed the law in Denmark after the rainfall event, so sewage fees can be used for above ground measures. In Sweden, fees from the sewage cannot be used for above ground measures, it can only be used underground. The problem is that the finance system is not in place. Most people forget about the rain because they, maybe, were not affected by it. Every time a new housing project is done, there has to be a clear idea on how to mitigate pluvial flooding. What is needed is another kind of thinking, however, the municipality is not there yet. It is a long way to get this understanding within all levels of the municipality, the developers, and the private house owners. It should be a combined effort of all stakeholders (Interviewee D).

It is a struggle to show the importance of UGS and the gain for society. It is a social question, that the property prices do not increase due to the value of UGS (Interviewee E)**.** There is no direct economic value of UGS in comparison to housing, but there is an indirect value because it can reduce the costs

for flooding and health, and provides ES (Interviewee D and G). *"We are far away from valuing UGS as they should be. We should have a lot more trees in our urban spaces but planting them and maintenance cost a lot of money"* (Interviewee D). People are willing to pay more if they live close to a UGS, but it is a planning challenge (Interviewee G).

Selling the land is seen as the best opportunity to enforce something on the new development and it is easier to make a clause in the sales agreement rather than in the detailed plan. Once land is sold, then urban planners lost the control if something happens (Interviewee D). If you build a new urban development project, part of the investments for the public space can be redirected. The property owner has to pay the city money for the land-use plan and for the infrastructure, which could include public space and USGs. Through this, you can work with climate change mitigation (Interviewee E). Another idea is to put taxes on the property owners who use the sewer system and to use this money for measures above ground and adaptation purposes (Interviewee D).

5.5.3 Training & Education

Concerning the question if citizens are aware of the climatic benefits of UGS, contrasting answers were given. Interviewee B states that people are not aware of it, whereas Interviewee D mentions that some people are aware of the benefits of UGS and others not. Interviewee B and D point out a problem with private property owners in residential areas, who transform their front gardens into asphalt or stone paving. They are not aware of the benefits and are upset when flooding occurs (Interviewee D). Interviewee D states that urban planners have to work with information and raise the knowledge in all municipal levels and the public.

In order to make long-term change, a change in attitudes is needed on how the city should look like and a better understanding that it can and has to change due to sea level rise and CCA, according to Interviewee D. He calls for a stronger support in the laws and ideas on how CCAM can be financed. In his opinion, it is a slow process and the question remains what the municipality can enforce. The city of Malmö is not adapted to the new flooding situation (Interviewee D). Interviewee J stresses that urban planners cannot know what is the right kind of urban planning because everyone has a different understanding of what sustainable urban planning is (Interviewee J).

5.5.4 Public Participation

As said by Interviewee D, there is always a need for citizen participation in urban planning. He suggests if citizens are involved in UGS planning they will take better care of UGSs. The question remains what is citizen participation and who is included and who is not (Interviewee D and C). Urban planners have to look at all inhabitants, also those who are not participating (Interviewee D). The Swedish planning model has a focus on top-down strategies, but the Streets and Park Department

has done many projects with citizens, but participatory approaches have not been mainstreamed into urban planning yet (Interviewee E). It is not possible to work with participation all the time. Projects on UGS with citizens are dependent on individual initiatives. There is a huge interest of having more projects in dialogue with urban residents. The question is how you can reach new persons? Environmental education, cooperation, and networking with others are important (Interviewee E). The Street and Park Department conducts surveys to evaluate what citizens think about UGS. In Nyhamnen it is planned to involve the people living there (Interviewee E).

5.5.5 Public Private Cooperation and Technology

The former mayor, Ilmar Repaluu, implemented a new Comprehensive Plan in the mid-1990s with the aim of becoming a knowledge and information society. The plan argues that growth should take place in the private sector. The municipality should assist with this development by providing land for new businesses and expansion of infrastructure. The plan states which people Malmö wants to attract: immigration of highly educated people (Holgersen, 2014, p. 290).

If there is not an active and strong municipality that plans, developers will take away UGS. Hence, planning becomes an important tool to safeguard UGS (Interviewee C). It is important to build more housing achieved through densification rather than urban sprawl, and it is easier to go against the interest of poor people than the rich (Interviewee C). *"I don't think we could make just and democratic cities in a cruel, undemocratic and unjust world. That is utopist to me. But in processes of larger transformations of society (including our cities), planning and planners do plan important roles"* (Interviewee C). The developer of new land has to bear the cost for public parks. This is a way how the city can share costs for UGS (Interviewee C).

5.6 Spatial Dimensions

5.6.1 Regional Connections and Urban-Rural Linkages

Malmö is located in the Öresund Region, a transnational metropolitan area, between Copenhagen, Lund and Helsingborg (Nauwelaers, Maguire & Marsan, 2013). The region is characterized by commuting, student flows, and cross-border residency (Nauwelaers, Maguire & Marsan, 2013). 3.9 million people are living there (Region Scania, 2016). Greater Malmö is recognized as a metropolitan area (*Storstadsområde*) by the Swedish state. Malmö is facing a problem other Swedish cities are not facing: a space problem. Malmö needs to grow inwards because Sweden´s most fertile and highly valuable agricultural land is situated next to the city. It is an imperative of the city planners not to use the valuable agricultural land (Interviewee A; Malmö Stad, 2013).

5.6.2 Density, Size, Topography, and Urban Configuration

Malmö is a flat, low-lying, coastal town and to avoid urban sprawl, one of the main planning goals is a dense and compact city (Delshammar, 2015, p. 5; OECD, 2012, p. 272; Interviewee A and B). In Sweden, the compact city is seen as an important way of achieving urban sustainability (OECD, 2012, p. 272). Malmö should not grow outside the outer ring road (yttre ringvägen), therefore few areas for larger UGS are left. This can be considered as a space problem for new UGS (Interviewee A). CCA, and especially heavy rain falls and future coping mechanisms while continuing strategies and measures to mitigate climate change are among the urban planning challenges Malmö is facing (Interviewee A).

Malmö transitioned from an industrial and leading shipbuilding city (1960s) to a "knowledge" city (Delshammar, 2015, p. 3). Malmö Högskola opened in 1998 and the Öresund Bridge in 2000. In 2001, the housing exhibition Bo01 took place in WH. During the economic crisis in 2008, the urban policy was to continue construction in the city (Holgersen, 2014, p. 292). A series of *Leuchturm* projects followed, such as The City Tunnel (2010), the new shopping center Emporia (2012), and Malmö Live (2015) (Holgerson, 2014, p. 232). Most densification projects are former industrial areas, such as WH, Norra Sorgenfri, Järnvägsverkstäderna (and Östervarn station) and Nyhamnen (Windgren et al., 2015, p. 18). New high-rise buildings such as the Greenhouse in Augustenborg and CultureCasbah in Rosengård are being implemented (Malmö Stad, 2016).

6 Discussion

This chapter presents the discussion of the results. First, I discuss the findings in relation to the sub-research questions. Second, I elaborate on the usefulness of the SCA. Third, I bring the discussion back to the presented background chapter about climate-adapted neighborhood design. Finally, I reflect on the research process.

6.1 Ecosystem Services and Benefits of Urban Green Spaces Incorporated in the Housing and Open Space Design

Figure 5. Urban sketch of potential UGS design measures in Nyhamnen (Author, 2017).

The results suggest that UGSs in Nyhamnen have to be adapted to the following potential problems such as coastal and pluvial flooding, storms and wind, UHI, contaminated soil, air pollution and noise from traffic. UGSs should be incorporated in the housing and open space design through a mix of measures, such as making squares greener, wild vegetation and rain gardens, street trees, pocket parks, and extensive and intensive green roofs (see Figure 5). In order to cope with flood risk, retention or detention areas are preferred and measures, such as rain streets, where the rain can be directed to. Through multifunctional or temporal space use these measures should be combined. Already existing places have to be retrofitted according to these guidelines. UGS problems in other areas in Malmö should be avoided, such as no ownership and no accessibility of UGSs.

UGSs should favor a rich biodiversity through native plants which attract native pollinators. In relation to housing design, UGS help to reduce energy costs and GHG emissions. The housing and street design should preserve existing flora and fauna. To ensure long-term sustainability and affordability, long-lasting building material should be used. The housing typology needs to enable long-term flexibility and adaptability. Different biotopes and buildings should form a symbiosis to reduce negative climate change impacts. For Nyhamnen a mixture of coastal flood defense and flood-adapted housing design is recommended. Here, I recommend to look at Rotterdam and their floating pavilions for best-practice examples.

UGSs in Nyhamnen help to increase the total amount of UGSs in Malmö and decrease the deficit of UGS in the Eastern part of the city center. Raising information and knowledge about UGS and their multiple benefits are vital to increase acceptance of those measures. The findings show that creativity and innovation is an important element for rethinking and reframing the design of UGS. Shared values of UGS are important because then, citizens are more likely to protect and preserve it and accept new designs of UGSs.

These findings are in line with research conducted by Caruso et al. (2015). They argue that carefully addressing the spatial design of UGSs and buildings deliver more sustainable cities. Public UGS are essential elements in achieving sustainable urban planning and human well-being (Littke, 2016, p. 5). In CCAM strategies, UGSs should be a central component because they are vital to fulfil CCA goals in cities (Mathey et al., 2010, p. 479; Demuzere et al., 2014).

In terms of pluvial flood risk reduction, extensive green roofs and street trees are not enough to mitigate the risk fully. A study by Bengtsson (2002) investigated runoff from extensive green roofs (3-4 cm soil substrate, sedum vegetation) in Malmö. He concludes, that 10 mm rain generates runoff. I advise to look at best case examples such as Copenhagen and their cloudburst boulevards. A successful implementation of the envisioned UGS measures, depends on different parameters. In the case of green roofs, these are soil thickness, soil type, vegetation cover type, roof geometry, slope and roof position (Berndtsson, 2010, p. 353).

I recommend to arrange UGSs so that they fulfil the municipality´s aim of increasing green stripes (*ekostråket)*. Possible design solutions are to link UGS to local organic food production, where the products could be sold at a food market in Nyhamnen. These recommendations are in line with the research conducted by Cvejić et al. (2015). I advise to move away from the standard street widths and create more room for UGSs. Research needs are the contribution of UGSs for air pollution reduction and decreasing UHI. Besides this, municipal CCAM laws and concrete measures in detailed plans are needed.

6.2 Ensuring social benefits through UGSs in the new neighborhood

The results show that the municipality is aware of the segregation in the city, social tension, and that social problems scare private investors away. Urban planners want to include the social sustainability dimension into long-term urban planning. They address the need for increased research on social sustainability and how people act in urban environments. Urban design needs to include the social dimension of having a good balance between private and public spaces. A social mix can be achieved through a different and diversified distribution of m^2 of the apartments. UGS in Nyhamnen are envisioned in the Eastern part to avoid residential inequality. But through UGSs, the Eastern part will become more expansive. It is a social question, that the property prices do not increase due to the value of UGS.

I recommend not to build exclusive UGSs which exclude people, such as it is done in WH with the greenhouse. My recommendation is in line with the research by Wolch, Byrne and Newell (2014, p. 235), stating that urban planners need to focus on the just planning of UGS.

Even though Sweden does not have a social housing policy, there is a need for social mix and to including all inhabitants in the planning process and implementation in Nyhamnen. Hopefully, this will stimulate social cohesion, integration, social mobility, and decrease residential inequality. A future research area is the relationship of Nyhamnen and the other neighborhoods in Malmö, such as Rosengård and Hyllie.

There is a need to act today and to find short-term solutions due to the pressing need of affordable housing, especially for new citizens in Malmö. The shortage calls for an innovative design. An important area is to combine affordable housing with UGS. Possible measures could be to design urban parks on the roof of public buildings, such as schools, which are accessible for all citizens in Malmö. MKB is planning such measure for WH.

6.3 Ensuring Economic Feasibility of UGSs

The results indicate that Malmö is facing financial challenges and the design, implementation, and maintenance of UGS measures are linked to the availability of money. Public and private UGS have high maintenance costs, such as cutting the grass, watering and cleaning.

In my opinion, an idea to reduce the costs for the municipality is to link citizen participation possibilities with UGS planning and maintenance, such as the involvement of citizens into UGS design and management in their own neighborhood. This brings other benefits such as attachment to the place and ownership. Another possibility is to link employment possibilities with UGSs such as local food production which is sold in a local market.

Rusche (2012) states that investments in UGS offers opportunities to reshape the negative image of cities which suffer from industrial decline. High quality environments contribute to building competitive cities and regions (Rusche, 2012). UGSs impact the urban economy as a preventive measure to reduce long-term costs for CCAM, such as flood risk and safeguard natural resources as well as enhancement of neighborhoods and through this the whole image of a city (Rusche, 2012).

6.4 The SymbioCity Approach - A Useful Sustainable Urban Planning Tool?

The application of the SCA has been criticized in terms of social issues in Hammarby Sjöstad (Stockholm) as being an area for the urban elite, having a high-consumption lifestyle, e.g. through a high share of private cars (Metzger & Olsson, 2013). Through my field visits in WH, I can state that similar results can be seen in WH. There has also been an ethical and technological incommensurability critique of exporting this model to China (Mejía-Dugand, 2016).

I conclude that disadvantages of the SCA are that is does not give any recommendation on how to design climate-adapted neighborhoods in particular. I recommend to broaden the scope of the SCA and to include urban microclimate parameters and to create climatope maps. Besides this, it is not defined what is included and excluded in the terms presented, such as technology, tolerance, innovation, human development, and risk hazards. The SCA serves as a good tool for an overall analysis but is not specific for climate-adapted neighborhood design. In my opinion, the definition of urban design by Reicher (2010) is more helpful for an analysis.

I conclude that there are different rationalities of what sustainable urban planning is and what types of UGSs are preferred by different user groups. Hence, it is difficult to have a tool, such as the SCA, which can be applied in every city and in every context. A flexible approach is required that enables adaptation of measures. The future will show if the existing and new UGSs in Nyhamnen will be “sustainable” and just for everyone or not.

6.5 Nyhamnen a Climate-Adapted Neighborhood?

I defined climate-adapted neighborhood as combining urban design with urban climatology. Recalling the five important features of urban design (Barnett, 2003), Nyhamnen´s urban design, should foster a sense of community, create livable neighborhoods and workplace, reduce traffic congestion, encouraging social equity and environmental protection (Barnett, 2003). Urban climatology should be incorporated as early as possible in the urban development process through urban climate analysis and establishments of climatope maps. According to these analyses, urban design measures should be suggested.

UGSs serve as CCAM measures. I recommend to put UGSs in the detailed development plan for Nyhamnen to ensure sufficient UGSs. I conclude, that in order to implement a climate-adapted neighborhood in Nyhamnen, there is the need for CCAM laws on the municipal level. Referring to other countries, Germany has a detailed spatial planning law on the municipal level. It is stated in the Federal Building Code, under *§ 1 (5),* that urban areas need to adapt and mitigate climate change. The aim of inner urban development instead of urban sprawl is one of the guiding principles in spatial planning.

6.6 Reflection Upon Research Process

Limitations are that the state of knowledge on this topic changes over time. This thesis can only give a picture of the current knowledge and practices in urban planning. Another limitation is the lack of English literature for the case study analysis.

Advantages and strengths of the case study design for urban planning are its analytical depth, its high conceptual validity, understanding of context and processes and creating new research questions (Flyvbjerg, 2011, p. 314; Cambell, 2003, p. 17).

A weakness of the case study design is that the selection bias can overstate or understand relationships (Flyvbjerg, 2011). This is valid for the representation of urban planners though the interviews and represents a deficit. There has been the difficulty of finding correct operational measures for the main units of analysis. Relating to external validity, analytical generalizations cannot be done which can be applied for other cities (Yin, 2012, p. 18). In regard to reliability of the case study all units of analysis depend on several factors which will change over time. Therefore, if this study will be conducted in 30 years, the results will be different due to e.g. institutional changes, culture, and ethics, and planning theories. Not all components of the SymbioCity Approach were mentioned by the interviewees, such as radiation. The results section is displayed in a sectoral way for easy reading, deviating from the SCA, where everything is interconnected and connected.

7 Conclusion

Prior work has documented the benefits of UGS for CCAM. However, these studies have not been combined with practice on the ground. In this thesis, I analyzed the urban development project Nyhamnen through the lens of the sustainable urban planning tool, the SCA.

It was found that CCAM measures should be linked and that UGSs are successful combinations of those measures. Extensive green roofs are not sufficient to mitigate pluvial flood risks. There is a difficulty of designing housing and the area for coastal and pluvial flooding simultaneously. Social issues are important in climate-adapted neighborhoods. This thesis recommends to ensure a social mix and to welcome all inhabitants in Nyhamnen to decrease social tensions in Malmö. In order to achieve economic sustainability of UGS in Nyhamnen, the citizens should be incorporated into the planning, design, implementation, and maintenance of it. It is recommended that Nyhamnen adopts its streets system for a car-free future and narrows the widths of the streets. Another important area are the shadow effects of buildings, and adjusting housing typology for wind and precipitation events. The historical foundation of Nyhamnen as a leading ship-yard industry needs to be taken into account.

Sectoral approaches in urban planning are not successful, and a transdisciplinary approach is needed which looks at the water, energy, soil, and climate nexus. Although the SCA is a helpful tool for an overview of the sustainability aspect of urban planning projects, I advise to enhance the SCA through the inclusion of microclimatic parameters, and through the establishment of climatope maps.

The findings of this thesis extend those of Lenzholzer (2015), confirming that multiple microclimate factors need to be taken into account into urban planning. In addition, the outcome of this study improves the existing SCA. Most notably, this thesis is among the first studies to investigate climate-adapted neighborhood design for the area of Nyhamnen.

Future research areas include the use of UGS in Nyhamnen and their contribution to reduce negative climate change impacts. Another interesting topic is the willingness to pay of citizens for green measures or how noise reduction can be achieved through UGSs, as well as how not to overdesign UGSs. More research on UGSs is needed, e.g. what are the advantages and disadvantages of ecological gentrification through new UGSs in the city of Malmö.

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9 Appendices

Appendix A. Questionnaires for expert interviews

Questionnaire for Nyhamnen

1. What are the most important functions of UGSs for CCAM for the city of Malmö and for the new development area of Nyhamnen?
2. Is there any specific measure (such as green roofs, street trees, pocket parks) which is need the most for tackling CCAM or is it more a mix of measures?
3. What kind of trees will be planted there? How do you deal with possible contamination of the ground? How do you ensure that every house will have a green roof?
4. Is there a conflict between a compact and dense city development and providing sufficient green spaces for CCAM in Nyhamnen?
5. How will the tension of the need for new housing as well as UGSs be addressed in Nyhamnen?
6. Do UGSs in comparison to new housing development play a subordinated role in urban planning in Malmö? Is this due to the "low" economic value of green spaces in comparison to housing?
7. Does the PBL support the integration of ecosystem services (especially for CCAM) into urban planning?
8. Will there be a decline of public (green) spaces which are accessible for all due to privatization tendencies and financial constraints of the municipality or will these green spaces be used more and more as a business strategy and for marketing reasons in the city to attract more investments and more tenants (e.g. higher rental prices due to proximity to UGS)?
9. I have read that there will be a "High-Line Park" in Nyhamnen. The High-Line Park in New York has been criticized for leading towards ecological gentrification. How do you ensure that this will not happen in Nyhamnen?
10. Is there a trend that new UGSs are only planned in areas where people with higher income and education should settle or live?
11. Are the housing prices/rental prices higher where there is an UGS of high quality value in Malmö?
12. Are private investors interested in providing UGSs for CCAM in Nyhamnen?
13. Is there a need for more citizen participation in UGSs planning (due to financial constraints/high maintenance cost of green spaces)? Is this taken into account into the UGS planning in Nyhamnen?
14. Are the needs of the citizens taken into account into the planning of UGS in Nyhamnen?
15. Do you believe that urban residents are aware of the benefits of green spaces for CCAM?
16. What is needed for an evaluation of the efficacy of green spaces for CCAM in the long-term?

General questionnaire

1. Is there a conflict between a compact and dense city development and providing sufficient green spaces for CCAM in the city of Malmö?
2. Is there a tension of competition for land between providing UGSs for citizens which are important for CCAM and the real estate development in Malmö?
3. Do UGSs in comparison to new housing development play a subordinated role in urban planning in Malmö? Is this due to the "low" economic value of green spaces in comparison to housing?
4. Critical urban theory studies how cities, under capitalism, are places of commodification processes as objects of economic values and accumulation of capital (e.g. Brenner and Marcuse, 2009: 177). How does this influence the planning and provisioning of public and private UGSs in Malmö?
5. David Harvey writes in his book, the rebel city, that urban growth is neglecting social and environmental consequences (Harvey, 2012: 16). Is this true for Malmö?
6. Are private investors interested in providing UGSs for CCAM?
7. Will there be a decline of public UGSs which are accessible for all due to privatization tendencies and financial constraints of the municipality or will these green spaces be used more and more as a business strategy and for marketing reasons in the city to attract more investments and more tenants (e.g. higher rental prices due to proximity to UGS)?
8. Is the construction of UGSs misused for economic gains in Malmö? Are UGSs instrumentalized spaces for profit making in the city of Malmö?
9. To what extent can the planning of UGSs be regarded as an ecological and economic crisis management tool in Malmö?
10. Are the housing prices/rental prices higher where there is an UGS of high quality value in Malmö?
11. Are there any hints of ecological gentrification due to UGSs in Malmö? Do you think this trend will be more likely in the future as urban development projects continue? Is there a trend that new UGSs are only planned in areas where people with higher income and education should settle or live?
12. Is there a way how UGSs could decrease the social divide in Malmö?
13. In how far are UGSs itself places of injustice?
14. The Professor Guy Beaten writes that "the Malmö planning community is facing the danger of becoming the administrative wing of a profit-seeking development regime that has no apparent interest in 'good' or 'just' planning " (Beaten, 2012, 22). Is this also true for the planning of UGSs in Malmö?
15. In the opinion of critical urban theorists, another form of urbanization is possible which is more democratic, socially just and sustainable (Brenner, 2009, 198). What is needed that Malmö can become this in regard with urban green space planning? What should be the role of urban planners to achieve this?
16. Is there a need for more citizen participation in UGSs planning (due to financial constraints/high maintenance cost of green spaces)?
17. How can the planning of UGSs be changed towards the interests and needs of the inhabitants? What if the citizens are not aware of the benefits of UGSs for CCAM? How could this trend be changed and who should be responsible for it?
18. How can we build a social sustainable city in Malmö? Do we need to think differently about how we have use space?

Appendix B. Information about interviewed experts

Ask author for further details.

Table 4. Overview of interviewed experts (Author, 2017).

Code	Date	Affiliation	Meeting	Recorded
A	03.03.2016	Malmö Stad	Direct meeting	Not recorded
B	14.07.2016	Malmö Stad	Direct meeting	Recorded
C	20.07. 2016	Stockholm University	E-mail questionnaire	E-Mail
D	27.07.2016	Malmö Stad	Skype	Recorded
E	02.08.2016	Malmö Stad	Direct meeting	Recorded
F	03.08.2016	Sustainable Business HUB	Direct meeting	Recorded
G	10.08.2016	Professor, SLU	Direct meeting	Recorded
H	11.08.2016	Malmö Stad	Skype	Recorded
I	12.08.2016	Conservation Biologist, Lund University	Direct meeting	Recorded
J	15.08.2016	Professor Lund University, Architect	Direct meeting	Not recorded
K	16.08.2016	Professor Malmö University	Direct meeting	Recorded
L	19.08.2016	Professor Malmö University	Direct meeting	Recorded
M	23.08.2016	Malmö Stad	Direct meeting	Recorded
N	23.08.2016	Malmö Stad	Direct meeting	Recorded
O	12.09.2016	Private Real Estate Company	Direct meeting	Recorded
P	16.09.2016	MKB	Direct meeting	Recorded
Q	10.01.2017	LTH, Lund University	Direct meeting	Not recorded

Appendix C. Information about the field trips

Ask author for further details.

Table 5. Places visited during field visit in the city of Malmö (Author´s material, 2016).

Date	Places
31st July 2016.	Rosengård, Dockan, Western Harbour, inner city, Hyllie and Nyhamnen
19th of August 2016	Western Harbour (Möteplats Skåne 2030)
23rd of August 2016	Western Harbour and Hyllie
8th of September 2016	Western Harbour and Hyllie
12th of September 2016	Western Harbour and Hyllie
26th of December 2016	Nyhamnen
4th of January 2017	Nyhamnen

Appendix D. Overview of municipal plans (2001-2016)

Table 6. Overview of analysed plans (Author, 2017).

Year	Name of published plans
2001	Bo01 – Green space factor
2003	Grönplan
2009	Environmental Programme for the city of Malmö 2009 – 2020 Climate smart Malmö Mijöprogramm Syd (stopped in 2016)
2012	Climate Change Adaptation Strategy BiodiverCity Miljöprogramm Syd 2
2013	Resilient city campaign Malmö´s path towards a sustainable future
2014	Comprehensive Plan for Malmö
2015	Action plan for the Environmental Programme 2015-2018 MEST Plan Ekosystemtjanster Odling over gränser Comprehensive Plan Nyhamnen
2016	Vattenplan BEST rapporten (Boverket och EkoSystemTjänsterna) Skyfallsplan för Malmö (remission) New environmental strategy (in the planning stage)
2017	New green plan: Plan för Malmös gröna och blå miljöer (in the planning stage)

Appendix E. Literature Review and Glossary of Terms

Table 7. Literature analysis (Author, 2017)

Sörensen, J., Persson, A., Sternudd, C., Aspegren, H., Nilsson, J., Nordström, J., ... Mobini, S. (2016). Re-thinking urban flood management – time for a regime shift. Water, 8(8), [332]. DOI: doi:10.3390/w8080332
Mottaghi, M., Aspegren, H., & Jönsson, K. (2016). Integrated urban design and open storm drainage in our urban environments: Merging drainage techniques into our city's urban spaces. Water Practice & Technology, *11*(1), 118-126. DOI: 10.2166/wpt.2016.016
Wamsler, C. & Pauleit, S. Making headway in climate policy mainstreaming and ecosystem-based adaptation: two pioneering countries, different pathways, one goal, Climatic Change (2016) 137: 71. doi:10.1007/s10584-016-1660-y
Mottaghi, M. (2015). THE NECESSITY FOR RE-THINKING THE WAY WE PLAN OUR CITIES WITH THE FOCUS ON MALMÖ. Towards Urban-Planning Based Urban Runoff Management. VATTEN – Journal of Water Management and Research 71: 37–44
Lenzholzer, S. (2015). *Weather in the city - how design determines the urban climate*. Netherlands: NAI Publishers.
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Demuzere, M., Orru, K., Heidrich, O., Olazabal, E., Geneletti, D., Orru, H., … Faehnle, M. (2014). Mitigating and adapting to climate change: Multi-functional and multi-scale assessment of green urban infrastructure. *Journal of Environmental Management*, *146*, 107–115. doi:10.1016/j.jenvman.2014.07.025
Davoudi, Crawford & Mehmood (2009). Planning for climate change. Strategies for Mitigation and Adaptation for Spatial Planners

Compact City	The OECD (2012) defined a compact city to have the following three components: dense and proximate development patterns, urban areas linked to public transport, and accessibility to jobs and local services.
Spatial planning	This thesis uses the definition of spatial planning as outlined by the spatial planning faculty of the Technical University Dortmund: it is an interdisciplinary field, focusing on the spatial development of living, working, and environmental conditions. It looks at different spatial levels. Its aim and objective is to analyze different spatial demands, conflicts, and opportunities, and to develop concepts, solution processes, and strategies until their implementation. Current and future problem-situations are anticipated (Ritter, 2004).

Appendix F. Additional material for Nyhamnen

Table 8. Overview of the different quarters in Nyhamnen (Author, 2016, data from comprehensive plan, Malmö Stad, 2015, p. 4)

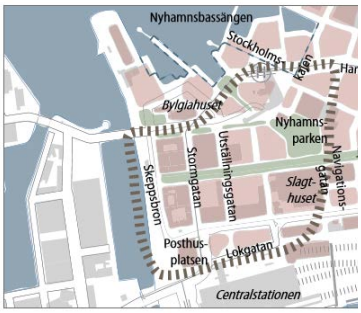
STATIONSOMRÅDET	NYHAMNSBASSÄNGEN OCH NYHAMNSPIREN	NYHAMNENS MITT	LÄNGS CARLSGATAN OCH VÄSTKUSTVÄGEN
			
			
			
1 out of 6 parks 2015 - 2035	1 out of 6 parks 2015 - 2045	4 out of 6 parks 2025 - 2055	0 out of 6 parks 2025- 2055

Figure 6. Collage of Nyhamnen (Author, 2017).