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WATER RESILIENT CITIES

Swedish cities and the need for the integrated urban water management with focus on flood resilience

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Introduction

According to the United Nations projection, until the year 2050, around 67% of the world's population will reside in the cities. The urbanization of these proportions usually has negative impacts on the water quality and hydrology (Qin et al., 2013). Due to the increased emission of contaminants and nutrients, the human health is at high risk as well as ecosystems of the large number of cities (Finotti et al. 2014). The climate is getting more and more unpredictable and intense which makes it more hostile to the urban environments. However, the severity of the climate change impacts is strongly dependent on the level of city's vulnerability to climate extremes (IPCC, 2012). More than half of the world's population lived in either river- or coastal cities during 2014 (UN, 2014). Almost 15% of the world's population, mainly urban, is predicted to be at the high risk of being flooded from river discharge or sea level rise (Ligtvoet et al. 2014). The climate change in combination with the rapid urbanization will most probably result in more flood issues, water scarcity and water pollution (Van Leeuwen, 2013). Severity and impact of the extreme rainfalls, due to the global warming, will be more noticeable (Jongman et al. 2014).

According to IPCC (Intergovernmental Panel on Climate Change) the rainfall increase will be up to 20% by 2100 in northern Europe, including Sweden, during the winter period (IPCC, 2007). Furthermore the climate change is believed to be a cause of very unpredictable weather. Just within the year 2013, four heavy storms happened in Sweden and two of them, Simone and Sven, affected the Öresund region. In August 2014 flash flood led to chaos in southern Sweden and caused serious damages in transportation network and buildings in Malmö. There is lots of evidence, indicating the necessity for increasing the preparedness in southern Sweden for even more extreme events. Copenhagen, just 40 kilometers away from Malmö, was hit by an extreme rainfall in July 2011. The total rainfall during the two hour period was almost 150 mm and it caused enormous damages in the city, almost reaching one billion Euros. Accordingly, the project aims to understand the role of urban planning with respect to the climate change in order to make the Swedish cities water resilient. The focus is on southern Sweden, Skåne County, which is threatened by water related environmental pressures.

Objectives

Due to the consequences of the climate change and geographical location, some of the cities located in Skåne County are among the most vulnerable places in Sweden. The purpose of this project is highlighting the necessity for understanding the water related environmental pressures and addressing them early, in the process of urban planning. Accordingly, four cities are selected in the region for this study. All these cities are casually dealing with various water-related challenges. Malmö and Helsingborg are the two major coastal cities of Skåne which will be flooded in case of the sea level rise. Kristianstad is located below the sea level and Eslöv has recently been experiencing floods in its urban areas. The target is to see if these cities need to take a different perspective on urban planning, design and building. Accordingly, an assessment approach has been chosen to evaluate the sustainability of urban water cycle services which gives us the opportunities for not only a national but also an international comparison.

Methodology

The evolution of urbanization and its future are yet uncertain but some development paths are more desirable. When it comes to the water challenges, a rich urban water cycle management is more likely to provide the city with water resiliency. According to the European environmental agency report, cities are facing three types of water related challenges categorized as heat waves, flooding, water scarcity and drought (EEA, 2012). Water pollutions could be also among the environmental pressures. However, the water quality target has been already achieved not only in Sweden but also in almost entire Europe. The combination of such environmental pressures with social and financial pressures is devastating for urban life. Thus, it is of the crucial importance for those to be presented and addressed in integrated urban water management. The urban water management objective is to ensure that no damage has been caused in the city or on the countryside, even when the precipitations or droughts are at their peaks (Potz, 2012). The City Blueprint baseline assessment is used to give a quick image of the sustainability of urban water cycle services (UWCS) of the four south Swedish cities, Malmö, Kristianstad, Eslöv and Helsingborg as well as Stockholm. This is a methodology which has been developed by KWR, Watercycle Research Institute in the Netherlands and has been applied further in the EU Research Project TRUST, and elaborated as contribution to the European Innovation Partnership on water (EIP Water), as a part of the City Blueprint Action Group. It is based on 24 indicators, where each has a score between 0 and 10 (Van Leeuwen, 2014).

The City Blueprint approach tries to promote the best practices, through sharing knowledge and experiences between the cities. The objective is increasing awareness among decision makers to develop the appropriate frameworks for transforming the cities to more water resilient ones. The key elements of the City Blueprint are simplicity, transparency and ease of communication (Van Leeuwen et al., 2012). The City Blueprint baseline assessment was used for making a comparison between Swedish cities in preparedness against water related environmental pressures, as well as understanding the possibilities of making improvement in urban water management in the Swedish context. The assessment has been done in collaboration with KWR. In order to collect the information, a questionnaire consisting of 24 questions has been provided by KWR. The questionnaire is available on p57-81 of the below linked document.
http://www.eip-water.eu/sites/default/files/City%20Blueprint%20questionaire__0.pdf

Each question refers to one indicator and the answer is a score from 0 to 10. Indicators are categorized in the following 8 categories: water security, water quality, drinking water, sanitation, infrastructure, climate robustness, biodiversity and attractiveness and governance. Some questions which are based on the national data have been answered without any need to contact local authorities. Questions regarding the local levels have been partially answered by the researchers, if the information was available at the local websites or municipal documents. Others have been answered by the local municipalities. The questionnaire has been sent to the experts in different departments of municipalities to be answered by stakeholders as well as giving the answers the final check. In the case of Swedish cities, the three main departments involved in this assessment were the city planning office as well as the environmental department and water utility. All the answers have been collected by the researchers and sent to KWR. They have put together all the information and created the final City Blueprint diagram of each city. At the end the Blue City Index (BCI) was calculated and is represents the overall score for UWCS sustainability with the maximum of 10 and minimum of 0.

UWCS assessment has been made for each city and followed by making national and international comparisons. A workshop has been organized and held through strong collaboration between VA-teknik (Water and environmental engineering) at Lund University, KWR from the Netherlands, VA SYD and different departments of the municipality of Malmö (Malmö Stad). Collaboration between all these partners and their input were very beneficial for this project. The workshop called '*Malmo Water Plan, From Idea to Practice'* has been held as part of this project in the city planning office of Malmö municipality.

Discussion

In southern Sweden the most problematic water challenge is flooding. In general sea level rise, river discharges or extreme rains can cause flooding. In most cases the urban drainage will be also flooded. By making a quick glance of the result of the City Blueprint assessment, concerning water pressures, we can make the conclusion that none of these cities deals with water scarcity. All the studied Swedish cities have been able to achieve high level of quality for surface water and ground water. However, in terms of flood challenges there are some indicators which clearly pinpoint the vulnerability of these Swedish cities to the flood hazards. Infrastructure separation, Climate commitment, Adaptation strategies, Climate-robust buildings and Management and action plans are considered as the flood related indicators in this research. Although all cities have achieved very high BCI and categorized in the blue cities categories, the research aims to highlight those urban water services in which cities require improvement in management. Despite that, in recently published article from KWR named '*City Blueprints: baseline assessments of water management and climate change in 45 cities',* Helsingborg turned out to have relatively highest BCI, 8.5 compared to other 44 cities. (Van Leeuwen et al. 2015). BCI for other Skåne cities are 7.4 for Eslöv and 8.0 for both Malmö and Kristianstad. The Score is 7.7 for the city of Stockholm.

Table 1. City Blueprint summery information of Malmö, Kristianstad, Eslöv, Helsingborg and Stockholm

	Malmö	Kristianstad	Eslöv	Helsingborg	Stockholm
1-Water footprint	7,0	7,0	7,0	7,0	7,0
2-Water scarcity	9,3	9,3	9,3	9,3	9,3
3-Water self-sufficiency	4,8	4,8	4,8	4,8	4,8
4-Surface water quality	9,6	9,6	9,6	9,6	9,6
5-Ground water quality	9,8	9,8	9,8	9,8	9,8
6-Sufficient to drink	10,0	10,0	10,0	10,0	10,0
7-Water systems leakage	9,2	9,5	8,5	8,1	8,3
8-Water efficiency	6,0	6,0	7,0	7,0	5,0
9-Drinking water consumption	9,3	7,3	6,0	9,7	3,6
10-Drinking water quality	10,0	10,0	10,0	9,4	10,0
11-Safe sanitation	10,0	10,0	10,0	10,0	10,0
12-Sewage sludge recycling	10,0	10,0	10,0	9,5	10,0
13-Energy efficiency	10,0	9,0	10,0	8,0	10,0
14-Energy recovery	10,0	9,0	10,0	10,0	10,0
15-Nutrient recovery	10,0	10,0	9,2	10,0	10,0
16-Average age sewer system	6,2	6,5	6,1	5,7	6,5
17-Infrastructure separation	7,9	9,3	9,3	9,0	6,5
18-Climate commitments	6,0	7,0	3,0	10,0	4,0
19-Adaptation strategies	6,0	6,0	3,0	9,0	4,0
20-Climate-robust buildings	7,0	3,0	3,0	7,0	9,0
21-Biodiversity	4,0	4,0	4,0	4,0	4,0
22-Attractiveness	5,0	9,0	4,0	10,0	6,0
23-Management and action plans	6,0	6,0	4,0	7,0	8,0
24-Public participations	10,0	10,0	10,0	10,0	10,0
BCI (Blue City Index)	8,0	8,0	7,4	8,5	7,7

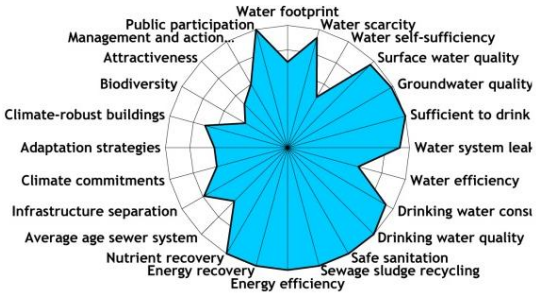

Figure 1. City Blueprint of Malmö, based on 24 indicator scores. The Blue City Index (BCI) is 8. The diagram is plotted by KWR.

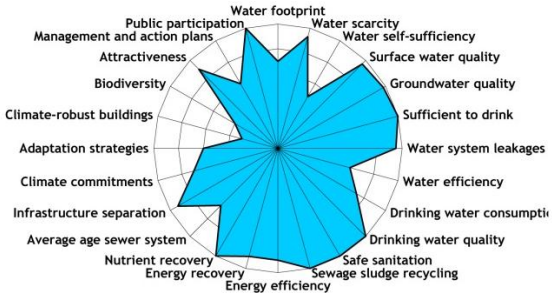

Figure 2. City Blueprint of Kristianstad, based on 24 indicator scores. The BCI is 8. The diagram is plotted by KWR.

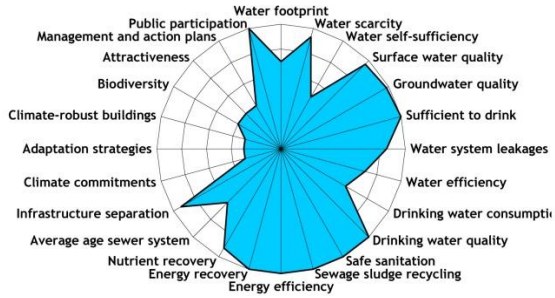

Figure 3. City Blueprint of Eslöv, based on 24 indicator scores. The BCI is 7.4. The diagram is plotted by KWR.

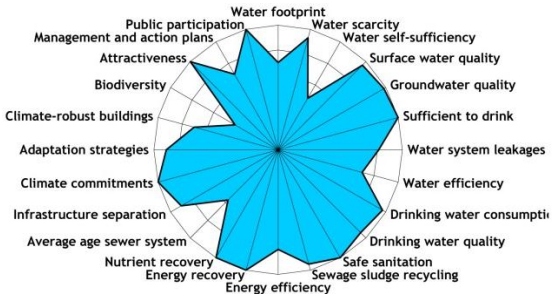

Figure 4. City Blueprint of Helsingborg, based on 24 indicator scores. The BCI is 8.5. Diagram is plotted by KWR.

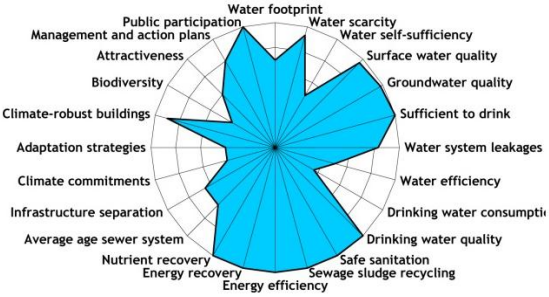

Figure 5. City Blueprint of Stockholm, based on 24 indicator scores. The BCI is 7.7. The diagram is plotted by KWR.

Generally speaking, according to Van Leeuwen et al. (2015) there is an obvious relation between BCI (the Sustainability of UWCS) and indicator 23, Management and action plans. This indicator is based on local data and is *"a measure of the application of the concept of Integrated Water Resources Management (IWRM) in the city".* There is also relation between BCI and VPI (indicator 24, Public participation). This indicator was answered based on the national data and is the same for all the cities, located in the same country. Moreover, there is correlation between BCI and various national indexes of the World Bank governance indicators such as Government Effectiveness, Regulatory Quality and Rule of Law and also with GDP (Gross Domestic Product). Nevertheless, each city has to build up a comprehensive flood resilience program and make the transition to a flood proof city. Integrated urban flood management is an essential path to be taken within a sustainable framework. In order to improve the Skåne cities' urban water management with respect to the intense and extreme climate change, there are some key indicators to take actions on. The national comparison shows how doable it is to improve different parts of the system. Sharing knowledge between the cities and learning from each another, particularly in the Swedish context, is usually of a great benefit. Table 1 reveals the possibilities of achieving higher flood resilience through emphasizing on some specific indicators and developing methods for implementation of flood resilience measures. In the text that follows, some comparison between the studied Skåne cities, with focus on flood related indicators, will be made.

Infrastructure separation

Extreme rainfalls and floods are the largest and the main cause of the more frequent overflow of the sewer system (Abdellatif et al. 2014). Infrastructure separation reduces the negative impacts of flood events. If Kristianstad, Eslöv and Helsingborg could be able to achieve the score of 9 out of 10, it is also possible for Malmö, with the score of 7.9, to get more benefits from infrastructure separation (Stockholm achieved the score of 6.5). In the City Blueprint assessment approach, infrastructure separation, indicator 17, is defined as *"a measure of the proportion of the wastewater system for which sanitary sewage and storm water flows are separated. In principal, a separate system is better than a combined system as extreme weather events may lead to sewer overflows into surface water. These sewer overflows are a major source of pollution. A lower Indicator score is given where the proportion of combined sewers is greater".*

Climate commitments

This indicator is defined as *"a measure of climate change commitments applied by the city authorities. A lower Indicator score is given where commitments are more limited"* and it is the 18th indicator of the City Blueprint approach. The assessment shows that there is more commitment to the climate change in the city of Helsingborg, achieved the maximum score of 10 than Kristianstad, Malmö and Eslöv with the scores of 7, 6 and 3 respectively (Stockholm achieved the score of 4).

Adaptation measures

This indicator is defined as *"a measure of the level of action taken to adapt to climate change threats. A lower Indicator score is given where actions or commitments are more limited"*. It is the 19th indicator of the City Blueprint approach and focuses on the implementation of adaptation strategies in the city. The assessment shows that there is more adaptation to the climate change in the city of Helsingborg, achieving the score 9, compared to Kristianstad and Malmö both with the score of 6 and Eslöv with the scores of 3 (Stockholm achieved the score of 4).

Climate-robust building

This indicator is the 20th indicator of the City Blueprint approach and defined as *"a measure of whether there is a clear policy for buildings to be robust regarding their contribution to climate change concerns (principally energy use). A lower Indicator score is given where policies are weaker".* The assessment shows there are stronger policies on climate-robust building in the city of Malmö and Helsingborg, both with the score 7, compared to Kristianstad and Eslöv, both with the score of 3 (Stockholm achieved the score of 9).

Attractiveness

This indicator is defined as *"A measure of how surface water features are contributing to the attractiveness of the city and wellbeing of its inhabitants"* and is the 22nd indicator of the City Blueprint approach .The assessment shows that surface waters have been applied in more attractive way in the cities of Helsingborg and Kristianstad with the scores of 10 and 9 respectively compared to Malmö with the score of 5 and Eslöv with the score of 4 (Stockholm achieved the score of 6). Implementation of innovative surface solutions is an approach to increase the city climate robustness. Investing more in urban blue-green infrastructure usually entails the richer biodiversity thus increasing the attractiveness. This topic has been addresses in *'Innovative storm water solution seminar and workshop'* which has been held in SBhub in April 2015. Presentations and the workshop report are available on the link:
http://www.sbhub.se/dokumentation/seminariepresentationer/2015/innovativa-dagvattenlosningar

Management and action plans

This indicator is the 23rd indicator of the City Blueprint approach and defined as *"A measure of the application of the concept of Integrated Water Resources Management (IWRM) in the city. A lower Indicator score is given where plans and actions are limited".* It also shows the relation between the Blue City Index (BCI) and urban water cycle services management and action plans. The assessment shows better IWRM is in the city of Helsingborg, the score of 7, and Malmö and Kristianstad, both with the score of 6, in comparison with Eslöv, with the score of 4 (Stockholm achieved the score of 8).

Role of Urban Water Governance

The evaluation and comparisson has been used to show the necessity for integrated urban water management and prioritizing the objectives due to the negative impacts of the climate change. Increasing water resilience requires long-term planning, which per se needs general improvement in urban water governance. The priorities, principles and strategies are different in each city and need to be clarified locally. However, further studies are required on the municipal priorities and working systems, which might be of use later for understanding the reasons behind such variation in climate commitment, adaptation measures, climate-robust building, and attractiveness as well as management and action plans which is out of the limits of this research. In order to deal with water challenges, there are some key interrelated questions on sustainable urban water management to be answered. It is inescapable for Swedish cities to take comprehensive approaches. Therefore, it is crucial to prioritize the goals and set a new planning hierarchy. Learning from other cities' experiences and sharing the knowledge, usually provides us shortcuts.

An international comparison has been also been made between Malmö, as the third largest and important city of Sweden, and the cities of Rotterdam, Hamburg, Copenhagen and Amsterdam and the result is published in the March 2015 issue of Vatten Journal. The paper is called *"The necessity for re-thinking the way we plan our cities with the focus on Malmö; towards urban-planning based urban runoff management"* in which the City Blueprint assessment is used to compare the flood resilience of the city of Malmö with front runners in urban flood management. All these cities are located along the North Sea and share some similarities with southern Sweden when it comes to the climate challenges. All of them have been exposed to devastating water catastrophes in their history. The paper is attached at the end of this document. The result showed that although, in general, the sustainability of urban water cycle services in Malmö is good, climate change adaptations have not yet been a part of the agenda of the Swedish cities' urban water management (Mottaghi et al. 2015).

According to OECD (Organization for Economic Co-operation and Development) report there is still need for protecting the OECD countries against water related risks. Sweden is also a member of OECD since 1961 and there is still need for improvement in three matters. *Urban infrastructure* generally requires upgrading and adaptation for providing urban water security. *Emerging pressures* are necessary to be addressed in urban water management while intensity and frequency of extreme events is increasing as well as uncertainty in predicting the climate. *Urban water governance* should be developed and fill the several existing gaps (OECD, 2015).

Swedish cities need to start defining the urban planning objectives, and go all the way down to integrating urban planning and water system planning and creating conditions for the change. All the planning steps should be elaborated down to the finest details and offer drainage guides for the future watersheds. As a result, urban and architectural design should be used as a helpful tool to overcome water challenges and at the same time reply to all different needs of society (Mottaghi et al. 2015). As indicated by OECD (2015) municipalities require setting priorities on urban planning. Skåne cities need to clarify their concerns as:

- Who is responsible to pay the additional cost for adaptation to the pressures on water bills?
- What innovative approaches are required and how should cities apply such approaches in urban water management?
- Since solidarity is important, clarifying how cities should co-operate is essential. Cities, as well as their rural surroundings, cannot pass problems to another region, city or even district. Each has to take the responsibility and apply the three-step strategies of retention, detention and drainage. Upstream and downstream solidarity along the Skåne borders is of the crucial importance in drawing up regional plans with specific flood zones.
- Last but not least, how can cities fill their governance gaps and achieve a sustainable urban water management?

Localization is essential. Cities are clustered in non-identical categories due to their exposure to water risks, urban features and institutional architecture. Even if in some parts of Skåne the risks are similar, they are different in features such as affluence, endowment in energy resources, city's surroundings, size of the population, urban dynamics and spatial patterns. Also they are not the same in fiscal autonomy, informal/soft co-ordination, inter-municipal authorities, super-municipal authorities and metropolitan cities (OECD, 2015). The result from '*Malmo Water Plan, From Idea to Practice'* workshop also

emphasizes on the importance of urban water governance and the internal municipal collaboration (Mottaghi, 2015). The workshop was planned with the hope of bringing experts together to the city planning office of Malmö municipality and giving them the opportunity to discuss the Plan for Malmö water with focus on the water governance. The report is attached at the end of this document and it is also on Malmö Stad website.

According to the UN, *"water governance encompasses the political, economic and social processes and institutions by which governments, civil society and the private sector make decisions about how best to use, develop and manage water resources"*(UNDP, 2004). In order to achieve effective water governance, cities need to become aware of the existing gaps and try to bridge them. According to the OECD multi-level governance framework (OECD, 2011; OECD, 2015), the gaps are divided into seven categories:

- Administrative gap: *"the ecological dimension of water cuts across spatial scales, but institutional, functional and hydrological logics affect its governance in cities".*
- Information gap: *"information asymmetries and difficulty in collecting and sharing data can affect the decision-making process".*
- Policy gap: *"several policy areas influence water governance in cities; policy coherence is often overlooked".*
- Capacity gap: *"limited scientific, technical and financial capacities of the local actors make it difficult to implement water policies and strategies properly".*
- Funding gap: *"unstable or insufficient revenues undermine the effective implementation of water responsibilities at the sub-national level".*
- Objective gap: *"conflicting objectives across water uses (agriculture, energy, etc.) and stakeholders can compromise long-term targets for integrated urban water policy".*
- Accountability gap: *"difficulties in ensuring transparent practices across the different constituencies affect engagement, deliberation and decision-making".*

Conclusion

In order to make the cities of Skåne more resilient to the climate change and its water related environmental pressures, storm water drainage systems must be managed in a way that makes them more functional in a dynamic way. The urban water management should be designed under influence of trans-scale thinking and through an appropriate collaboration. Different planning strategies and highlighting the water challenges in all scales of planning are the tasks which should be prioritized by the municipalities and sometimes even by the government. Integrated urban water cycle management and urban planning is the key to success and achieving sustainable urban environments. Sustainable planning is only achieved through combination of top-down and bottom-up approaches and it is different from city to city. In order to reduce the negative impacts of the climate change, cities need to move towards ecological urbanism. Since urban water governance plays the most critical role in improving the sustainability of urban water infrastructure, it is essential for cities to recognize the existing gaps and try to bridge them. Cities need a long-term vision and implementation plan. If political leaders wait, the cost of inaction will be very high and more expensive adaptation measures will be necessary.

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THE NECESSITY FOR RE-THINKING THE WAY WE PLAN OUR CITIES WITH THE FOCUS ON MALMÖ

Towards Urban-Planning Based Urban Runoff Management

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Abstract

The project is proposed in order to highlight the necessity for developing a climate-robust urban planning. The City Blueprint baseline assessment was chosen to evaluate the sustainability of urban water cycle services (UWCS) of Malmö and compare it with Rotterdam, Amsterdam, Hamburg and Copenhagen as cities which experienced extreme water events in their history. Although Swedish Municipalities previously have done many efforts for adaptation to climate changes, at least in case of Malmö the experiences showed that it was not enough. The City of Malmö needs to revise its methodology. The purpose of this paper is to encourage Swedish cities to take more advantage of urban planning and design in order to develop climate-robust planning and appropriate sustainable solutions for urban runoff management. Climate-robust planning is supposed to formulate strategies and reduce the collaboration gap between water and environmental engineers, urban planners, architects and all the cities' decision-makers.

Key words – Adaptive Planning, City Blueprint, Climate change, Climate-robust planning, Urban Design, Urban Planning, Urban runoff, UWCS, Water resilience, Blue-Green infrastructure

Sammanfattning

Projektets syfte är att visa på behovet av utveckling av klimatrobust stadsplannering. City-Blueprint baslinjebedömning valdes för att utvärdera UWCS hållbarhet i Malmö och jämföra det med Rotterdam, Amsterdam, Hamburg och Köpenhamn. Dessa städer har haft erfarenhet av extrema väderförhållanden i sin historia. Trots att svenska kommuner lagt ner mycket ansträngning i försök att anpassa sig till klimatändringar, visar erfarenheten åtminstone i Malmö, att det inte räckte. Malmö kommun måste revidera sin metodologi. Syftet med den här artikeln är att uppmuntra svenska städer att utnyttja fördelarna med stadsplanering och design. Målet är att betona behovet av robust klimatplanering samt hitta passande hållbara lösningar för dagvattenhantering i svenska städer. Den klimatrobusta planeraringens uppgift är att formulera strategier. Att reducera gapet mellan vatten- och miljöingenjörer, stadsplanerare, arkitekter och alla beslutsfattare i staden är av avgörande betydelse för det fortsatta arbetet.

Introduction

According to the United Nations projection, in 2050 around 67 % of the world's population will live in cities and it implies the megatrends in the future. It is documented that urbanization has negative impacts on the hydrology as well as the water quality (Qin et al., 2013). On the other hand the climate change is expected to be more intense and unpredictable and induce more economic instabilities. The severity of the impacts depends on the level of exposure and vulnerability to weather and climate extremes (IPCC, 2012). Sweden, like many other countries, is also believed to be affected by the climate changes and face more rainfalls, storms and sea level rise in the future (Scaife et al., 2012). If cities do not get prepared enough to deal with the situation, they

will be at high risk of facing the consequences of catastrophes with huge stress involved. Minimizing the negative environmental impacts and providing people with safety and security are of crucial importance for all municipalities. Cities need to be developed based on the future challenges and become more resilient. Although the cost for revising the water infrastructures is high, the cost of failure in climate change adaptation strategies will be higher. In other words, early adaptation will be less costly. Accordingly, it is necessary to take the crucial steps of integrating water and urban planning and improving the technical and design aspects together and create more qualified urban environments. Addressing the future challenges are the main objectives for developing theoretical and practical methods for transformation of the cities to water resilient ones. Climate change impacts should be understood and measured during the process of urban planning and design. All departments of municipalities should realize and take advantages of art, technology and design potentials. They have to make sure whether all layers of cities infrastructure (in terms of aesthetical-, social-, environmental-, economical-, functional-, technical aspects, etc.) work together or not.

The Development of Urban-Planning Based Water Management

Urban-Planning based water management uses the planning and design as a more efficient tool in urban water management. It also helps to apply the full-potential of urban spaces and vegetation in the process of urban water management. Vegetation and open spaces can also take some additional roles in urban runoff management. Techniques such as adaptive urban landscaping or vegetated storm water treatment systems, including bio filters or rain gardens, green roofs and facades, wetlands, swales and so on are some samples of practical methods. Most of the techniques are about mimicking the nature as a resilient system. Creating natural topographies, pavements, using specific vegetation, etc. are some of the elements that enable the creation of attractive urban space.

We need a good understanding of how water catchment areas are connected and how they work together. The same kind of understanding also applies to the cities' green infrastructure. Furthermore, having a comprehensive knowledge of the cities' existing land use and physical plans, as well as the residents' needs, are of crucial importance.

To deal with the urban runoff, different sustainable solutions, as storm water management techniques, have been developed. The techniques are called Water Sensitive Urban Design in Australia, Sustainable Drainage System in UK or Low Impact Development (LID) in US but the objectives are the same. They all depend on the management measures to control the storm water. However, all the techniques have different effectiveness during storm events (Qin et al., 2013). It is very important to study the area to understand the context and the possible rainfall characteristics which might occur in the area.

To describe the storm water management techniques, Water Sensitive Urban Design (WSUD) is explained as an example. WSUD a term in the planning and design of urban environments to make them sensitive to water issues and it is based on integration of urban planning with the urban water cycle management (Wong, 2011). Through WSUD, cities let their communities live in harmony with natural water environments and make them more resilient to the challenges. In a water sensitive city, planning and design are done around the issues of water conservation and risk of flooding in parallel with improving the cities' livability. As a part of WSUD, natural systems and green infrastructure requires effective management to take part in sustainability and livability of our urban environments (Wong et al., 2013).

In all storm water management techniques, management of sectors such as planning, transport, energy and health, functions as a part of integrated water cycle management and provides principles for sustainable development strategies (Langford, 2011). There are several sustainable open drainage systems that provide different functions during the process of drainage. Achieving attractive and functional open urban spaces and open storm-water solutions at the same time, is an ideal situation for cities. Getting to this situation, the comprehensive regional plans needs to be well-matched with storm drainage systems. To start with, "Drain Programs" are required for removing the gap between the water levels that drainage systems can cope with today and the levels that they need to be able to cope with in the future. Since the four main characteristics of climate changes are uncertainty, contentiousness, multiplicity and complexity, adaptation to climate changes requires "adaptive spatial planning". In other words, adaptation measures cannot be implemented as single-purpose strategies. It needs multifunctional adaptation strategies with a clear win-win character (Buuren, 2013). Planning of storm water for any site should be coordinated with planning of land use and the master plan (UDFCD [1], 2008). Drainage facilities require work with both open spaces and transportation simultaneously. Thus, new identified opportunities may assist to solve the drainage problems (UDFCD [1], 2008). Merging urban life and adaptation strategies is very important. As a practical sample,

Figure 1. *Watersquare Benthemplein in Rotterdam combines water storage with urban spaces. Photos are obtained from Rotterdam Climate Initiative Press kit.*

we can mention Watersquares, proposed in some Dutch cities, as multifunctional solutions applied in the flood resilient urban planning (Figure 1).

Assessment of Malmö Urban Water Cycle Management

The urban water management objective is to ensure that no damage has been caused in the city or on the countryside, even when the precipitation or drought are at their peaks (Pötz, 2012). The City Blueprint baseline assessment is used to give a quick image of the sustainability of urban water cycle services (UWCS) of Malmö as the third largest city of Sweden. This is a methodology which has been developed by KWR, Watercycle Research Institute in the Netherlands and has been applied further in the EU Research Project TRUST, and elaborated as contribution to the European Innovation Partnership on water (EIP Water), as a part of the City Blueprint Action Group. It is based on 24 indicators, where each has a score between 0 and 10 (Van Leeuwen, 2014). The City Blueprint tries to promote the best practices through sharing knowledge and experiences between cities. The objective is increasing awareness among decision makers to develop the appropriate frameworks for transforming cities to more water resilient ones. The key elements of the City Blueprint are simplicity, transparency and ease of communication (Van Leeuwen et al., 2012). The goal for choosing the City Blueprint assessment method, for the evaluation of Malmö's UWCS, was comparing it with some other European cities like Rotterdam, Amsterdam, Hamburg and Copenhagen. All these cities are located along the North Sea and share some similarities with southern Sweden when it comes to the climate challenges. All of them have been exposed to devastating water catastrophes in their history.

The study showed that, Malmö achieves a very good score for the Blue City Index (BCI) (Figure 2). BCI is the average of 24 indicators with the maximum of 10. Although Malmö Blue City Index gets one of the highest scores, almost equal to Hamburg and Amsterdam, the indicators which are categorized under the groups of Water Security, Water Quality, Drinking water, Sanitation and infrastructure are the ones that score highest. On the other hand for some of the indicators related to the climate robustness and governance with focus on water resilience and integration between blue and green structures, Malmö gets almost the lowest score among all these cities. The low scores of Malmö belong mainly to indicators of Commitments to climate change, Climate change adaptation measures, Climate-robust buildings, Attractiveness and Management and action plans (Table 1).

Referring to other countries' experiences shows that, depending on local conditions, the management process is picked up differently. Countries such as the Netherlands started to rethink the way they plan their cities after extreme events and enormous damages. It was no other choice for the municipalities but taking a holistic approach towards water resilience. Another very good example is Copenhagen, just 40 kilometers away from Malmö. After enormous damage from the extreme rainfall in July 2011 with the precipitation of almost 100 mm/hour, two plans were developed. One is the Copenhagen Climate Adaptation Plan (2011) which sets the framework for implementation of climate adaptive measures in the city administration area. The plan con-

Tabel 1. *Comparison between the five indicators which have a strong relation to planning. The information is obtained from EIP Water. City Blueprints® of 30 cities and regions and its Annex 3. Reports of cities/regions Van Leeuwen (2014).*

Indicator	Commitments to climate change	Climate change adaptation measures	Climate robust buildings	Attractiveness	Management and action plans
Rotterdam	9	10	9	8	8
Amsterdam	8	10	7	9	7
Hamburg	10	10	10	10	10
Copenhagen	8	8	6	10	8
Malmö	6	6	7	5	6

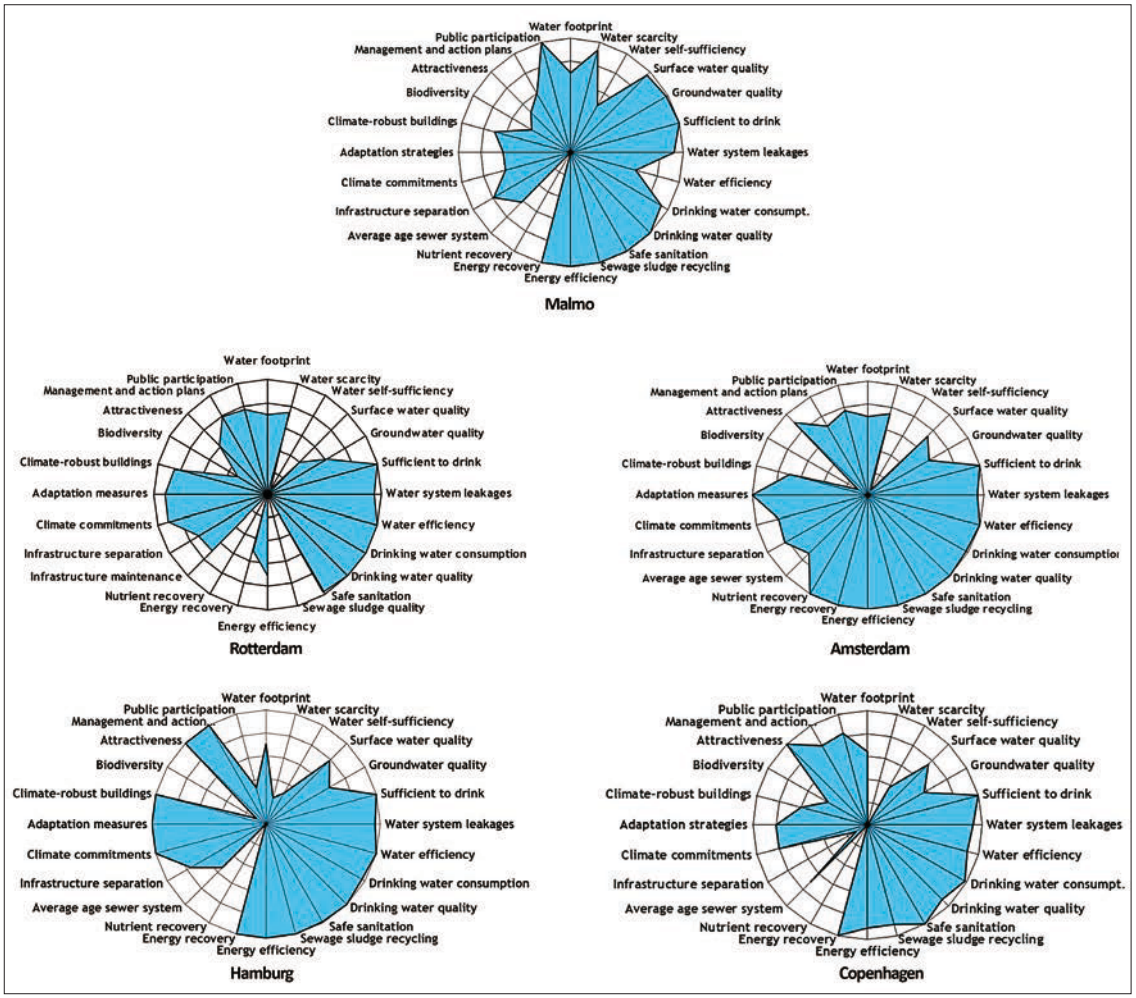

Figure 2. *Comparison between City Blueprints of Malmö and cities of Rotterdam, Amsterdam, Hamburg and Copenhagen. The diagrams are obtained from EIP Water. City Blueprints® of 30 cities and regions and its Annex 3. Reports of cities/regions Van Leeuwen (2014).*

sists of three adaptation levels in Region Scale, Municipality Scale, District Scale, Street Scale and Building scale. The three levels are reducing likelihood of the event; reducing the scale of the event and reducing vulnerability to the event. The second plan is The City of Copenhagen Cloudburst Management Plan (2012) as a branch of the first one. It is mostly defining the methods, priorities and measures. In Copenhagen, surplus water is not addressed as a problematic challenge but a resource for pleasure and value. It is supposed to provide the city with a robust framework for sustainable design solutions in the future. For a better management, Copenhagen was divided into seven water catchment plans and followed by breaking down all the seven areas into projects. All the planning and design within the city should pass the Climate Unit City of Copenhagen and need to be in parallel with each other and match Copenhagen climate adaptation strategies. Balancing between robustness and flexibility is a challenge within the process of both spatial and physical planning of our cities (Buuren, 2013). Cities need to exhibit a good level of adaptation before the climate changes start reaching the peaks of their destructiveness (Figure 3). All the cities that have been pioneers in considering the climate changes in urban water cycle services, have been going through water catastrophes in their past. Swedish cities do not need to wait for a real catastrophe to understand how to set and transform strategies and analysis into actual projects. Other cities' experiences should be our wake-up calls. "The longer political leaders wait, the more expensive adaptation will become and the danger to citizens and the economy will increase" (Jacqueline McGlade, former EEA Executive Director).

Figure 3. *Watersquare Benthemplein on a dry and sunny day (upper image), after a heavy rainfall (middle) and during a cloudburst (lower image). Photos are obtained from Rotterdam Climate Initiative Press kit.*

Planning the Swedish Cities

It was always hard to accept that the drainage of storm water should be one of the important parameters that should influence the city planning. There were always priority related conflicts between city planners, developers and drainage engineers. According to Peter Stahre; "the best way of tackling the conflict, is to establish a spirit of close and trustful co-operation between the involved municipal departments" (Stahre, 2006). Realizing the importance of highlighting storm water issues at a very early stage of the planning is the key to achieve sustainable urban drainage which should be addressed in the different levels of the physical planning (Stahre, 2006). In case of Malmö, the municipality was always trying hard to give this city a Blue-Green character. It was initiated in 2000 by publishing the Storm-water Strategy for Malmö and setting the principles for storm water management. The book Blue-Green fingerprints in the city of Malmö, written by Peter Stahre in 2008 is also a document proving how important this issue was for Malmö. The book tries to set a framework for the transition from a traditional urban drainage to more sustainable urban drainage. By overviewing the implemented facilities for Malmö and its storm water runoff, the document shows how the approach was developed from the end of 1980ies.

As one of the best practices of Malmö that shows the design power and the necessity of interdisciplinary urban design, we can mention Augustenborg Eco-City which was formed based on integrated urban-water planning. The Augustenborg settlement was developed in the 1950's. In the 1970's people started to move out and social status of the area started to decline. The Eco-City of Augustenborg started 1998 as a good example of transforming an urban area within the framework of sustainability. The goal was solving the overloaded sewer

system problem during heavy rains with ecological techniques such as green roofs, green gardens, different drainage canals, mini wetland, pond, swale, permeable pavements etc. (Stahre, 2008). The municipality not only implemented solutions for water challenges of the area, but also made the area more attractive and popular through ecological storm water techniques (Figure 4). The techniques have both appealing appearance and fulfil their purpose. Figure 5 shows the area during the storm in Malmö on 31 of August 2014. There is no official report on the damages of the city available yet, but the field studies show that Augustenborg managed the runoff much better than before the constructed retrofit.

Role of Planning and Design

Regardless of what has been so far the BCI results of Malmö clearly indicate the necessity of making Malmö more resilient and that water issues should be more effectively integrated in the urban planning process. Since all the five mentioned indicators (Table 1) are somehow related to physical and spatial planning, Malmö as a sample of Swedish cities needs more improvement in its blue-green infrastructure. There are also other signs emphasizing this need, such as the storms which recently struck Sweden. Just within the year 2013, four heavy storms happened in Sweden and two of them, Simone and Sven, affected the Öresund region. In August 2014 flash flood led to chaos in Southern Sweden and caused serious damages in transportation network and buildings in Malmö. Furthermore the climate change is believed to be a cause of very unpredictable weather. According to IPCC (Intergovernmental Panel on Climate Change) the rainfall increase will be up to 20 % by 2100 in northern Europe during the winter period (IPCC, 2007).

Obviously the cities still need a better understanding of tackling large quantities of water, either from the sea level rise or the extreme rainfalls. Water challenges needs

Figure 4. *Storm water Ecological techniques on a usual day in Augustenborg EcoCity. Photos are obtained from VA SYD.*

Figure 5. *Storm water Ecological techniques in Augustenborg EcoCity during the rainfall 31 of August 2014. Photos are taken by Henrik Thorén. The places are the same as the Figure 4.*

to be considered through the process of developing cities. The capacity of existing sewage pipe systems is limited. The drainage systems will be overloaded while the urban runoff has more volume than the predicted. Planning strategies and measures within a well-organized framework are needed when dealing with larger quantities of urban runoff. Every stage of urban planning should be done in parallel with planning of green spaces and water facilities. On the other hand adaptation needs to take place through an interdisciplinary procedure. A combination of artistic and scientific approach is essential to take us towards climate-robust urban planning. This is where design, architecture and engineering knowledge needs to meet and stimulate each other.

Considering the expected and unexpected water challenges during the planning will help cities to achieve a more resilient environment. Integrating the planning process with the climate adaptation strategies and techniques minimizes the flooding risks and negative impacts. Of course it will be a long run process but an early start is vital. We need an effective management which covers mitigation of side-effects as well as adaptation to the extreme situations. In other words, it is necessary to make the cities ready for both preventing the challenges and dealing with the already occurring ones. To implement the approach, all departments and administrations should start working together from the initial stages of planning. In Sweden, planning has three steps. *Comprehensive Planning* as a general one for the total area, *Local Planning* which is more about the detailed development planning like specifying the land use or height and finally it comes to the *Building Planning*. In each and every step, the planning needs to be integrated with adaptation to climate change. Many urban design elements such as green structures and roads should be applied in the direction of flood resilience. Therefore, cities need to be planned based on inclusive climate adaptation strategies.

Conclusion

Although, in general, the sustainability of urban water cycle services in Malmö seems good, climate changes adaptation has not yet been a part of the agenda of the Swedish cities' urban water management. It is inescapable for Swedish cities to take comprehensive approach towards the urban run-off management. Since the pipe systems are limited, open urban spaces have some potential to assist the urban runoff management. Although, in general, the sustainability of urban water cycle services in Malmö is good, climate change adaptations have not yet been a part of the agenda of the Swedish cities' urban water management. Therefore, it is crucial to prioritize the goals and set a new planning hierarchy. Learning from other cities' experiences and sharing the knowledge, provides us shortcuts. Malmö also needs to start defining the urban planning objectives, and go all the way down to integrating urban planning and water system planning and creating conditions for change. All the planning steps should be elaborated down to finest details and offer drainage guides for the future watersheds. As a result, urban and architectural design should be used as a helpful tool to overcome water challenges and at the same time reply to all different needs of society.

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Malmö Water Plan, From Idea to Practice

Workshop

7 May 2015

LUND UNIVERSITY sweden water research VASYD Malmö stad

Malmö Water Plan, From Idea to Practice

Workshop

Stadshuset, Stadsbyggnadskontoret, Room 4033

7 May 2015

This workshop was planned with the hope of bringing experts together to the city planning office of Malmö municipality and giving them the opportunity to discuss the Plan for Malmö water with focus on the water governance. On the May 8th Malmö stad organized a conference on Malmö water and climate in which the important target group was the politicians and officials who usually do not work with water and climate change issues. The goal was highlighting the necessity for the city of Malmö to adapt to the climate change. Kees van Leeuwen, from University of Utrecht in Netherlands and KWR Water Cycle Research Company was invited, among other speakers, to give a presentation on water governance. This workshop was organized on May 7th through strong collaboration between Lund University, Sweden Water Research Company, Malmö stad and VA SYD. The suggestion for the workshop came from Tyke Tykesson from city planning office of Malmö stad. The planning came from Misagh Mottaghi from Va-teknik at Lund University, when she was doing part of her research studies in the Netherlands at KWR. The goal was achieving a broader perspective of the ongoing work with Malmö water plan and weighing up the pros and cons of the current framework. Below are the list of speakers and participants that were from different departments and specialties which are somehow involved in the future Malmö water plan.

Speakers:

Kees van Leeuwen is a principal scientist from KWR Watercycle Research Institute, in the Netherlands. He studied biology and is a professor of water management and urban development at Utrecht University. He used to work at the European Commission as a Director of the Institute for Health and Consumer Protection of the Joint Research Centre in Ispra, Italy. He currently coordinated the City Blueprint action group of the European Innovation Partnership on Water of the European Commission: http://www.eip-water.eu/City_Blueprints

Stef Koop is from KWR Watercycle Research Institute, in the Netherlands. He has reviewed and revised the city blueprint assessment framework for sustainable water management**.**

Misagh Mottaghi from VA-teknik Lund university, is an architect, urban designer and leader of the two projects, "*Adaptive urban landscape and solutions to water challenges in Europe* "and "W*ater resilient cities of Sweden*". Both projects are addressing the role of physical and spatial planning in tackling the flood issues in urban areas.

Participants:

Tyke Tykesson, Tor Fossum, Åse Andreasson and **Mikael Ström Remin** from city planning office of Malmö stad
Rasmus Fredriksson from environmental department of Malmö stad
Andreas Nordin and **Anders Nilsson** from streets and parks department of Malmö stad
Christian Röder from real estate department of Malmö stad
Kristina Hall and **Christopher Gruvberger** from VA SYD, water utility
Kees Van Leeuwen and **Stef Koop from** KWR, water cycle research institute
Misagh Mottaghi, Karin Jonsson and Salar Haghighatafshar from VA-teknik Lund University

Thursday 7 May 2015 13:00-16:30

Introduction

This workshop was part of the two ongoing research projects called *"Water resilient cities of Sweden* "and "*Towards adaptive urban landscape and solutions for water challenges in Europe* " lead by *Misagh Mottaghi* at VA-teknik Lund University.

Tyke Tykesson, who is responsible for the Malmö water plan, welcomed the participants and emphasized the role of water governance in the process of providing the Water Plan for the city of Malmö.

The workshop started with an introduction part. *Kees Van Leeuwen,* together with *Stef Koop*, held a presentation on governance challenges in integrated water resource management. The presentation was continued with a short presentation by *Misagh Mottaghi* about different approaches taken by Dutch cities of Rotterdam, Amsterdam, Dordrecht, as well as Copenhagen which have been flooded severely in their history. The focus was on how water governance should work and what will happen if we do not have the appropriate framework, legislation and water governance.

The definition of Water Governance was emphasized in the introduction part. According to the UN, "water governance encompasses the political, economic and social processes and institutions by which governments, civil society and the private sector make decisions about how best to use, develop and manage water resources".

As required principles to water governance, the five principles of "**taking the initiative**", "**emphasizing outcomes**", "**seeking consensus**", "**being reasonable**" and "**maintaining credibility**" were mentioned. As a general conclusion on the introduction part, cities require a

long-term vision and implementation plan. If political leaders wait, the cost of inaction will be very high and more expensive adaptation measures will be necessary.

In order to achieve effective water governance, cities need to become aware of the existing gaps and try to bridge them. According to the OECD multi-level governance framework (OECD, 2011; OECD, 2015), the gaps are divided to the seven categories:

-**Administrative gap**: "the ecological dimension of water cuts across spatial scales, but institutional, functional and hydrological logics affect its governance in cities. "

-**Information gap**: "information asymmetries and difficulty in collecting and sharing data can affect the decision-making process. "

-**Policy gap***:* "several policy areas influence water governance in cities; policy coherence is often overlooked. "

-**Capacity gap**: "limited scientific, technical and financial capacities of the local actors make it difficult to implement water policies and strategies properly."

-**Funding gap:** "unstable or insufficient revenues undermine the effective implementation of water responsibilities at the sub-national level. "

-**Objective gap**: "conflicting objectives across water uses (agriculture, energy, etc.) and stakeholders can compromise long-term targets for integrated urban water policy. "

-**Accountability gap**: "difficulties in ensuring transparent practices across the different constituencies affect engagement, deliberation and decision-making. "

After the introduction part, the participants had a 20 minute discussion about challenges that the city of Malmö deals with. It was mainly about extreme events such as cloudbursts and sea level rise as well as the difficulties of ongoing work with the water plan.

Challenges:

What are we facing? What kinds of flooding related issues do we have in Malmö? Will the problems increase?

We do not exactly know what we are facing in Malmö. Our knowledge goes back only two years, when in 2013 the city had been flooded not only from the sea level rise, also from an extreme rainfall. The main challenges which have been realized so far are divided into:

- ***Climate change***

  Malmö, as well as many other cities in Northern Europe, is facing extreme climate change which may worsen water services and the quality of urban life. We know the climate change is getting more intense and unpredictable and we have enough scientific evidence for this. Modeling studies, such as the one done by IIASA, show that the extreme weather events will increase 5 times from now until 2050 (Jongman et al., 2014). We are already experiencing serious problems here in Malmö since we are witnesses of both sea level rise and heavy rain events. The height of recent tides was the largest since the past 130-140 years.

- ***Two major types of floods***

  Malmö mainly deals with two kinds of floods. Flooding from the sea level rise and flooding from the extreme rain events. Flooding from Risebergabäcken (stream) is not a real problem except in some specific areas where it causes serious problems.

- ***Public awareness***

  There is limited public awareness in these issues and people are convinced that they do not have any power or possibility to do anything themselves. They rely on the municipality too much when dealing with these issues. People can do a lot to protect themselves and avoid many issues. We could see that people did not understand the magnitude of the rainfall so much and instead e.g. they just drove their cars without even thinking that they could get stuck when the water is too deep. Bus drivers drove straight into the heavily flooded underpass and all the people had to be evacuated. Some people invest a lot in their basements and sometimes fill them with high-tech audio-video facilities without even thinking about protecting it from the flood. They think it is municipality that needs to handle it. They should have taken some responsibility for their own safety and their house. They can e.g. invest around 5000 Euros more and have waterproof walls. If they are aware enough of the threats, they will never arrange an expensive basement without preparing it for the worst case flood situation.

- ***Political awareness***

  It is surprising that the initiative did not come from Swedish politicians after the last rain compared to Danish politicians which took initiative after the big flood in Copenhagen. Politicians often react on issues only if the issue affects people, who vote for them. It seems the issue was not yet close enough to affect those people. They usually look at the current severity of the event. Fortunately the events were not as heavy as many other cities in Europe. Nobody died and there were only some damages, including cars and properties. This indicates that we also need to invest on increasing the awareness among the politicians.

- ***Educational gap***

  When it comes to water challenges we really need to improve the educational system. It is necessary even among the politicians. To most of them, the only problem is the size of pipes. Thus they give signals that the solution is having the bigger pipes. Unfortunately this is the perception of majority of people, even some of those who work with water challenges or those who have important role in shaping the urban environments. Bigger pipe is not the solution since it is expensive and inflexible. It is also not an environmentally friendly solution. A calculation is done by VA SYD on the minimum size of the pipe system that would be able to handle the last rainfall in August 2014. The 2000 km pipe, one meter in diameter, is needed for the extra water from Rosendahl and Turbinen drainage areas which cover approximately a third of Malmö. This is an enormous investment and entails a huge infrastructural change which makes it understandable that the smart solution is not only burying the bigger pipes.

- ***Time matters***

  It is essential to go through all the different stages of “being convinced with facts”, ”putting the plans in place“ and “getting support from third parties and other stakeholders“ in which timing is crucial. We need to be considerate of time and reduce it between idea and implementation as much as we can. E.g. in the new planning of Malmö, we are not supposed to build less than 3 meters above the sea level, due to the sea level rise. Although the decision was made almost seven years ago, it was addressed in the comprehensive plan just one year ago while many constructions have been going on without considering this rule for seven years. Unfortunately most of the newly built areas in the city are actually below this limit, central city and the old city, western harbor where lots of money have been pumped in during the last couple of years and the northern harbor where industries will be concentrated for the next 50 years.

- ***The Streets***

  After the Sven storm in 2013, in which the water rose almost two meters, one run-off modeling was provided by the municipality. In this model, Malmö is imagined to undergo the same rain event as Copenhagen went through in July 2011. It shows that if the rain had fallen evenly, it will mainly remain on the streets, especially in central Malmö. Although the map is completely unrealistic and without the knowledge of the exact magnitude, it gives us some ideas of what will happen.

- ***Insurance companies***

  According to reports like IIASA, insurance cost for flooding have increased 5 times more in the last 10 years and expected to increase more in the next decades. Malmö needs to avoid the situation where insurance companies refuse to insure people's properties. Insurance companies made a calculation on the cost of flooding in 2014 and it was 100 million Euros. They estimated that the price for insurance for 6 hours of rain in Malmö in 2014 was around 30 million Euros which means a third of the total cost for one year.

- ***Sufficient material***

  The materials such as risk assessment and economic model are of crucial importance for increasing the awareness between different stakeholders. Malmö needs risk assessment in order to show that if we do not react now and such crisis happens again, it will cost much more. Unfortunately, at the moment, there is no awareness of the necessity for thinking long term among the economists. On the other hand we need to be aware of the fact that many of economic models are lousy. There are institutes like IIASA or JRC or the European Environment Agency in Copenhagen, which work on such predictions and they can provide us with lots of information. Through using right materials the politicians will also become more aware of the situation. Sometimes we can use the materials and experiences of other cities as shortcuts. E.g. after hurricane Sandy in New York, the city made a very comprehensive study. They concluded that artificial infrastructures such as pipes are not the solution. They realized, in order to reduce the combined sewers' overflow there is a need for greener solutions. In some cases we can also use reports from such cities, to convey that message.

- ***Involvement of different parties***

  There is a need for involvement of different parties (OECD, 2015). The challenge is a multi-dimensional one which requires a strong collaboration between different sectors and parties such as insurance companies. Through such involvements, it would be even easier to convey messages to political use. We need to take initiatives. We really have to think about ways to absorb their attention and convince them.

- ***Lessons from Copenhagen***

  Copenhagen is a very close neighbor to Malmö, just on the other side of the Öresund Bridge. Copenhagen and Malmö went through very similar crisis which means Malmö can learn a lot from it. Although there are some differences between these two cities, they are very similar in many aspects which make them comparable. From the climate point of view, they are quite similar but at the same time different in many ways. Copenhagen sewage system is older than Malmö and in Malmö we have more separated systems. Malmö has around 35% combined system and 65% separated system while Copenhagen has almost 90% combined and only 10% separate system. The rain flooded Copenhagen should also have affected Malmö, but that day Malmö was lucky enough. A summary of the experiences in Copenhagen has been published (Leonardsen, 2012).

- ***Magnitude***

  Of course, the size of event will be very important for cities to react. The magnitude of what was happening in Copenhagen made the population aware of the necessity for changes in the laws. Besides, it is also crucial which priority the government is putting on the city. E.g. Copenhagen is capital, which means the Danish government is focused on it while our government is focused on Stockholm, where issues of this kind are rarity. Accordingly, sometimes there are big differences between the cities. Copenhagen has stronger possibilities and of course higher awareness among the people also makes the necessity for changes more understandable.

- ***The costs***

  We know it will cost a lot of money. On the other hand, the costs of inaction are much higher, and that has been the reason why Copenhagen has started an action to make the city more resilient. Next step is finding the way to make people understand that this will cost and they need to provide the money for this. We have to find understandable solutions for the economists and politicians which make it easier to implement the measures.

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Workshop questions:

The participants were divided into three working groups and each group was discussing all the three questions for one hour. Each working group had a chair person who had the responsibility to report as well. At the end the rapporteurs talked about the key answers to the questions.

The workshop was addressing the three following questions:

1. Where does Malmö stand today? Where should it go? What have we done so far? What has been achieved?
2. What is missing? Who are the main stakeholders? What is the strategy for the community involvement? How do we include other stakeholders?
3. What can we learn from other cities? Do we need a central coordinating unit in Malmö? Any other recommendations?

Question 1

Where does Malmö stand today? Where should it go? What have we done so far? What has been achieved?

- **Threats.** Malmö, as well as many other cities, is going to face extreme climate changes and it is also likely to suffer from enormous damages from catastrophes if it does not get prepared to deal with water challenges. Recently it has also experienced two extreme events that revealed some vulnerability.

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- **Climate resilience.** Malmö municipality is aware enough that it needs to be climate proof as well as water proof and comprehensive planning plays an important role within this process.
- **Win-Win situation.** Malmö wants to stay attractive, by being secure. To get there, different plans need to work together which requires strong collaboration between different departments. E.g. Cloudburst plan needs to be matched with the plans for transportation, green infrastructure and etc.
- **Densification.** Since we do not want to expand the city over the farmlands, we decided to go for inner-city densification. The decision is already applied in the comprehensive plan, which might not necessarily be matched with solutions for the water challenges. Since densification usually leads to thinning of the city greenery and replacement of parks with buildings, we need to focus on roofs, edges of the streets as well as multifunctional open and public spaces. We also need to regulate the design of the streets in development plans as well as being aware of the difficulties of addressing multi-functionality in the planning stage.
- **Influence on land owners.** We have to rely on actions both on private properties and public lands. Municipality does not have the ownership of most of the lands. The only control that municipality has over these lands is during the planning phase. Accordingly, providing the cloudburst plan is very important.

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- **Impact study.** We have made rainwater modeling "Översvämningskaraktärisering" which can be used as input in planning on different levels.
- **Cloudburst Plan-initiation.** We know what we need to do, but we have not done much yet. The Cloudburst plan was already decided and started just two months ago.

Cloudburst plan and action plan can give us some input when discussing localization of important functions.

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- **Awareness.** We have achieved more awareness but it started recently and has a long way until satisfactory. Besides, Swedish records gave us more information on the amount of reported incidents.

Question 2

What is missing? Who are the main stakeholders? What is the strategy for community involvement? How do we include other stakeholders?

- **Plans.** The key is comprehensive plans which should be provided before any other measures.
- **Budget.** Most probably, we need a separate funding for climate adaptation. We also need to find out how to finance the measures.
- **Enough awareness.** Even if the plans are in place, awareness inside municipality, among politicians, private and public sectors, etc. need improvement.
- **Legislation.** There is need for updating the legislation in regards of the ability to defend against flooding. We need synchronized policies and set of laws. E.g. If we want land owners to take the responsibility of security, in some cases we need to do against the national law.
- **Implementation of rules.** There is a delay between setting rules and implementation. Also some of the cities' critical infrastructure are not still covered by any new rules e.g. in terms of sea level rise new buildings should be at least 3 meters above the sea level, while the city tunnel is located much lower.
- **Tax system (paying).** With current legislation we are only allowed to develop the specific area where the money is allocated to. Usually areas with more water issues have inhabitants with lower income.
- **Social economic models.** We need to improve our social economic modeling to see if there is any cost benefit in investment. Benefit analysis is crucial.
- **Risk assessment.** Risk assessment is needed, e.g. in Augustenborg eco-city no evaluation has been made to show the exact differences with or without such investments.

- **Coherence.** There is scattered responsibility among a series of different authorities.

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- **Stakeholder's involvement**. It is difficult to collect the responsibility in one function accordingly and thus the shared responsibility is needed. There are some main stakeholders such as lands' private owners, the government and politicians and etc. Of course the insurance companies are among the most important stakeholders. We can also observe and learn from other successful cities and see how they improved their involvement. Maybe some parts of their approach can be useful for Malmö.

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- **Community involvement.** The power of communities should not be underestimated. Although the goal is to work with community involvement in the intended cloudburst plan, it will be very limited and needs more initiative.
- **Urban farming.** There are some companies and parties who work with this topic and we need to take advantages from their activities. They can be very effective on people's view on urban farming as well as avoiding some possible problems. E.g. there are some people who apply measures in their gardens while they don't even realize how necessary it is to consider how they affect other people's properties.
- **Education.** We need to work more on different levels of education through climate adaptation courses, programs, even games and so on. This will help to fill the gaps as well as increase the awareness among people.
- **More implementation.** In order to become more experienced we need more implementation. Besides, such projects would be very useful to transfer messages to the society. We need more implementation of icon buildings, innovative storm water solutions etc.

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- **Communication group.** In order to make the process more efficient, communication through media, website, mobile application and such is necessary.
- **Controlling.** We have to plan both for new urban areas and existing ones while having more control over the implementation process. Gaining the control over the implementation protocol requires modification of laws. E.g. by the current law, the municipality is only responsible for a 10-year period and no more, while if it turns to a 100-year period, it will be more long term responsibility for the municipality.
- **Follow up.** Municipality needs to follow up the procedure.

Question 3

What can we learn from other cities? Do we need a central coordinating unit in Malmö? Is there any other recommendations?

- **Combining values.** We need to combine different values and develop check list for the comprehensive plan. E.g. we need to show the benefits for the cloudburst plan clearly which is not addressing only water challenges, also other challenges that city needs to deal with.
- **Looking ahead.** It is important not to only look at the current situation but also plan for the future.

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- **Coordination unit Yes and No.** We are still not sure if we need a separate department such as Climate unit. In Malmö stad, we have decided to start with working in existing groups and it is obvious that we need coordination and understanding in and between the groups. When we get to implementation and communication phase, we will see if we need any coordination office.

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- **Right language.** In order to get supports from politicians, we need to find the right language to convince them. Also for communicating with people, we need to do the same.
- **Trust.** Communities need to trust the municipality. If they make sure that the city will do everything to protect them, they will collaborate more and we can get use of it.
- **Right direction.** Since this is a long term process, we need to choose the right direction for all the planning stages. We need to include all parties, public and private sectors. It will also make it easier for implementation.
- **Localizing the solutions.** We need to combine our own experiences with other cities' experiences. Although it is essential and convenient to get good view of other cities with similar challenges and update ourselves, we have to look for the solutions locally.

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