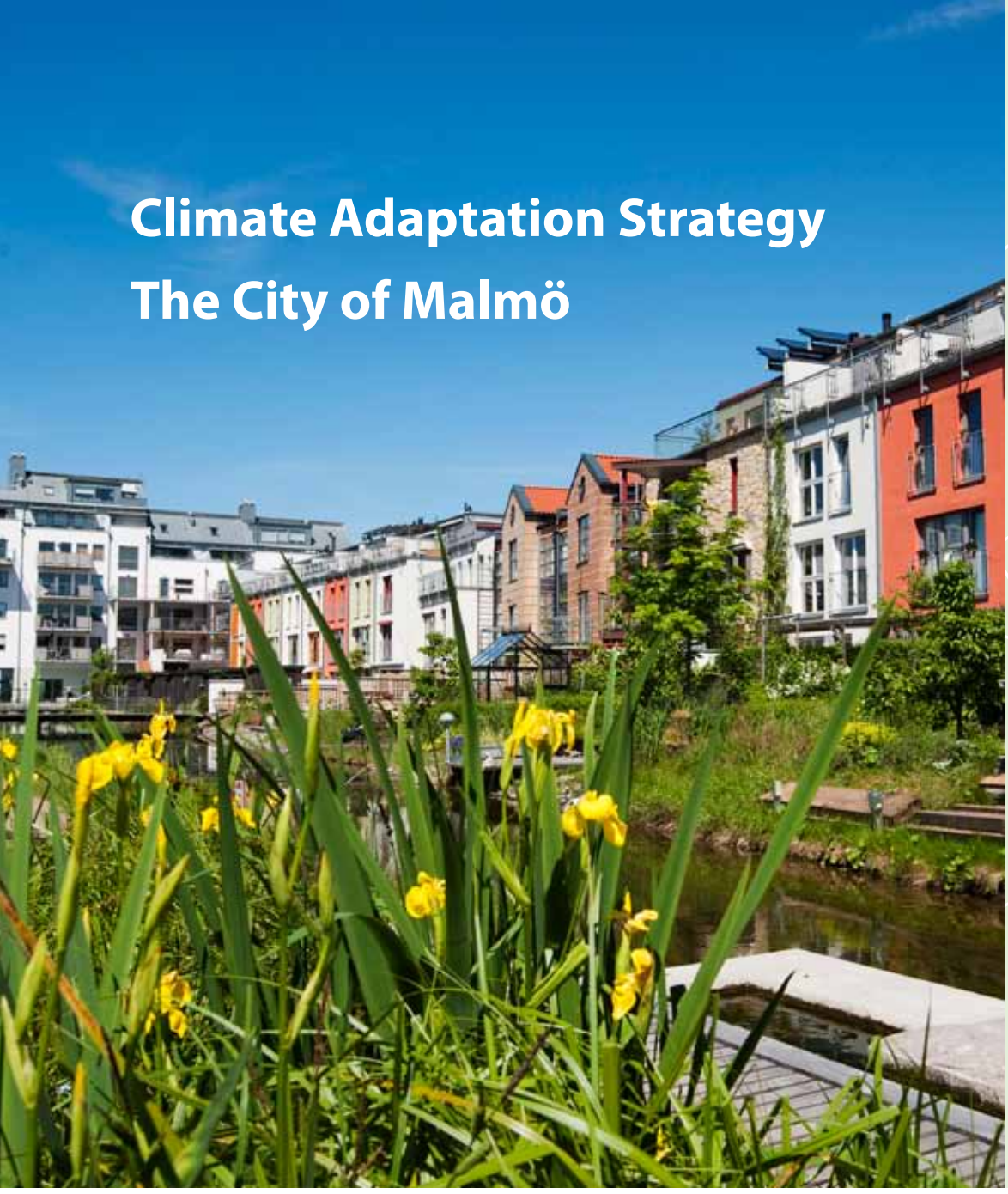
Climate Adaptation Strategy
The City of Malmö



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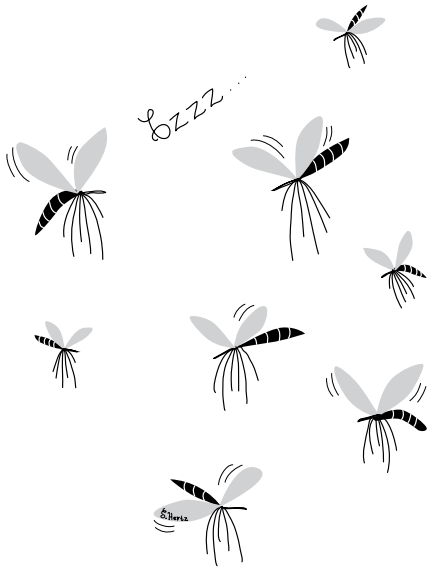
Summary

Climate change is no longer a future scenario - it is the reality of today. And it is a reality that local authorities must be prepared to deal with. Climate change is the result of an increased concentration of greenhouse gases in the atmosphere. The consequences of this can be both positive and negative but because we have designed our society to suit a particular climate, it must adapt to the changing conditions. How vulnerable our society is to upcoming changes depends on how quickly such changes occur but also on how well prepared we are.

While the City of Malmö endeavours to reduce greenhouse gas emissions, it is also important to work on climate adaptation. This may involve establishing new guidelines/regulations or taking concrete steps to protect existing and future housing developments. The Climate Adaptation Strategy is an indication of what climate we can expect in Malmö in the future, what consequences there could be for the city and what actions should be taken to reduce the effects of climate change prediction. It is a major challenge that lies ahead and in order to achieve primary objectives, all key actors in our society must collaborate.

The strategy gives a clear account of the areas where we can expect the greatest change in Malmö: Increased precipitation and risk of flooding, rise in sea level and a warmer climate. The Climate Adaptation Strategy proposes a number of actions for each of the risk areas in the city of Malmö and also identifies the parties affected. The importance of collaboration and communication is also discussed.



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Background

Our climate is changing. In the long run, we can expect to see rising temperatures with heavier rainfalls and a rising sea level. Malmö needs to be better prepared in order to cope with the consequences of these changes and improve its skills in collaborating on issues that concern the City.

In 2009, the City Council adopted the Environmental Programme for the City of Malmö 2009 - 2020. The programme incorporates two climate change sub-targets. In order to achieve the objectives of the Environmental Programme, an Environmental Action Plan for 2011 – 2014 was established. This Environmental Action Plan has brought to light the need for a climate adaptation strategy.

A climate adaptation strategy for Malmö City is a step towards a more structured approach to managing the consequences of climate change. The purpose of the strategy is to raise awareness of climate change and its impact on Malmö and to provide examples and suggestions of possible actions. The Climate Adaptation Strategy is aimed at officials with competent knowledge of the subject area as well as politicians.

The Climate Adaptation Strategy begins with a general description of what climate change means from a vulnerability perspective based on information attained mainly from the IPCC (Intergovernmental Panel on Climate Change) and the Swedish Commission on Climate and Vulnerability (SOU 2007:60). The Swedish Meteorological and Hydrological Institute (SMHI) follow up with climate scenarios for the southwest parts of Götaland County.

Section three 'Climate adaptation tools' addresses some of the tools that may help the municipality to adapt to climate change:

- Green and blue structures.
- Climate-resilient planning.
- Other activities and experiences.

The section on 'Climate adaption in Malmö – recommended actions' describes the possible effects of climate change on the three main risk areas in Malmö:

- Increased precipitation and risk of flooding.
- Rise in sea level.
- A warmer climate.

This section illustrates possible implications for each of the three risk areas in Malmö. A number of recommended actions are also presented. A successful outcome is dependent on good collaborations and communications and a number of actions are also recommended in this context.

So, what is climate adaptation?

Climate adaptation means that contrary to reducing greenhouse gas emissions, focus is instead on introducing measures that either alleviate or prevent the effects of climate change or derive some benefit from the possibilities it may bring. Such measures are then implemented in both existing and planned future communities.

CHANGES IN THE CLIMATE IN MALMÖ

Long-lasting heat waves and local flooding caused by heavier rainfalls are two problems that are already on the increase in Sweden and in many other parts of the world. According to IPCC, we can already see the effects of climate change, which will only get worse with time.

Global efforts to continue reducing emissions of greenhouse gases are just as important as the ongoing endeavours to adjust our society to current and future climates. Areas that were previously considered safe from extreme weather events may also become affected and hence, it is hugely important to reduce vulnerability both in current and future climate situations.

How we plan to respond to such forthcoming challenges will largely determine how vulnerable our society is to climate change. The Swedish Commission on Climate and Vulnerability (SOU 2007:60) was published in 2007. The Commission identified the vulnerability of the Swedish society to climate change and assessed the cost of climate change. In addition, the Commission gave an indication of what adjustments ought to be implemented in order to avoid the worst impact of climate change.

As a basis for assessing future climate change in Sweden, the Swedish Meteorological and Hydrological Institute (SMHI) has outlined possible regional climate scenarios, including the following two: A2 (a rapid population growth and intensive use of energy) and B2 (a slower population growth and less use of energy). The information below is taken from scenario A2.

According to SMHI's climate scenarios, the following changes are likely to take place in Malmö before the end of the century:

- Considerably warmer climate, up to 5.2 oC higher annual mean temperature.
- Heat waves will become more common and an annual occurrence from year 2070 onwards.
- Increased annual precipitation, approximately 15% of which the largest increase during the winter season. Incidents of extreme precipitation in one single day or week are expected to increase by 20%.
- Growing season extended by nearly two months.
- Considerably less snow and ice as precipitation is more likely to be rain.
- Significantly reduced heating of buildings and premises, approximately 40%, while the need for cooling increases from 3 to 37 days per annum.

Sustainable storm water system in Augustenborg Eco-City, Malmö

Climate adaptation tools

Key concepts in the preparation for the climates of today and tomorrow are 'reduce vulnerability' and 'improve flexibility'. Being well prepared and applying a carefully planned methodology are essential for Malmö to meet the challenges that lay ahead.

Equally important is an improved basis for planning. The challenge is to interpret and analyse potential risks at an early stage – risks that may be associated with entirely new situations. What new weather and climate situations can be expected? What does this mean for Malmö? What structures could be employed in the city to address the impact of climate change?

In addition, Malmö City must meet two challenges that require two different tactics:

- Adjustment of existing buildings.
- Adjustment in the design of new buildings.

The potential for adjusting new and existing buildings differentiate hugely. The location of Malmö City cannot be changed and so, it must be our first consideration.

GREEN AND BLUE STRUCTURES

One way of working with existing buildings is to utilise the space available in the city and the green and blue structures (i.e. green areas and water). A better strategy for the green and blue structures and a clearer integration between buildings and surrounding areas entail trees, green areas, spur terraces and waterways improving the air quality but also combating the effects of urban heat islands. At the same time, the management of increased amounts of water is improved.

Combining urban vegetation with local storm water management is a more effective way of reducing extreme temperatures since a large amount of water would enhance the cooling effect due to evaporation. Also, trees providing shade have a direct cooling effect. These two parameters decrease the effects of heat related health problems. Good examples of climate friendly city districts where one has consciously worked with the green and blue structures are the Eco-City of Augustenborg and the Western Harbour.

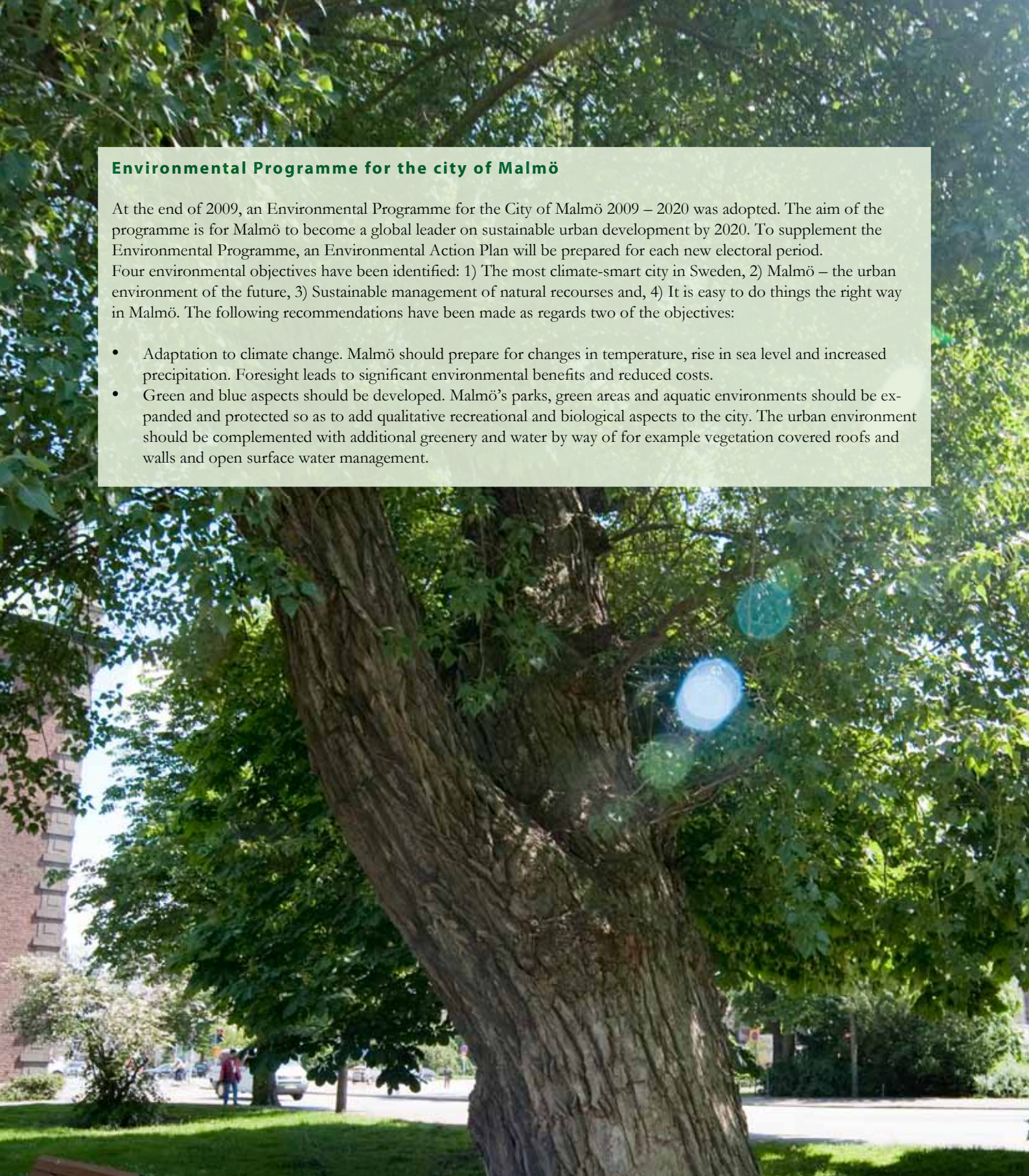
Making cities greener is a good example of synergy between adaptation and mitigation of climate change. The result is positive in all three dimensions of sustainable development – ecological, economical and social. In addition, the urban planners are given more flexibility to adapt the infrastructure in a changing climate.

There are also many other positive aspects of a greener city. The air quality is better as the trees counteract air pollution. The urban biodiversity is enhanced, especially if choosing native species of shrubs and trees and endeavouring to promote diversity. The benefits of urban cultivation are many, e.g. economic development, leisure and community building activities, neighbourhood integration and educational opportunities for children and young people.

Green surroundings have an affirmative effect on the health and welfare of people in general and aid the recovery from stress related disorders. Other positive effects for the individual as well as the society are enhanced and attractive residential areas, improved opportunities for recreational activities and reduced energy consumption.

CLIMATE ADAPTED PLANNING

Urban planning is a vital climate adaptation tool for every municipality. Naturally, the most desirable course of action would be to get the planning completely right from the start and from a climate adaptation viewpoint. We must also be prepared to adjust the regulatory framework as and when required in order to better meet and cope with climate change. One such example is the recommendation given in the Dialogue Memorandum 2008:2 titled 'The climate, sea level and planning'. It suggests raising the minimum ground level allowed for new building constructions from +2.5 m to +3.0 m.



Environmental Programme for the city of Malmö

At the end of 2009, an Environmental Programme for the City of Malmö 2009 – 2020 was adopted. The aim of the programme is for Malmö to become a global leader on sustainable urban development by 2020. To supplement the Environmental Programme, an Environmental Action Plan will be prepared for each new electoral period.
Four environmental objectives have been identified: 1) The most climate-smart city in Sweden, 2) Malmö – the urban environment of the future, 3) Sustainable management of natural recourses and, 4) It is easy to do things the right way in Malmö. The following recommendations have been made as regards two of the objectives:

- Adaptation to climate change. Malmö should prepare for changes in temperature, rise in sea level and increased precipitation. Foresight leads to significant environmental benefits and reduced costs.
- Green and blue aspects should be developed. Malmö's parks, green areas and aquatic environments should be expanded and protected so as to add qualitative recreational and biological aspects to the city. The urban environment should be complemented with additional greenery and water by way of for example vegetation covered roofs and walls and open surface water management.

Environmental Programme for the City of Malmö
The Environmental Programme for the City of Malmö 2009 - 2020 sets forth objectives for Malmö City in its endeavour to adapt to climate change. For each new electoral period, an 'Environmental Action Plan' is drawn up. The plan highlights the actions that are most crucial in order to achieve the overall objectives by 2020.

Comprehensive Plan
The Comprehensive Plan is the most important and long-term tool for the municipality in connection with the use of land and aquatic areas and the development and preservation of built-up areas. The Comprehensive Plan should formulate visions for the future and act as a practical guidance for making decisions relating to concrete planning and building permit issues.

One of the cross-cutting objectives of the Comprehensive Plan 2012 is a denser and more integrated city (Malmö Densification Project (Så förtätar vi Malmö!) Dialogue Memorandum 2010:2). This approach will in turn result in a more composite and varied local environment, improved proximity between housing, work and services, less use of transport and a richer city life. However, densification and an increased population reduce the proportion of green space per inhabitant, unless parks are concurrently enlarged. In Malmö densification and increased population should not mean that the proportion of quality parkland per capita decreases.

Another challenge in connection with densification of the city is the sustainable management of storm water. Urban green spaces could also be multi-functional: better storm water management, enhanced biological diversity, recreation, microclimate and other eco-services.

Environmental Protection Programme
Malmö's Environmental Protection Programme provides a basis for the general and detailed planning of the future. The programme has identified 172 natural areas of specific conservation value. The overall objective of the Environmental Protection Programme is to boost the number of areas of a high conservation value. This is made concrete by means of the following three nature conservation strategies:

- Protect and develop natural areas.
- Create new and compensate for natural areas.
- Increase knowledge about nature and conservation work.

Storm Water Strategy
So as to achieve a long-term sustainable storm water management, the Storm Water Strategy includes among other things the following key objectives (prepared in 2008 on the initiative of VA SYD in collaboration with various Administration Committees):

- The hydrological balance must not be adversely affected by urban planning.
- The surface water management must be dimensioned so as to avoid destructive flooding.
- Open surface water systems should be used as much as possible in newly built areas.

Green Space Factor
The Green Space Factor system should be applied in connection with the construction of new buildings in certain areas of Malmö to guarantee that a certain proportion of green space is maintained in relation to new building developments. The Green Space Factor (a slightly lower factor) is also part of 'Miljöbyggprogram SYD' (the Environmental Building Programme South) applicable to the development of land owned by the City of Malmö. The Green Space Factor is a quantitative instrument that does not take into consideration for example biological diversity in the development of building sites.

Green Plan
A strategic green planning is essential when bringing a planned development in relation to an existing or desirable future green structure. Malmö's Green Plan was adopted in 2003. The general objectives of the Green Plan include:

- To increase the total area of green space in Malmö.
- To secure and protect green areas from exploitation.

The Green Plan should also include green areas and vegetation on building sites and buildings.

Environmental Building Programme SOUTH (Miljöbyggprogram SYD)
The Environmental Building Programme SOUTH is the joint environmental programme for the development of municipal land between Malmö City and Lund Municipality. It also acts as a guideline for constructions on private land. The programme has been used in Malmö City since the turn of the year 2009/2010.

The programme means that property developers are assessed in four core areas, one of which is urban biological diversity. Apart from the amount of greenery and vegetation that is regulated by the Green Factor, certain requirements relating to for example nesting boxes and other animal habitats, biotopes and selection of plants must be met.

The core areas are divided into three categories – A, B and C, where A is the best option. Building on municipal land requires a minimum compliance of Category C in all of the three core areas. The programme is continuously monitored to ensure sustainable and climate adapted developments. Thus, the requirements will gradually evolve in future versions of the Environmental Building Programme.

OTHER ACTIONS AND EXPERIENCES OF CLIMATE ADAPTATION

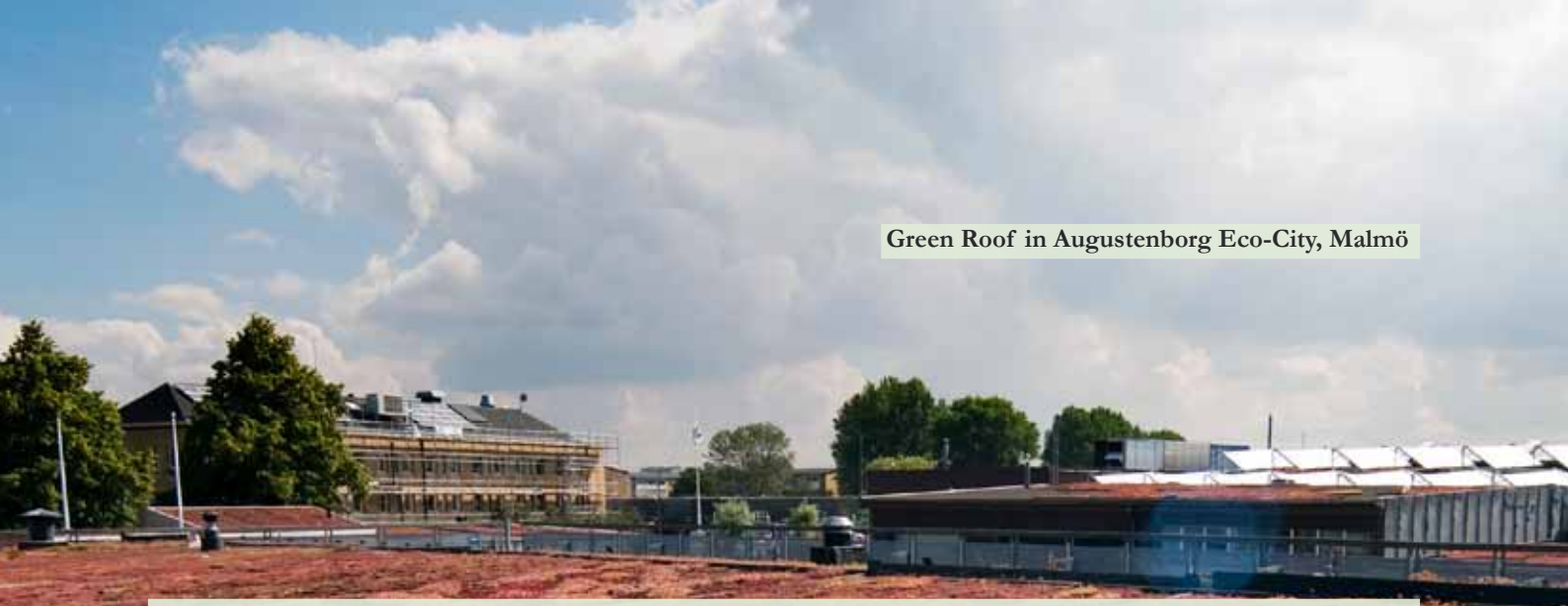
In addition to the green and blue structures and a climate safe planning, there are of course other actions that may be implement such as the construction of sea barriers and buildings designed to cope with extreme weather conditions. One important area of climate adaptation is collaboration and communication and this is an area in which Malmö City has considerable previous experience.

The Building-Living Dialogue
The Building-Living Dialogue was a project run by the Swedish National Board of Housing, Building and Planning and tested in a number of Swedish municipalities. Malmö City used the method in the planning phase of the Flagghusen Development – 'The useful conversation'. By creating a new planning process, the objective of the Building-Living Dialogue was to build a sustainable residential district with affordable housing and create a new standard for sustainability in the Western Harbour (Västra Hamnen) that was not dependent on government grants. Property developers were invited to participate in the very early stages of planning whereupon the entire process remained transparent. The dialogue concept created an unusual affinity between the individual property developers. The development of 'the useful conversation' led to Malmö City attaining primary standards for sustainability in the Western Harbour on which the continued work is now based.

Responsibility of the County Administrative Board to coordinate climate adaptation
In Spring 2009, the government proposal 'An integrated climate and energy policy – Climate' (2008/09:162) put forward that all County Administrative Boards, at a local and regional level, should be commissioned to manage and coordinate the adaptation of our society to climate change. Skåne County Administrative Board will among other things organise seminars, set up networks and create a regional climate adaptation portal. These and similar actions support the adaptation actions taken by Malmö City.

Green Tools for Urban Climate Adaptation
Green Tools for Urban Climate Adaptation, GreenClimeAdapt, is a LIFE+ project managed by Malmö City. The project demonstrates how cities can tackle the consequences of climate change such as increased precipitation and heat waves with the introduction of 'green' solutions. An open storm water management will be constructed adjacent to the Riseberga brook in the industrial area of Fosie whereas in Augustenborg, new vegetation walls and roofs have been introduced.

ClimaTools
ClimaTools is a research programme working to develop a set of tools that will aid planners and policy makers to adapt society to the impacts of climate change. The main three sections of ClimaTools are health, environment and infrastructure developments as well as tourism and recreation. Malmö City is through its Environment Department part of the reference group.



Green Roof in Augustenborg Eco-City, Malmö

Examples of the negative and positive consequenses of climate change

Negative

- Increased risk of flooding and erosion
- Seepage from contaminated industrial sites due to flooding
- Higher demands on water supply and sewage
- Poorer drink water quality
- Loss of eco-systems, plants and animals
- Introduction of new pests and plant species (mostly insects)
- Algal blooms
- Increased need for pesticides against noxious insects
- Increased need for irrigation
- Subsidence of land and buildings
- Increased use of energy for air conditioning systems due to a greater need for artificial cooling
- Health-related issues such as heat stress, dehydration and contamination
- Heat induced curving and other similar problems for all rail-bound traffic
- More green area maintenance due to a longer growing season
- Changed insurance terms
- Climate refugees
- Rise in heat related deaths

Positive

- Longer growing season
- Drop in cold related deaths
- Reduced need for de-icing
- Increased tourism
- Potential of cultivating new crops such as wine
- Less use of energy for heating homes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Climate adaptation in Malmö – recommended actions

The following three are the most likely and most serious consequences of climate change:

- Increased precipitation and risk of flooding.
- Rise in sea level.
- Warmer climate.

Like all other contributors in our society, Malmö City needs to start looking at what changes are needed and how these will affect our city. This Climate Adaptation Strategy for Malmö City constitutes the beginning of our endeavours by identifying the most relevant areas in Malmö in addition to giving examples of and making recommendations for appropriate actions. The strategy is not comprehensive but gives an indication of the problems and possibilities of adapting and preparing Malmö City for the challenges of climate change.

Actions and areas are selected on the basis of a SWOT-analysis (strengths, weaknesses, opportunities and threats) of the expected climate changes in Malmö and information obtained from the Swedish Commission on Climate and Vulnerability and the IPCC. Many of the actions selected mitigate the effects of extreme weather events and generate positive results in several of the areas of intervention.

The actions are divided into different categories (city, district and neighbourhood).

City: Adaptation to climate change of this magnitude is of benefit to the entire city and its inhabitants. All use of land is also incorporated. This level of actions provides the greatest opportunity for creating cost effective and integrated solutions in conjunction with an overall risk assessment of extreme weather events. These and similar adaptation actions ought to form part of a comprehensive plan.

District: Incorporates residential areas and related infrastructure and services. Alternatively, actions at this level can also be applied to commercial units such as shopping centres or business parks. Consideration must also be given to public areas. These and similar adaptation actions ought to form part of a detailed development plan or the comprehensive plan.

Neighbourhood: Smaller areas of development including individual homes, apartment blocks and commercial or public buildings. This level of actions offers more opportunities to integrate adaptation actions in and around buildings. Significant emphasis is put on the design of buildings, their surroundings and how they are used and managed so as to maximise current and future adaptation to climate change. Actions taken on a neighbourhood level ought to be uniform so as to fit in with the townscape.

Malmö City administrations engaged in the Climate Adaptation Strategy

Real Estate Office - FK
City Office - SK
Social Resource Department- SRF
Environment Department - MF
Department of Internal Services - SEF
Water and Waste municipality Authority - VA SYD
City Planning Office - SBK
Streets and Parks Department - GK
City Districts - SDF
City Executive Board - KS

Sustainable storm water system, Fjärilsparken, Malmö

INCREASED PRECIPITATION AND RISK OF FLOODING

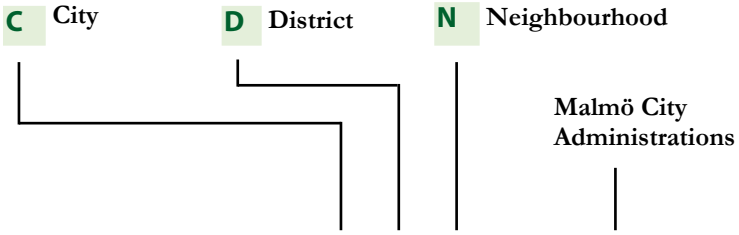
In Malmö, climate change will lead to increased precipitation and a greater proportion of heavy downpours both of which will result in a rise in surplus storm water. In summer, the rainfall will be considerably less and not as frequent but when it rains, it will be in the form of heavy downpours. In the past four years, Malmö has been hit by two extreme precipitation events. Extreme precipitation puts added strain on for example buildings and the drainage of water from buildings, roads and urban areas. The surface water distribution system is not designed to cope with extreme precipitation that, taking into consideration the current projection of an increase in the intensity and duration of future precipitations presents an extra challenge and highlights the need for the additional flood drainage solutions.

Another consequence of climate change is a more common occurrence of flooding along riverbanks. In Sweden, flooding and high levels of water area a frequent occurrence. However, short and intensive rainfalls can cause flooding in densely populated areas because of an overflowing storm water runoff system. In Malmö, flooding will mainly occur along Sege River and the Riseberga brook. Also grade-separated interchanges are at risk of flooding, which may lead to serious traffic congestions to and from Malmö with the added risk of personal injuries. Local rainfalls that cause surface water and sewage drains to flood are a major problem. Pollutants found in soil and land may be released and consequently, contaminate water supplies, grazing fields, bathing waters and irrigation systems. Sewage may seep into the drinking water supply system. The problem with basements flooding and sewage seepages is expected to worsen in future. The increased popularity of living near the sea has lead to homes being built in areas that are already at risk of flooding. These areas are likely to expand along with socio-economic costs.

Solutions to consequences of increased precipitation
Urban vegetation can take care of a large amount of the increased precipitation but is not in itself a sufficient solution to the problem of increased precipitation. Retention and preferably also infiltration of rainwater into local storm water systems are required to minimise the risk of local flooding. There are also other benefits with a local storm water system: Cleaning of storm water, elevated groundwater level as well as both people and animals having access to water in an urban environment. Retention of the storm water should take place as close to the source as possible, for example in courtyards, along streets and in car parks. Bowl-shaped grass and planting areas on housing estates, in parks and in green areas can be used as flood irrigation and retention of storm water – the rest of the year the same areas simply revert to being areas of grass and plants.

Many cities incorporate the construction of local ecological storm water systems in the development of new areas. One such example is Gyllins Trädgård (Gardens) in Husie. However, it is also possible to construct such systems in existing residential areas, as in Augustenborg, a residential area from the 1950's. The storm water system in Augustenborg consists of ditches, canals and ponds with a local wetland vegetation/flora. Since its construction in the late 1960's, the former problem with frequent flooding has ceased to exist. An alternative to the measures described above is to rebuild the existing system, which is likely to be more expensive at the same time as one would lose the many benefits of a local storm water system.

In order to implement the most effective solutions from a sustainable perspective, one must take into consideration a number of aspects. When implementing an action, the value of that action can be increased at a limited marginal cost. For example, when construction is taking place, the proportion of hard surfaces is reduced and replaced with vegetation and green areas, etc. This reduces the risk of flooding and increases biodiversity. By weighing the risks against the benefits and making well-considered assessments, it is possible to obtain higher values through a high input.



RECOMMENDED ACTIONS - FLOODING

Tool	Action	C	D	N	Parties involved
Protection of critical social functions	Identification and protection of infrastructure such as transport, water and sanitation, energy production and distribution.				SK, VA SYD, Räddningstjänsten Syd, GK, SBK
Storm water strategy	Link the storm water strategy to a community-wide adaptation strategy				VA SYD, MF
Hard surfaces	Specify the highest proportion of hard surfaces in the detailed plans (to be included in the Comprehensive Plan 2012) to increase infiltration and reduce the risk of flooding				SBK, VA SYD, MF, FK, SEF
Mapping	More accurate height data to identify low points in areas that are particularly vulnerable to increased precipitation and heavy downpours				SBK, County Administrative Board, VA SYD, GK
	Mapping of the Riseberga brook and Sege River				VA SYD, SBK
Sustainable storm water systems	Increase the proportion of sustainable storm water systems such as open runoff systems, retention and flood irrigation areas				VA SYD, SBK, GK, FK, SEF
	Construct open runoff systems by making use of vegetation. The vegetation absorbs and breaks down nutritive salts and some pollutants, giving a cleaner water				VA SYD, property owners, SBK, FK, SEF,
Waterways	Restore waterways in arable fields, carry out measures to improve meandering and eliminate enveloping				FK, VA SYD, SBK
Green infrastructure	Apply the Green Space Factor in all planning				SBK
	Incentives (by way of a tariff) to homeowners to maintain and increase the amount of greenery and vegetation in their gardens				VA SYD

RECOMMENDED ACTIONS - FLOODING

Green infrastructure	Apply the Green Space Factor in all planning				SBK
	Incentives (by way of a tariff) to homeowners to maintain and increase the amount of greenery and vegetation in their gardens				VA SYD
Riseberga brook	The Riseberga brook becomes a designated pilot area for climate adaptation (flooding)				KS, VA SYD, FK, SBK, GK, MF
	Levelling on one side of the Riseberga brook to reduce erosion at high tide. Important to cover the levelled surface with vegetation				VA SYD
	Meandering and restoration of the creek				VA SYD, SBK
	Buffer zones of trees along the shores of the Riseberga brook to stabilise the edges, increase oxygen levels and reduce overgrowth				VA SYD
Local disposal of storm water	Roof water collected and reused for irrigation				GK, VA SYD, SEF
Car parks	Storm water runoffs from large car parks to be retained and treated as necessary for example by redirecting it across vegetation covered surfaces				GK, VA SYD
	Storm water from highly contaminated areas to be treated for example by using an oil and silt excluding device				GK, VA SYD
Damage prevention	Protect sites that are susceptible to flooding such as tunnel entrances, water and sewage system, roads and electricity and telecommunications plants				GK, VA SYD, Swedish Transport Administration
	Installation of a backwater gate or pump in buildings to protect against backflow from storm water pipes				Property owners, VA SYD, FK, SEF

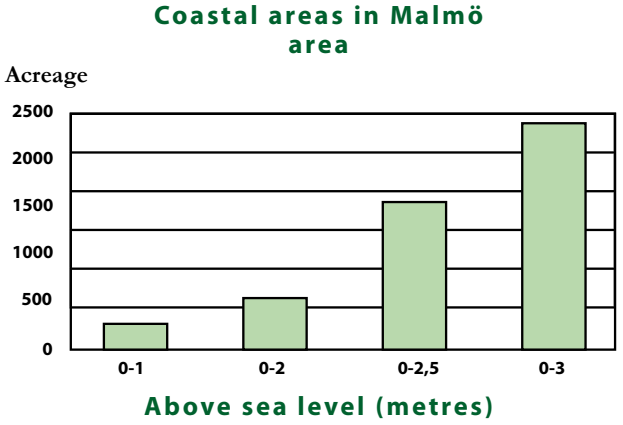
RISE IN SEA LEVEL

One effect of the current global warming is that the sea level rises. In Malmö, the mean sea level is estimated to rise to 22 – 66 cm above today's levels by 2100. Malmö's coastline is about 43 kilometres long inside of which are low-lying areas at risk from rising sea levels and changing flood conditions. When the mean sea level rises, the extreme flood water levels will also rise. In a hundred years, the sea could in extreme cases reach as high as three metres above the current sea level. See Figure 2a. Extreme flood water levels include waves, wind and high tide. The entire coast of Malmö, significant sections of the inner city, the harbours and also large parts of the main development areas in the city, i.e. Western Harbour and the harbour areas of Nyhamnen and Limhamn are all situated below the three metre level.

Figure 2a showing a sea level rise of 3 m

Consequently, enormous values in the form of housing, offices, infrastructure and other things could in an extreme case scenario become seriously damaged by rising sea levels and flooding. See Figures 2 a and b. Critical communal services and functions risk being wiped out for a shorter or longer period of time but things of a historical cultural value in the centre of Malmö also risk being damaged.

Climate change plays a significant role in Malmö's protected natural areas such as the heathlands south of Lernacken. As the sea level rises, the heathlands will become flooded and stand permanently under water unless an effective coastal protection system is established. Whether or not a permanent coastal protection system is established, the heathlands with their natural values will still be affected.



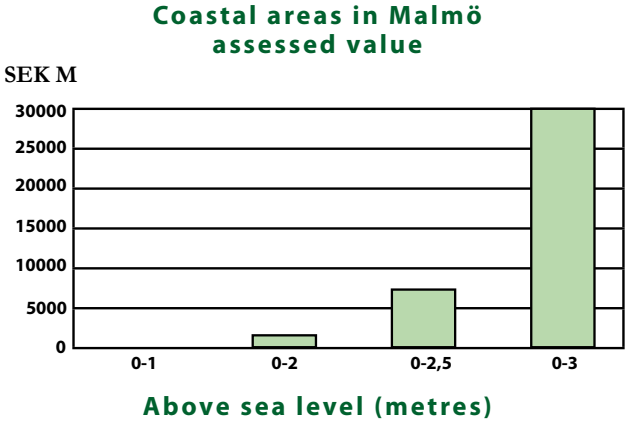


Figure 2b: Loss of area and assessed value due to sea levels rising 0 – 3 m.

RECOMMENDED ACTIONS - RISE IN SEA LEVEL

Tool	Actions	C	D	N	Parties involved
Planning	Raising the minimum ground level allowed for new developments from +2.5 metres to +3.0 metres and incorporate this in the Comprehensive Plan 2012				SBK
Protective structures	Investigate the pros and cons of different types of coastal protection structures and provide a future strategy on how to best manage the rise in sea levels				SBK
	Build protective barriers along the seashore and along some waterways				SBK, VA SYD
Relevant risk level	What risks are acceptable when developing strategically important areas?				SK, GK, VA SYD, FK, SEF, MF, SBK, SDF, SRF
	A general cost-benefit analysis where for example the cost of an adaptation action is weighed against its benefits would give an indication of the level of risk facing the municipality				SK, VA SYD, MF, GK, SEF, SRF
	Identification of critical communal functions and mapping of vulnerable areas				SK, SBK, VA SYD, GK, MF, FK, SEF

A WARMER CLIMATE

Heat waves with an average day temperature of over 20 degrees Celsius will become more common. In summer, the number of days of extremely high temperatures is expected to increase. It is also anticipated that the growing season will be extended by around two months and with a changing climate, the natural environment in Skåne will also change. This will bring more favourable conditions for parts of our agricultural industry as conditions for both cultivated and wild plant species changes. A warmer climate will also have an impact on the reproduction of plants and animals and the number of pests may increase with diseases spreading more easily.

One direct effect of a warmer climate is increased mortality, especially for vulnerable groups such as the elderly and sick people. A clear increase in mortality has been observed during previous heat waves after only two days of sustained heat. According to estimates carried out in the Stockholm area, a rise in the average temperature of four degrees would result in the mortality increasing by more than five percent. An alarming example of this was the heat wave that struck Europe in 2003 causing 35,000 deaths. Another example of the indirect effect on human health due to the change in the length of our annual seasons is that an array of new and to us alien plant and animal species will spread northwards. As a consequence, the pattern of contamination and contagious diseases will change with the added risk of new contagions and parasites emerging.

Green planning
Dense cities are a prerequisite for an exciting and attractive city life. The challenge is to make our cities greener without making them less dense. Green roofs and walls are important components in a greener city. All surfaces that do not have to be hard for a specific reason can be made green and converted into so-called green space areas. Large trees can be planted along streets, in schoolyards and in gardens and parks. The Green Space Factor, which can been seen in the Western Harbour and where also the Environmental Building Programme SOUTH (Miljöbyggprogram SYD) has been applied, is one way of achieving a high proportion of greenery in areas of new developments. In future, the Green Space Factor could also be used in connection with urban transformations. Grounds, courtyards, green plots and public parks could potentially become multi-functional green spaces for storm water management, enhanced biodiversity and recreation, microclimate and eco-system services.

Cooling
Several studies in recent years have shown that an increase in the amount of urban vegetation can be an effective way in which to prevent unwanted heating of cities. The maximum temperature in a city has to do with the proportion of vegetation and this is something that will become increasingly important in future. By adding 10% green space in areas with little vegetation such as city centres and high-density residential areas, the maximum temperature can either be retained or lowered to below the current temperature, even in a possible scenario of a temperature rise of up to four degrees. Today, the cooling of buildings and homes is in large part by way of fossil fuels, which further supports the development of urban greenery. Covering roofs with vegetation to increase the amount of urban greenery is a smart solution. The study of different air temperatures in cities around the world produced some interesting results. The air temperature was monitored in a street with buildings and no vegetation plus in a street with buildings with vegetation clad walls and roofs. The air temperature was drastically lower in the greener street – from 3.5 °C to 11 °C.

Health
It is becoming increasingly important from an urban planning perspective to carefully consider the location and design of new hospitals and nursing homes. It is about the orientation of the buildings (i.e. no large windows facing west or south), the amount of shading vegetation and green roofs. According to the Swedish Commission on Climate and Vulnerability, the indoor temperature at hospitals, nursing homes and other premises of sick and elderly must be kept at a comfortable level, even during a heat wave. Air conditioning must become standard at all emergency and intensive care units across the country, according to the Swedish Commission on Climate and Vulnerability.

Augustenborg Eco-City, Malmö

Multi-functional surfaces

Strategically located in the city and integrated with buildings and surrounding areas, trees, green areas, waterways and ponds can serve to improve the air quality and reduce the temperature in the city while at the same time manage increasing quantities of water. A multi-function surface can:

- Take care of storm water
- Lower the temperature both indoors and outdoors during hot summer periods
- Protect against harmful UV rays by adding extra shade
- Act as social meeting places and outdoor venues for recreation and rest
- Support urban biodiversity

RECOMMENDED ACTIONS - WARMER CLIMATE

Tool	Actions	C	D	N	Parties involved
Green infrastructure	Targets for increased vegetation				SBK, GK, MF, SEF, FK, VA SYD
	Planting of more trees for shading and cooling. This could also be incorporated in the Comprehensive and Detailed Plan				GK, SEF, FK, SBK
	Provisions for green roofs (and green walls) in all new detailed plans				SBK
	Introduction of a municipal appropriation for private individuals, homeowners associations, housing cooperatives, etc., to apply for grants to help make their courtyards and gardens greener.				KS, GK, MF, SEF, SBK, VA SYD
Multi-functional areas	The Green Space Factor that currently applies to new developments on land owned by Malmö City has generated a higher proportion of greenery in our neighbourhoods. Draw up a similar policy for public places where a minimum proportion of green space is guaranteed.				SBK, GK, MF, FK, SEF, VA SYD, SK
	Both new and existing green areas should be designed for multiple functions, e.g. storm water management and recreation				VA SYD, SBK, GK, MF, FK, SEF
Cost-benefit analysis	A cost-benefit analysis of actions linked to climate change adaptation and eco-system services should be carried out				SK, MF
Cooling	Inventory of municipally owned properties as regards an anticipated rise in temperatures and how to best meet the increased need for cooling, particularly in the health care sector, preschools and schools				SEF, SDF, FK
	Planning for the use and development of district cooling from groundwater				SBK, SEF
Heat waves	Improved preparedness for heat waves				SDF
	Investigate the potentials of a heat wave warning system				SMHI, County Administrative Board, SK, Region Scania, SRF

Care	Look at routines for home care services, nursing homes, etc., in case of a heat wave				SRF, SDF
Planning	Take the risk of frequent heat waves into the planning of new developments and in existing areas through detailed plans and building permits				SBK, MF, SF, FK, SEF
	Look at the urban heat-island effect in different areas of the city environment				SEF, SBK, GK, MF, SK, FK
	Limit the proportion of windows facing south				SBK, property owners, FK, SEF
	Appropriate loft apartment designs				SBK

Sustainable storm water system Western Harbour, Malmö

COLLABORATION AND COMMUNICATION

Malmö City administrations must collaborate on the issue of climate change adaptation. A consensus on climate change, climate adaptation, analyses and actions is needed. It is important to spread information about what different parts of Malmö municipality do in order to adapt to climate change. In addition, we need a common analysis and a mutual set of actions. Many of the actions also require a well-developed collaboration with other municipalities in Skåne and a frequent contact with municipalities in similar circumstances.

In order for an adaptation strategy to become a useful basis for planning, a review of the planning and management functions in the municipality is required. Is the overall management process sufficiently developed to deal with the issue? Is there a need for putting together an overall management strategy group at senior level for the mapping out of the work needed? Should climate change adaptations be incorporated in steering documents, action plans and policies or be a separate document?

One way of working with climate change adaptation is to integrate it with existing processes, e.g. comprehensive planning and risk and vulnerability assessments (RSA). The purpose of risk and vulnerability assessments is to identify risks and vulnerabilities in connection with extraordinary events that could have serious implications for critical communal functions and facilities.

Another way is to expand the comprehensive plan. By expanding the comprehensive plan, the municipality makes clear its intentions as regards the use of municipal land and water areas as well as the development and preservation of built-up areas. The comprehensive plan is not legally binding but should be used as a guideline for subsequent detailed planning. According to the Planning and Building Act, the comprehensive plan should specify what environmental and risk factors that ought to be considered when deciding on the use of land and water areas and the location of operations, buildings and facilities. This means among other things that areas at risk of flooding, erosion, landslides, etc., will be reported in the comprehensive plan and subsequent detailed plans. On 1 January 2008, several changes to the Planning and Building Act came into force, which meant that the risk of accidents, flooding and erosion were added to the appropriateness criteria of the municipality of Malmö. As a result, the risk of flooding and erosion will be addressed in the comprehensive plan and taken into consideration in the detailed planning and building permit review process. Hence, the ability and obligation of the municipalities to take responsibility in the planning for climate adaptation have increased.

Private contributors

A general public that is informed and involved facilitates the planning of changes in an urban environment. A good dialogue with local citizens usually aids the process of change. In Malmö, there are currently various processes on citizen participation. However, there is not one explicit process linked to the work on climate change. However, instead of creating a new process, one ought to make use of the existing channels in the different administrations of Malmö City.

For a successful climate change adaptation throughout the city, it is important to get the citizens of Malmö involved in the work. There is also a great need for providing property managers, homeowners and homeowner associations with direct information. The importance of the vegetation found in existing courtyards and gardens throughout Malmö City should not be underestimated. This is an area that the municipality does not control. It is necessary for property owners to understand the benefits of a green courtyard against covering it with concrete or asphalt. However, this can be controlled by municipal water and sewerage charges. One step towards creating pleasant outdoor environments and to optimise the storm water management is to advise property owners on the extent of their green spaces and how these could be improved. The same conditions do not apply to all outdoor environments and subsequently, it is important to find and develop local solutions.

In addition to the parties above, other parties are also needed to get involved in the preventative work and adapt

the city of Malmö for future extreme weather events. Some of these include the research society, Sydvatten, CMP (Copenhagen Malmö Port), Region Scania, County Administrative Board, farmers, Swedish Transport Administration, Skånetrafiken, property developers, insurance companies, energy suppliers and environmental and nature conservation organisations.

Follow-up
Parties involved report annually to the City Executive Board.

RECOMMENDED ACTIONS - COLLABORATION AND COMMUNICATION

Tool	Action	C	D	N	Parties involved
Responsibilities	It is proposed that the City Executive Board through the Swedish Association of Local Authorities and Regions initiates a government study into the revision of laws and responsibilities relating to climate change adaptation				KS
New economic models	For the financing and carrying of costs				SK, MF
New forms of collaboration	Augustenborg should be used as basis for calculating the socio-economic benefits of the actions carried out. Develop new forms of collaboration, solutions and tactics based on the result.				All administrations, The municipality housing company, VA SYD
Climate change adaptation administration	It is proposed that the City Executive Board commissions one of the administrations to set up a climate adaptation strategy group for the purpose of promoting and coordinating the work on climate change adaptation				All administrations and corporations
External network	Start a network with external actors				MF, SBK
Conflicting objectives	Identification of conflicting objectives, hindrances, other influences and how to interact with other objectives				MF
Crisis plan	Increased/climate adapted crisis preparedness				SK
	Incorporate climate change adaptation into the Crisis Management Plan				All administrations

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