Green Tools for Urban Climate Adaptation


FINAL REPORT

LIFE07 ENV/S/000908

LIFE Project Number
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FINAL Report
Covering the project activities from 01/01/2009 to 31/12/2013

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LIFE+ PROJECT NAME or Acronym
Green tools for urban climate adaptation
GreenClimeAdapt

Data Project

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Data Beneficiary

Name Beneficiary	City of Malmö
Contact person	Mrs Anna Lindblad
Postal address	Environment department, Box 205 80 Malmö, Sweden
Visit address	Bergsgatan 17, Malmö, Sweden
Telephone	+46-40- 34 21 29
Fax:	+46-40-34 20 60
E-mail	anna.lindblad@malmo.se
Project Website	www.malmo.se/greenclimeadapt

1. List of contents

2. Executive Summary

The environmental problem targeted in GreenClimeAdapt is climate change, especially adaptation to a changing climate in urban areas. Two main effects of climate change in Europe are standing out, increased precipitation and higher temperatures and heat waves. The effects of these changes will be particular acute in urban areas where sealed surfaces exacerbate weather events such as heat waves and intense rainfall. On a local level, we expect that Malmö will receive much more precipitation and heavy storms. These two factors together enhance the risk of flooding in the city. But we also expect higher temperatures, especially during the summer.

The objective of GreenClimeAdapt is to demonstrate climate adaptation in urban areas using innovative green tools such as open stormwater systems, green facades and green roofs.

Technical part

Action 1 and 2
Skogholms ängar is a green area in the middle of Fosie Industrial area in Malmö, which has been saved due to high natural values. An old alder forest is sited in Skogholms ängar, which is the only one of its kind remaining in Malmö. The alder forest was saved but mistreated because less water was lead in to it when all stormwater in the area was lead down in pipes and out in the Riseberga creek. The project has realized the implementation of open stormwater detention facilities in Skogholms ängar combined with a recreational area with enhanced biodiversity.

From a technical point of view the ground and the stormwater management facilities are set and working, but the area as a recreation area is yet in an early phase and will take a couple of years before it feels really nature like. More surveys are needed to follow up the development of the area, both regarding to the number of visitors but also surveys on how flora and fauna is developing. The horse-riding school is still the main visitor of the area but birdwatchers have started to discover the area and are an increasing group.

Action 3
Climbing vegetation has been found on facades for centuries. Usually they grow directly on the outer most layer of the wall, risking to cause damage there. In this action climbing vegetation, growing on wire systems or in a cassette, detached from the facades have been demonstrated.

From esthetical point of view employees in the building with green facades thinks that the green facades are a very nice feature in Augustenborg. Especially in an industrial area as Augustenborg where the greenness otherwise are very low. The facade of the buildings with the green facades has a temperature approximately of 8 degrees Celsius lower than the facades of the buildings without the green facades and the indoor temperature is 1-1,5 degrees lower than the outdoors temperature. The biodiversity of the green facades in is rather high. The numbers would not indicate a high biodiversity in an ordinary garden, but for an urban industrial area as Augustenborg, the numbers are high.

Action 4
The project has tested and demonstrated alternative, environmentally friendly green roofs built up by different substrates. The intention was that these should be light weight solutions that could be possible for private house owners as well as construction industry to build at a low cost at existing houses. In total five different test sites were prepared, installed and monitored.

The two roofs with the best overall plant coverage and with the best germination of seeded plants were at test site 4 and 5 with hemp in the bottom. The hemp as a bottom layer beneath the substrate was more beneficial than straw since the hemp gave a solid base layer which didn’t mix too much with the substrate when the substrate layer was installed, not even at test site 4 with a relatively thin substrate layer of 4-5 cm.

Action 5
The dialogue activities in this project, including two dialogue meetings and several interviews, have focused especially on reaching a broad variety of different groups and individuals (i.e. multi-stakeholders) around Riseberga Creek and the demonstration area of open green stormwater system in Skogholms ängar.

Among the stakeholders involved in the dialogue activities implemented, it can be argued that their knowledge and understanding about climate adaptation and possible adaptation measures, through the dialogues, has been immediately increased as a result and that their views and ideas has been incorporated in the project.

Action 6
An important impact of a changed climate in the future could be a change in the hydrological behaviour of the Riseberga creek. The consequences of climate change are possible future alterations in flow variability and flood frequency. In order to quantify possible future impacts on the catchment and on the creek, it is essential to first investigate and understand the current hydrological behaviour of the creek. This was accomplished with an extensive analysis of historical data and the establishment of a new flow monitoring station. To enable a comprehensive analysis of the creek hydrology, a semi-distributed hydrological model was set-up and calibrated. With the use of the hydrological model and synthetic climate data flood frequencies for present and projected future climate conditions were estimated.

The main result of the action is foremost an important increase of the knowledge of the hydrology of the Riseberga Creek. The work carried out in the action confirmed a strong impact on the creek hydrograph from urbanization as it was evident from the observed discharge that the response time from rainfall events to observed peak flows is very short, typically 0,5-2 hours at the location of the acoustic flow meter station. Another important finding is that the differences in specific runoff between different parts of the catchment are large. The area closer to the catchment outlet is more heavily urbanized and has a 15-20 % higher runoff than areas upstream of the discharge station at Jägersro.

Action 7
Action 7 aimed at evaluating the effects of green climate adaptation on biodiversity, i.e. aquatic biodiversity, in Riseberga Creek and the terrestrial biodiversity (birds and vascular plants) in the area of Skogholms ängar. Also effects on the recreational values were evaluated.

Two surveys of the Riseberga Creek have been carried out. Valuable data was collected that has increased the understanding of both biodiversity and the functioning of the aquatic system. The data has been crucial in the development of a robust methodology to make impacts assessment for river habitats under changing climate conditions.

There is no clear trend in the number of nesting species, nor in number of visiting individuals and species. The low number nesting the first year could be a result of the assessment starting a little bit too late in the season. The construction work during 2011 and 2012 have not had a negative influence on the number of nesting birds. An increase in number of nesting species could have been expected after the completion of the ponds and the diking of the alder wetland, since these are new qualities added to the area. It is possible that the time span is too short for number of species to increase, and that bird assessments in just a few years' time would show another result

Action 8
Two workshops and one evaluation of experiences from installing green facades and green roofs were performed within Action 8, The first workshop “Integrating green tools for urban climate adaptation in the built environment” had the aim to gather important stakeholders, learn from each other, increase knowledge of advantages of using green tools for urban climate adaptation, identify obstacles and find ways to overcome them. The second workshop “Green Tools for Urban Climate Adaptation” had the aim to answer question like: how can we make our city districts greener? What obstacles are there for greener cities?

Analysis of long-term benefits

The GreenClimeAdapt project has many direct environmental benefits. A more than 40 000 square meters large recreation area have been partly reconstructed, maintained and open for the citizens of Malmo The open stormwater system in Skogholms ängar has direct positive effects on reducing flows in Riseberga Creek as well as on the biodiversity. The existing old alder wetland has been given better conditions for preservation due to more water coming into the forest/wetland.

The evaluation of the green facades indicates that the facades covered in green plants have a lower temperature than facades without greenery. The green facades help to cool the facades and protect the envelope. This is an important impact for the building envelop especially with the ongoing climate change where the air temperature is rising.

The long-term environmental benefits from the open stormwater system in Skogholms ängar are reduced risk of damage of the natural banks as well as the risk of flooding along the Riseberga creek.

A long-term environmental benefit of the green roofs installed is the potential carbon sink factor as biochar is used in several of the substrate batches. The biochar itself counts as an carbon sink and hence is a very interesting future green roof substrate. Biochar has a great potential to be used on large scale in the green roof industry and new producers have thereby been introduced to the green roof market as a potential area for their products.

The city of Malmö and other partners will continue to work for implementation of green tools for urban climate adaptation in a lot of ways in the future. Malmö's new comprehensive plan outlines a green and dense city as a goal for city planning, and is an extremely important policy document for implementation.

The replicability and transferability of the actions carried out in GreenClimeAdapt to other EU countries are high, especially the transferability to other urban areas. The climate change occurs in the whole world and effect all with the same problems.

3. Introduction

The environmental problem targeted in GreenClimeAdapt is climate change, especially adaptation to a changing climate in urban areas. Two main effects of climate change in Europe are standing out, increased precipitation and higher temperatures and heat waves. The effects of these changes will be particularly acute in urban areas where sealed surfaces exacerbate weather events such as heat waves and intense rainfall. On a local level, we expect that Malmö will receive much more precipitation and heavy storms. These two factors together enhance the risk of flooding in the city. But we also expect higher temperatures, especially during the summer.

The catchment of the Riseberga Creek is 38 km^2 and situated in the eastern part of Malmö, The creek has been modified over the decades as the city and its suburbs have been growing and the natural surroundings of the creek have been subject to intense development from housing, industry and agriculture. The development of the catchment has altered the physical properties of the stream and many stretches have been straightened, channelized and dredged. In addition, the city infrastructure has expanded and substantial parts of the creek are now led in tunnels under roads and railways. With changed land use in the catchment the creek has become the recipient of an increased amount of stormwater from urban drainage, more rural runoff and increased nutrient load due to intensive agriculture practice, which has changed both its hydrology and water quality over the decades. Flooding of the creek which causes damages on buildings, property and infrastructure is a problem today and is likely to increase in the future with current projected climate change scenarios. This is a typical development for many streams located in or in the vicinity of major cities.

The objectives of GreenClimeAdapt are to demonstrate climate adaptation in urban areas using innovative green tools such as open stormwater systems, green facades and green roofs. The activities in the project have been implemented in Augustenborg, a city district with an eco-profile and near Riseberga Creek in the Fosie Industrial area.

In the beginning of the 1990s a light weight green rooftype, with only about 20-30 mm of substrate, was introduced and started to become popular in Sweden. But a green roof with a substrate depth of 50 – 100 mm could have much more advantagoues. Green facades have been used for decades, but usually growing directly on the facade with the risk of damaging it.

To improve the resilience of Riseberga Creek, 45 ha of an industrial area in southeastern Malmö will have been turned into a green climate adaptation area with open stormwater management with enhanced biodiversity and recreation. The stormwater system built in this project will retain 90% of a 10-year rain. In order to evaluate the efficiency of the open storm-water system, the flows and flooding of the water recipient in focus, Riseberga Creek, will have been modelled.

Installations of climbing plants detached from the facade itself have been used for shade facades, cooling booth buildings and photovoltaic panels and rendering them more efficient. Measurements will have been undertaken to verify the positive effects of the construction, such as decreased indoor temperature in summer, reduced indoor noise, enhanced biodiversity, particle binding and efficiency of photovoltaic panels.

600 m^2 of a new type of light weight green roof will have been installed, as well a rain water recirculation system to irrigate intensive green roofs. The survival rate of the roofs and functionality using different materials and methods of construction will be documented and evaluated.

The architectural integration of green tools for urban climate adaptation have been discussed at two scenario workshops and resulted in illustrations and workshop documentations and stakeholder dialogues have been held with stakeholders and decision makers.

4. Administrative part

4.1 Description of the management system

In the beginning of the project a project management team was established, consisting of a project manager, a project secretary (responsible for financial management), a communication office, the Head of Climate Change and Energy Unit, acting as support for the project management team.

Actions, responsible beneficiary and action leader:

Project co-ordinator 10: Malmö/Environment department Anna Lindblad	**Project secretary** 10: Malmö/Environment department Anita Tapper
1: VA SYD Stefan Milotti	6: IVL Ida Westerberg/TonyPersson
2: Malmö/Streets and Parks Dep. Caroline Larsson	7: Malmö/Environment dep. and IVL Annika Kruuse/Tony Persson
3: Malmö/Internal Services Dep. Viktoria Olsson	8: Malmö/Environment dep. and IVL Annika Kruuse/Ivana Kildsgaard
4: SGRI Jonatan Malmberg	9: Malmö/Environment department Nina Eneroth
5: IVL Ivana Kildsgaard/Anja Karlsson	

Project team

Figure 1: Organigramme of the project

The project manager and the project secretary were present at the Kick off meeting for Life+ projects in Stockholm on the 5th of March 2009.

A kick-off meeting was held on the 2nd of February 2009 in Malmö. At the meeting one person who is responsible for each action in the project, was appointed as an action leader. The project management team and the action leaders together form the project team. During the meeting a study visit to the Fosie area, where Action 1 and 2 will be implemented, was arranged.

A second project meeting was held on the 26th of March 2009 in Malmö. During the meeting progress of action implementation was discussed and a study visit to Swedish Green Roof Institute and the Augustenborg Eco City was conducted.

The project manager and the project secretary visited all partners except IVL in the first months of the project to discuss practical issues such as time schedules, reports, budgets to establish good routines. The project manager and the project secretary have held separate meetings with partners regarding economic issues to give support and help throughout the project.

Project meetings with the project team have been held in Malmö and in Stockholm. The meetings included site visits to the project sites, Fosie industrial area and Augustenborg.

The coordinating beneficiary has throughout the project requested that the associated beneficiaries to submit a brief progress report and their updated financial report every six months.

A steering group consisting of three heads of departments or sub departments from involved departments in Malmö and one person each from the four remaining partners was established. During the project and three steering group meetings were held. The steering group had more frequent meetings in the beginning of the project.

An expert panel (reference group) was set up and included three researchers and officers in the field of green roofs, urban greening and stormwater management. One expert panel meeting was arranged with the project group. The project covered the expert panels travel costs. Good contact was established and the expert panel members have in various amounts given input to the implementation of the project.

A LIFE-network has started up in Malmö with representatives from organisations that are coordinating LIFE+ projects in Malmö. The group has had regular meetings and discuses different issues such as economic matters and communication. A joint seminar to celebrate LIFE's 20th anniversary "LIFE 20 years of getting things done" was arranged on May 9th 2012.

The project co-ordinator, together with VA SYD and the Parks and Streets Department, arranged an opening event at Skogholms ängar in September 2013 as well as a final conference event for the project in December 2013.

Action	**2009**				**2010**				**2011**				**2012**				**2013**			
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
1 Open stormwater systems																				
2 Enhanced biodiv.+recr.																				
3 Green facades																				
4 Green roofs																				
5 Stakeholder dialogue																				
6 Modelling flows																				
7 Effects on biodiv.+ recr.																				
8 Architectural integration																				
9 Dissemination																				
10 Project management																				

Figure 2. Timetable of the project

Two amendments have been submitted to the Commission. The first one was submitted in June 2009 and the second in October 2011. The first amendment was due to a reorganisation of the infrastructure management of the City of Malmö. The water management part of the municipality, responsible for Action1, had been formed into a separate legal entity called VA SYD. The second amendment was due to a change in the partnership in the project. Ms. Kruuse working for ISU (former beneficiary number 2) and responsible for action 7 and 8 changed her employment and started to work for the City of Malmö (coordinating partner). ISU's commitments in the project were therefore moved to the City of Malmö and ISU was not a part of the project any longer.

The Partnership agreements were submitted to the Commission with the Inception Report in October 2009.

4.2 Evaluation of the management system

A lesson learned is to build the project team so that representatives from different partners are involved in each action to obtain a wider collaboration. The different actions in GreenClimeAdapt have been implemented relatively separate and the cooperation between the actions could have been better. A reason to this is that only one partner has been involved in most of the actions besides Action 1 and 2 which have been led in parallel.

The Commission was on a visit just before the inception report was submitted in 2009 and attended the "LIFE 20 years of getting things done" conference that was arranged in Malmö.

The GreenClimeAdapt project has changed monitors four times and three different monitors have been responsible for the project. At times the monitoring structure felt a bit unclear, but however the communication with the monitors has always worked well with quick responses to questions. It would have been a great idea to have some meetings with the monitor with the whole project team instead of just the project manager and project assistant. That would have given the monitor a more deep understanding of the project and the project team a greater knowledge of the administrative routines.

5. Technical part

5.1. Technical progress

5.1.1 Action 1 Open green stormwater system

The action has realized the implementation of open stormwater detention facilities in Skogholms ängar (Skogholms meadows) located in Fosie industrial area in Malmö. VA SYD has been the project partner responsible for this action. The work undertaken in Action 1 has been made together with the City of Malmö, the Streets and Parks Department (responsible for Action 2). The action can be divided into six distinctive parts:

1. Planning and surveys (2009, VA SYD, Streets and Parks Department)
2. Public tendering for the appointment of a consultant engineer regarding the detailed planning process (2009, VA SYD and Streets and Parks department)
3. Detailed planning, design process (2010, consultant Landskapsgruppen Öresund, VA SYD, Streets and Parks Department)
4. Public tendering for the appointment of a sub-contractor (2010, VA SYD, Streets and Parks)
5. Construction (2011, Peab Sverige AB)
6. Maintenance guaranteed by the contractor (2012-2013)

Planning and surveys

In this phase a project organization was formed with members from both the Parks and Streets Department and the Water Management Department. The administrative part took some time due to reorganisation of the infrastructure management at the City of Malmö. The water management part of the municipality was by that time formed to a separate legal entity called VA SYD. Therefore the Grant Agreement had to be modified. The project description was prepared and describes: defined goals, time- and cost frames, identified risks and risk management, special conditions and visualization of functions, deliveries and commitments of the project.

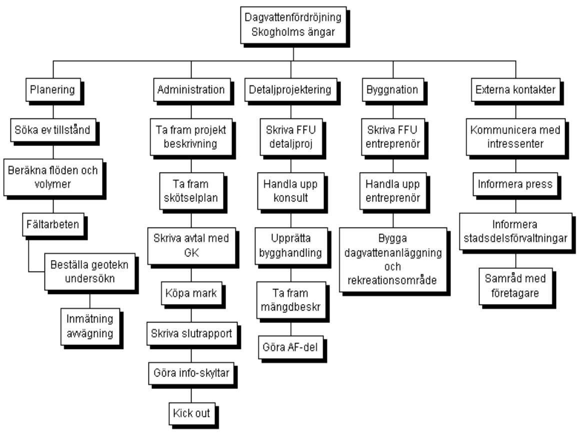

Figure 3. Planning - Visualization of project functions and activities to be undertaken

Planning and surveys also consisted of the following parts:
- hydraulic calculations
- geotechnical studies
- negotiations concerning eventual land purchase
- planning and built surveys (scaling, geodetic surveys)

The detention volumes were dimensioned in relation to current regulations concerning the hydraulic load of the Riseberga watercourse. The dimensioning rainfall frequency was set to ten years, i.e. the detention ponds should statistically be full only every ten years. Due to climate change, however not knowing future precipitation intensities, the rainfall data used in the calculations were scaled up by 20 %. Using a climate factor of 1.2 for new stormwater facilities is a standard procedure in Sweden.

In the beginning of this action negotiations regarding a land acquisition failed. A privately owned parcel of land, west of the alder wetland that from the beginning was planned to be a part of the project, could not be acquired. Therefore we had to deviate from the original plan but this had no impact on the project goals besides that the action was delayed.

Detailed planning – design process

The design process was realized by the landscape architects Landskapsgruppen Örsund AB in 2010 together with VA SYD and the Streets and Parks Departments. They also produced the construction documents and parts of the documents used in the procurement process.

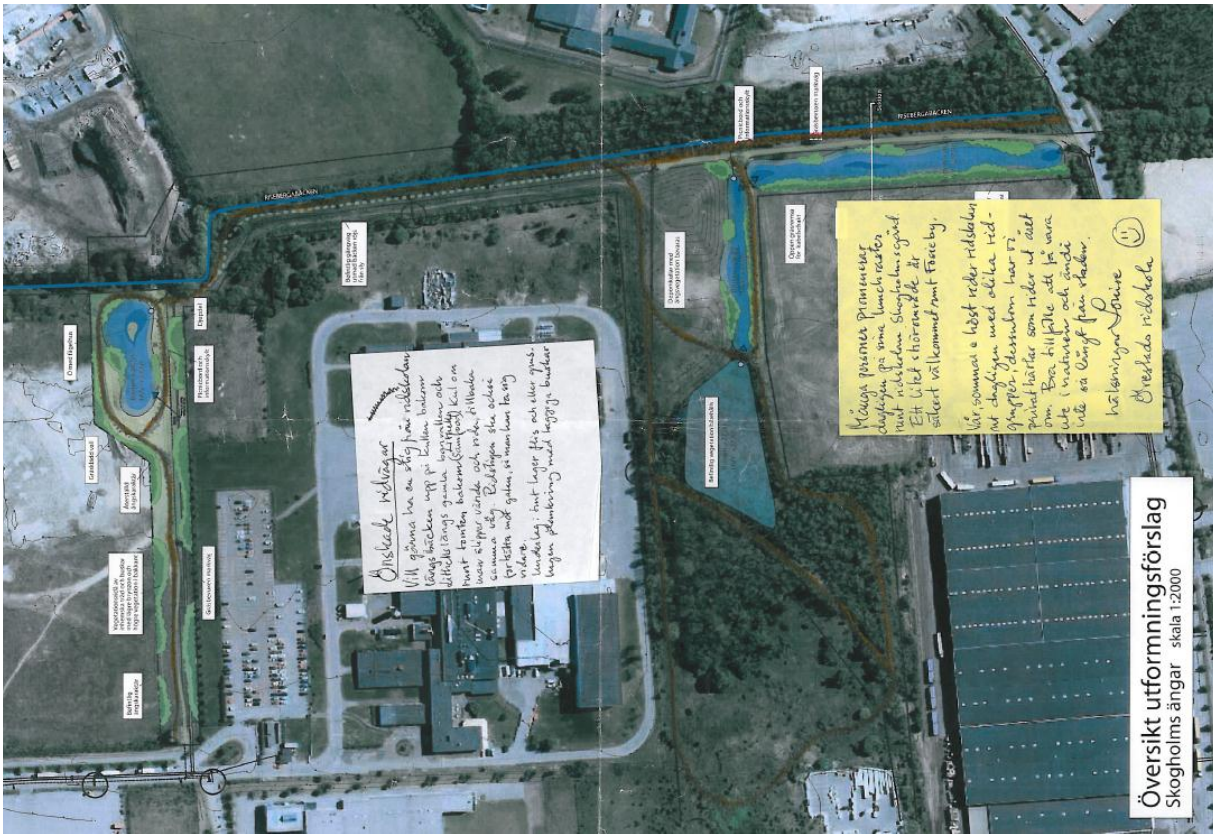

Figure 4. Design proposition during detailed planning process

Construction and maintenance guaranteed by the contractor

The construction started in January 2011 and ended in the beginning of 2012. When the construction ended, a stormwater detention system using an exciting alder forest and three new retention pounds had been built in order to lead to improved hydraulic conditions (figure 5-8). The following parts had also been constructed and installed:

- one new outlet to the creek
- three control devices for flow regulation
- 160 m of new stormwater pipes

Figure 5. Detention pond

Figure 6. Pipes between the alder wetland and constructed oblong detention pond.

Figure 7. Manhole with weir function

Figure 8. New outlet to the alder wetland

As shown in figure 9, an existing low-lying alder marsh is used for retention.

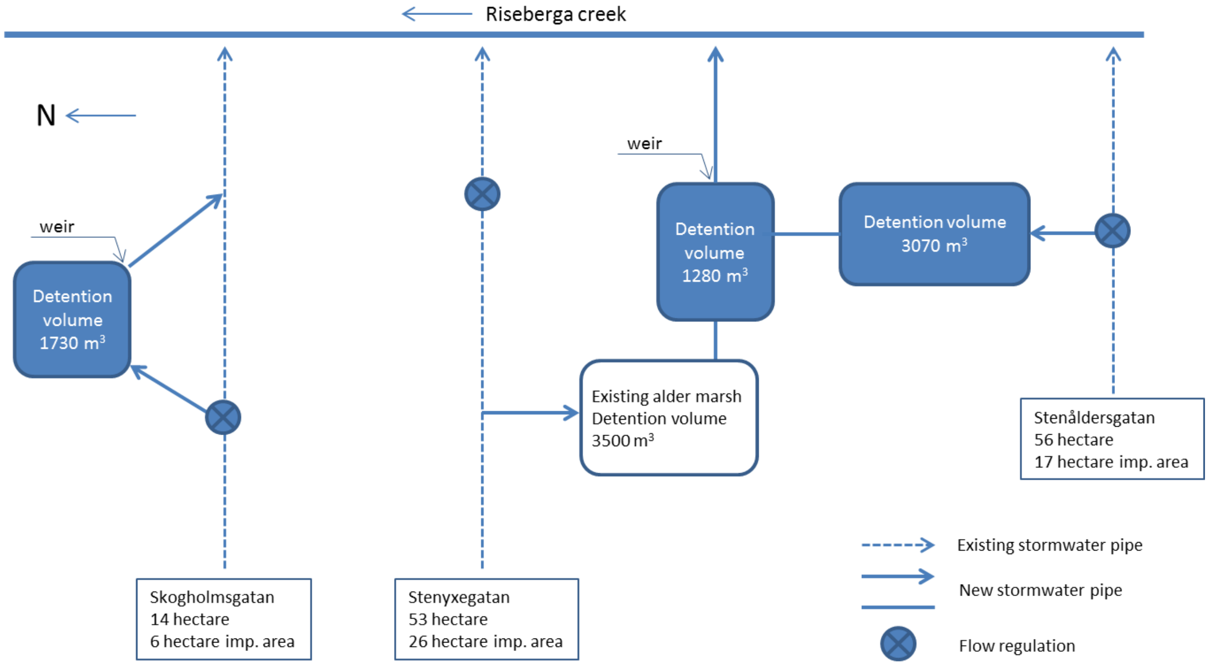

Figure 9. A schematic presentation of the detention system in Skogholms ängar

According to the tendering documents for the construction the sub-contractor was responsible for the maintenance for two years after the final inspection. During this period VA SYD and the Streets and Parks Department ensured supervision of the site that lead to different improvements that was carried out by the contractor, such as fixing fences and weeding protection cloths.

Follow-up work was carried out by VA SYD after the facility was put into service in the beginning of 2012 which includs measurements of the hydraulic function and adjustment of the flow regulations.

The control devices for flow regulation that were installed control the flow from the existing system to the Riseberga creek. When the capacity of the ponds is reached the water is discharged over a weir to the watercourse in order to prevent damage upstream.

Besides improved hydraulic conditions the project has also led to major improvement regarding biological and recreational values in a highly dense industrial area. Today, Skogholms ängar – a place that are sandwiched between heavy industry and a heavily trafficked - has now become a place for sustainable stormwater management, recreation, horseback riding and improved conditions for buzzards and dragonflies.

The output from the action corresponds very well with the planned output. Lower detention volumes were installed and instead the existing alder wetland was used as part of the detention system. The effect of this is only positive.

In 2013, oil leaking from one of the industries, whose drainage is directly connected to one of the detentions ponds, was observed. The leakage may provoke the need of decontamination measures. Required measures are being planned for both by VA SYD and the Environment Department in the City of Malmö.

Figure 10. New outlet

Figure 11. Detention pond in connection with alder wetland.

Figure 12. Detention pond after heavy rainfall

Figure 13. Detention pond with "bird island" after heavy rainfall.

When sustainable urban drainage is concerned, water is made visible and available for the citizens. Therefore it is obvious that the present project which is in an existing industrial area, and also provides recreational values, will only face minor problems (feedback or complaints from the public) that are easily fixed. One must realize know that the follow-up and development of projects concerning open stormwater drainage is inevitably subject to trial and error.

Not long after the constructed facility was put into service, littering occurred at the northern entrance to the site, see figure 14. This problem was fixed by moving the waste receptacle away from the entrance, where it was easily accessed by truckers, to a more suitable location. During a couple of heavy precipitation events, flooding occurred from two of the manholes where the control devices are installed, se figure 15. Different measures have been performed in order to prevent this from happening again. For instance, the control devices have been enlarged and the manhole covers have been replaced.

Figure 14. Littering at the entrance

Figure 15. Flooding due to heavy rain

The continuation of this action consists especially of maintenance. Otherwise the project is terminated. However, the construction can be subject to eventual modifications and additional developments, according to figure 16, initiated by feedback of maintenance experiences and feedback and/or complaints from the public that uses the site. For instance, due to the risk of flooding some additional development concerning the large pond at Stenåldersgatan will be realized before the summer of 2014. VA SYD are also looking for the possibility for other similar measures along the creek.

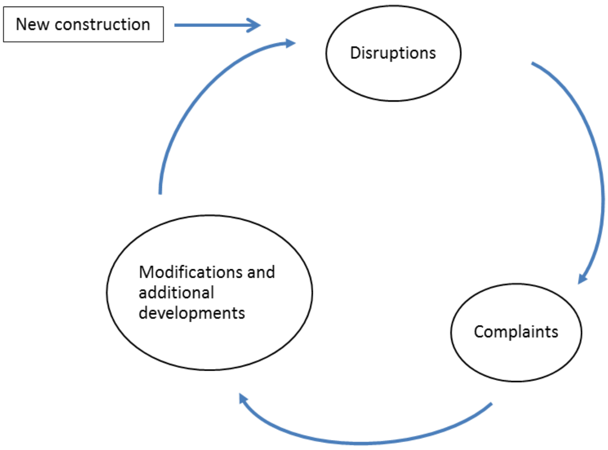

Figure 16. Feed-back of maintenance experiences that leads to modifications and additional work

5.1.2 Action 2 Enhancing recreation qualities and biodiversity in combination with stormwater system

Skogholms ängar is a green space in the middle of Fosie Industrial area in Malmö, which has been saved due to high natural values. An old alder forest is located in Skogholms ängar, which is the only one of its kind remaining in Malmö. The alder forest was saved but mistreated because less water was lead in to it when all stormwater in the area was redirected into pipes and out in the Riseberga creek.

The action is led by the City of Malmö, the Streets and Parks Department, in cooperation with VA SYS (who is responsible for Action 1). We have seen the stormwater as a resource instead of a problem. By leading the stormwater in to the alder forest the forest as a biotope will benefit. When doing this the Street- and Parks Department also wanted to make this area better known to the public and make it in to a recreation area. The demonstration in this action was to show that it is possible to combine adaptive local stormwater management while enhancing recreational values and biodiversity. Since there are few opportunities for visitors in and around Malmö to be near to wetlands, the contact with open water and suitable vegetation is highly interesting.

The project started in 2009. A project group with members from both the Parks and Streets Department and the Water Management Department was formed. The administrative part took a little time due to formation of VA SYD.

The first part of the project was delayed due to problems with purchase of land. A bit of private owned land that was important for the project was no longer for sale. The area that was available for the project thereby became less significant and a new plan for the open stormwater system had to be elaborated. An alternative solution had to be worked through, a solution that led to higher temporary water levels (after heavy rain) in the alder wetland that was going to be restored. It was the project’s opinion that from an individual point of view the higher water level would be fatal to some alder trees, but from a biotopical point of view the species would benefit.

The small delay in time schedule had no change in the long run for the project and as soon as the solution was accepted a comprehensive specification to hire a consulting engineer for the detailed planning process began. The consulting company Landskapsgruppen was contracted for the task in early 2010 and the construction part of the project went smoothly until it was discovered that the minimized area had resulted in not enough area for the stormwater ponds, unless some of the existing tree- and shrub groups were cut down. It had been the project’s aim from the start to save all vegetation in order to secure the areas attraction as a recreation area. But the main purpose of the project was to reduce peak flows in the Riseberga stream and therefore some of the existing tree groups were cut down. The loss of this vegetation will have a negative impact on the recreational values of the area in the beginning but this will be compensated for with the addition of trees and meadow vegetation that are more similar to the natural flora in the area, and it is the project’s opinion that this solution, after a couple of years, will give visitors an even more nature-like experience in the area. Also, the fauna in the area will probably benefit in the long run.

The horseback riding club in the area, identified as a major stakeholder, was invited into the planning process for valuable feedback.

An inventory of the existing insect species was conducted in the summer of 2010, before the actual rebuilding of the area took place, see appendix 1.

By the autumn of 2010 the detailed planning of the project was finished and the process to choose a construction company took place. In December PEAB AB was signed for the job.

The construction of the area Skogholms ängar started in the beginning of 2011 and was completed during the end of that same summer. The contractor constructed the stormwater ponds and small walking/horse-riding paths, planted trees, and planting meadows. Most stormwater is lead down into the alder forest, that is now more of a wetland, and where the natural wetland flora will soon establish itself. The water ponds are planted with flora that range from wet to dry habitus. This was necessary since the water level will vary.

Paths for horse-back riding were placed separately from the waking paths to avoid conflicts. The paths and vegetation has been laid out in order to look as natural as possible and to match the existing landscape and biotopes, but yet in a way that renders the area more accessible. The vegetation at the site was preserved as far as possible; as much existing vegetation as possible was saved and new vegetation, that would intensify the biotope and the recreational values, was planted. In the parts where the ponds were placed, the field-layer contained the "seed bank", was saved and used in the meadow areas, in order to conserve as much of the existing species as possible. Key species, such as Alnus glutinosa, Betula pubescens, Prunus padus and Salix caprea were planted in addition to the existing alder forest. In dryer parts of the area, new tree plants that will form an oak forest in the future was planted, with key species such as Quercus robur, Corylus avellana and Prunus avium. The slopes down to the stormwater ponds were sowed with a range of herbs and grass species to match the existing flora, which was inventoried before the planning of the area, but also with additional species that will increase the biodiversity in Skogholms ängar.

The existing fauna in the area was disturbed as little as possible, for example construction near the creek took place at the best times to not disturb the fish spawning.

During the construction process, meetings were held regularly in order to follow the building progress and to be able to follow up on problems and/or new possibilities that came up. One possibility that appeared was that since the total area had become smaller, and thereby the total cost of the project had decreased, there was money in the budget to enlarge the area to the north. The path along the creek was stretched out another half kilometre. This action did not only make the recreation area larger and more interesting to visit, but also gave the area a third entrance close to a public bus stop which made it more visible to people working in the surrounding area.

During 2012 the area has little by little been increasingly used by the public. Still it is mostly horse riders who use the area (see figure 17). But since the well-known ornithologist has done bird surveys here and blogged about it, an increasing number of bird watchers have discovered the area. Our aim is to have more activities in Skogholms ängar to make even more people aware of Malmö's new recreational area.

Figure 17. Horseback riding in Skogholms ängar

During the summer of 2013 follow up studies of flora and fauna were made, to ascertain whether the actions have had any effect on the wildlife in Skogholms ängar. It is still too soon to draw any conclusions from the result.

The survey must be followed up again in a couple of years, but to date no alarming signs in number and/or species of flora and fauna are yet seen.

A post-inspection of the facility, focusing on the establishment of the landscape plants, was realized in September 2012 and the whole area was included in the normal maintenance as a recreation area of Malmö City.

The project of combining stormwater management and ponds with arranging better recreational possibilities in a natural area is completed and the result of the project shows that this could be done again. Also, the work to establish better recreational areas along the Riseberga creek will continue.

5.1.3 Action 3 Climbing plants for cooling buildings – green facades

Climbing vegetation has been found on facades for centuries. Usually they grow directly on the outer most layer of the wall, risking causing damage there. In this action climbing vegetation, growing on wire systems or in a cassette, detached from the facades have been demonstrated. The City of Malmö, Department of Internal Services, has been the project partner responsible for the planning and implementation the green facades and solar panels.

Designing and projection

Suitable buildings/facades were identified for the implementation of the green facades. The first building was an office building, three stories high. The second building was a workshop building. Both buildings are located in the district Augustenborg in Malmö. The buildings belong to the technical department of the Department of Internal Services. The office building was chosen because of the problems with high indoor temperatures during spring and summer. The workshop building was chosen to implement a green facade on a facade pointing in the north cardinal direction. The buildings undertook several technical investigations to acquire information, which helped in the planning of the green facades e.g. the bearing of the facades and roof.

In cooperation with SLU, the Swedish university of agricultural science, the plants and substrate was discussed and chosen. SLU has great knowledge regarding which plants are best suited for green facades. This information was presumably gathered through previous research projects. SLU was also involved in the discussions concerning the irrigation system for the green facades. The in-house energy-team and architect was involved with the planning of the solar panels. Investigations were undertaken to place the solar panels in the best angle to capture sunlight.

Procurement and Construction

After the procurement a supplier was chosen to deliver/build the green facades. At the office building the facades were implemented on the western and south facades. Two different systems of green facades were implemented. On the western façade, a cassette system with evergreen plants, Polypodium vulgare, was established. On the south façade, a wire system was used with non-evergreen plants, Parthenocissus and Fallopia baldschuancia. At the workshop building the wire system was implemented with the non-evergreen plants. The systems are built 15 cm out from the facades to avoid negative effect on the facades of the building.

Two different systems for irrigation were built, one to the cassette plants and one to the wire plants. The irrigation system was very advanced with many parameters to tune in. However the main control for the irrigation system was situated in the distribution house electrical board. In other words, the system was not user-friendly and had no easy access.

A total of 80 solar panels were installed with an total area of 112 m^2 and a top efficiency of 14.400 W. 32 of the solar panels are assembled on the south facade and the rest on the roof. The ones on the facade are incorporated with the wire systems of plants. (For more technical information see appendix 2) The supplier of the solar panels was Energikonsulterna i Sverige AB.

The efficiency of the solar panels decreases when the temperature of the solar panel is higher. Conversely, the efficiency increases when the solar panels are located in a cool environment. An important task for the greenery on the facades is to reduce the solar radiation on to the facades and create a “heat suppressor” between the greenery and the outer wall. The objective with combining the solar panels with the greenery of the facades is that the combination can hopefully result in a higher degree of efficiency of the solar panels as well as other advantages, which could be achieved with the greenness of the facades.

A digital sign was mounted in the reception- area of the office building to show the production of the solar panels, a pedagogical instrument for the people working in the building and visitors.

This phase ended during autumn 2010.

Establishment

This phase is the most time consuming in the project. The establishment for the plant of the green facades is approximately 3-5 years.

The non-evergreen plants on the wire system have not grown according to plan. In the spring of 2013 the plants were not yet covering the desired surfaces. Shearing of the plants has been made several times to that they grow on the intended surface. The plants are growing vertically but not horizontally between the windows. The consequences of this are that the measurement and evaluation are performed when the plants are not fully established.

Major problems occurred with the so-called evergreen plants in the cassette system in the winter of 2010/2011. 90% of the all-evergreen plants froze to death. Likely cause may be:

- Low quality of plants
- Too monotonous plant material.
- Improper planting time, the plants did not have enough time to root sufficiently before the unusually early frost hit.

Figure 18. Green facades in Augustenborg

Investigations and discussion were conducted with the supplier of the plants to find a solution to avoid this happening again. The quality of the plants and the monotonous plant material were considered in the discussion. The watering system has also been in focus for the analysis. The analysis and investigation generated new knowledge which was used later on in the project. New plants were bought. It was not possible to purchase fully-grown plants, so the plants first had to grow in a greenhouse. When the plants were of a desirable size, they were transplanted to the cassette system for a second time. Four different plant species were used, to discover which one would best meet the local conditions best in the green facades. The plants used were Alchemilla erythropoda, Polypodium vulgare, Hosta ’Golden tiara and Oshimastarr, Carex ’Evergold (Appendix 3). It is too early to make any evaluation of the different species as the plants needs more time to establish.

With the green facade on the workshop building with the facade pointing north, the conclusion could be made that the establishment is even slower than the other facades pointing in other cardinal directions.

5.1.4 Action 4 Green roofs for home building

The Scandinavian Green Roof Institute (SGRI) was responsible this action with the aim to test and demonstrate alternative, environmentally friendly green roofs. The intention was that these should be light weight solutions that could be possible for both private house owners as well as the construction industry to build at a low cost on existing buildings. In total, five different test sites were prepared, installed and monitored. For a detailed description see annex 4.

Test site 1
100m^2 of green roofs were established in November 2010. The loading capacity at the site (roof F) was 70kg/m^2. The instalment was planned in collaboration with Dr. Tobias Emilsson and with input from Professor Stephan Brenneisen. Three batches were prepared with different ratios of each material (vol-%), see table 1.

Table 1. The three batches used at pilot test site 1, percentage ration in volume.

Batch	**1***	**1****	**2***	**2****	**3***	**3****
Straw	80.0	0.0	70.6	0.0	77.4	0.0
Compost	4.0	20.0	5.9	20.0	6.5	28.6
Cow manure	4.0	20.0	5.9	20.0	6.5	28.6
Chrushed bricks	6.0	30.0	8.8	30.0	9.7	42.9
Gravel	6.0	30.0	8.8	30.0	0	0

* Including straw
** Excluding straw

The total weight of the roof was determined to be 50kg/m^2 (when fully saturated).

A seed mix with both herbs and grass species and seed compost were scattered over the test site. Afterwards sedum and moss cuttings were spread over the whole site**.**

Observation
Monitoring of the site during summer 2012 showed low total plant coverage. A clear domination of grass was seen. In June the number of species was counted (See annex 4, appendix 1). Few of the seeded herbs had established themselves, as they had been outrivaled by the grass.

In august 2013 the grass was still dominating. Hence, a goal with the following test sites was to reduce the amount of grass domination.

Test site 2
6 m^2 of green roofs were established in July 2012 with input from Ayako Nagase. A low organic substrate mix was chosen on this site, using 3-4 cm crushed bricks of two different colours and 10% and 5% of compost soil respectively on 3m^2 of each brick colour. In all of the four rows, 15% leca was added. A seed mix with annual herbs was chosen.

Observation
An irrigation plan was set up, after two days without rain the substrate was irrigated for 6-8 minutes. Already, after just four weeks several of the plants had bloomed. The vegetation was then inspected in September (Annex 4, appendix 3). Considering the shallow substrate depth of 5 cm the test site was a success.

Test site 3
In order to improve the results from test site 1 in a new straw-based pilot, Stephan Brenneisen was once again asked for advice.

90 m^2 of green roofs were established in November 2012. The maximum loading capacity was 60-70 kg/m^2. The substrate material was similar to the mix on pilot test site 1. But the non-organic materials were mixed with compost prior to use. Rye straw, which less nutrient rich than straw from wheat, was used and it was not mixed in with the other batch materials. Instead, the rye straw, used as the bottom layer with holding water as the main purpose, and crushed clamshell was tested. The substrate materials were mixed in four batches, see table 2 and figure 19.

Figure 19. Materials used in the substrate mixes that were placed on top of the rye straw. From left to right: clamshells, gravel, crushed bricks, compost and stone dust.

Table 2. The baches in pilot test 3, percentage ratio in volume and added clamshells in g.

Batch	B1	A3	A2	A1
Compost	22,2	33,3	33,3	33,3
Crushed bricks	55,5	44,4	44,4	44,4
Gravel	7,4	7,4	7,4	7,4
Stone Dust	14,8	14,8	14,8	14,8
Added clamshells/m^2	300 g	600 g	300 g	0 g

The same seed mix that was used at pilot test 1 was chosen for pilot test site 3 and sedum species were spread over the whole site as well. Some plug plants was also established with a mix of plants found in the seed mix, plus some additional perennial plants.

Observation
Despite the effort to make the rye compact some of the substrate poured through the rye straw layer and hence mixed more than intended. The goal to have a 40-50 mm substrate layer above the rye straw was therefore not accomplished. The substrate layer on the straw turned out to be 30 mm–40 mm with substrate and straw to a certain extent mixed beneath. During

the summer of 2013 the vegetation was quite poor in cover but many of the plug plants seemed to survive despite hot weather.

In august 2013 the vegetation was examined with a relatively good result concerning the number of species from the used seed mixture and at the same time much less weeds and grass domination than at pilot test 1 was observed (see Annex 4, appendix 4).

Test site 4
At the 4th and 5th pilot test site hemp was the next material to be tested. The substrates at pilot test site 4 were similar to test site 3 but with two new ingredients included. First, a fine and smaller fraction of crushed bricks. Secondly, biochar was tested as an alternative to the compost, see figure 20. The total amount of organics was decided to be less than in both test site 1 and 3.

Figure 20. Materials used in the substrate mixes that was placed on top of the hemp. From left to right: Crushed bricks (finer), compost, crushed bricks (coarser), biochar and stone dust.

The hemp was much easier to handle than the rye straw and created a nice and even layer. The only problem was its low weight, making it very difficult if windy at installation.

The test site was divided into four test beds with hemp in the bottom in three or the four beds. The objective was to see if the hemp would have any effect at all, or if it was enough to use a little bit more substrate but reaching the same total weight of approximately 65 kg/m^2, when fully saturated.

Table 3. The substrate mix at pilot test 4, ration in percentage.

Batch	C1	C2	C3	C4
Crushed bricks (coarse)	57,1	60	60	60
Crushed bricks 0-2 mm (fine)	9,5	10	10	10
Compost	14,3			20
Biochar	9,5	20	20	0
Stone dust	9,5	10	10	10
Hemp beneath	Yes	Yes	No hemp	Yes

Observation

In august 2013, the vegetation was examined with good result concerning the number of species from the seed mixture and at the same time (like at test site 3) much less weeds and grass domination than at pilot test 1 (see Annex 4, appendix 5). The plant coverage at pilot test site 4 was better than at pilot test site 3.

Test site 5

At test site 5 the goal was both to try different kinds of substrates, and to create a 360 m^2 greenroof with a functioning ecosystem with a high biodiversity of herbaceous vegetation. Consultation was obtained by Dusty Gedge, president at European Federation of Green Roof Associations.

The roof construction was estimated to be able to carry to 100 kg/m^2 over most of the roof, and with higher load ability directly above four supporting pillars.

The substrate used was mixed in sic different batches to further diversify the environment of the roof (see table 4). The substrate layer was between 5-8 cm.

Table 4. The substrate mix at pilot test 5, ratio in percentage

Substrate	Batch D1	Batch D2	Batch D3	Batch D4	Batch D5	Batch D6
Hemp	5-6 cm	5-6cm	5-6cm	5-6cm	Brown field	(for bees)
Crushed bricks (2-10 mm)	65	70	70	65	0	0
Crushed bricks (2-30 mm)	0	0	0		90	50
Crushed bricks (0-2 mm)	10	10	20	15	0	20
Stone dust (0-2 mm)	10	10	0	0	10	0
Compost	5	10	10	0	0	0
Biochar (0-2 mm)	10	0	0	20	0	0
Sand (0-4 mm)						30

Stream-like furrows of natural stone were laid out on the structural areas able to carry a slightly heavier load (above the pillars) with thicker layers of substrate and stone. Other features with the single goal to increase biodiversity were installed on the roof, such as logs and whole bricks to further increase the number of microhabitats, hills and creek-like elements with natural stone, drier and wetter areas and a ridge of sand to offer space for bumblebees to potentially to dig themselves a home. Two plant mixes of perennial herbs were also developed.

Observation

Irrigation was given only three times in 2013. Some plug seedlings had to be replanted due to birds that were drawing up plug plants. This was the only problem experienced during the summer.

The vegetation cover was a great success. Only test site 2 with annuals resulted in a similar cover as the first summer. But the main goal with test site 5 was the diversity of plants. Also, from this perspective, test site 5 seemed to be very successful. In August the vegetation was surveyed and the result was very good with a diversity of a total of minimum 56 herbaceous perennials and annual species (plus 5 sedum species and some grass).

Figure 21. In the foreground Corn Poppy (Papaver Rhoeas) with its red color. Behind the "creek" with larger stones

Green roof training events in 2013

Two different training events were held in cooperation with the project Green Roof Course. Within these events GreenClimeAdapt gave lectures focusing on alternative green roof substrates, and climate adaption with green roofs. The two training events were:

1. Two classes from the upper secondary School "PEABSkolan" (cooperating with the construction and building industry) In addition to theoretical lectures the pilot test site 4 & 5 was installed.
2. Summer course with participants from a wide range of countries

The training events resulted in increasing the students' interest for green roofs in general due to a greater understanding of climate change and climate adaptation. And for the second workshop, many of the course participants started up their own green roof initiatives upon completion.

5.1.5 Action 5 Dialogue with stakeholders around Riseberga Creek

Dialogue with stakeholders is the key to successful adaptation measures and has hence been an integral part of the project. It is widely recognized that stakeholder interaction and dialogue is essential to improve decisions about, and awareness of, climate change and climate change adaptation. The dialogue activities in this project, including two dialogue meetings and several interviews, have focused especially on reaching a broad variety of groups and individuals (i.e. multi-stakeholders) around Riseberga Creek and the demonstration area of open green stormwater system in Skogholms ängar. The main point of departure for the dialogues with stakeholders about climate change and adaptation has been the river basin perspective i.e. the Riseberga Creek as a whole. The demonstration area of implemented measures has served as an example to stimulate and reflect up on the issue both at a local scale as well as on the river basin scale. IVL Swedish Environmental Research Institute (IVL) has been the project partner responsible for the planning and implementation of the stakeholder dialogues.

As a preparation for the dialogue activities, meetings for more detailed planning activities were held together with the project partners from all other actions as well as some key stakeholders. The suggested dialogue set-up was also discussed with the Project Steering Committee. A result of this work was the definition of methods for stakeholder dialogue available in the report "Methods for Dialogues" (Annex 5)

As a first step before carrying out the dialogue activities, a stakeholder analysis and identification was conducted. In order to identify relevant stakeholders for the project, stakeholder types (depending on their role and influence in connection to the Riseberga Creek and the demonstration area) were first outlined. Four major stakeholder types that have an influence on and/or are influenced by the creek were identified: public administration, industry/companies around the Riseberga Creek, upstream groups exerting an influence on the Riseberga Creek, and downstream end users. Next, stakeholders within each type were identified. This was initially done with help from project team members with local knowledge of the Riseberga Creek area. Identified stakeholders in their turn suggested additional stakeholders, a so called "snow-ball" sampling method. In addition, maps of the area were used to identify stakeholders, mainly from industry, situated in close connection to the creek and demonstration area. The list of key stakeholders has evolved over the course of this action due to a growing understanding of the roles and interests of different stakeholders around the creek. Based on the stakeholder analysis, the dialogue activities were further planned regarding the design of the activities to attract the key stakeholders and types of communication and marketing that would reach and involve different stakeholder groups in the best way.

During 2011–2012, two dialogue meetings and several interviews with key stakeholders were carried out. The dialogue meetings were organized with the aim to increase the knowledge among invited stakeholders on climate adaptation and possible adaptation measures, discuss different stakeholders' willingness to take action to adapt to climate change and incorporate their views and ideas on how the Riseberga Creek and the surrounding areas can be adapted to a changed climate while increasing the biodiversity and recreational values. Both meetings were divided into two parts, a closed dialogue with invited key stakeholders using a focus group methodology followed by an open meeting where the general public could participate. In the first part, key stakeholders were selected based on the stakeholder analysis and identification and invited via e-mail and telephone to a focused dialogue on different pre-decided topics. The focused dialogue included both presentations by the project team concerning climate adaptation from a Riseberga Creek perspective (e.g. based on work from

Action 6 and 7) as well as open discussions. In the second part, the dialogue was opened up for the general public to share their views and ideas. To reach the public, the meetings were advertised in local media, at local libraries and meeting places, through the municipality and social media. Presentations from the closed meeting were printed out and put up to facilitate discussions.

The first dialogue meeting in October 2011 focused especially on the development of the Riseberga Creek, and how the area can be adapted to a changing climate while also increasing biodiversity and recreational values. Special emphasis was on the possible measures around the Riseberga Creek and planned measures in the demonstration area in Skogholms ängar. Sixteen representatives from the project and key stakeholder groups participated in the meeting, including stakeholders from the local allotment compound (Jägershill 1 and 2), the local fishing club SFK Spinnaren and the Federation of Swedish Farmers (LRF). Four people, all residents in the creek area, took part in the second part of the dialogue meeting.

The second dialogue meeting in October 2012 also focused on the development of Riseberga Creek and how the area can be adapted to a changing climate while also increasing biodiversity and recreational values. More specifically, this second dialogue focused on discussing the result of the project and open green stormwater management in general as well as future measures, visions, values and a continued dialogue. The European experience was also discussed with an invited guest from Bradford University in the UK working with social aspects on water management. In total, 36 representatives from the project and key stakeholders participated, including the local allotment compound (Jägershill 1 and 2), the local fishing club SFK Spinnaren, the Federation of Swedish Farmers (LRF), municipal district administration, industry, the local water council, Jägersro residents association and the Riseberga Creek drainage company (the association responsible for the water in the creek). After the focused dialogue with invited stakeholders, the general public was invited to an open dialogue for continued discussions. However, only one person participated from the public.

Interviews were also carried out as part of the stakeholder dialogues. The interviews were aimed at reaching important stakeholders around the Riseberga Creek that were difficult to reach with other dialogue activities e.g. dialogue meetings. As a first step, a selection of stakeholders was made based on the stakeholder analysis and an identification and evaluation of the stakeholders not reached in the previous dialogue meeting (October 2011). The main focus was on important user groups downstream not yet reached, as well as industries and companies in the Fosie industrial area, with substantial influence on the creek. In total, 26 prioritized stakeholders were selected of which 15 of the most important and central stakeholders (by size and proximity to Riseberga Creek) were contacted. Seven stakeholders were interested in participating and were also later interviewed. The interviewed stakeholders included both downstream end users; the local football club, Jägersro racetrack and the local riding school, as well as four industries and companies (including the local correctional facility) situated in Fosie industrial area, surrounding the Riseberga Creek and demonstration area. The interviews were structured around three main themes: i) the stakeholders' experiences related to the Riseberga Creek including the current and potential future usage of the creek area, ii) the stakeholders' effect on Riseberga Creek and stormwater situation including their knowledge about climate adaptation, and iii) the stakeholders' knowledge and attitude towards the project GreenClimeAdapt.

As a concluding activity, the results from the dialogue activities have been summarized in a stakeholder- oriented report, "Multi-stakeholder dialogue on green urban climate adaptation" (Annex 6). The report has also been distributed to all key stakeholders involved in the dialogue activities. Additionally, based on the experiences and lessons learned from the dialogue process in the project GreenClimeAdapt, a generic dialogue strategy has been developed with the aim to inform and help other climate adaptation projects with a dialogue process after the end of GreenClimeAdapt project. The strategy has been developed with the purpose to be used independently from the report and distributed both electronically and in printed form

It was furthermore agreed by most stakeholders taking part in the multi-stakeholder dialogue activities within GreenClimeAdapt that a continued dialogue was important in order to continue to successfully adapt Riseberga Creek and surrounding area to climate change, indicating a continued dialogue beyond the scope of the project.

Action 5 has been somewhat modified and some activities pushed forward during the project timespan, however, the final outputs are on the whole in line with those initially planned.

The main modification is related to the stakeholder dialogue input into the planning process of the demonstration area (Action 1 and 2). As the planning process was more mature than originally anticipated, the dialogue process needed to be adapted to these changes. The original plan was to include stakeholder dialogues in the early phases of the project's planning process in order to incorporate their views and ideas, and by doing so, increase the understanding and acceptance of the need to take measures as well as increase the value e.g. recreational and aesthetic values. However, the planning process had already moved to the next phase and a formal permission process had already been initiated giving few opportunities for stakeholders to directly influence the design of the measures and the planning process unless they formally opposed the implementation of measures, which would then be a legal matter for the City of Malmö. Hence, the main emphasis of the dialogue processes in this project was on the stakeholder opinions about the ongoing process and the future adaptation of the city of Malmö for a changing climate, on the river basin scale, using Skogholms ängar as an example. The measures demonstrated were in this way related to the river basin scale by climate change modelling and studies of the effect on biodiversity and recreation.

Furthermore, the dialogue meetings were deliberately delayed compared to the original plan. The reasons for this were to attain a higher impact of the action, and to avoid clashes with other workshops performed in the project (Action 8). It became evident that there was a significant overlap in the stakeholder communities that were asked to participate in several events and as the project wanted to make the best out of the given resources without risking "stakeholder burnout", the dialogue meetings were pushed forward.

5.1.1 Action 6 Modelling climate change impact on flood frequency and flow

An important impact of a changed climate in the future could be a change in the hydrological behaviour of the Riseberga creek. The consequences of climate change are possible future alterations in flow variability and flood frequency. In order to quantify possible future impacts on the catchment and on the creek, it is essential to first investigate and understand the current hydrological behaviour of the creek. This was accomplished with an extensive analysis of historical data and the establishment of a new flow monitoring station. To enable a comprehensive analysis of the creek hydrology, a semi-distributed hydrological model was set-up and calibrated. With the use of the hydrological model and synthetic climate data flood frequencies for present and projected future climate conditions were estimated.

IVL has been the project partner responsible for this action, which can be divided into seven distinctive parts (for a detailed description see Annex 7).

1) Hydrological data analysis and installation of a new discharge monitoring station
2) Collection and quality control of climate data from the Riseberga Creek catchment
3) Hydrological modelling
4) Flood frequency estimates for the Riseberga Creek for present climate conditions
5) Climate change impact on flood frequency estimates for the Riseberga Creek
6) Impact of changed land use in the catchment on flood frequency
7) Estimation of nutrient loads on the creek

Hydrological data

There were no long-term hydrological stations within the Riseberga Creek catchment, and the closest hydrological stations in the region mainly covered rural areas with different hydrological response behaviour compared to the highly urbanised Riseberga Creek catchment. High-resolution data were available for a shorter period from an existing station in the Riseberga Creek, Sallerupsvägen, and these data were analysed. However the data were found to have many gaps and periods where it could not be concluded if the data were reliable.

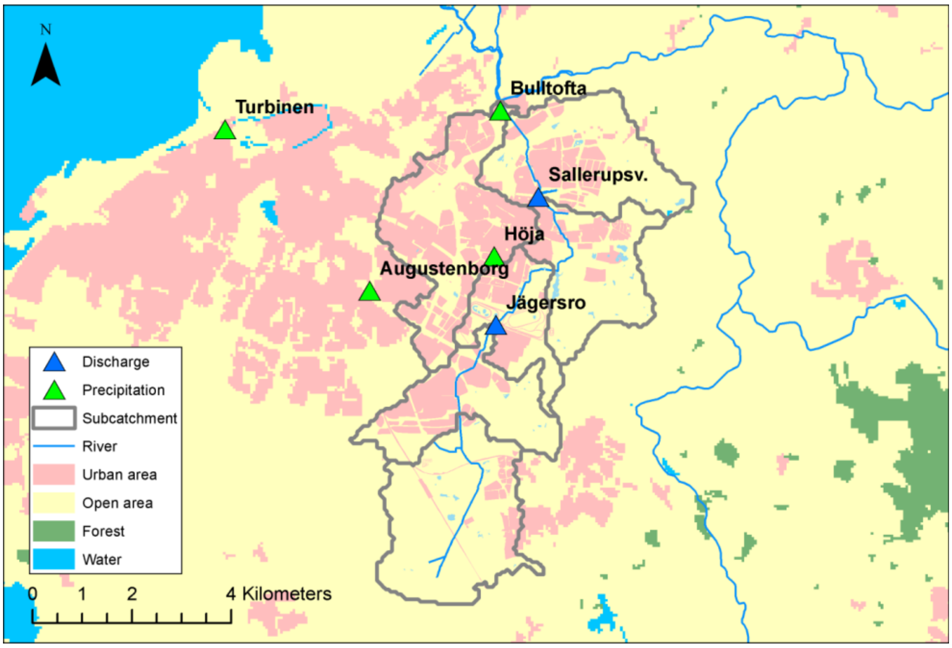

Figure 22 The Riseberga Creek catchment with the sub catchments used in the model setup, the precipitation and discharge stations that were used to run, calibrate and evaluate the model are also shown.

To address the lack of high-quality discharge information, especially for high-flow conditions, for the hydrological analysis and modelling, a discharge station (Jägersro) was installed in the catchment in June 2010 (Figure 22). The measured data from 2010–2011 were then quality controlled and the uncertainty in the data was estimated and used in the calibration of the hydrologic model.

Quality control and analysis of precipitation and temperature data
Precipitation data of high-quality and good spatial coverage is needed to run the hydrological model. High-resolution precipitation data from twelve gauges in and around the catchment were collected and analysed. The data span the period 1980–present. Four of the gauges were chosen for use in the hydrological modelling (Figure 22), including the three nearest to the catchment and the longest time series for use with the weather generator (Turbinen). For the temperature, data from the synoptic station in Malmö were used (and when missing from Falsterbo, 30 km S-SV of Malmö).

Hydrological modelling
The conceptual HBV-light model was set up to model the hydrological behaviour of the catchment for the period of observed climate records and to enable modelling of long time series with synthetic data from a weather generator for the flood-frequency analysis. Several different model structures were tested and a semi-distributed setup using separate soil-routine parameters for urban and non-urban land-use areas was found to give the best results. The model had three groundwater reservoirs with the upper two distributed by land use. The model was set up using six subcatchments (Figure 22) and runs on an hourly time step.

The effect of the highly urbanised land use in the catchment is clearly visible in the observed and simulated discharge hydrographs. Mean flow at Jägersro October 1996 to November 2011 was 0.08–0.12 m3/s (≈180–270 mm/year) and at the catchment outlet 0.27–0.36 m3/s (≈225–300 mm/year). The mean annual runoff was greater at the catchment outlet than at the Jägersro station, since there is a higher percentage of urban land use in the area that drains to the catchment outlet. The average maximum yearly discharge (MHQ) during the same period was between 20–40 times larger than the mean yearly discharge (MQ). These figures are rather high and illustrate the influence of urbanisation on the hydrological behaviour of the catchment. The average minimum yearly discharge (MLQ) was around 5–35% of the MQ.

The response time between rainfall input and a discharge peak in the creek is very fast, around 0.5–2 hours at Jägersro, with longer times observed at Sallerupsvägen closer to the outlet. Flow peaks generally only last a few hours, with short recession periods. During the summer, base flow is low and there are frequently high flows of short duration in response to high-intensity precipitation events. The summer is the period during the year with most precipitation, but because of high evaporation there is more total runoff during the winter when base flows are higher, while high flows tend to be of lower magnitude than in the summer. For the 15 years with observed climate input, nine of the annual maximum flows occurred in August or July, with the remaining in May, June, September, October and one in February.

The largest flow in the period with observed climate input data, October 1996 to November 2011, occurred in July 2007 (Figure 23). The flow at the Jägersro station was estimated by the model to be between 4.5–10.5 m^3/s for this event. The second largest flood event in August 2010 was not recorded by either the newly installed station or the station at Sallerupsvägen (Figure 23). The evaluation at the downstream station Sallerupsvägen, showed that the calibration of the model to the Jägersro station worked acceptably further downstream in the catchment as well. However, there were no high peak flows during this period with reliable measured data.

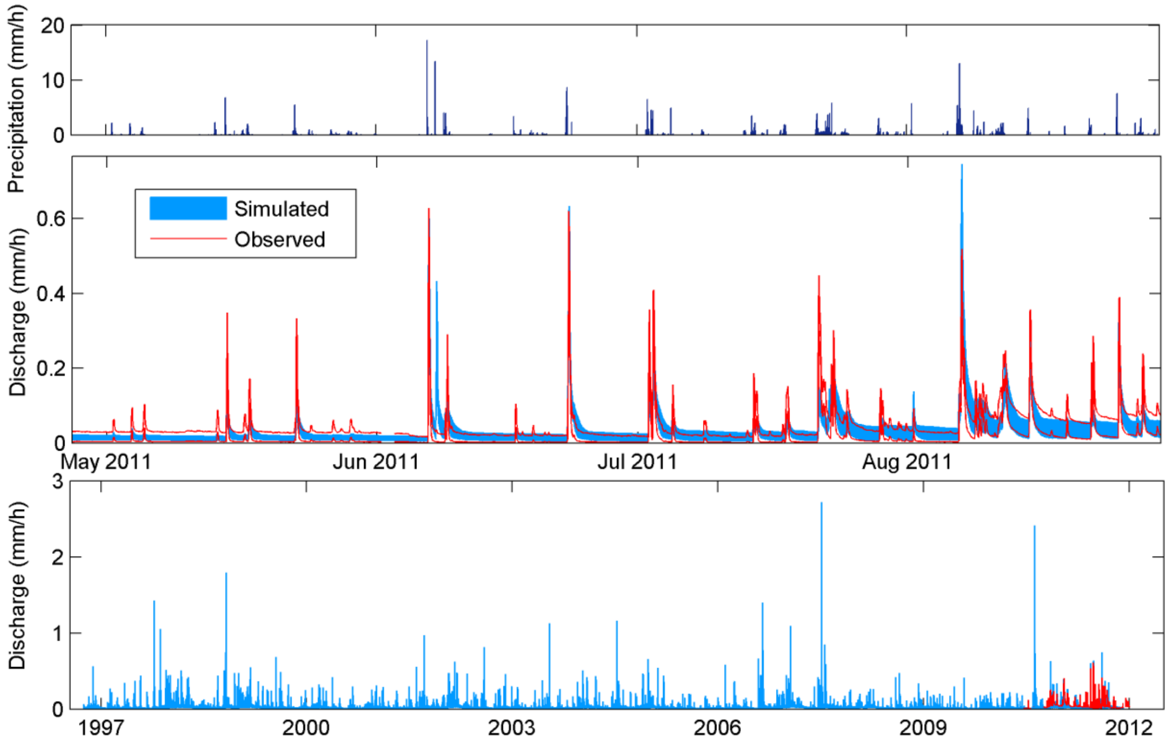

Figure 23. Precipitation (top), comparison of simulated and observed discharge with uncertainty bounds during calibration 2011 (middle), and for the whole period with observed climate input 1996–2011 (bottom).

Flood frequency estimates for the Riseberga Creek for present climate conditions

For the Riseberga creek only short periods of flow data were available. Because of the lack of long time series of both flow and climate data a continuous simulation approach was adopted; using long time-series of synthetic climate data generated from a weather generator as input to a hydrological model. This made it possible to simulate a sufficiently long discharge time series for studying different aspects of the catchment flood response and estimate flood frequency for longer return periods.

The simulated discharge for the floods in 2007 and 2010 correspond to return periods of approximately 30 and 10 years respectively (Figure 24). The flood-frequency curves for the three 500-year realisations from the weather generator were of similar magnitude and matched the flood-frequency curve for the period with observed climate input data (even if the comparison is uncertain for the highest flows since the sample from the observed climate period is small). At the catchment outlet, there was a larger difference between the simulated flood frequency for the observed climate record and the simulated flood frequency using the input from the weather generator, than for the other sub catchments. It could be seen that the uncertainty in the flood-frequency estimates for present climate is important to consider. This uncertainty could be further constrained by obtaining more and higher flow data to further constrain the model simulations at high flows. However, for these high flow events, the uncertainty in the precipitation input will still be an important limiting factor. Heavy precipitation occurring during convective (summer) storms can be expected to be particularly uncertain because of high spatial variability, and more precipitation gauges within the catchment are likely needed to obtain accurate input data during such events.

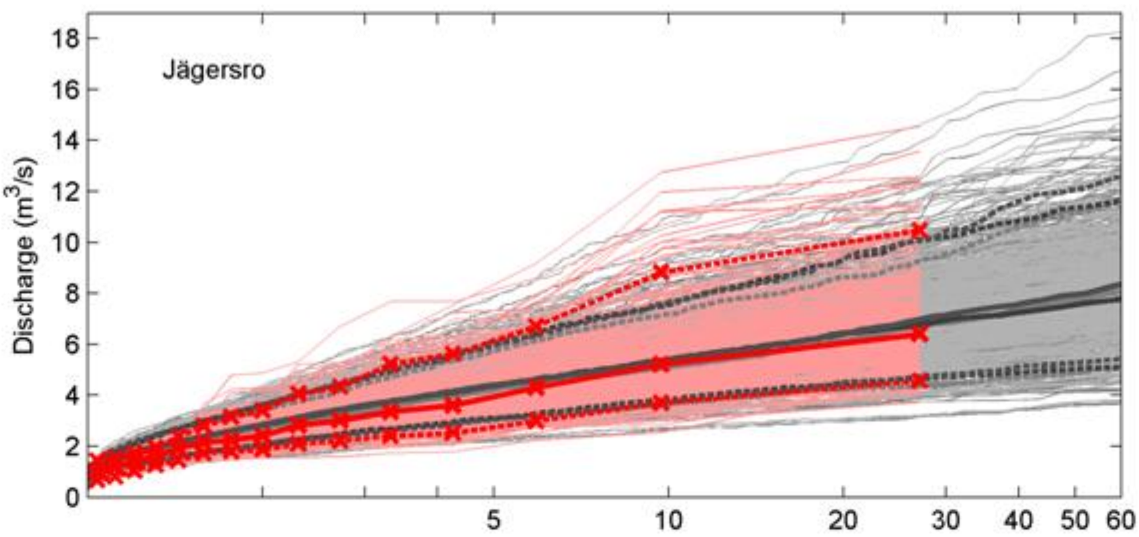

Figure 24 Simulated flood-frequency curves (thin lines) and corresponding likelihood-weighted medians (thick lines) and uncertainty bounds (5/95 likelihood-weighted percentiles, dashed lines) at the Jägersro station in the Riseberga catchment.

Climate change impact on flood frequency and hydrologic behaviour of the Riseberga Creek

Climate change impacts were studied by changing the monthly mean values of temperature and precipitation in the weather generator by the difference between present climate and General Circulation Model (GCM) projections for different scenarios for the region. Flood frequency estimates for the generated climate change time series were carried out in the same way as for the estimates for present climate.

Output from three different GCMs and three emission scenarios were used. The mean precipitation change per month for the different scenarios and GCMs was as high as approx. ±25% compared to today's climate. Most scenarios and GCMs have an increased winter precipitation. The largest differences occur during summer, when precipitation is often generated by small-scale convective precipitation events, which are not well represented in the large-scale GCMs.

The temperature increase varied between approx. +1–2.5 degrees for the different scenarios and GCMs, and the minimum and maximum temperatures showed similar distributions of changes within the year. The distribution of changes within the year between the different GCMs and scenarios was however different, with the largest/lowest increase in summer temperature for HADGEM-SRA2/BCM2-SRB1 that had the most negative/positive change in summer precipitation.

The uncertainty bounds for the flood-frequency estimates for the different scenarios all overlapped (Figure 25). The flood frequency results followed the changes in precipitation with the largest increase in flood frequency for BCM2-SRB1 that had the largest increase in precipitation and the smallest for HADGEM-SRA2 that had the largest decrease in precipitation, especially in the summer. The MPEH5-SRA1B scenario that had the largest increase in early spring precipitation showed only a small increase compared to the present climate simulations.

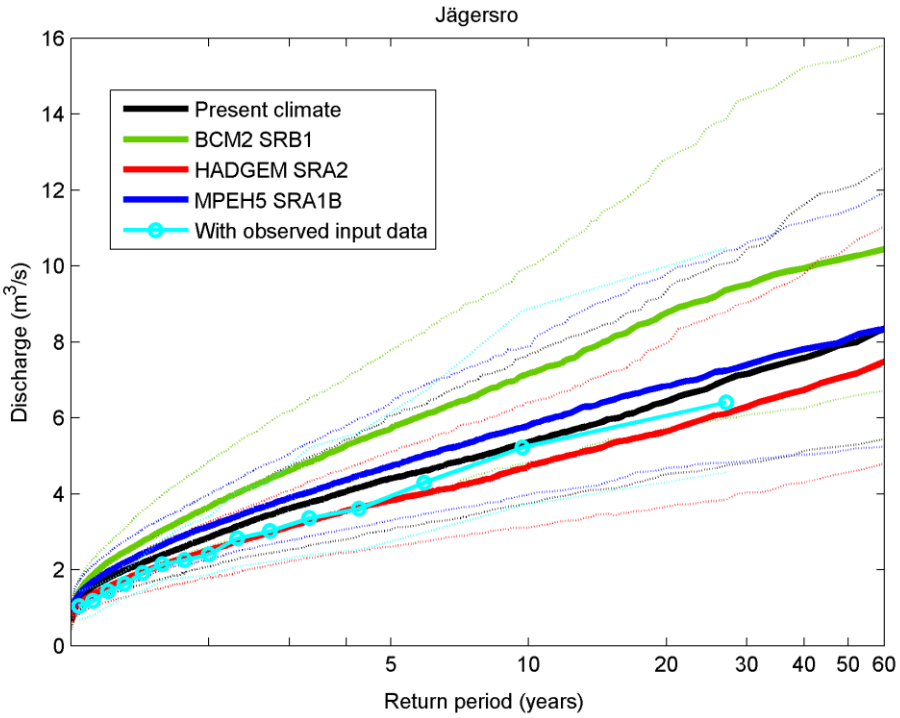

Figure 25. Simulated flood-frequency curves (likelihood-weighted median predictions from all 286 behavioural parameter sets, solid lines) with uncertainty bounds (5% and 95% likelihood-weighted percentiles, dotted lines) for Jägersro for present climate and three climate-change scenarios.

Impact of changed land use on flood frequency

New land developments in the Riseberga Creek catchment are subject to strict runoff regulations, and an increase in urban areas will therefore not necessarily lead to increased runoff. The land-use change scenarios that were investigated with the hydrologic model therefore comprised a test of the sensitivity of the model to land-use change rather than the modelling of a plausible future change. Two scenarios, of 30% increase and decrease respectively, in urban land use were tested, using one of the realisations for present climate conditions from the weather generator. The effects of the land-use change scenarios were also compared to the effects of the climate change scenarios.

The land-use change scenarios resulted in a similar change to the flood frequency as the climate scenarios did. This was particularly the case for the catchment outlet to which runoff from highly urbanised areas is contributing (Figure 26). Combined scenarios of climate and land-use change were not considered here.

Estimation of nutrient loads for present and changed conditions

Long-term average nutrient loads were calculated using precipitation data in combination with leakage and runoff coefficients for different land-use types. The load of nitrogen and phosphorous on the Riseberga Creek were calculated for each land-use type. Although farmland occupies more than a third of the catchment area the main phosphorus load originates from industrial sources. However, farmland is the main contributor for nitrogen (Figure 27).

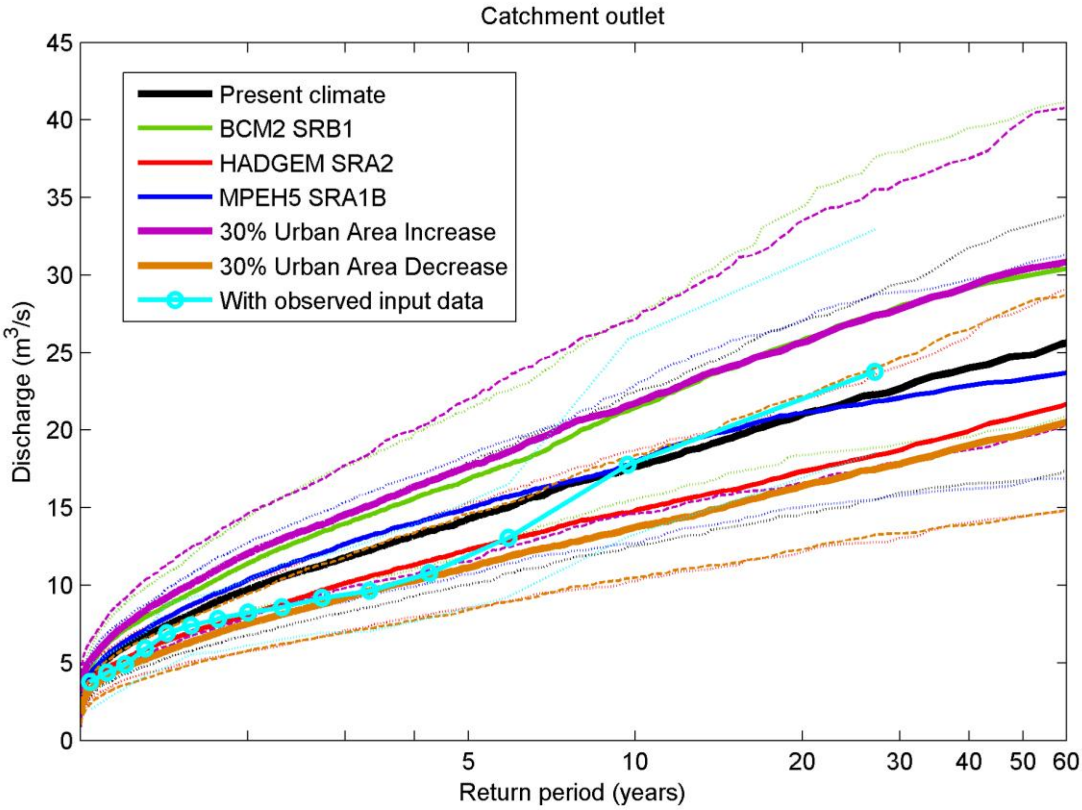

Figure 26. Simulated flood-frequency curves (likelihood-weighted median predictions from all 286 behavioural parameter sets, solid lines) with uncertainty bounds (5 and 95 likelihood-weighted percentiles, dotted lines) for the catchment outlet for present climate, two land-use change and three climate-change scenarios.

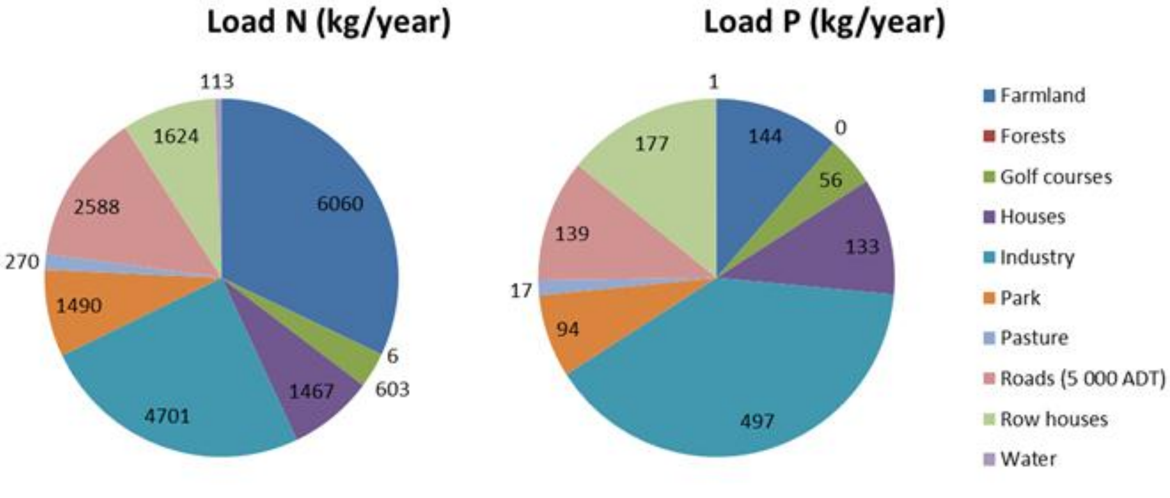

Figure 27. Estimated long-term average annual load of nitrogen and phosphorous discharged from the Riseberga Creek catchment.

The output from the action corresponds very well in terms of both evaluated improved hydrological modelling of the catchment, as well as estimated impact from climate change and societal development (demonstrated through modelling of impact of changes in land use) projections on the hydrology and flood frequency. A planned output that was not achieved in quantifiable terms was the assessment of effects of demonstration actions and other potential actions on hydrological regime, flow, flood risk and discharge of nutrients. Lack of high-quality follow-up data measured before and after the completion of the demonstration actions contributed to preventing a successful evaluation.

The major modification, although it did not have any impact on the objectives, methodology or output for the action, was that some technical difficulties with the WinHSPF software caused a change to the HBV-light model that was successfully used to perform the hydrologic modelling (see above). This problem did not result in a substantial delay since a large part of the modelling work consisted of data analysis and preparation, which was mainly the same for the two models, and the software problems were identified early on.

Part of the action, namely the flow measurements with the current meter which was installed early in the project will continue after GreenClimeAdapt. Since the action demonstrated possible large changes in flood frequency that may have potentially adverse effects on infrastructure and property along the Riseberga creek it is likely that the modelling work will continue in some form in cooperation with the city of Malmö.

5.1.2 Action 7 Evaluation of the effects of green climate adaptation on biodiversity and recreation

Action 7 aimed at evaluating the effects of green climate adaptation on biodiversity, i.e. aquatic biodiversity, in Riseberga Creek and the terrestrial biodiversity (birds and vascular plants) in the area of Skogholms ängar. Effects on the recreational values were also evaluated.

Aquatic biodiversity

IVL has been the project partner responsible for this sub action, with the task of evaluation of the effects on aquatic biodiversity. For detailed descriptions of the work carried out see "Biodiversitetsundersökningar inom Vattenförvaltningen" (Annex 8).

The sub action will continue after the end of this project as part of another IVL project. The methodology for long-term (climate change impact assessment) habitat suitability that was developed needs to be further refined and tested. The data-set and the creek itself will be utilized for modelling purposes.

Manual mesoscale mapping of habitats by walking along the creek and delineating habitats

In order to collect data on the biodiversity baseline, the first inventory of the aquatic habitats of the Riseberga Creek was carried out during May, 2009. The inventory covered 6 km of the creek's total length of about 12,5 km. Measurements and observations were made for 13 separate reaches and each reach was subdivided in up to 14 sections which could consist of a point or an area between two transects. The sections were also photo documented (Figure 28). About ten habitats were assessed as possible spawning grounds for migrating fish.

Figure 28. Examples of habitats in the Riseberga Creek. Photo: IVL Swedish Environmental Research Institute 2009

Habitat modelling

An important part of the inventory was to collect physical data of selected river habitats that could serve as input to a habitat model. During the inventory physical characteristics of river cross-sections and river reaches were surveyed. The width of the stream at the water surface, three cross-sectional depths, water velocity, substratum type and particle sizes were observed. In addition, the water level was measured as the distance between the water's surface and at fixed reference points (street surface at culvert or bridge). To model selected habitats the Physical Habitat Simulation software PHABSIM was used.

Collection of benthic fauna

A springtime collection of benthic fauna was performed in May 2012 as a complement to earlier samplings in 2009. The collection of animals was made according to the Swedish Standard for running water SS 028191, by kick-sampling on the bottom in 1 meter transects.

Five different sections were sampled from each locality and three different localities were chosen from the previous collection period. Everything sampled were transferred to a box with ethanol (70%) prepared with rose bengal to stain all animals red.

An examination was made at the laboratory of every subsample. The number of individuals expressed as percentage of the total number collected at five locations at Riseberga in spring 2012 (Figure 29).

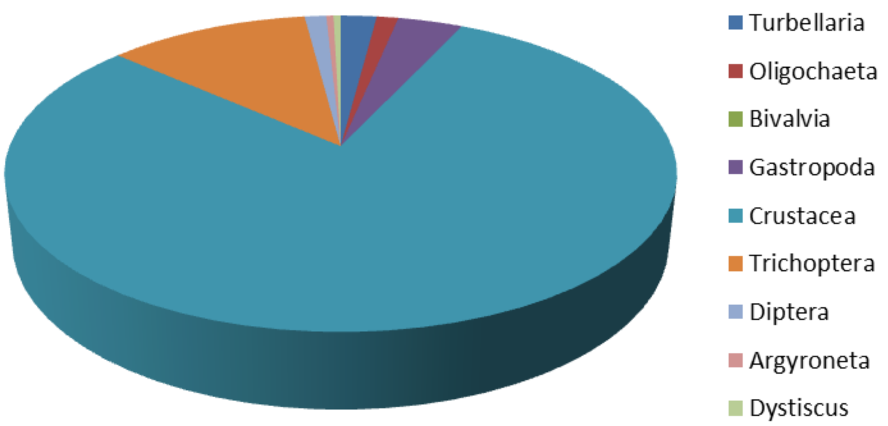

Figure 29. The number of individuals expressed as percentage of the total number collected at five locations at Riseberga in spring 2012

The results from the study performed in 2009 showed a fair diversity of eight different benthic groups at the Riseberga station. Several groups were relatively low in number of individuals. Less sensitive species, such as Oligochaeta were more frequent. The station was affected by eutrophic pollutants and insignificantly affected by acidification (Ekologgruppen 2010).

Water velocity experiments

Water velocity experiments were performed in the laboratory, in glass aquaria, according to SS 028193, a Swedish standard embryo/larval test with fish. The aquaria were filled with water to a depth of 200 mm which corresponds to a median depth for localities visited in Riseberga creek. A Petri dish that could host bottom substrate was placed inside each aquarium. To simulate stream conditions, an Eheim filter was attached to the aquaria with outflow in one end and inlet in the opposite side. The velocity of the water could be adjusted on the inlet side. The experiments were carried out with different aquatic organisms representing all major families. The single specimen used for each experiment was adapted to a low velocity in the stream system. After a 10 min acclimatization period the velocity of the water was slowly increased and the animal was carefully observed until it could not withstand the velocity. The velocity that moved the animals were measured for each individual experiment. The measurements were carried out from the exact point where the animals were when detached from the bottom substrate.

Fish

Electro-fishing has been carried out in Riseberga Creek on several occasions. Trout (Salmo trutta) and Stone loach (Barbatula barbatula) are the most abundant species. Pike (Esox Lucius), Common roach (Rutilus rutilus) and Ninespine stickleback (Pungitius pungitius) are also to be found. Eel (Anguilla Anguilla) have been observed on two occasions (in 2002 and 2006). Information on the electro-fishing results is retrieved from SERS (Svenskt ElfiskeRegiSter, 2012).

Aquatic biodiversity

To measure the impact of the project activities on the aquatic biodiversity in Riseberga Creek it is important to develop an efficient monitoring strategy. Today, no standard methods for measuring and assessing biodiversity are available. The width of the concept makes it difficult to include all aspects, a measure easy to grasp and quantify would be desirable. Both researchers and stewardships have developed a range of methods to estimate biodiversity through indicators and mathematical indexes but the methods are not always suitable for biodiversity assessment and instead they focus on one level at the time e.g. a systems number of species. An undergraduate thesis under the supervision of IVL examined how the impact on aquatic biodiversity from the green tool measures in the Riseberga Creek could be monitored and evaluated (Carlberg, 2010). When reviewing biodiversity measures the conclusions were drawn that the number of species and relative abundance of indicator species can be used as simple measures for assessing changes in biodiversity on a species- and population level within the Riseberga Creek case study. The selected measurements are easy to both grasp and communicate and can be applied in Riseberga Creek as well as other small streams. Suggestions for assessment were presented as examples of how interventions in Riseberga Creek can be evaluated and assessed.

Habitat degradation is one of the strongest reasons for biodiversity loss. Through hydraulic habitat modelling where physiological parameters and habitat preferences for fish are considered the distribution of its habitats can be calculated in an objective way. As no habitat preferences for fish in Swedish waters are available for this kind of modelling, specific preferences have been retrieved for the indicator species Brown trout (Salmo trutta) and Stone loach (Barbatula barbatula) for the Riseberga creek.

Terrestrial biodiversity

The Institute for Sustainable Urban Development/Malmö University was responsible for this action during the first two years. After that the responsible person moved to Environment department of City of Malmö, which took over the action in 2011. The same person, Annika Kruuse, has been responsible for the action during the whole project. Bird assessments were made by a consultant, Hirschfeld Media.

Birds

Assessments of numbers of visiting and nesting birds and bird species have been conducted in the project area, Skogholms ängar, yearly from 2009 to 2013. Both number of individuals and number of species were highest in 2010. Total numbers of individuals and species are listed in table 5. (Annex 9)

Table 5. Numbers of bird individuals and bird species observed in Skogholms ängar

Year	**2009**	**2010**	**2011**	**2012**	**2013**
Number of bird individuals	425[1]	646[2]	343	382	299
Number of bird species	37	54	42	44	48

1A flock of 200 starlings is included in the number.

2 Flocks of 40 eiders and 150 Barnacle geese are is included in the number

A total number of 25 bird species nested in the project area during year 1 to 5. Species names and number of nesting pairs are shown in table 6. The number of nesting bird species varied between 16 in 2009 and 30 in 2011. Numbers are shown in table 7.

Table 6. Species name and number of nesting bird pairs in Skogholms ängar year 2009 - 2013

Species/Year	2009	2010	2011	2012	2013
Phasanius colchicus	0	1	1	1	1
Buteo buteo	0	0	1	1	1
Columba palumbus	3	3	2	2	2
Prunella modularis	1	3	1	2	1
Erithacus rubecula	0	1	0	1	0
Luscinia luscinia	3	3	3	3	3
Phoenicurus phoenicurus	0	3	3	1	1
Oenanthe oenanthe	0	1	0	0	0
Turdus merula	4	2	2	2	4
Turdus philomelus	0	1	1	1	1
Acrocepahlus palustris	2	3	0	3	2
Hippolais icterina	1	2	2	2	2
Sylvia atricapilla	2	3	6	3	5
Sylvia borin	2	2	5	2	3
Sylvia communis	2	2	7	3	3
Sylvia curruca	0	1	0	2	3
Phylloscopus collybita	3	3	6	3	4
Phylloscopus trochilus	4	9	11	5	3
Parus major	2	2	1	1	1
Cyanistes caeruleus	0	1	1	1	1
Corvus corone cornix	0	0	0	1	0
Pica pica	1	1	1	1	1
Fringilla coelebs	1	1	1	1	2
Carduelis chloris	2	1	2	0	2
Carduelis cannabina	1	1	4	2	1

Table 7. Number of nesting bird species per year in the project area Skogholms ängar.

Year	2009	2010	2011	2012	2013
Number of nesting species	16	23	30	23	22

Figure 30. Phoenicurus phoenicurus at Skogholms ängar. Photo: Erik Hirschfeld

Vascular plants

Vascular plant species were assessed in 2009, 2010 and 2012. A synoptic assessment was made 2011 when a more thorough assessment was not seen as meaningful due to construction work on the sites. The number of species in the field- and bush layer was 212 in 2009, 199 in 2010 and 235 in 2012. The number of tree species increased, since one new species (Prunus avium) was introduced. In 2012 the number of tree species was 17. One rare species, the grass Vulpia myuris, was found during all years. Detailed descriptions are found in Annex 10.

Figure 31 .Dipsacus fullonum at Skogholms Ängar. Photo: Annika Kruuse

Recreational values

13 persons who participated in the official opening of the recreational area Skogholms ängar answered an enquiry on the recreational values of the area. Very few spontaneous visitors are found at Skogholms ängar, and it was not considered reasonable to find a high enough number of respondents if the opening occasion was not utilized. For the same reason, the interviews were carried out during 2013 and not as originally planned, in 2012. The respondents were asked to give a value between 1 (lowest) and 5 (highest) for five different qualities of the area: overall impression, beauty, species richness, pleasantness, and easiness to move around. They all recieved high values, mean values were between 3.8 (beauty) and 4.1 (overall impression). The question if the level of maintenance was too high, too low or satisfactory, was answered with satisfactory by 11 respondents. On the question if the respondent wanted to return to the area on a later occasion, all 13 answered yes. One should not count too much on an evaluation with this few respondents who had all come by their own interest to the area in question, but still the grades can be considered very high and the project a success on recreational grounds. Detailed descriptions are found in Annex 11.

Design guide

A design guide for designing green areas was produced based on the experiences from GreenClimeAdapt and on the writer's earlier experience from working with urban ecology for many years. A matrix design was chosen for the guide, where the qualities biodiversity, water management, health/quality of life, energy usage and microclimate met with the design elements trees/bushes/vegetation, green roofs, green facades, ponds, biotopes, animal's nests, and urban farming. There is also a section on maintenance. The aim of the matrix design is to show the advantages of multifunctionality when designing green areas. It is an inspirational guide with best practice examples and nice pictures. The guide has been widely used since it is used as a tool for reaching the goals of Malmö city’s Environmental Building Programme, and published on that programmes web page. Detailed descriptions are found in Annex 12.

5.1.3 Action 8 Architectural integration of green tools for urban climate adaptation into the built environment

Two workshops and one evaluation of experiences from installing green facades and green roofs were performed within Action 8. The activities are described in further detail in annexes 13, 14 and 15. The ISU and IVL were responsible for this action.

Workshop 1
A one day workshop, "Integrating green tools for urban climate adaptation in the built environment" was held on the 10th of April, 2010 in Malmö. The aim of the workshop was to gather important stakeholders, learn from each other, increase knowledge of advantages of using green tools for urban climate adaptation, identify obstacles and find ways to overcome them. Titles of presentations and speakers were:

- Climate changes, urban implications. Christina Frost, IVL
- Ecological advantages with the dense and green city. Annika Kruuse, ISU
- Effects on health of heat and heat waves in Sweden. Joacim Rocklöv, Yrkes- och miljömedicin, Umeå University
- Inspiration/best practice. Ivana Kildsgaard, IVL
- Four groups workshopped around the questions of obstacles for greening buildings and ways to overcome them.

Obstacles: Economy and market – if there is an extra cost there needs to be a demand for it on the market, or it must be financed by the public. The investment is made by the developer but the gain is made by the public. There is not enough knowledge about green solutions in the building sector. Physical obstacles such as underground parking, pipes and wires was also identified.

Ways to overcome them: management of green solutions must be easy. Engage inhabitants of the building. People tend to move less often when they are engaged in green neighbour activities like urban farming – decreased cost for the home owner. Choose suitable construction method and suitable plant systems. A definition of urban quality is needed where greenspace is highly valued. Make areas multifunctional: art, temperature regulation, well-being and energy savings. New routines in design phase of the project – co-operation with landscape architects.

Figure 32. Illustration from the workshop 1

Workshop 2
A one day workshop; "Green Tools for Urban Climate Adaptation" was held 8th of September 2010 in Malmö. Local specialists in architecture, landscape architecture and urban planning were the main target group for the workshop, but a couple of experts from Gothenburg and Stockholm participated as well. The aim of the workshop was to answer question such as: how can we make our city districts greener? What obstacles are there for greener cities? In the

morning there were six presentations and after lunch four groups workshopped around the above-mentioned questions. Presentation titles and names and positions of speakers were:

- Impact of climate change on the city environment. Ivana Kildsgaard, IVL
- Challenges for stormwater management. Annika Kruuse, ISU
- Greening the city! Planning, climate adaptation and green infrastructure. Ulrika Åkerlund, Swedish National Board of Housing, Building and Planning.
- Using Green Infrastructure to support sustainable and adaptive towns and cities. The English experience so far. Andy Gale, Natural England.
- Green space factor – how can it be developed? Agneta Persson, Lund city.
- Greener school yards Lisa Östman, Lund city.
- Climate adapted and green outdoor environment in Norra Djurgårdsstaden. Gösta Olsson, City Planning Administration, City of Stockholm.

The question how can we make our city districts greener was answered with: Introduce laws that creates framework for carrying out the climate change adaptation measures. Support visionaries. Dare to try and fail. Local authorities should be ahead and lead the way forward. Positive information/PR.Train politicians. Citizen processes. Use win-win situations. It should be easy and give extra value to do the right thing. Think in systems. Different ways of communication and different arguments with different groups, starting with children. Comprehensive visions and structures – responsibility, law. Costs for environmental solutions that are not considered today’s “standard” are important obstacles.

Figure 33. Illustration from workshop 2

Evaluation of experiences from green roofs, green facades and workshop as a methodology

An interview study with stakeholders from Action 3 and Action 4 was carried out to evaluate experiences and identify obstacles and success factors from building green facades and green roofs (Table 8 and table 9). Interviews were made by email and phone by IVL during autumn 2013. Experiences were at first planned to be collected through a third workshop, but due to difficulties meeting with the same stakeholders again, the evaluation completed through interviews.

Table 8. Identified obstacles for green roofs and green walls in Action 3 and Action 4

	Green facade	Green roof
ORGANISATION	No/poor cooperation between supplier and maintenance organisation.	Handing over between staff members Change of staff
	Maintenance organisation did not participate in the design	
KNOWLEDGE/ COMPETENCE	Lack of experience - Among suppliers - In the project management - Among all actors	Little experience of Swedish climate
	Few suppliers of products/systems	Little knowledge on straw substrate
		Little knowledge about thick/heavy roofs
	Law on public procurement influence the choice of contractor – you might not get the best one	Hard to find a localisation for the green roof – low interest among property owners
TECHNICAL	Hard to access the irrigation system	Pumps: find the right localisation, find the right model.
	Advanced irrigation system	Low knowledge in the project organization on irrigation systems on an early stage.
	Hard to find methods to measure/evaluate	Hard to mix the roof substrate on your own
		Large proportion of organic material caused large, unwanted growth of grasses.
		Limited number of suppliers of Swedish plants/herbs
ECONOMY	Too low budget for the investment	Too low budget on tools, evaluation and measurements
	Evaluation was not possible to carry out due to high costs	Limited number of suppliers of Swedish plants/herbs raises the costs
	The installation was more expensive than the budget allowed	
MAINTENANCE	Maintenance is labour-consuming when the systems don't work	Sustainable use of storm water was expensive and difficult
	Different information from different maintenance actors	
	Unclear routines for work and control	
	The plants died the first winter	

Table 9. Identified success factors for green facades and green roofs in Action 3 and Action 4

	GREEN FACADES	GREEN ROOFS
ORGANISATION		Repeated tests are good – transfer of competence to later tests
KNOWLEDGE/ COMPETENCE		Input from researchers in Switzerland and UK
	A learning project for creating knowledge and testbed	Contacts made early in the projects were used when installing the last test site
TECHNIHAL		Worthwhile to collect our own seeds
		Hemp and biochar are interesting and successful substrates
ECONOMY	Low cost for maintenance – when it works	Installation of a larger roof area was not as expensive as apprehended
MAINTENANCE	Competent maintenance staff	Long experience among maintenance organisation
	The maintenance organisation has been able to make minor changes of the wall during maintenance phase	
	Green facades are easy to maintain – when the system works	Some test areas are relatively easy to maintain

5.2 Dissemination actions

5.2.1 Objectives

Dissemination of the project has happened on three levels: local/regional, national and European level. The target group has been e.g. city planners, landscape architects, green roof experts, home-owners wanting to install green roofs, politicians, companies at Fosie industrial area, neighbors/visitors, and employees in the area.

5.2.2 Dissemination: overview per activity

The Environment department has been responsible for all dissemination activities besides the e-learning course where SGRI has been responsible. Substantial national and international disclosure of GreenClimeAdapt project results has also been achieved in action 5, 6, 7 and 8 through participation in several research conferences, seminars and workshops

Web site

The City of Malmö, Environmental department, has been responsible for the project website www.malmo.se/greenclimeadapt. The website has a brief presentation of the project and has been updated regularly with project events and outputs.

The website has had 4223 unique visitors since 16th June 2011 to the end of the project.

Study visits

During the project period the City of Malmö has developed a new system to handle the requests we receive for technical visits to the city. We provide technical visits around different themes, where climate adaptation is one of them.

A great number of study visits have occurred, especially to the Augustenborg area, where the green facades and green roofs area part of all study visits. During 2012 the Augustenborg botanical roof garden was visited by 230 study tours and during 2013 the Augustenborg botanical roof garden was visited by 200 study tours. The groups came from European countries, but also from e.g. Japan, USA, China and India.

LIFE 20 years of getting things done

A LIFE-network has started up in Malmö with representatives from organisations that are coordinating LIFE+ projects. The group has had regular meetings and shared experiences and discussed different issues such as economics and commutation. A joint seminar to celebrate LIFE’s 20th anniversary, “LIFE 20 years of getting things done”, was arranged on May 9th 2012. All four project leaders held a brief presentation about their LIFE project and study visits to the project sites were arranged. Stefan Welin from the European Commission was present and held a presentation about the history of the LIFE program.

Seminars

Presentations about the project have occurred at several seminars in Sweden as well as around Europe, for example in:

- ”Train of Ideas” in Malmö May 2011
- Skånes Energiting in June 2011 in Malmö
- The STREAM Policy Seminar “State of the Art in Urban Water Management” in November 2011 in the framework of the official programme of the International Water Week in Amsterdam (IWW)

- Stormwater Management 23 - 24 November, 2011, Malmö, Sweden. The subject for the presentation was “Habitat Modelling and Ecosystem Perspectiv in Water Resources Management”
- The Catchment Change Network International Conference 2012, Lancaster, UK with a contribution titled “Integrated monitoring and modelling for flood-frequency estimation in an urban Swedish catchment”
- The PUB Symposium 2012 “Completion of the IAHS decade on Prediction in Ungauged Basins and the way ahead”, Delft, The Netherlands. “Monitoring and modelling for flood-frequency estimation in an urban Swedish catchment”
- Presentation for contractors and building companies about Green Roofs in Stockholm, December 2012 and January 2013. In the talk Jonatan discussed the possibility for contractors and builders in Norra Djurgårdsstaden to use alternative substrates.
- Conference in St. Petersburg on Strategic City Planning, October 2013. The topic of green roofs for climate adaption was addressed, among other issues.

Making Cities Resilient

The City of Malmö has applied to be a role model city in UNISDR’s campaign “Making Cities Resilient: My City is getting ready!“. The campaign that was launched in May 2010, addresses issues of local governance and urban risk. The project team has worked as a reference group to the project leader for the application of the campaign.

E-learning course

In early 2013 SGRI started the work with an e-course, the main objective of which was to spread the knowledge gained in Action 4, but also green roofs in general as it does not exist a similar e-course. A Beta version of a green roof course was produced including writing material, programming the e-course web page, taking video footage etc. within the project

Roofs in Vienna, Zurich, Basel, Budapest, London, Berlin, Copenhagen, and Malmö were included in the e-course. Three well known green roof experts, Nathalie Baumann (Switzerland), Peter Dezsenyi (Hungary) and Dusty Gedge (UK), were asked as to write different parts of the e-course material. A programming firm was contracted to do the design and programming.

Already in the autumn of 2013, before the green roof e-course was finished, SGRI made efforts to spread the idea and get in contact with universities in Sweden such as the Swedish University of Agricultural Science (SLU) and the Swedish Spatial Planning programme in Karlskrona, at Blekinge Technical University (BTH).

Complementary actions will follow in 2014 with additional filming/interviews, creating quizzes, preparing teachers instructions so the e-course can be complemented by class room workshops, tests and changes in the course layout according to teachers and students feedback. These complementary actions are planned to be covered partly by funding from SGRI, but also from national funding within a VINNOVA project.

Opening event at Skogholms ängar

An opening event was arranged at Skogholms ängar on the 19th of September 2013. Around 30 persons where present e.g. stakeholders in the area, city planners and politicians in City of Malmö. The Deputy Mayor for Urban Ecology in City of Malmö, Lari Pitkä-Kangas, held the opening ceremony where after a guided tour in the area along the Riseberga creek and the open stormwater system was given by the project members and the bird watcher Erik Hirschfeldt.

Figure 34. Lari Pitkä-Kangas at the opening event in Skogholms ängar

Final event
A final event was arranged on the 9th of December 2013. The project results were presented and site visits to the green roofs, the green facades and Riseberga creek, including the open stormwater system were arranged.

List of deliverables

1. Web site: www.malmo.se/greenclimeadapt
2. Notice board – construction phase
3. Notice boards
    a. Skogholms ängar, 3 different
    b. Green facades
    c. Green roofs
4. Brochures
    a. Project leaflet
5. Press cuttings
6. Roll-ups
7. Study visit concept

5.3 Evaluation of Project Implementation

5.3.1 Action 1 Open green stormwater system

VA SYD and the Streets and Parks Department have realized such a project is, besides the overall objectives according to the application, of great importance. Such cooperation projects are always important regarding, similar projects in the future. A large challenge in this type of integrated planning is to overcome institutional barriers that exist between the different city departments. Thus the fact that engineers and planners from VA SYD and the Streets and Parks Department involved in this project have worked together in an open-minded and flexible way may be referred to as a success.

Many different aspects can give added values to this technique of handling stormwater. Some examples of the positive values associated with open stormwater in systems in Fosie industrial area are:

- Recreational value
- Biological value
- Aesthetic value
- Pedagogic value
- PR value

The required detention volume was achieved in combination with green, biological and recreational aspects. The constructed facility (ponds, outlets, inlets, plantations) comprises a result that is immediately visible whereas the risk of flooding and the prevention of erosion can only evaluated after a certain period of time.

From a hydraulic point of view a direct result of the project is the reduction of peak flows. With a total detention volume of approximately 6 000 m3 that's been built the peak flow to the Riseberga creek during rain event is reduced by 90 %. Hence the hydrology of the catchment is restored to natural conditions that the creek is aimed for, to a runoff pattern prior to urbanization. In other words an inappropriate stormwater management leading to poor performance of the urban drainage system in which the creek composes the weak link has been restored. The urban drainage system in Skogholms ängar are now seen and managed as an entirety r with its recipient.

In terms of success and failures it can be concluded that land use is crucial for downstream storage on the surface. In the early planning phase a lot of time was spent on trying to acquire privately owned area that was regarded as a very important condition in order to manage the runoff from more than one third of the total the catchments impervious area. As neither VA SYD nor The Streets and Parks department has the possibility to buy private property The Real Estate Department was put in charge of this process. The process had been defined already in the project description. However the planned purchase of the required land failed. Instead a "plan B" was studied, and consequently the initial failure was turned into success. The plan resulted in the use of the alder marsh for storage purposes. The alder marsh, a natural wet lowland in relation to the surrounding land, functions now as a detention basin with large storage capacity. The natural storage capacity of the swamp is significantly larger than the detention volume that was desired in the early planning.

Furthermore concerning land use, the switch of land in the northern part of the project area, also turned out successfully. Due to lack of land east of Skogholmsgatan the initial idea for managing the stormwater runoff here required quite certain methods. In order to find enough space for storage the creek ought to be reshaped, as shown in the technical application. Such restoration would need appropriate permission and would result in expensive measures.

However, Malmö Real Estate Department realized a land trade with the owner of a private property in the vicinity, which guaranteed the acquisition of enough land on the ”right” side of the creek for storage purposes. Before the project started the City of Malmö only owned a piece of land on the right side of creek, i.e. on the wrong side in relation to the existing drainage system. The traded land was made available only for this project by the compiling of a detailed development plan, which made it possible to realize a much more adequate stormwater detention facility according to the project’s goals.

The costs of the constructed facility are significantly less expensive compared to a conventional drainage system. Concrete basins or pipe packages would have to be installed quite deep in relation to the existing system requiring pumping of the store volumes. The annual average maintenance costs are also much lower compared to the conventional alternative.

The cost-efficiency of the action is related to the reduction of damages along the water course. By reducing the peak flows less erosions damages and less flooding damages will occur. These damages are costly for citizens, for VA SYD and for the City of Malmö. By implementing upstream storage solutions as in Fosie industrial the need for expensive solutions and protective measures downstream can be prevented. Furthermore the requirement of rigorous restrictions of the urban storm runoff in development areas connected to the Riseberga creek is reduced. Rigorous constraints regarding the runoff can lead to more expensive urban development.

The objectives were clearly met, although the constructed result was changed according to the initial plan. The most important lessons learned from the project are that access to and control over land is crucial for sustainable stormwater management, in particular concerning downstream storage solutions where much space is needed.

Objective	Indicator	Achieved	Evaluation
Reduce stormwater peak flows to Risebergabäcken	90 % reduction	90 %	
Reduce erosion along the creek	-	Yes	See above
Reduce the risk of flooding	-	Yes	See above
Reduce the transport of pollutants to Risebergabäcken	-		A side effect of the project, not quantifiable

5.3.2 Action 2 Enhancing recreation qualities and biodiversity in combination with stormwater system

The land issue should have been solved before the project started. Lots of time and effort was spent, first to try to solve it with the landowner, and then to try to find another solution.

The project group spent a lot of time in the pre-planning stages to agree on a mutual description of aims, where both the areas value as a recreational space and the need of land for building stormwater ponds, would be taken under consideration. This was necessary during the planning-process, since there were two purchasers leading the consulting constructer. The experience of from this stage, as well as the building process, was that it went very smoothly, thanks to the pre-planning work.

From a technical point of view the ground and the stormwater management facilities are completed and working, but the area's potential as a recreation area is yet in an early phase and will take severalof years before it really feels natural

More surveys are needed to follow up the development of the area, both regarding the number of visitors but also surveys on how flora and fauna is developing. The Streets and Parks Department has an inventory program, and in a couple of years Skogholms ängar will be taken in-to this program. The horse-riding school is still the main visitor of the area. Birdwatchers too have begun to discover the area and are an increasing group. They are leaving notes about the area on different internet sites for bird watchers, and this will hopefully inspire more people to visit Skogholms ängar.

More activities to invite the public to the area are needed. Exactly how this will be done is not yet decided.

Objective	Indicator	Achieved	Evaluation
Enhanced biodiversity	Surveys of the vegetation and fauna	Yes	It is yet too soon to make any conclusions from the results of the surveys, but the result so far are promising. The surveys must be followed up and will do so in the Street and Parks departments continues survey program.
Increase numbers of visitors and higher knowledge about the area	Counting visitors and telephone surveys	Yes	No counting of visitors has been performed, but since the area had nearly no visitors in the beginning of the project the number of visitors has increased, for example bird watchers has started to visit the area.

5.3.3 Action 3 Climbing plants for cooling buildings – green facades

Evaluation of the users' impressions

Qualitative interviews were made with seven informants working in the office building to evaluate the installation of the green facades impact on the indoor climate. The informants experienced a big different in the indoor climate depending on the season. In the wintertime it was very cold, especially on the ground floor. In the summer time it was very hot. Nevertheless, the informants did not experience any change of the indoor climate with or without the green facades present

The informants have not experienced any noise reduction with the green facades. On the other hand the informants have never experienced any problems with disturbing noise when they are working in the office building.

From an aesthetic point of view the informant thinks that the green facades are a very nice feature in Augustenborg. Especially in an industrial area, that this area of Augustenborg is, where the greenness otherwise are very low. The informants enjoy sitting outside in the spring and summer time and looking at the green facades. Overall, according to the informants the green facades improve the work environment.

Temperature

Sensors have been placed at the office buildings to monitor the outdoor and indoor temperature. The sensors have been placed on the outer walls both with and without green facades present. The sensors placed on the walls without the green facades work as a point of reference.

The data from the sensors indicate a difference on the facades of the buildings covered in green facades and the facades of the building that is not covered in green facades. The facade of the buildings with the green facades has a temperature approximately of 8 degrees Celsius lower than the facades of the buildings without the green facades. (Annex 16)

The reduction of heat from the building envelope reduces the ageing of the facade itself. Since the impact of the building envelope is lower with the help of the green facades, it can be conducted that they lead to reduced ageing.

The indoor temperature is 1-1.5 degrees lower than the outdoors temperature where the facades of the building have green facades. The lowering of the temperature indoors is displayed after a couple of days with high outdoor temperature. (Annex 16)

Ground level ozone

Two measuring devices, one close to the office buildings and the green facades and one 400 meters away from the office building were used in the evaluation. The device close to the office building indicated a bit lower amount of ground level ozone, but within the margin of error. (Appendix 17)

Solar panels

The evaluation of the solar panels shows that the solar panels are working rather well. The first years there were some installation problems, which are now corrected. The solar panels on the roof produce more energy than the ones placed on the wall. The solar panels implemented with the green facades produced more in 2013 than in the early stages of the project. (Annex 18) In 2013, the trees in front of the facade of the building shaded the facade, which negatively influenced the production of electricity from the lower solar panels negative. To solve the problem the trees either will be cut down or the lower panels moved to a higher position on the facade. The green facades could probably have a positive impact on the production of the solar panels. Since the plants are not fully established on the façade the project cannot verify the green facades positive impact on the solar panels. The evaluation of the green facades and the solar panels will continue after the end of the project to establish if the hypothesis is correct.

The operation and maintenance for the installation of solar panels is a total of approximately 1500 Euro per year. The intensity of managing and of trimming the greener on the facades increases (the solar panels cannot be shaded by the plants) if the advantages for the solar panels are to be realised. From a cost-benefit perspective, the combination with solar panels and green facades utilised in this project could be questioned.

Inventory of Insects

During the summer of 2013 an inventory of insects was performed by Fredrik Östling, Ph D in zooecology in the green facades of Augustenborg (Appendix 19). A total of 187 species of invertebrates, mapped into 177 insect species, 12 arachnids and two molluscs was found.

An interesting finding in the inventory is the red listed bee, *Lasioglossum nitidulum*.

The result of the inventory establishes that the biodiversity of the green facades in Augustenborg is rather high. The numbers would not indicate a high biodiversity in an ordinary garden, but for an urban industrial area as Augustenborg, the numbers are above expected.

Objective	Indicator	Achieved	Evaluation
Identifying suitable facades for the action	3	3	2 buildings, 3 facades in different cardinal directions.
Aquring data from measurement toll	3	3	
Establish green façade	3	3	3 facades in west, south and north direction. Two different systems, wire and cassette.
Establish photovolactic solarpanels	3	3	On the façade and roof of the office building. Three different installations of solar panels.
Evaluate results of above installation	1	1	The installation led to a lowered indoor temperature with approximately 8, lower number of ground level ozone and higher biodiversity.

5.3.4 Action 4 Green roofs for home building

Results from plant survey

The study of plant coverage was mainly focused on the diversity of different species and divided into sedum, planted / seeded herbaceous perennials, spontaneously established herbaceous perennials and grass. What became important in the project was to reduce the amount of grass that dominated in test site 1. In the results from the surveys of the vegetation, it was obvious that this goal was reached in the following test sites. Besides the counting of different species we also made ocular inspection of the plant coverage. Even though these observations were subjective, it could add some value.

The two roofs with the best overall plant coverage and with the best germination of seeded plants were at test site 4 and 5 with hemp in the bottom. The hemp as a bottom layer beneath the substrate was more beneficial than straw since the hemp gave a solid base layer which did not mix too much with the substrate when the substrate layer was installed, not even at test site 4 with a relatively thin substrate layer of 4-5 cm. Another reason for the test site 4 and 5 being successful was the usage of finely crushed bricks (0-2 mm). The pilot test site 5 had the overall best plant coverage and this was because of the substrate layer being thicker (5-8 mm) than at the other test sites. Another important discovery was that the amount of organics being much less in test site 2-5 than at test site 1 was not a problem. Instead the usage of 5-20% organics helped reducethe weeds and the herbaceous flowers from seeds did not decrease.

Results from long term monitoring

To measure the roofs water holding capacity and cooling effect on the micro climate (and potentially the meso climate), temperature and moisture loggers were placed on the test sites and weather data from a weather station located at the botanical roof garden were collected.

The roof with the best soil moisture (as VWC – Volumetric water content) was higher in test site 4 with hemp straw in the bottom compared to test site 1 and 3 with straw from rye or wheat. In relation to soil temperature, the difference between the sites 3 and 4 was small. The loggers were placed in the bottom layer of the roof and a good soil moisture measured by the loggers was an indication of the straw and hemp’s water holding capacity. The hemp was better than rye straw, possibly because the hemp created a more compact layer but still with a lot of small air pockets where the water was held. Other reasons for the hemp being more successful could potentially be the hydrophobic character of the hemp, with the water as a moist layer around the hemp instead of being absorbed.

The water holding capacity monitored in the hem- based roofs at pilot test site 4 was an indication that hemp is an interesting green roof material, not only storing water for the available use by plants but also reducing the hard roof surfaces contribution to sudden flood events. For detailed results see Annex 4.

Objective	Indicator	Achieved	Evaluation
600 m2 of green roof	600 m2	610 m2 at 5 different test sites	The number of square meters became, in fact, not the most important part of the project. Evaluating different mixes of substrate was more important. Luckily dividing the 600 m2 into five different test sites opened up the possibilty to examine the pilot content several times in different conditions. The outcome of the project is both a lot of experience in different substrates but also two final batches that we can recommend and the notion that hemp is potentially a very good alternative green roof material.
Water harvesting	2	2 (in 2011 and 2013),	The water harvesting was too optimistic in the project's beginning. What we could see was that the roofs stored a lot of the rainwater that fell during summer. Hence the water for irrigation with reused rainwater was far too little. Only at a few times we did have water enough from the roof to harvesting. Rainwater harvest should instead have been done from a roof without green roofs, and there are few of that kind at Augustenborg Botanical Roof Garden.
Public training	40 participants	A total of 56 participators in 2013.	To install a green roof you need different competences and the training we organised focused on different target groups. The courses included both information and educational material on conventional green roof materials and on alternative, local and if possible reused materials. The mix of including both conventional and alternative materials was a great success because it made it easier for course participants to grasp what is important on a green roof such as the water holding capacity and free draining product.
Evaluation report	In time	Yes	

5.3.5 Action 5 Dialogue with stakeholders around Riseberga Creek

The main objectives with Action 5 and the dialogue with stakeholders around Riseberga Creek were to increase the knowledge among stakeholders on climate change, climate adaptation and possible adaptation measures, as well as to incorporate stakeholders' views and ideas in the project.

Among the stakeholders involved in the dialogue activities implemented, it can be argued that their knowledge and understanding about climate adaptation and possible adaptation measures, through the dialogues, has been immediately increased as a result and that their views and ideas have been incorporated in the project. Inter alia, the participating stakeholders gave insight to main problem areas of Riseberga Creek and input for future measures to overcome these problems. This information was also used for modelling tasks in the project (Action 7) of consequences for evaluating different measures in the view of climate change. During the dialogue activities, it was made clear that the stakeholders have many important insights that can inform planning processes of climate adaptation measures and thus increase its quality.

With the dialogues, the project also aimed at gaining a deeper understanding among key stakeholders of obstacles and opportunities in relation to implementation of climate adaptation measures, investigating key stakeholders' willingness to take action to adapt to climate change as well as understanding obstacles and opportunities for a successful dialogue process.

The results from the dialogues carried out show, inter alia, that a major obstacle to overcome in order to implement adaptation measures was the current lack of knowledge about local climate change, climate adaptation and climate adaptation measures among stakeholders. In particular during the interviews it was made clear that many stakeholders lack knowledge of climate adaption and, even more so, lack an understanding of their role in adapting the urban environment to climate change. This lack of knowledge and incomprehension of one's role regarding adaptation also creates a lack of willingness to take action to adapt to climate change. However, stakeholders around Riseberga Creek showed an increased willingness to take action to adapt to climate change after receiving information about climate adaptation and adaptation measures and having a dialogue on the issue. For the urban climate adaptation work in connection to the Riseberga Creek, this increase in acceptance and willingness to take action as a result of the dialogues can have a positive affect for the future work on urban climate adaptation in the area. From a more general point of view, the results indicate the wider importance of increased knowledge among key stakeholders as well as the need to disseminate information about climate adaptation in order to increase the acceptance for climate adaptation measures. A working dialogue can be seen as one way to increase the understanding and knowledge among stakeholders concerning urban climate adaptation.

As evident from the above discussion, dialogue can hence be an important means to communicate and discuss local climate change and urban climate adaptation which in turn could increase the acceptance and willingness among stakeholders to take action to adapt to climate change. However, there are several obstacles in achieving a successful dialogue which need careful consideration. One obstacle made clear during the dialogue concerning Riseberga Creek is the difficulty to know who has the overall responsibility for running dialogues concerning urban climate change adaptation, i.e. who should be the driving force, as many actors are involved. Another obstacle in achieving a successful dialogue is the difficulty to reach the general public, but also other more passive stakeholder groups, and engage them in a dialogue. For the dialogue activities carried out in GreenClimeAdapt, the general public was invited to an open dialogue for continued discussions after the focused dialogue held with invited key stakeholders. Different means for reaching the public were used, such as announcements in the local newspaper, articles, Facebook groups, advertising on announcement boards, e-mails to clubs and voluntary associations. However few people joined these open dialogue meetings. To increase the interest from the general public, it was suggested that the dialogue meetings in the future could be held on site. Dialogues can then be held several days in a row and at different times of the day making sure everyone has the possibility to attend. Likewise, to engage representatives from the industrial areas around the creek in a dialogue, the dialogue activity should be adjusted to consider their limitation in time or resources. The same view was expressed concerning involvement of upstream farmers. Raised to a more general level, it is apparent that dialogue activities and information dissemination need to be adapted and carefully considered depending on the stakeholder.

The lessons learned, obstacles highlighted and opportunities stressed during the project, should not be specific for Riseberga Creek but could prabably be applied to other urban climate adaptation projects. At the time of writing this report, a lack of general strategies and methodology for dialogues with stakeholders specifically concerning climate adaptation was also identified. For this reason, and to increase the utility of project results beyond the scope of this project, the experiences from the dialogues in this project was taken as a point of departure to develop a general dialogue strategy and methodology that can be used for dialogue activities in other projects concerning climate change adaptation. The "Strategy for multi-stakeholder dialogue on green urban climate adaptation" was developed during 2012 in the format of a brochure and spread to key stakeholders involved in the project dialogue activities as well as made available online.

More results from the dialogue with stakeholders can be found in the report "Multi-stakeholder dialogue on green urban climate adaptation" (Annex 6)

Objective	Indicator	Achieved	Evaluation
Increased knowledge about climate change and adaptation among involved stakeholders	2 dialogues performed	Yes,	Two dialogues have been performed (2011 and 2012) with in total 56 involved key stakeholders. The knowledge among involved stakeholders about climate change and adaptation can be argued have increased as a result of their participation. Additionally, seven interviews have been carried out reaching more passive stakeholders difficult to reach with the dialogue meetings.
Information spread to the wider community of Malmö and Europe	Report in Swedish and English at end of project	Yes	A stakeholder oriented action report has been produced in English summarizing the results from the dialogue activities. Furthermore, a dialogue strategy has been developed in order to increase the utility of action results, which goes beyond the objectives of this Action. The report and strategy has been spread through the information channels used by IVL and Malmö city, distributed to all involved stakeholders and the results have been presented e.g. during the final conference of the project.

5.3.6 Action 6 Modelling climate change impact in flood frequency and flow

The methodology which was a combination of hydrological monitoring and modelling was successful since the approach made it possible to resolve the major problem, which was the lack of reliable discharge data for quantification of hydrological behaviour. A relatively short period of high-quality discharge measurements made it possible to calibrate the hydrological rainfall-runoff model. The hydrological model was then used to extend this short observed record to the longer periods for which measured climate data was available.

The main result of the action is foremost an important increase of the knowledge of the hydrology of the Riseberga Creek. The work carried out in the action confirmed a strong impact on the creek hydrograph from urbanization as it was evident from the observed discharge that the response time from rainfall events to observed peak flows is very short, typically 0,5-2 hours at the location of the acoustic flow meter station. Another important finding is that the differences in specific runoff between different parts of the catchment are large. The area closer to the catchment outlet is more heavily urbanized and has a 15-20 % higher runoff than areas upstream of the discharge station at Jägersro.

The work carried out in this action quantified flood frequency for six sub catchments in the Riseberga creek for up to 60 year return periods. The simulated discharge for the floods that occurred in 2007 and 2010 corresponded to return periods of approximately 30 and 10 years respectively.

Flood frequency estimates for the climate change projections revealed a large range in results depending of the GCM and the scenario that was used. As an example, one GCM-scenario combination has an associated the return time for a 25 m^3/s discharge at the outlet is 20 years compared to a present climate return time of 60 years for the same discharge. The results also showed that the uncertainty in the estimates increases substantially compared with flood frequency estimates for present climate. This is important to note since flood protection measures should be robust and function for a range of present and future flow conditions.

The impact of land use on run off was demonstrated by a simple analysis with a 30 % increase and 30 % decrease in urban areas in the hydrologic model which resulted in a similar change of the flood frequency as the climate change scenarios. The scenario with a decrease in urban areas illustrates how green storm-water management that results in a more naturalised flow regime may alter the flood frequency in the catchment.

The main objective of the action was to evaluate the efficiency of the green climate adaptation tools that were demonstrated in GreenClimeAdapt. This objective was not entirely met in quantifiable terms. There are two main reasons for this. First, all of the planned demonstration actions were not implemented and those actions that were implemented were reduced in extent and started late in the project. Lack of high-quality follow-up data measured before and after the completion of the demonstration actions further prevented a successful evaluation. Second, it became evident from the analysis of the discharge measurements and the hydrological modelling exercises that the uncertainty in these are far larger at high flows than the impact of a reduction of the peak flows that would result from the different *new* demonstration actions. Even though a current meter was installed the time-series is still too short to fully resolve the small-scale flow dynamics of the creek that is required to study the impact of the demonstration actions. However, it i*s certain* that all demonstration actions (especially Skogholms ängar, open stormwater system and to a lesser extent green roofs) have an effect on the hydrologic regime in the Riseberga Creek since all these constructions store water which will have a smoothing effect of the creek hydrograph. Also, the lack of historical discharge data prevented an analysis of the effect of the green stormwater solution that was already constructed before the GreenClimeAdapt-project started.

The main focus of this action was to establish a good knowledge of the hydrology of the Riseberga creek for the present climate as a baseline for omplementation of adaptation measures and in order to be able to estimate the climate change impact on flood frequency for the creek. This was achieved with a combination of analyses of measurements and modelling and the use of generated synthetic climate data. Less focus was put on the detailed modelling of nitrogen and phosphorus leaching, transport and retention in the system, while it became evident in the project that the main problem to face in the Riseberga creek is flooding and not eutrophication and other water quality issues.

Objective	Indicator	Achieved	Evaluation
Assessment of climate change impact on flood frequency and flow	Compiled database for hydrological modelling. Calibrated hydrological model	Yes	Since no efforts to estimate flood frequency for present and future climate projections had been carried out in Riseberga Creek before the GreenClimeAdapt-project this is an important result that can serve as a base-line for the continued work with robust climate adaptation measures in the catchment.

5.3.7 Action 7 Evaluation of the effects of green climate adaption on biodiversity and recreation

The methodology of field inventories and habitat modelling in combination for assessments of the impact on the habitats from the demonstration actions is successful in its own right. However, for this project, as little historical data from the creek existed that could be used for model testing, another strategy that focused much more on inventories and less on modelling should have been chosen from the start of the project.

The result however, after more focus was put on data analysis, shows that the creek has fair diversity of benthic fauna both in its upper reaches and closer to the outlet. The analysis of the results from the electro-fishing shows a trend of decreased density of brown trout further upstream. An explanation for this might be that several barriers in forms of tunnels and steep tunnel outlets function as barriers and prevents fish from spreading in the stream. The best spawning grounds are located in lower and central parts of the creek.

The objective of evaluating the demonstrations according to their ability to increase biodiversity and recreational values was not met. The main reasons for this is that not all of the planned demonstration actions were implemented and some started late in the project. Lack of high-quality data measured before and after the completion of the demonstration actions further prevented a successful evaluation. The evaluation was intended to be carried out with the aid of habitat modelling but the initial tests showed little promise to carry on with the habitat modelling as stated in the project plan. More focus has instead been put on data collection and analysis and development of a methodology to assess and model long-term effects of habitat suitability using benthic fauna as the modelled species instead of fish. Recent research has shown promising results of using benthic fauna for habitat modelling since these more static species carry a long term signal if the habitat is degrading. Reasons for degrading habitats can be that the probability that bottom substrate gets flushed away will increase in a future climate with higher discharge and increased flood frequency and also that the water velocities become too high that some benthic fauna species will be detached from the bottom substrate and flushed away as well. This approach will enable modelling of the impact of the habitats and also a methodology to determine which habitats that are suitable today will not be suitable under changed climate conditions in the future. It will also be possible to utilize flood frequency estimates to make a vulnerability assessment for each surveyed habitat. The approach can also be used to increase cost-effectiveness when conducting river restoration by using the model results to avoid restoring habitats that will be at risk in the future and instead put effort into protecting habitats that might become better in a changing climate.

Objective	Indicator	Achieved	Evaluation
Knowledge of the impact of the project on aquatic biodiversity	Data collection	Yes	Two surveys of the Riseberga Creek have been carried out. Valuable data was collected that has increased the understanding of both biodiversity and the functioning of the aquatic system. The data has been crucial in the development of a robust methodology to make impacts assessment for river habitats under changing climate conditions.

For bird assessments, the standard method of nesting bird assessment was used. Bird species and individuals are observed from set GPS points, and behaviour indicating nesting is noted. Plants were assessed by two persons walking slowly through the whole area. It was the same two people every year which makes comparison between years reasonable. Recreational values were assessed through interviews. The methodologies were all found to be successful and cost-efficient. There is no clear trend in the number of nesting species, nor in number of visiting individuals and species. The low number nesting the first year could be a result of the assessment starting a slightly too late in the season. The construction work during 2011 and 2012 did not have a negative influence on the number of nesting birds. An increase in number of nesting species could have been expected after the completion of the ponds and the diking of the alder wetland, since these are new desirable qualities added to the area. It is possible that the time was too short for the observed number of species to increase, and that bird assessments in just a few years’ time would give another result. Detailed descriptions are found in Annex 9.

Objective	Indicator	Achieved	Evaluation
Knowledge of the impact of the project on terrestrial biodiversity	Data collection	Data collection year 1, 2, 3 and 4	Data on terrestrial biodiversity have been collected year 1, 2, 3, 4 and 5 (fifth year birds only).

5.3.8 Action 8 Architectural integration of green tools for urban climate adaptation into the built environment

Workshops were used as methodology. The objectives of the workshops were reached, the expected target group was reached and the aims set up for each workshop were reached. On a low budget we managed to involve important local stake-holders and increase their knowledge and understanding of green urban planning and green tools for urban climate adaptation, both by the inspirational presentations and by them learning from one another. The workshops resulted in illustrations of ideas of greening buildings and city districts, which were immediately visible. An illustrator was engaged to help the participants to translate their ideas and visions to clear pictures that could be communicated to a wider target group on the project webpage. To implement the workshop participants' knowledge in building and planning actions was a slow process influenced by many circumstances.

Evaluation of experiences from green roofs, green facades and workshops as a methodology was conducted using interviews by email and phone. A very specific list of obstacles and success factors were identified and will be extremely useful in the future when working for enhancing the use of green tools in Malmö. This method was the most suitable for the kind of results that were needed and was cost efficient as the questions that were asked were well prepared.

Objective	Indicator	Achieved	Evaluation
Three illustra-tions from each of the workshops.	Workshops held and illustrations produced	Six illustrations	The workshops resulted in illustrations of ideas of greening buildings and city districts, which were immediately visible. An illustrator was engaged to help the participants to translate their ideas and visions to clear pictures that could be communicated to a wider target group on the project webpage.

5.4 Analysis of long-term benefits

5.4.1 Environmental benefits

The GreenClimeAdapt project has many direct environmental benefits. A more than 40 000 square meters large recreation area has been partly reconstructed, maintained and open for the citizens of Malmö The open stormwater system in Skogholms ängar has direct positive effects on reducing flows in Riseberga Creek as well as on the biodiversity there. The existing old alder wetland has been given better conditions for preservation due to more water coming into the forest/wetland. Also other present biotopes and new biotopes will lead to a higher biological variety, which will both be positive to the wild life but also for the recreational experience of the visitors. There is a significant aesthetic value of surface water in the urban environment. The area that has previously been rather unavailable and practically not known by the public has now become a pleasant site of green infrastructure.

The design of the ditches and recreational areas were adjusted according to the results of the plant surveys made in Action 7. A part of the demonstration was left untouched to protect a rare species, and species suitable for sowing and planting the demonstration were identified through the plant surveys. The field-layer establishment method of the areas around the ponds was also adjusted to obtain a quicker regrowth of the field-layer. Thus the assessments have had a direct environmental benefit. They are also necessary for quantifying the environmental benefits of the biodiversity-related parts of the project.

The evaluation of the green facades indicates that the facades covered in plants have a lower temperature than facades without greenery. The green facades help to cool the facades and protect the envelope. This is an important impact for the building especially with the ongoing climate change where the air temperature is rising. Green facades are one solution to reduce the negative effect that higher temperature has on the building envelope.

The green facades also have a positive impact on the urban areas where the green space otherwise decreased.

The environmental benefits from the green roofs will be the contribution of increasing and restoring biodiversity of both rare native perennial herbs and invertebrates such as bumblebees and solitary bees. Other environmental benefits are reducing the effect of heat-waves as well as heavy rains–and therefore a great tool for climate adaption.

Through the workshops held on green tools key actors in city planning and development have been given better knowledge and understanding of the importance and possibilities for using green tools in urban climate adaptation.

5.4.2 Long-term benefits and sustainability

The long-term environmental benefits from the open stormwater system in Skogholms ängar are reduced risk of flooding and the protection against downstream erosion along the Riseberga creek. The continuation of the project is instinctive and represents the storage of rain and the using of the facility by the citizens. By marketing Skogholms ängar as a recreational area and maintaining it on a more regular basis the different biotopes within the area are safe from future exploitations. The maintenance will improve the biodiversity, especially the meadows that from now on will be kept open and thereby more rich in flower species.

The awareness of Riseberga creek as a natural and accessible blue and green path through eastern Malmö, instead of a stormwater canal, will improve the possibilities for the municipality to continue similar projects and actions along the creek. The project of Skogholms ängar also shows that a small area a can be used and be of importance in the work with stormwater management, but most important in the work of recreational areas within the city. Also the location in an industrial surrounding is not necessarily negative. Skogholms ängar are also used for educational purposes and will inspire education for sustainable development.

The benefit of the green facades cannot be determined with certainty. But the project came without a doubt in the right period of time, and has contributed strongly to increased interest in modern green facades. This could in the long term result in significant contributions regarding improvement of air quality in urban areas, decrease the cooling demands in our buildings, increase the biodiversity in urban environment and create new local work opportunities in installations and maintenances work.

The City of Malmö has continued its' work with Riseberga Creek. The Environment Department is leading a project which aims at identify and demonstrate the economic value of the ecosystems of the creek. The project is also a test of the methodology described by TEEB – The Economics of Ecosystems and Biodiversity. The methodology consists of six steps:

(i) Specify and agree the policy issue with stakeholders

(ii) Identify which ecosystem services are most relevant

(iii) Define the information needs to tackle your issue and select appropriate methods for assessment.

(iv)Assess ecosystem services, expected changes in their availability and distribution.

(v) Identify and appraise policy options based on your assessment.

(vi)Assess distributional impacts of policy options on different groups in your community.

In step ii above, the report from GreenClimeAdapt's Action 5 on stakeholder dialogue has been used as a means of mapping different stakeholders' use of the creek. In March 2014, the project has reached step iv. When the project finishes in December 2014, all the steps of the method will have been gone through.

The Parks and Streets department will make a pilot study on laying out a recreational track along a larger part of the Riseberga creek. If and when the pilot study is realized, the track will be a continuation of the ones laid out within the GreenClimeAdapt project.

The green facades have also inspired local initiatives on green facades in Malmö such as:

- A green edible facade has been developed on an apartment house by a local network of city farming in cooperation with the residents in a socially exposed area with a high number of immigrants.
- Malmö school restaurants (the department that cooks lunch for all the schools in the City of Malmö) are building a green herbal indoor facade where the guests can pick their own herbs etc. to their lunch.
- Two ice arenas/sport facilities have been provided with greenery on a cable system of a facades
- Within the frame of a large innovation project with many stakeholders, private entrepreneurs with the Swedish university of agricultural science (SLU) have developed several different systems for vertical green environments in urban areas

The green facades in this project and the above mentioned initiative will be displayed during a large manifestation in the summer of 2014 called GreenCity Malmö.

A long-term environmental benefit of the green roofs installed is the potential carbon sink factor as biochar is used in several of the substrate batches. The biochar itself counts as carbon sink and hence is a very interesting future green roof substrate. Biochar has a great potential to be used on large scale in the green roof industry and new producers have thereby been introduced to the green roof market as a potential area for their products.

Conventional green roofs are usually built up with plastic drainage layers. Alternative green roofs based on only local substrates as in this project and with hemp as a water holding layer, without plastic, are strengthening green roofs overall sustainability and viability.

The main benefit from the dialogue activities has been the increased awareness of climate change adaptation and adaptation measures and increased willingness to take action among most stakeholders participating in project dialogue activities. The involved stakeholders actively took part in the dialogue meetings and interviews and were willing to share their experiences as well as discuss issues concerning urban climate adaptation from a Riseberga Creek perspective. This increase in awareness among key stakeholders and their willingness to take action can have a very positive effect on the coming climate adaptation work in the area. The local knowledge and insights of the stakeholders can further inform future planning processes of climate adaptation measures and thus increase its quality.

It was furthermore agreed by most stakeholders taking part in the dialogue activities within GreenClimeAdapt that a continued dialogue was important in order to continue to successfully adapt Riseberga Creek and surrounding area to climate change, indicating a continued dialogue beyond the scope of the project.

With the report "Multi-stakeholder dialogue on green urban climate adaptation" and the general strategy "Strategy for multi-stakeholder dialogue on green urban climate adaptation", the lessons learned and experiences from Action 5 can be further utilized beyond the scope of the project, informing other projects on climate adaptation around Europe.

The hydrological modelling has provided increased knowledge of the hydrology of the Riseberga Creek. The calibrated model and the quantified flood frequency for the present climate and estimated flood frequency for a range of future climate projections can be used for impact assessments. Also the results can be used for setting and reviewing the hydro morphological environmental standards for the creek.

The development of a methodology in Action 7 will allow better qualitative assessments of habitat suitability for changed climate conditions. This methodology can be used for any creek.

Quantitative assessments are a suitable way to measure environmental benefits and to estimate wheather an action is sustainable or not. The assessments conducted here in Action 7 shows that it is possible to combine actions for biodiversity and recreation in stormwater projects.

The two workshops and the evaluation of installing green roofs and green facades will be two small but important drivers in the process of implementing green tools for urban climate adaptation in the planning and development of Malmö. This implementation is certainly a long term sustainable technology, and has a high visibility. To decrease the risk of flooding and reduce the impacts of severe heat waves will mean long-term financial savings. New technology for green urban solutions is a growing market in both Sweden and Europe and will lead to massive business opportunities, which in turn will lead to positive effects on employment levels. Decreasing the risk of flooding and reducing the impacts of severe heat waves will also have positive impacts on health. The city of Malmö and other partners will continue to work for implementation of green tools for urban climate adaptation in multiple ways into the future. Malmö's new comprehensive plan outlines a green and dense city as a goal for city planning, and is an extremely important policy document for implementation.

5.4.3 Replicability, demonstration, transferability, cooperation

The replicability and transferability of the actions carried out in GreenClimeAdapt to other EU countries is high, especially the transferability to other urban areas. Climate change occurs over the whole world and affects all with similar problems.

The open stormwater system within this project can advantageously be transferred elsewhere and also function as demonstration objects and source of inspiration for other future similar projects. The technique is rather simple, the most important issues consist of land use and overcoming institutional barriers between different departments within the city administration. The project shows that the used method of sustainable drainage system is less expensive than conventional systems. At the same time the technique of combining stormwater management with green and recreational benefits in a multi-functional urban infrastructure give positive values that never can be achieved in a conventional drainage system.

The city of Malmö and VA SYD will continue to inform about the possibilities and the principles of sustainable stormwater management. Whereas this project only concerns public land, much can still, and will need, to be done on private land. Examples of techniques to work with are green roofs, infiltration on lawns, permeable paving, local ponds, and collection of roof runoff for irrigation. On public land the city administration and the water planning departments still have a lot to work with regarding slow transport and on site control, configuration such as for instance swales, filter strips and temporary prepared surfaces for flooding.

The cost effectiveness of the recreational measures in Skogholms ängar has been good, even though it is difficult to see that the municipality will use the same kind of budget in areas where such a small group of people is affected. So this action would probably not have been undertaken if was not for the GreenClimeAdapt project and, mainly, the co-financing between the Streets and Parks department and VA SYD. Even though it is an important project since it has shown the positive effect that a small scale biotope can have on wildlife and has also helped to bring focus to the stormwater problem in Malmö and on the Riseberga creek as a recreational pathway. More actions near the creek are likely to be realized now with this action as a good example.

Hopefully knowledge of the area will be spread and more visitors will find it. There are plans to develop more recreation paths along Riseberga creek. The Street and Parks Department has applied for such a project in cooperation with the Environmental Department of City of Malmö, within LONA, a nature preservation project supported by the Swedish Government.

As the use of biochar as a green roof substrate sparkled an interest among both resellers of biochar and among some of the Scandinavian Green Roof Associations members monitoring of the green roofs with biochar used will continue for several years. The biochar will last for a much longer period of time compared to other green roof organic substrates such as compost and peat which will biodegrade slowly, and is therefore an interesting product from the long term benefits perspective.

A limitation with biochar is that it's still relatively expensive as a substrate compared to other organic materials such as compost. However, if used in a mix of compost, like some of the batches in the pilot tests, it could potentially be a feasible alternative. Already in the spring of 2014, biochar is planned to be used in conventional green roof systems at a new demonstration surface at Augustenborg Botanical Roof Garden.

The hemp is not expensive and the material is light-weight which is beneficial for extensive green roofs. However, installing with hemp straw was a challenge with even light wind and also time-consuming. However, compared with straw from rye (or wheat) it was still much easier since the substrate poured down into the rye straw-based roof, and this did not happen with the hemp. If hemp is going to be used on a large scale by green roof companies it should be transformed into a somewhat more easy-to-handle product such as a mat or a thick cloth.

Workshops as a method for communicating the importance of implementing green tools for urban climate adaptation has been tested and evaluated and found to be efficient. The method has a high degree of replicability and transferability and builds on cooperation between participants. The evaluation of installing green roofs and green facades will be transferred nationally and will be extremely useful when overcoming obstacles for implementation of green tools. Stakeholders have benefitted from the public workshops where the project results were presented and measures to improve the aquatic life in the Riseberga Creek discussed.

5.4.4 Best Practice lessons

The most valuable lesson consists in the use of existing lowland, the alder marsh, as a solution for stormwater detention. Hereby the largest storage volume was given to the project for free, however with some required adjustments. Even though Skogholms ängar is a rather small area and located in the middle of an industrial area the intention to recreate a natural biotope has been made into o reality. Most of the existing vegetation was saved and the new meadows are already functional. The newly planted trees/forested areas are yet small but the growth is very satisfactory and the signs of the building site will soon have disappeared. Saving existing field-layer and re-using it in the area was successful and easier to carry out than expected. The result from this is very good, with natural looking meadows. Another best practice example is the dialogue kept with the horseback riding club, one of the important stakeholders, during the detailed design process.

The worry of redirecting large amounts of stormwater into the alder wetland sometimes resulting in a much higher water level in the area was exaggerated. Some of the old alder trees are negatively affected by the action, and may even be dying, but the biotope as a whole is clearly benefitting from this decision, which can be seen in the ground vegetation.

Of the three green facades the best practice was found to be the one facing south, using the wire system. The one pointing north has a longer establishment period and in the cassette system it seems to be difficult to find suitable plants. Regarding the irrigation system, a less advances system with the possibility to see the amount of water used should be used in the future. To improve the implementation of green facades the staff managing the green facades, plants and irrigation system, should be involved from an earlier stage in the project to receive the correct knowledge about the systems and the specific management.

From the project findings on green roof in combination with the exchange with other European experts on green roofs our suggestions for best practices are the following list:

- Use between 5-20 % of organic content in extensive green roof substrates depending on the choice of plants and type of organics.

- On a roof for herbaceous plants the substrate layer is beneficial at a minimum of 8-12 cm without a water holding layer (such as hemp straw or a green roof product with water storage capacity) and at least 6 cm with a water holding layer beneath.
- Biochar should be used more often in the green roof market due to its lightweight and stable characteristics with the potential of being a carbon sink. Biochar is also a potentially good substrate with the same function as clay – storing water and nutrients.
- A seed mix from local flora of annual and perennial herbaceous plants are good for the regional biodiversity and nature conservation.
- Local reused substrates such as crushed bricks are good green roof products.

The best practice when carrying out projects in streams where historical data is scarce is to focus on establishing a good baseline instead of modelling from the outset of the project. This will save time.

5.4.5 Innovation and demonstration value

Normally the co-operation between the Streets and Parks Department and VA SYD takes place in new residential areas were stormwater management is included in new parks. This time we worked together to implement stormwater ponds in an existing and, by bio topical means, sensitive area. This partly new way to work between the two organisations has been an eye-opener and this combined with the good result from the project will probably lead to additional co-operations between the two. The problem with flooding is starting to be obvious and the City of Malmö is about to make a special plan for all management of water as an addition to the Comperhensive plan.

To save existing field-layer and re-use it in the area was successful and easer to carry out than expected. This will probably be a method more used in Malmö in the future.

It is still rather uncommon to make direct assessments of biodiversity in construction projects like this, and it can be considered an innovation. The data makes the demonstration value of the project at Skogholms ängar more complete, since we can now tell what effects on biodiversity and recreational values the actions have had.

With the help of EU and LIFE the city of Malmö had the opportunity to cooperate with SLU and other companies with experiences and innovative thoughts regarding green facades. This is the first green facades the Department of Internal Services has implemented in our buildings. It is not only a green facade but green facades implemented with solar panels.

The level of innovation in Action 4 can be questioned since straw-based green roofs already have been tested for a long period of time in Switzerland. However, since the climatic conditions differ a lot between Malmö and both Basel and Zurich (where most of the Swiss green roofs studies been done) it was of great value for us to be able to test their approach in more northern climate. A great innovation made in acion 4 was the usage of biochar in some of the substrate batches as the only organic material. Since these batches were successful with regarding to the number of plants thriving in these mixes this is an interesting result.

The green facades and the green roofs of this project are situated in an area of Malmö, Augustenborg, known as the ECO-city where several achievements have been made to build a sustainable area. The demonstration value is obvious as a great number of visitors come to Augustenborg and it’s Botanical Roof Garden. The pilot test sites (except from pilot test site 5, being on top of a roof not viewable from the roof garden) have been seen from one meters distance by nearly 2000 people during the summer period of 2013. The discussion that the project contributes to is not only about the environmental benefits of green roofs but also about sustainable practice and environmental products in general. A green roof is very often perceived to be a good thing because of its potential effect on local micro and meso climate and the potential contribution to increasing urban biodiversity. But if a green roof is made out of a wide range of plastic products and the main substrate component in the green roof substrate is peat (which arguably should be considered as an non-renewable resource) the environmental benefits of green roofs could in fact be questioned. The GreenClimeAdapt project and the EU funding has, in a vital and important way helped SGRI to spark discussions and critical thinking among the visitors at Augustenborg Botanical Roof Garden as well as among others reached by the project findings and results.

5.4.6 Long term indicators of the project success

Long term indicators for the development of Skogholms ängar are flood frequency in Riseberga creek, number of species present and number of visitors. A regular maintenance is necessary for Skogholms ängars development as an important biotope. The meadows and the ponds must be kept open, both to maintain the biodiversity and to keep it accessible for visitors. And since the area is now accepted as a recreation area, this will be done. It is the City of Malmö's ambition to repeat the bird and plant assessment in a few years' time. Resources for such activities are scarce, however, and must be used in the highest prioritized areas.

The high-quality measurements at the Jägersro discharge station will continue to be operated by VA SYD. Also the calibrated model and the flood frequency estimates can be used for creek studies, dimensioning exercises and impact assessments.

An indicator to be used in the long term could be dampness of the facades. Many building owners are afraid that the green facades are the reason for increased moisture in the facades. Damp as a quantifiable indicator for assessments of green facades could decrease the antagonism towards green facades.

The hemp in the green roofs is likely to break down and it is only after very long term monitoring, around ten years, that we will be able to tell how feasible it is to use hemp as a bottom layer beneath an extensive green roof. Our prediction is that the hemp will have similar qualities to the straw-based roofs in Switzerland. The biodegrading will happen but can potentially leave a partly broken down bottom layer which still is airy (and lightweight) with the beneficial capacity to store water.

The monitoring of number of plant species is not only an indicator of the value the green roof has for the native plant populations, but of course also an indicator for number of invertebrates like bumblebees that potentially will thrive on the roof. However, measuring only the vegetation will not be sufficient to state the number of invertebrates on the green roofs. Therefore along with plant cover and diversity studies that will continue in 2014–2017 as part of the BiodiverCity project that the SGRI is part of (with funding from the national VINNOVA project funds), monitoring of the number of invertebrates visiting and nesting on the pilot test site 5 will also be one of the future assessments.

Long term indicators of project success can also be the number of installed green roofs, green walls and green stormwater systems in Malmö and continued dialogue activities between stakeholders regarding the Riseberga Creek as well as number of other dialogues initiated regarding urban climate adaptation.

6. Comments on the financial report

6.1 Summary of Costs Incurred

PROJECT COSTS INCURRED				
	Cost category	Budget according to the grant agreement*	Costs incurred within the project duration	%**
1.	Personnel	983 432	781 054	79%
2.	Travel	38 678	24 594	64%
3.	External assistance	217 659	73 316	34%
4.	Durables: total non-depreciated cost			
	- Infrastructure sub-tot.			
	- Equipment sub-tot.	800	0	0%
	- Prototypes sub-tot.	1 674 141	1 084 092	65%
5.	Consumables	23 290	14 089	60%
6.	Other costs	21 125	4 253	20%
7.	Overheads	**207 139**	**138 698**	67%
	TOTAL	**3 166 264**	**2 120 097**	67%

*) If the Commission has officially approved a budget modification indicate the breakdown of the revised budget Otherwise this should be the budget in the original grant agreement.
**) Calculate the percentages by budget lines: e.g. the % of the budgeted personnel costs that were actually incurred

6.2. Accounting system

City of Malmo

Accounting system

Raindance, the accounting system for City of Malmö, was employed during 2006. Special project codes are created on request by a Controller. Supporting documents are compulsory for a project code such as Grant Agreement. Transaction reports are available from this system sorted by project codes. The costs from these reports are then transferred to the "Standard Statement of expenditure".

Invoices

The procedure for approval is that after ledger allocation they are sent off to the employee responsible for the expense. The employee allocate the project code and if needed attach additional documents to the invoice. The invoice will then be approved by the employees Manager or persons with budget responsibility before payment.

Time recording system

Within City of Malmo different approaches have been decided about time recording depending on the department involved. At the Environmental department all permanent employees working in projects with external contributions are to register their time into a module in the accounting system Raindance. The employees once a month approve electronically their timesheets and then sent to the employees Head/deputy head of the department for the final approval. Temporary staff is normally not connected to the accounting system and must therefore fill in their time on LIFE approved timesheets. The costs are then transferred to the project code either directly through the HR system or manually.

Other departments within City of Malmö may use other system for time recording. At the Streets and Park department their system is called "Vegas" and the procedure is the same as for Environmental department but their time is transferred to LIFE timesheets. Department for Internal Services also use the LIFE approved timesheet for time recording. Independent of which procedures are used all costs will be entered into the common accounting system Raindance.

Insurance of invoice reference

The purchaser/employee (in general the project manager) instruct the consultant to put in the correct reference onto the invoice, it could be either the project abbreviation or the project code. In such cases where the consultant might ignore/miss to enter the code the project manager must enter the reference manually onto a printed copy of the invoice.

<u>Malmo University (ISU)</u>

Malmö högskola employs the same accounting system, Raindance , as Malmo Stad. The Activity number tells what project it is. Every cost is described with a ledger code. The verification date corresponds to the date of approval for payment.

Approving costs

The approval procedure follows two steps. Every cost is approved by the employee who's responsible for the expense and then approved by manager with the budget responsibility.

Type of time recording system used

Malmo University did not at the time have any digital time registration system. For this project time registration at ISU were done in the designated Excel files supplied by LIFE that were monthly approved by the coordinator at ISU.

Invoices

Every invoice accounted for by Malmö University has a clear reference to the GreenClimeAdapt project. The reference is as follows:

5030/253004/31 "ISU Green Clime Adapt / Kruuse" (Raindance-ID , Employee)

Objekt 253004, Green Clime Adapt (project code, name of the project)

253004 is the project number. In the accounting system, Raindance, the project number is connected to the project named ISU Green Clime Adapt / Kruuse

<u>IVL</u>

IVL is using the accounting system Visma PX - ProjectxChange (version 6.7) by Visma Consulting Ltd. PX that is a leading solutions for time registration, project and resource management for larger consultancy and research organisations, both within private and public sector. PX has about 180 installations of the software with 18.000 users in mainly the Nordic countries. The internal project number for GCA in our accounting system is 201268.

- IVL treat environmental and quality issues within the frame of an integrated quality and environmental management system and are certificated in accordance with SS-EN ISO 14001:2004 and SS-EN ISO 9001:2000. According to this quality system the IVL project manager of GCA should approve all project costs and they should also be approved by appropriate management level dependent on cost amount.

- The time reporting system Visma PX is completely electronic and the data is stored in a central database.

-The project worker is writing their own time reports in PX and the Head of Team is responsible for control and approval of the time reports. The project manager has also full access to all time and cost put on the project in PX.

-IVL has an electronic invoicing system (Visma Invoicing Manager). The invoice is sent to the project worker stated on the invoice who should put the cost on the correct project number and activity. The invoice should after this be approve by the project manager or for larger cost by appropriate management level.

VA-SYD

Accounting system
VA-SYD employs the same accounting system, Raindance, as City of Malmo. The project number is crucial for the accounting. Each project is connected to a "financial post", corresponding to a specific person in charge of the financial post. Every cost is described with "type". The verification date corresponds to the date of approval for payment.

Approving costs
The approval procedure follows two steps. Every cost is approved by the employee responsible for the expense and then approved by manager with the budget responsibility.

Time recording system
Time recording is managed in the accounting system Raindance. Hence, the time sheets are electronically completed.

Brief presentation of the registration, submission and approval proecedure/routines of the time registration system
Each employee is responsible for their time registration and approval. The routine is that after the employee has approved a manager automatically will by the electronic system receive the timesheet for a final approval.

Insurance of invoice reference
Every invoice accounted for by VA-SYD has a clear reference to the LIFE+ project. The reference is as follows:
VA6408, Stefan Milotti (Raindance-ID, Employee)
Object 8260, Green Clime Adapt (Project code, name of the Life+ project)
8260 is the project number. In the accounting system, Raindance, the project number is connected to VA SYDs internal project name Fosieby industrial area.

Scandinavian Green Roof Institute (SGRI)

Accounting system

During the years of 2009 – 2011 the accounting was done by Nina Jörgensen Revisionsbyrå AB and the accounting system used was Visma Compact. During the years of 2012 and 2013 SGRI changed to BLA Administration and the accounting was done by John Gustafsson. Several reports are available from this system and all transactions on the project in 2012 and 2013.

Approving costs

All costs at SGRI above 10 000 SEK must be approved by the CEO of SGRI, either verbally, email or by written signature. The staff at SGRI can incur project related expenses without prior approval if beneath 10 000 SEK.

Recording system used

The Co-ordinating Beneficiary (City of Malmo) supplied LIFE approved timesheets. These were filled in on a monthly basis by hand and later the administrative personnel or the project manager at SGRI. The approval of timesheets and registration system is done by the CEO of SGRI.

Invoice practice

All suppliers, sub-contractors and resellers was informed about the GreenClimeAdapt project and carefully asked to state the project name (GCA) and product type at the invoice they provided to SGRI. In such cases where this was ignored the project manager entered the reference manually.

6.3. Partnership arrangements

There are no financial transactions between the Co-ordinating beneficiary and the associated beneficiaries. All beneficiaries were responsible to enter their financial information into the financial tables.

6.4. Auditor's report/declaration

Lennart Öhrström, Executive Director/Auktoriserad revisor/Certifierad revisor/Assurance, Ernst & Young, Torggatan 4, Box 4279, 203 14 Malmö, Sweden.

The auditor's report (to be included with the financial report) must follow the format of the standard audit report form available on the LIFE website, in particular the auditor must in section 7 clearly state that the financial report is in compliance with the LIFE+ Programme Common Provisions, the national legislation and accounting rules.

6.5 Summary of costs per action

Action no.	Short name of action	1. Personnel	2. Travel and subsistence	3. External assistance	4.a Infra-structure	4.b Equip-ment	4.c Prototype	5. Purchase or lease of land	6. Consumables	7. Other costs	TOTAL
1	OSWM	48 023					539 314				587 337
2	R&B	30 881					239 654				270 536
3	GF	13 312		26 518			283 171				323 001
4	GRHB	96 626					21 952				118 578
5	DWS	28 850	2 017								30 867
6	MF&F	68 748	2 017								70 765
7	EB&R	180 913	2 018	11 410							194 341
8	AI	29 583	2 017								31 600
9	DS	42 756	5 856	35 388					14 089		98 089
10	PM	241 364	10 669	6 146						4 253	260 286
11	After-Life Comm Plan										0
Over-heads											139 128
	TOTAL	781 056	24 593	79 463	0	0	1 084 092	0	14 089	4 253	2 126 674

Although that all of budget has not been spent, the project has achieved the objectives. Costs under action no 1, OSWM, are much lower, 44% of the expected budget because of that the construction was much cheaper than foreseen. The Prototype costs for action no 3, Green Facades, was more expensive than anticipated in the original budget although the personnel and external assistant cost was considerably lower. The costs for Action no 4, GRHB, increased by 11% as the original budget was set too low. Action no 7, EB&R, also show an increase from original budget. Action 9 and 10 are also showing lower cost than expected in original budget.

7. Annexes

7.2 Technical annexes

Technical reports

1. Insektsinventering – Inventory of beetles and butterflies in Fosie 2010
2. Teknisk beskrivning solceller – Technical description of the solar panels
3. Växtarter – Plant species
4. Final report - Green roofs for home building
5. Dialouge
6. Multi-stakeholder dialogue on green urban climate adaptation
7. Final report - Estimating flood frequency for present conditions and change impacts
8. Biodiversitetsundersökningar inom vattenförvaltningen –
9. Fågelinventering i Skogholms ängar, häckningssäsongen 2013 samt sammanfattning av sommarinventeringen 2009-2013 - Bird inventory in Skogholms ängar breeding season 2013, and summary of summer inventories in 2009-2013
10. Växtinventering – Plant invenroty
11. Utvärdering av rekreationsvärdet i Skogholms Ängar – Evaluation of recreational values in Skogholms ängar
12. Design guide
13. Sammanfattning av workshop 1 – Summary of workshop 1
14. Sammanfattning av workshop 2 – Summary of workshop 2
15. Erfarenheter och utvärdering av utförda arbeten i Action 8 med gröna klimatanpassningsåtgärder - Experience and evaluation of the work carried out in Action 8 with green climate adaptation

7.3 Dissemination annexes

7.3.1 Layman's report

7.3.2 After-LIFE Communication plan – for LIFE+ Biodiversity and LIFE Environment Policy and Governance projects

7.3.3 Other dissemination annexes

In electronic format:

1. **All the photographs**
2. **Standard presentation** illustrating the main actions and results of the project (set of slides / colour photographs, electronic images with captions)
3. Web site: www.malmo.se/greenclimeadapt
4. Notice board – construction phase
5. Notice boards
    a. Skogholms ängar, 3 different
    b. Green facades
    c. Green roofs
6. Brochures
    a. Project leaflet

7. Press cuttings
8. Roll-ups
9. Study visit concept

7.4 Final table of indicators

8. Financial report and annexes

IVL Swedish Environmental Research Institute Ltd.
Box 210 60, 100 31 Stockholm, Sweden
Phone: +46-8 598 563 00
Fax: +46-8 598 563 90
www.ivl.se

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