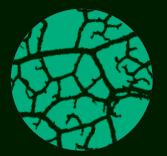
CLIMATE ADAPTATION & URBAN NATURE



Development Catalogue

Prepared by the Technical and Environmental Administration in collaboration with SLA

CLIMATE ADAPTATION & URBAN NATURE

Development Catalogue


WHAT WILL HAPPEN WHEN THE BUILT
AND GROWN ENVIRONMENT MEET
TO CREATE A WHOLE NEW COPENHAGEN?

INTRODUCTION

300 climate adaptation projects based on urban nature will transform Copenhagen. Nature's processes will not only aid rainwater management. Nature will also help to obtain a more robust and sustainable city with a new sense of community, quality of life and a whole new perspective on what a green city is.

The think tank for green identity and urban nature is convinced that the answer to Copenhagen's future quality of life is urban nature, which will create a meaningful relationship between the built and the grown environment. Copenhagen's urban nature entails the development of the city based on the processes of nature thus creating both high amenity value and high utility value. Copenhagen's urban nature is site specific and Copenhageners will be involved in creating it.

"We are working on a paradigm shift. It is initially about recognising that we cannot plan our way out of everything like we have done in the past. The world has become too complex for us to work from ideal images. Therefore, the think tank is also put together in a way that it reflects the vastly different approaches to climate adaptation and different perspectives on nature. The interesting part is where and how we can reach an agreement on urban nature as the future framework for climate adaptation in the future."

Tina Saaby

It has been the think tank's task to develop Copenhagen's green identity and future urban nature. The starting point has been Copenhagen's 300 climate adaptation projects spanning diverse goals such as cloudburst adaptation and everyday rain, as well as prevention of increases in temperature.

If Copenhagen is to succeed in making urban nature the framework for the future of nature based climate adaptation, the administration, consultants and locals must be prepared to work together in new ways. The common challenge is to create solutions that can withstand extremes while providing the best possible value for Copenhagen and Copenhageners. Copenhagen will change over time. So will the existing nature in the city and in a few years it will be supplemented by more diverse urban nature.

The think tank has in its work aimed at not just describing the goal, but also showing how Copenhagen can succeed with the challenge of climate adaptation on the basis of urban nature. The think tank has handed over their work to the City of Copenhagen in the form of a so-called Copenhagen Model and as specific recommendations.

This development catalogue has been put together in the light of the think tank's deliberations in the autumn of 2015. The development catalogue consists of three sections and an appendix.

The first section VALUES introduces the overall direction and development potential that relates to the urban nature based climate adaptation practice, which the think tank recommends the City of Copenhagen works from in the 300 climate adaptation projects.

In addition to this, the catalogue presents QUALITIES and CASES in the second and third sections, which respectively perspectivises existing knowledge about nature based urban development and implemented climate adaptation projects in Copenhagen. The Copenhagen Model is introduced as a concrete development tool.

The catalogue is in its entirety meant as an inspiration for everyone who may come to work with green identity and urban nature in Copenhagen. It is also our hope that the catalogue will be able to act as a starting point for dialogue between the municipal administration, as well as between the municipality, consultants and Copenhageners.

The Technical and Environmental Administration & SLA

CONTENT

Values

1. Copenhagen's green identity is urban nature
2. The Copenhagen Model brings climate adaptation and urban nature together in a new practice
3. Copenhageners are co-creators of future urban nature
4. Administration processes to be modified in line with managing the grown environment
5. Urban nature as the starting point for climate adaptation will change Copenhagen

Qualities

6. Amenity value
7. Utility value
8. Biodiversity
9. Uniqueness
10. Cloudburst typologies
11. Involvement
12. Tender & Operation
13. The Copenhagen Model as a development tool

Cases

14. Copenhagen Cases
15. Fredens Square
16. Tåsinge Square
17. Byggervangen & Skt. Kjelds Square
18. Enghave Park

Appendix

19. The think tank's recommendations
20. Members of the think tank
21. Copenhagen Services
22. References
23. Credits

Prepared by the Technical and Environmental Administration in collaboration with SLA
1st edition, May 2016. Reproduction is permitted with source reference.

”Water puts some fairly strict limitations on what we can do with urban spaces. One of our main challenges will be to ensure that there is maximum room for urban nature and the co-creation of it. This is important because even though rainwater management will not be active every day, we would like the cloudburst plan to become an omnipresent factor in the city that creates both utility value and amenity value for all Copenhageners every day.”

Lykke Leonardsen

VALUES

1.

COPENHAGEN'S GREEN IDENTITY IS URBAN NATURE

We need nature
We need nature in Copenhagen. And, the city of the future must be able to meet our human need for proximity to nature and be able to withstand climate change and environmental challenges.

"We have to look ahead, but perhaps also back? What can we learn from the past? Which qualities can we rethink by rediscovery? It is inspiring how biking and swimming in the harbour have blossomed and even become identifying features of Copenhagen out in the world."

Karen Margrethe Krogh

People need nature
There are many people today who grow up in the city – they are born, live, love, work and die in Copenhagen. Entire generations are now primarily living their lives in the city, which places high demands on its layout. The city must make sense - both emotionally and practically - we should be able to get around easily, feel safe, work, go to school and just be and enjoy ourselves.

And therefore we need urban nature.

Urban nature is not just nature in urban areas. It is not a greenification of urban spaces or nature on the built environment's terms. Urban nature is a concept that gives life in the city a whole new meaning: Where Copenhageners experience that the city works better in practice, while at the same time experiencing the aesthetic nature feeling that us humans lost contact with when we moved from the countryside to the city. As the city becomes denser, the aesthetic nature feeling offers a way of fundamentally improving quality of life. Nature makes us physically healthy; it cleanses the soul and makes us happier. It provides sensory experiences that enhance our creativity and gives us the desire to create something together with others. It gives us a strong sense of belonging to particular places, and to the city as a whole. It stimulates our ability to learn. It also reminds us that nature is the very basis of our existence and that we are a part of a greater context.

We refer to this particular characteristic of nature as its *amenity value.*

Ecosystem services are the services that ecosystems provide to society and the individual's quality of life. In Copenhagen, urban nature's amenity value will be linked to five cultural services.

The city needs nature

Copenhagen is growing in density, and an increasing number of Copenhageners perceive pollution as one of the biggest problems linked with life in the city – much more than the impact of the new climate. There is therefore a growing need for wise urban planning so that the city can self-purify the air, water and soil, while managing rainwater, regulating temperatures etc.

And therefore the city needs urban nature.

Urban nature has a practical function that helps create a better basis for our life in the city. With the help of nature's ecosystem services, the city can alleviate climate and environmental challenges, while improving the city's economical and social sustainability. Urban nature's overall growth condition is an important prerequisite for the ecosystem services. This also includes biodiversity, which regulates the ecosystem processes.

We refer to this particular characteristic of nature as its *utility value.*

In Copenhagen, the urban nature's utility value is linked to seven regulating and supporting services.

Urban nature is at the heart of Copenhagen's future green identity
Climate change and extreme rainfall pose a major challenge today, due to the volume of rain that ends in urban spaces. By making room for more urban nature, we do not only achieve better rainwater management, but also better climate adaptation and a more environmentally friendly city. Moreover, we can have a city that provides an enhanced contribution to biodiversity, while significantly increasing its amenity value.

"It is only the challenges that appear on the agenda. We need to find out what urban nature is and how we can use it, and that is why it is on the agenda now. The goal should be that urban nature is commonplace in 15 years from now and therefore not something we need to address on an agenda."

Brian Hansen

Therefore, urban nature is at the heart of the city's future green identity. An identity that is created from a new understanding of nature in the city, which also enhances Copenhageners' quality of life. In 20 years from now, urban nature will be the GREEN in the city that mediates between the built and the grown environment, and thus urban nature will at once become the art of living life, with everything we long for out in nature and everything that gives us an environmentally friendly and climate adapted city.

In this way, urban nature is the obvious choice as the next great Copenhagen story.

2.

THE COPENHAGEN MODEL BRINGS CLIMATE ADAPTATION AND URBAN NATURE TOGETHER IN A NEW PRACTICE

The Copenhagen Model brings climate adaptation and urban nature together in a new urban development practice. Nature's processes and the aesthetic nature feeling are used to develop the city's new quality of life, while the city climate adapts at the same time. The idea is that the City of Copenhagen uses the model as the starting point for all activities relating to the development and realisation of future urban nature in general, and urban nature based climate adaptation projects in particular.

The model is to be used as a dialogue and prioritisation tool from the moment of conception until the project is adopted and operational. This includes the budget memorandum, political recommendation, programming, procurement, planning, execution and evaluation of the project. Thus, the model helps to ensure a common language and direction for urban nature as a starting point for climate adaptation.

Nature based urban development
Ecosystem services are the services that ecosystems provide to society and the individual's quality of life. The Copenhagen Model for Climate Adaption & Urban Nature comprises a series of cultural, regulatory and supply services that are described individually in section 6 and 7. The Copenhagen Model is inspired by the ecosystem services way of thinking by adapting to a new vision that clearly distinguishes between urban nature's amenity value and utility value, while conveying that both principles are equally incorporated in future projects.

The Copenhagen Model for Climate Adaption & Urban Nature 1.0

Biodiversity needs the city
Biodiversity is the diversity of nature. The term biodiversity refers to a variety of life. That is, the variety of species, the genetic variation among species and the variation of ecosystems. Biodiversity contributes significantly to amenity value, since it relates to the aesthetic nature feeling through fertile and varied expressions and a multiplicity of species.

Copenhagen aims to increase the number of projects that reinforce biodiversity (Strategy for urban nature, 2015). Biodiversity should therefore be promoted in the 300 climate adaptation projects wherever possible. Moreover, it would be fitting to describe which initiatives for biodiversity each project can contribute to in future urban nature based climate adaptation projects. Biodiversity can sometimes be enhanced in synergy with ecosystem services, while on other occasions it clashes with the services. Therefore, biodiversity benefits from being prioritised in relation to ecosystem services when projects are developed using The Copenhagen Model as their starting point.

"Future urban nature is also about how we humans can make room for the unfolding of nature in the city. Under the title 'city for life', the Copenhagen of the future can show the world that we create quality of life for people, while leaving room for the unfolding of nature. This will demonstrate that we are a generous city that takes responsibility for biodiversity."

Philip Hahn-Petersen

Copenhagen as a climate conscious and biodiverse city
With focus on biodiversity, Copenhagen can demonstrate that it is a responsible city that makes room for the unfolding of life, while defending the intrinsic value of nature. This will be a strong signal to send to the world – that Copenhagen is able to address both climate change and the biodiversity crisis with the help of urban nature.

3.

COPENHAGENERS ARE CO-CREATORS OF FUTURE URBAN NATURE

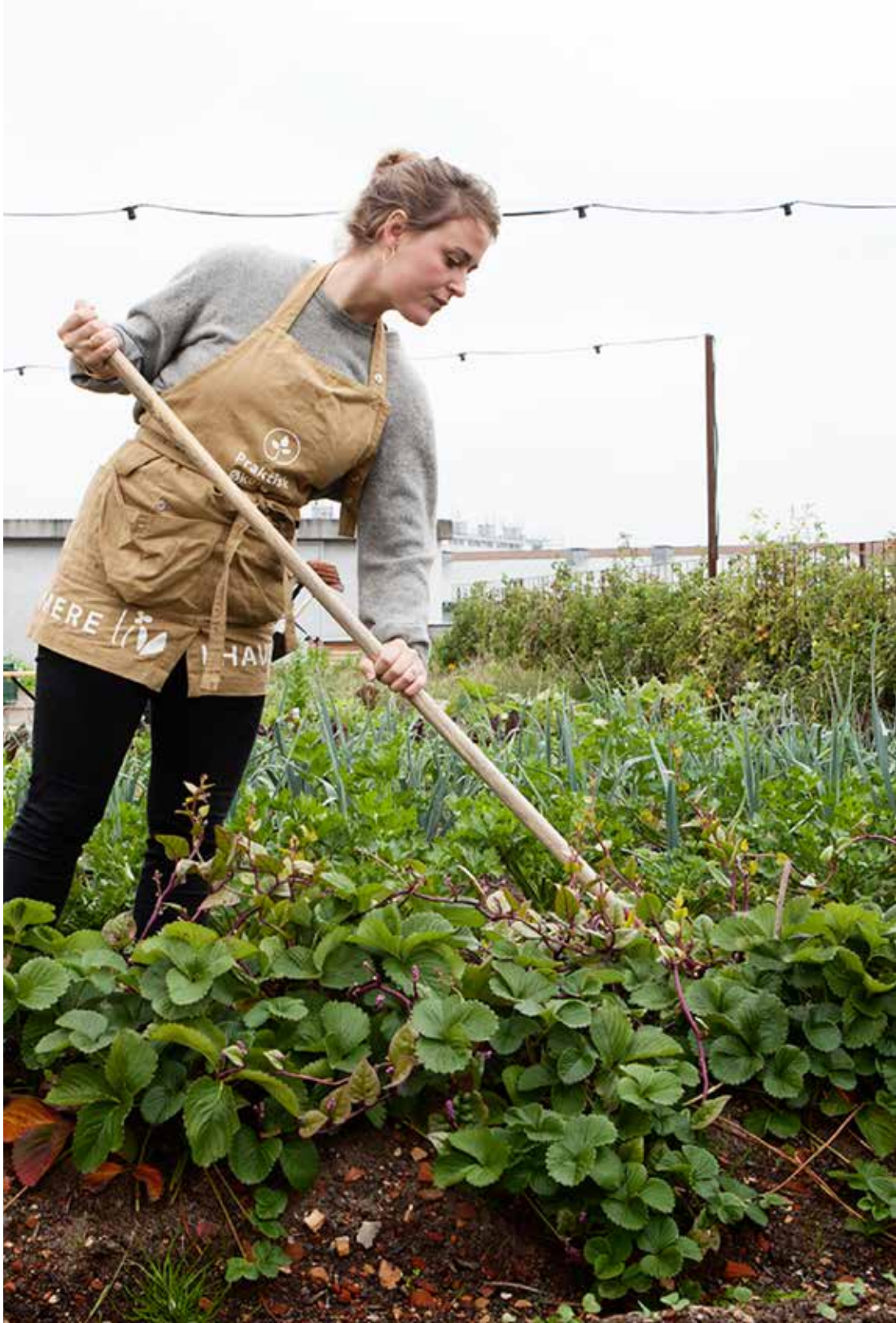
Urban nature as the new Copenhagen story only really makes sense to Copenhageners if it involves their commitment and active participation in the creation of future urban nature. Copenhageners must also be prepared to acknowledge the aesthetic nature feeling found in the city's comfortable urbanity. This is essential in order to achieve a balance between the built and the grown environment. Copenhageners must not only refine their concept of nature, they must also refine their concept of what life in the city entails.

"Today, the city's corridors are for the movement of people and for no other organisms. If we develop plans for nature in the city, it will also have an impact on our quality of life, we will influence the way in which we use urban spaces, our sense of belonging in our local area."

Hans Peter Ravn

ØSTERGRO

Østergro is a rooftop farm with its own restaurant on outer Østerbro. The project was started by three passionate pioneers, while the idea of using roofs originates from the municipality's neighbourhood renewal plan. The City of Copenhagen's role in the realisation of the project has been a catalyst for huge volunteer involvement.



From consumers to co-creators

The relationship between Copenhageners and city is already changing in many areas. More and more Copenhageners are already aware that they will be co-creators of the city, because it is where people live their lives, and because it makes the most sense for everyday life, if you feel a strong attachment to your city, your neighbourhood, your street and your neighbours. In accordance with this, a new awareness of the amenity value of the dense city's green areas has arisen, including both recreational areas and adjacent natural areas, just as there is a desire to cultivate the city and create local grown environments and sustainable communities with other Copenhageners.

"If co-creation is to succeed, it requires that all parties give up their usual roles. Politicians and administrators must dare to relinquish some control and deviate from familiar routines. On the other hand, citizens must get used to not just being demanding customers in the welfare shop, but must also step in and take co-responsibility. It will require adaptation from all parties."

Annika Agger

"What will it take to get people to show up? When it comes to involvement, we must never focus on people's motivation as crucial. The essence is in the details: We must make it easy for them, we must make it attractive, we must make it social and we must carefully consider the timing."

Simon Bentholm

Copenhagen has momentum

Copenhageners are ready to embrace urban nature and create their new city together with their fellow citizens. This momentum in urban nature and co-creation among Copenhageners can be utilised fully in connection with the 300 climate adaptation projects, if there is also focus on the development of a new practice where the municipal administration and locals can co-create the city's grown environment. Copenhageners will be involved before, during and after the realisation of the projects, where they especially should assume the role as central stakeholders in maintenance initiatives. The administration must facilitate the engagement of Copenhageners, so that the city's grown environment is promoted for everyone's benefit.

"Copenhageners are already seeking more nature in the city. It is up to us to ensure that urban spaces of the future are so great that urban nature will continue to be in demand."

Ole Vissing

"It is important that the municipality can convince Copenhageners about urban nature's great value, i.e. how it contributes to creating noticeably better quality of life."

Casper Harboe

4.

ADMINISTRATION PROCESSES TO BE MODIFIED IN LINE WITH MANAGING THE GROWN ENVIRONMENT

The methods used to develop and implement grown environments are not the same as the ones used to create built environments. Urban nature requires new systems for supply and operation that support nature with both a high amenity value and a high utility value. Unlike the built environment, the grown environment changes constantly and therefore it is important to allow room for development over time when establishing a whole new type of urban nature. Copenhagen's future urban nature would be developed most optimally with a holistic way of thinking, where everyone involved in concrete projects – from idea development, to selection of consultants and subsequent operations etc. – works with a comprehensive approach to design, planning, construction and care.

"Future operations must be rethought in both form and significance. Copenhagen can learn from cities like London that work with 10 year operating contracts, where social considerations are juxtaposed with areas of technical quality. For example, requiring that there must be a certain proportion of locals, women, immigrants and disabled employees involved in the operation."

Thomas Randrup

LONDON 2012 OLYMPIC PARK

The management and maintenance plan for the Olympic Park spans 10 years. The plan demands local community involvement in its operation. This involvement is to ensure, among other things, that the park develops in a direction where all local groups will use the park. The plan is thus an example of how the grown environment and the social environment can merge.

Lighthouse projects and long-term partnerships
Construction and operation must be tackled in a cohesive manner over a 10 year period. Consultants and contractors should enter into a long-term partnership and be included in the development of projects at an earlier stage. The window for innovative thinking must be kept open for several years and there must be room for above ground solutions to develop over time. The success criterion is that the projects will contribute to informing the administration, consultants and Copenhageners about urban nature in general and urban nature based climate adaptation in particular.

Experiments and systematic knowledge accumulation
It must be possible to test new practices in individual projects, so as to develop new knowledge about how to create urban nature that is robust enough to withstand both floods and drought. It should also be possible to achieve, in dialogue with environmental and health authorities, new standards within for example rainwater use and recreation in climate adaptation projects.

The conversation about the city's new nature must be kept alive
The administration should establish an interdisciplinary urban nature forum where stakeholders such as supply companies, consultants, contractors, and researchers can meet with the Technical and Environmental Administration and Copenhageners in order to share knowledge and develop a common understanding of urban nature based climate adaptation. Alongside this, it is equally important that the administration considers adjustments of operating practices and communication practices for example, on an ongoing basis.

"New green projects hold the beginnings of the fertile city, which will be developed over many years. The gap between new facilities and subsequent operation should be disintegrated. Could municipal gardeners perhaps plant the trees in the new green areas? Could architect firms be involved in the operation?"

Jens Ole Juul

"We must remember that it is unique to have the opportunity to implement an entirely new infrastructure in Copenhagen – an infrastructure, which demands that solutions above and below ground be integrated and a range of disciplines work together so that innovation and export possibilities can flourish."

Ole Fritz Adeler

"Integration of phases and areas of responsibility does not make it cheaper, but it makes it better."

Anders Melamies

"The underlying objective should be expressed so that the final result is something that rouses our perception of both city and nature."

Anders Asmind

"We are faced with a whole new understanding of both nature and city. We must respect the laws of nature, but the starting point for the future of the city must be that we can do everything, and we must therefore have a conversation about how the city can fit together in a new way."

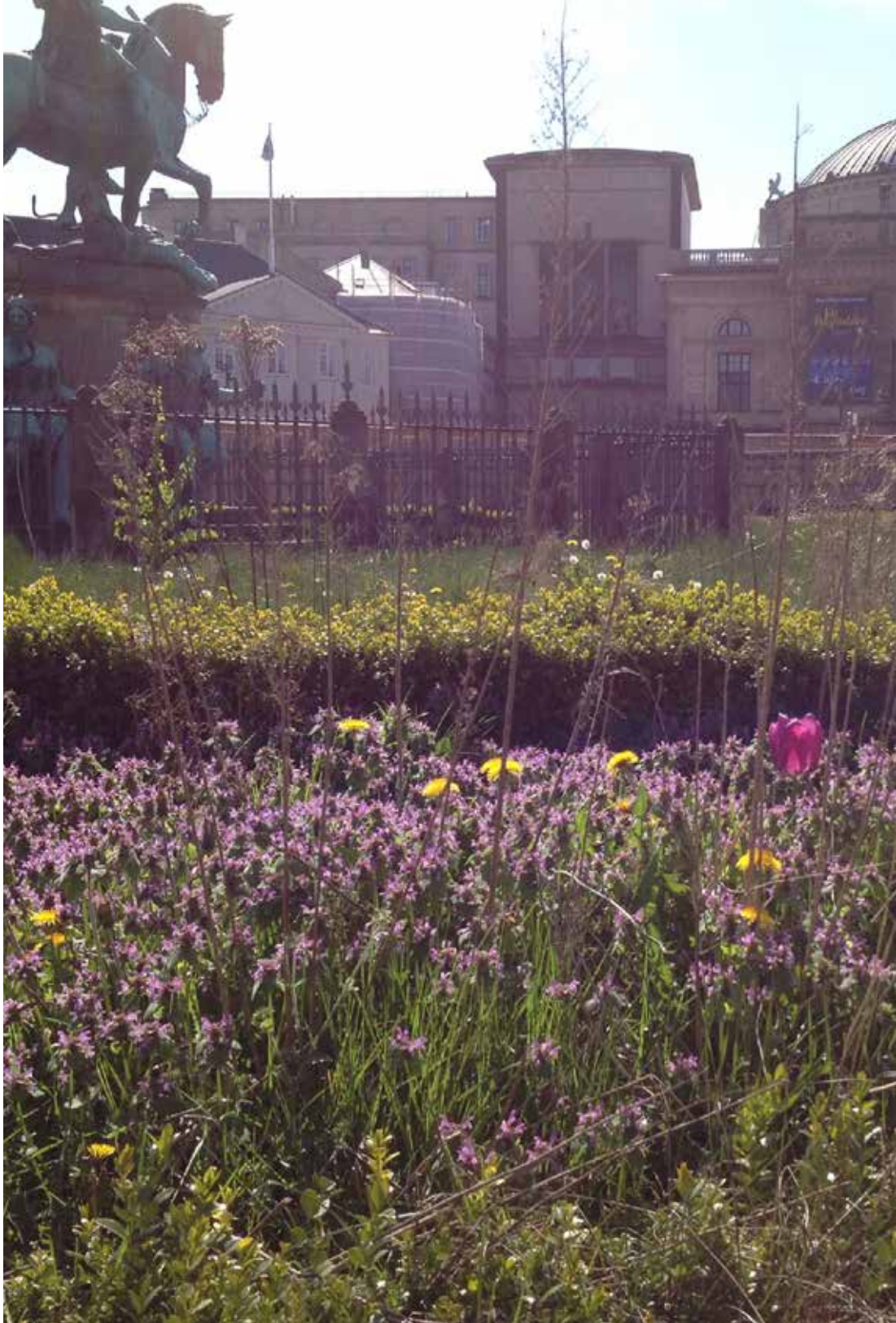
Søren Gabriel

"Rainwater and urban nature are connected. The urban nature of the future will contribute to creating more natural local water circulation, which is necessary so that urban nature can thrive, but it is important that the water is dispersed during cloudbursts so as to avoid damaging floods."

Peter Steen Mikkelsen

OVERLOOKED NEWS – FROM KRINSEN, KONGENS NYTORV

An art project by Camilla Berner, which deals with Copenhagen's self-grown biodiversity. Constructed in 'Krinsen' on Kongens Nytorv, surrounded by the metro construction site. The project was however dismantled because the neighbours deemed it ugly to look at.



5.

URBAN NATURE AS THE STARTING POINT FOR CLIMATE ADAPTATION WILL CHANGE COPENHAGEN

Copenhagen faces a historical change, which we have not seen the likes of since the mid-nineteenth century, where the city gates fell and use of the ramparts was discontinued. With urban nature as the starting point, the 300 climate adaptation projects will create a new version of Copenhagen over the next 20 years. There won't just be more nature or better nature - the changes will have a positive impact on the city's structure and identity. In the long term, this will result in Copenhagen being enriched culturally and economically.

The city and neighbourhood identity will be strengthened

On a municipal level, several projects should be put out to tender together as a holistic approach with the purpose of strengthening Copenhagen's architectural, social and cultural character in interplay with the existing natural heritage. In order to set the framework for design, the outline proposal will be developed in the first instance; hereafter a project proposal will be developed in close and ongoing dialogue with Copenhageners. Joint tenders will reach across typologies, such as green roads, detention areas and roads, as well as stormwater roads.

"Urban nature distinguishes itself as a climate adaptation tool by enabling the combination of a technical solution framework with the presence of a strong nature feeling, which contributes to making life in the city much more attractive."

Tina Saaby

The cloudburst plan's potential for urban nature and Copenhagen's existing green areas.

Societal gain
Urban nature can provide significant branding value for Copenhagen businesses where quality of life is a priority. In addition, land prices and rental prices increase when nature is a visible part of the surroundings. Copenhagen will gain new expertise within urban life quality, which we will be known for in the world. And, we will be able to share our experiences with the many cities in the world that strive to create improved quality of life for its residents.

A more complete city emerges
Urban nature will bind Copenhageners together in new relations and will create a prerequisite for the city dweller to be reunited with nature. Copenhagen language evolves and the conversation is enriched with new experiences from our everyday lives in the city. We suddenly realise that everything – biking, listening to the birds, clean water, reducing particle pollution and swimming in the harbour, the dead trees in the parks, housing, outdoor spaces and cars, jogging and shopping culture – are linked together and ARE the city. The built environment will be enriched by the introduction of the grown environment. City life will become more complete.

"We have succeeded in creating a city with a built environment that has stayed intact for centuries. The challenge is to integrate the grown environment to complement the built environment, and thus create a robust city that is worth living for."

Stig L. Andersson

Collaboration allows ambitions to grow
We must, as the administration, consultants and Copenhageners, jointly strive to think with the future in mind, with regards to each one of the future 300 climate adaptation projects. And we must endeavour to develop solutions in close dialogue with private landowners, neighbours, businesses, supply companies, neighbouring municipalities and the City of Copenhagen's other administrations.

THE YEAR 1857 MARKS THE BEGINNING OF A NEW ERA FOR COPENHAGENERS
Communal sewage system adopted
The gates fell (Nørreport, however in 1856)
Use of the ramparts was discontinued and subsequently transformed into recreational areas.
The city's first electric lightning circuit was installed at Christianborg's riding ground.
Copenhagen's first gasworks, Vestre Gasværk, started operations

QUALITIES

6.

AMENITY VALUE

Ecosystem services are the services that ecosystems provide to society and the individual's quality of life. In Copenhagen, the urban nature's amenity value is linked to five cultural services.

BELONGING

How do alder marshes, wetlands and salt marshes become Copenhagen's answer to green urban spaces?

Belonging is about how we as people associate a place's identity with their particular kind of nature. The local natural heritage or distinctive characteristic helps to create a positional anchoring for us, just as it is the starting point for our understanding of a place's particular character.

Belonging supports the City of Copenhagen's work with green identity, localised communities, natural and cultural heritage.

FACTS

Environmental authorities in the EU have emphasised the significance of urban green areas for creating opportunities for interaction between individuals and groups, which promotes social cohesion and reduces crime.
European Environmental Agency (2011)

"Many associate value with place identity, which may be connected to recognisable features in their environment. Various aspects of ecosystems and landscapes can constitute an important part of this. A place's attributes can also influence where people choose to live and spend holidays and their leisure time, including the location of housing."
Norway's official report (2013)

COEXISTENCE

How do old trees, limestone rocks and buzzing wild bees make one feel that we are a part of a big and living story?

Coexistence is about how we as people, in the meeting with nature's phenomena, achieve a realisation that we are part of a greater context. We realise that nature and its processes are our basis for existence and something, which is crucial to safeguard.

Coexistence supports the City of Copenhagen's work with sustainability and nature conservation.

FACTS

"Experiencing nature and green areas [...] increases the potential for responsible management of the environment and a stronger acknowledgement of ecosystem services." Tidball KG & Krasny ME. (2010)

"Direct experiences with all five senses should be offered to promote emotional attachment to, and interest in nature."
Kals E et al. (1999)

LEARNING

How do the elements of nature work as catalysts for Copenhagen children's development?

Learning is about how nature prompts us to sharpen our senses, thereby stimulating our cognitive development and learning aptitudes. By playing in nature, children reinforce both their motor skills and their mental abilities.

Learning supports the City of Copenhagen's work with children's development, but is also relevant for dissemination, education, integration and rehabilitation.

FACTS

"Unlike television, nature does not steal our time, but puts it into perspective. Nature can heal a child that lives in a destructive family or a dangerous neighbourhood. It serves as a blank slate on which a child can draw and reinterpret his/her fantasies. Nature inspires creativity in a child by demanding visualisation and the full use of the senses."
Richard Louv (2005)

"A pattern seems to emerge from the literature. The pattern suggests that a child living in a place with more nature, with a number of restorative resources, is likely to benefit in terms of his or her cognitive function or ability to focus."
Wells NM (2000)

SENSING

How does contact with trees, the wind, the smell of rain, bird song, fog and meadow grass make Copenhageners happier and healthier?

Sensing is about the physical healing and mental restorative processes, which the unmediated perception of nature initiates in people. In nature, we experience that time and place flow together, just as we may find that the senses come together in one primary emotion or state of mind.

Sensing supports the City of Copenhagen's work with preventive healthcare, well-being initiatives and rehabilitation.

FACTS

"90 percent of the surveyed had increased self-esteem after a walk in nature, while people who went for a walk inside a shopping centre, experienced reduced levels of self-esteem in 44 percent of cases." MIND (2007)

"On the premise of a causal relationship between the amount of greenery in the surrounding environment and health, 10% more green areas in the surrounding environment, leads to a decline in the number of (self- reported) symptoms that are comparable with a fall in age by five years." de Vries et al. (2003)

"Our data shows measurable positive associations between species richness in the city's green areas in Sheffield and the visitors' well-being... Taking the quality of the (green) area into account can ensure that it serves the objectives of improving biodiversity, provides ecosystem services, creates opportunities for contact with nature and improves physical well-being." Fuller RA et al. (2007)

COMMUNITY

How does the nature feeling inspire Copenhageners to want to create things together with other Copenhageners?

Community is about the desire to create something together with others and is rooted in the fact that we as people respond to the aesthetic experience of nature as an inclusive space, which invites us to occupy and use it. Nature is thus an ideal physical frame for the development of localised communities with creative thinking as the focal point.

Community supports the City of Copenhagen's work with social and cultural communities, including volunteer work and innovation.

FACTS

"Nature affects our behaviour by promoting generosity and localised communities."
Kals (1999)

"Active participation in tree planting programs has proven to increase a local community's feeling of social identity, self-esteem and ownership; it teaches the residents that they can work together to select and control the state of their environment."
Westphal LM (2003)

7.

UTILITY VALUE

In Copenhagen, the urban nature's utility value is linked to seven regulating and supporting ecosystem services.

RAINWATER MANAGEMENT

How can water become a resource that is noticeable in our everyday life and that supports nature's processes in the city?

With everyday rain, rainwater management consists mainly of providing space for the water in the ground, in the form of rain beds that delay the flow of water. Runoff in the city can be reduced significantly by delaying, infiltrating or evaporating rainfall through the ecosystem's soil structure, and the vegetation's leaf structure and hydrological systems.
In Copenhagen, 40% of the overall rainfall today becomes surface water, which is released into the Sound (Øresund) via the sewage system and treatment plants. Retaining and percolating rainwater in the city creates a better water balance with improved conditions for microclimate management.

Rainwater management with its starting point in nature based climate adaptation, requires robust urban nature that can adapt to the weather alternating between dry and wet periods. A dynamic that is amplified by the city's extreme conditions.

FACTS
"A single large tree can transpire 450 litres of water a day. This uses heat energy equivalent to 1000 MJ to drive the evaporation process. In this way, city trees can significantly reduce summer temperatures in the city."
Bolund P & Hunhammar S (1999)

"Urban landscapes with 50-90% impermeable surfaces can lose 40-83% of rainfall to surface runoff, compared to 13% in forested landscapes."
Goméz-Baggethun E et al. (2013)

TIANJIN QIAOYUAN WETLAND PARK, KINA
Inspired by the original marsh nature, this park has several hollows where rainwater is held and purified by means of versatile, indigenous vegetation. Water levels mirror the seasons, and the hollows can appear both as small lakes and as dry areas depending on the amount of rain.

The 300 climate adaptation projects are based on cloudburst proofing Copenhagen. The city's rainwater management is therefore crucial to all projects and will consist of technical solutions above and below the ground.

Ecosystems are related to the city's grown environment. Rainwater management in this context refers to how urban nature as an ecosystem can contribute to rainwater management on the city's surface, and not how rainwater management can be solved in the city in general. It is thus a matter of nature based climate adaptation.

FACTS

The City of Copenhagen in collaboration with HOFOR has set up the overall framework for rainwater management solutions by defining a range of cloudburst typologies, which consist of solutions above and below the city's surface. (Cloudburst proofing of Copenhagen, 2014) The City of Copenhagen's Climate adaptation and investment statement from 2015 contains a description of all cloudburst projects.

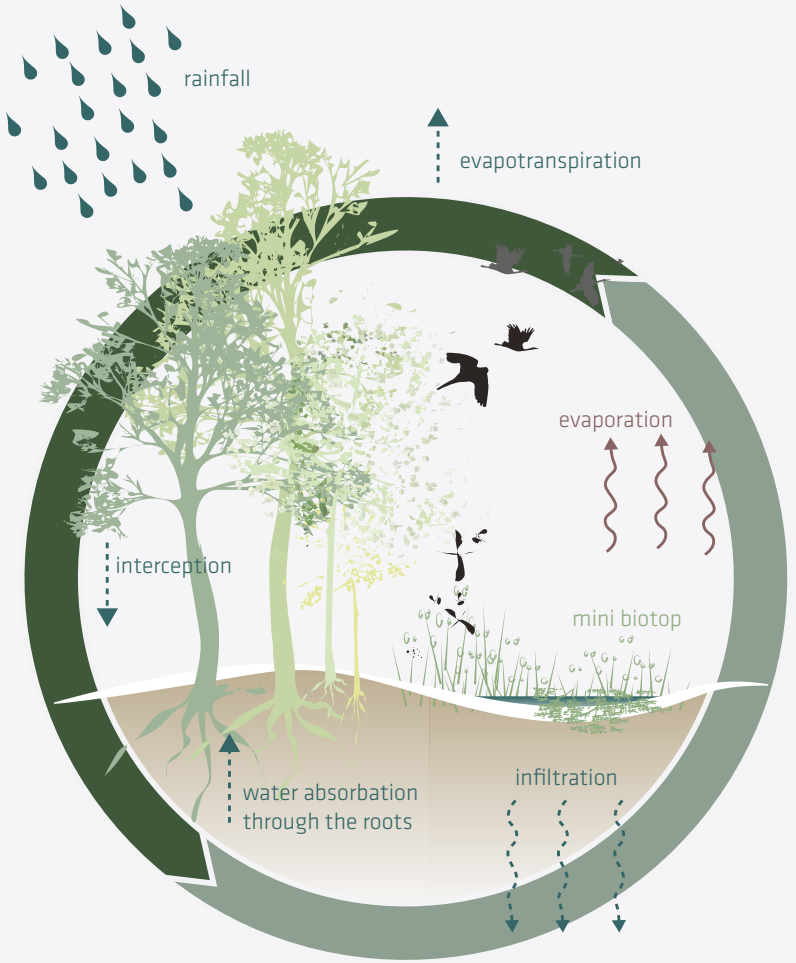


Illustration of a nature based approach to rainwater management with a description of an ecosystem's hydrologic processes

MICROCLIMATE REGULATION

How does vegetation counteract the heat in urban spaces?
Trees and shrubs counteract urban heat islands as shading from tree canopies and plant transpiration can locally reduce the average temperature by 2-8 degrees. Besides providing a pleasant outdoor environment, this also reduces the need for cooling buildings.

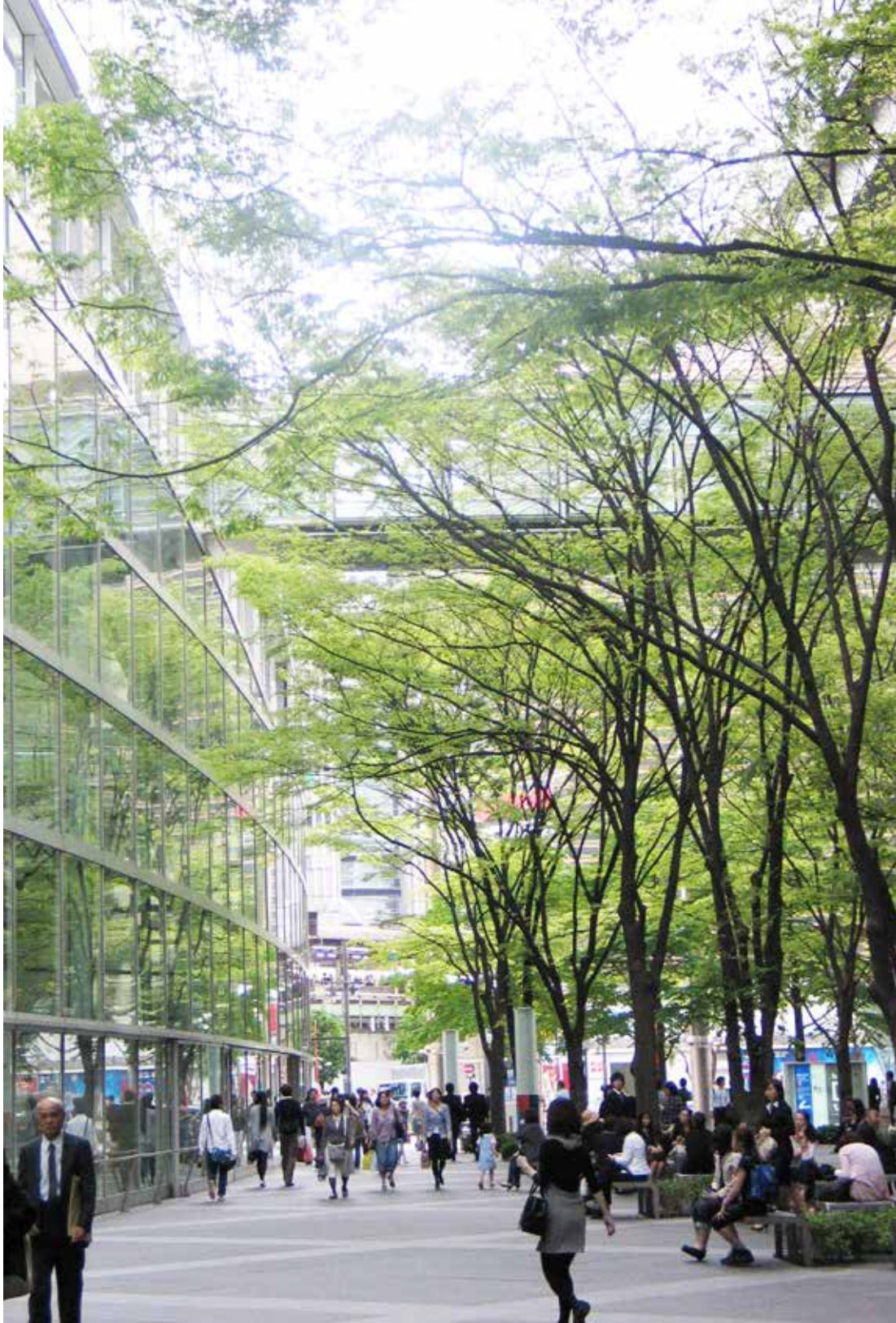
Effective transpiration requires that the plants always have access to water. Trees have deep and far reaching roots that can absorb a relatively large amount of water, while lawns have short and shallow roots, which means that their absorbing capacity is limited in comparison to the trees. Lawns tend to dry out in the summer, which means that transpiration deteriorates further.

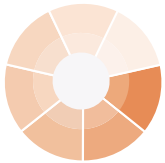
Just as urban nature contributes to a comfortable microclimate in urban spaces, a qualified placement of vegetation optimises the microclimate inside the buildings by providing shelter and shade. This can help reduce the buildings' energy consumption.

FACTS
"Vegetation can be very efficient as it delivers several cooling mechanisms simultaneously and in a complementary manner. Mechanisms for cooling are [...] evaporative cooling and evapotranspiration cooling, reflection and shade."
Doick K & Hutchings T. (2013)

"Urban heat islands are a reality in the City of Copenhagen. During the summer investigated (2006), a distinct difference in surface temperatures of up to 12°C were indentified between for example areas outside of the city and the inner neighbourhoods. Vesterbro was found to be the warmest neighbourhood."
Bühler, O. et al. (2010)

TOKYO INTERNATIONAL FORUM PLAZA, JAPAN
Trees placed on a central plaza give shade and shelter and create a comfortable microclimate on street level. In addition, they also have a cooling effect on the buildings and thereby help reduce energy consumption.





CO_2 REDUCTION

How do nature's processes help Copenhagen to become a CO_2 neutral city?

Trees and plants can reduce atmospheric CO_2 in two different ways. They can absorb CO_2 through photosynthesis, as long as they are actively growing, and they can reduce CO_2 emissions by having an insulating effect on the buildings in the city, as described in the previous section.

Up to ¾ of the overall carbon stock in the city is stored in the soil. This makes the city's soil a major contributor to the city's total CO_2 intake. In the city's overall CO_2 accounts, urban nature's direct CO_2 intake in vegetation and soil is of relatively little importance.

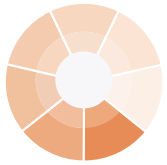
The establishment of green roofs in the city significantly increases the vegetation in the city.

FACTS

"By upscaling, it was established that the yearly fixation of CO_2 from all the urban tress in Chicago, IL, USA amounted to approximately 140 000 tons, equivalent to CO_2 emissions from all car based traffic in one week. A general estimate is that approximately 77% of the carbon is stored in the soil, while an analysis of a single residential area's greenery in Chicago found that up to 88% of the carbon was stored in the soil and less than 11% was stored in the trees and shrubs."
Fryd O. et al (2011)

GREEN WALLS, SWEDEN

Green walls make it possible to have urban nature even where space is limited. In this case, plants and concrete work together to fixate *CO_2* and filter airborne particles.



NOISE REDUCTION

How do natural elements counteract Copenhagen's noise pollution?

Varied vegetation reduces noise pollution. Vegetation is most effective if it consists of different kinds of trees - conifers, large deciduous trees and shrubs. Different trees and shrubs mitigate different frequencies of sound, and even narrow belts of vegetation can make a difference.

Although research is not conclusive on the effects of nature's ability to reduce noise, there is widespread agreement about the indirect effects. The sound of leaves draws people's attention away from the city's mechanical sources of noise, by which amenity value, and sensing of nature comes to the forefront in our experience.

Earth banks are effective when it comes to noise reduction. The vegetation covering the top of the earth bank also plays a major role with regards to the surface's ability to absorb noise effectively.

FACTS
Soft surfaces can reduce noise by up to 3 dbA. Composite vegetation can provide a reduction of p to 6 dbA. *Bolund P & Hunhammar S. (1999)*

WILLOW AVENUE, HAUTE DELE, FRANCE
The road and pavement are divided by composite vegetation, which contributes to noticeable noise reduction. This is an example of how nature takes the lead and camouflages the presence of cars even if the measurable noise reduction is minimal.

AIR QUALITY

How does Copenhagen's vegetation make the air cleaner?

Vegetation helps to clear the air of gaseous and particle pollution. Plants absorb harmful gases like sulphur dioxide and nitrogen dioxide, as they pick up particle pollution from the leaves. Dust particles firmly attach themselves to the leaves and are washed of when it rains.

Efficient filtration of the air requires a large leaf area, which is why trees perform better than shrubs. Conifers perform best among tree species, as they have a large leaf area due to their evergreen needles, which remain on the tree all year round. Planting density is also an important parameter, as successful filtration requires that air can blow through the vegetation.

FACTS

"In city areas with 100% tree cover (i.e. connected forests), short-term improvements (1 hour) in air quality were, due to the trees' removal of pollution, as high as 15% for sulphur dioxide, 15% for ozone, 14% for particles and 8% for nitrogen dioxide."
Nowak DJ & Dwyer JF. (2007)

"When Copenhageners are asked which problems relating to the environment should be tackled, air pollution is always the highest priority."
Clean air for Copenhageners (2013)

GUBEI GOLD STREET, CHINA

On this pedestrian street in Shanghai, more than 1100 trees have been planted that jointly filter 72 tons pollutants and particles a year. In addition the trees provide shade and cooling for 47% of the coated surface area and contribute to reducing local temperature.

WATER QUALITY

How do we ensure that Copenhagen can let surface water seep into the soil and that Copenhageners can safely go for a swim in the harbour that contains water from the streets of Copenhagen?

Clean water is the premise for water filtration, for the city's water balance and for the recreational pleasure of everyday rain being made visible and accessible. Good water quality is also a vital necessity in urban nature's biological diversity and fertility, as well as a prerequisite for efficient ecosystem services.

Rainwater from roofs and roads is contaminated with both particles and dissolved substances. Road runoff can be purified locally in various ways, including both green areas and 'gray' solutions. As a part of urban nature, a rain bed can be an effective way of purifying road runoff.

FACTS

"Rainwater basins are established and sized traditionally to protect the drainage system and recipients again hydraulic overload, but rainwater basins can also purify separate sewage rainwater and contribute with both nature and recreational qualities... With regards to filtration of road runoff, it must be ensured that the filtration system has an effective absorption capacity and that it is in an oxygenated unsaturated zone, otherwise there would be an unacceptable impact on the local groundwater. This is best accomplished by filtering the water through a land surface covered in vegetation." Gabriel S & Vollertsen J. (2012)

KING'S CROSS POND, ENGLAND

At King's Cross Pond Club, you can bathe in a fresh water pool in the heart of London. The water in the urban open-air bathing pond, is cleaned and filtered solely by means of water plants and without the use of chemicals.

FOOD CULTIVATION

How does urban nature contribute to Copenhagen's food supply?

The city's self-grown nature constitutes great potential as a collective pantry, from which berries and herbs can be harvested, and fish and insects can be caught.

The built environment - for example streets, roofs and facades - offers multiple possibilities for cultivation in the city. Either as allotments or full agricultural services that can contribute to the city's water management and the ecosystems that support self-grown nature in the city.

FACTS

"If vegetables grown in the city are washed and root vegetables are peeled, then the health risk is absolutely minimal, probably even less than with the consumption of industrially manufactured foods." Magid J & Lekfeldt JDS (2013)

"In Tokyo, local agriculture produces enough vegetables to potentially feed nearly 700 000 city dwellers." Moreno P. (2011)

"In 2017, NOMA plans to produce its own ingredients on the restaurant's roof and on a floating garden in addition to the practice of harvesting and catching wild ingredients in the city's self-grown nature, for example on Vestamager." Gordinier J. The New York Times (2015)

BROOKLYN GRANGE FARM, USA

The world's biggest roof farm is located on the roofs of two buildings in New York City. Nearly 23 tons of organic crops are produced per year. Brooklyn Grange advises urban farmers from all over the world and promotes healthy and strong local communities.

8.

BIODIVERSITY

How can biodiversity support ecosystem services with both a high utility and amenity value, and also possess an intrinsic value of nature itself?

Biodiversity is a prerequisite for successful urban nature. The different projects will have different conditions from which to work with biodiversity. It is therefore necessary to be able to distinguish between the different forms of biodiversity, which support different qualities in urban nature. This makes biodiversity in urban nature not a question of either-or, but a question of how.

Robust urban nature is achieved by planning, designing and maintaining its dynamic and diverse ecosystems. Urban nature is not a fixed and controlled condition.

FACTS

In 2016, the City of Copenhagen will prepare an administrative basis for biodiversity, which will serve as a concretisation of the guidelines in the urban nature strategy, tree policy and the think tank's work. This will result in four goal-oriented versions for The Technical and Environmental Administration's four service areas. The administrative basis will also take into account a previous biodiversity strategy 'Room for nature/Plads til naturen' and describes the principles for how Copenhagen can strengthen biodiversity in new and existing nature, as well as instructions on how the administration and citizens can look after Copenhagen's species.

SCHÖNEBERGER SÜDGELÄNDE PARK, GERMANY

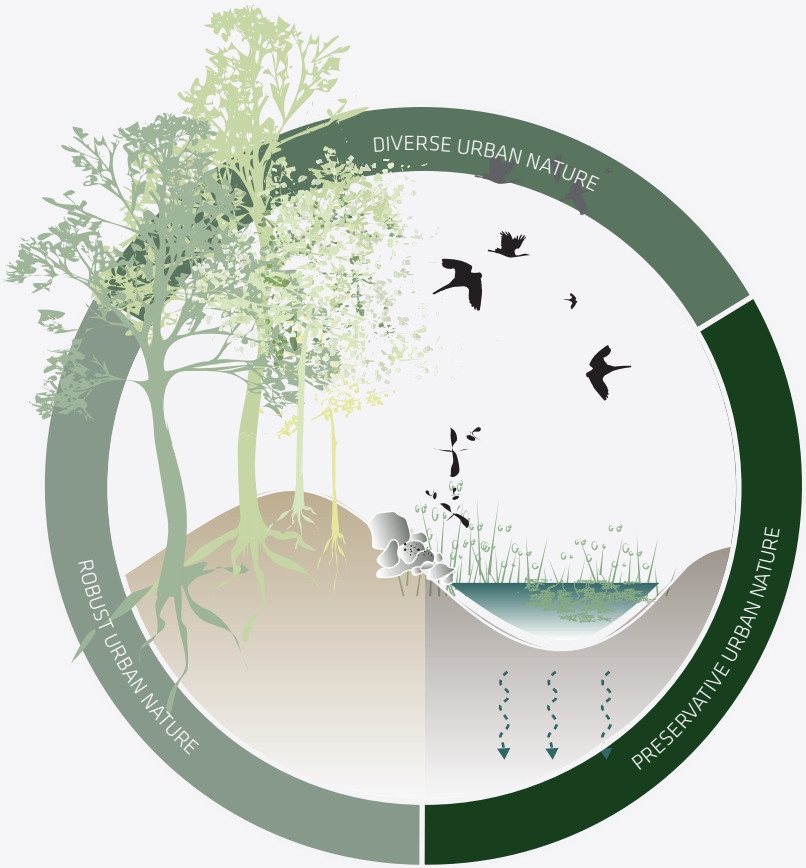
A closed-off railway ground with a natural and species rich vegetation in the middle of Berlin, has evolved into a urban nature park. The vegetation and constructions from the area's former life define the course of the park, and help give it a unique kind of nature and a strong identity.

Utility value
Robust urban nature is a prerequisite for well functioning ecosystem services. Robust urban nature is nature that can flourish in the city's extreme conditions. Ecosystems with high biodiversity are easily able to adjust to the city's forces such as pollution, salt exposure, usage and nutrient enrichment. Biodiversity should always be weighed against the utility value that will be gained through the choice of ecosystem services.

Amenity value
A high biodiversity with a multiplicity of life and habitats strengthens the experience of coexisting in a greater context. We realise that nature and its processes are our basis for existence and something, which is crucial to safeguard. Diversified urban nature is achieved by working with various preconditions for urban nature and thereby creates a variation in habitat, species and expresses a high amenity value. Varied urban nature will also be able to support the City of Copenhagen's uniqueness, which is described in the next section.

Intrinsic value
Urban nature contributes to preserving and strengthening the biodiversity of rare and endangered animal and plant species in the city. Urban nature must wherever possible recognise that nature is our basis of existence and that it holds an intrinsic value. This makes Copenhagen a responsible city in relation to biodiversity.

FACTS
Copenhagen's objective for biodiversity: To increase the number of initiatives that primarily aim to strengthen biodiversity, and that the possibility of promoting biodiversity is always included in deliberations when the municipality develops and transforms the city, so that we can contribute to developing, reinforcing and protecting urban nature as a whole.
Strategy for urban nature (2015)



Biodiversity and urban nature

9.

UNIQUENESS

Urban nature must contribute to strengthening and developing Copenhagen's uniqueness. By uniqueness, we mean Copenhagen's special urban identity, and this applies across the city scale. From the city as a whole, to the individual neighbourhoods and down to specific urban spaces. With urban nature, we can enhance the experience of the city's comprehensive coherence, while urban nature can support and develop the city's diversity. Based on urban nature, climate adaptation can develop Copenhagen as a vibrant and dynamic city with 'edge' (Community Copenhagen/Fællesskab København 2015).

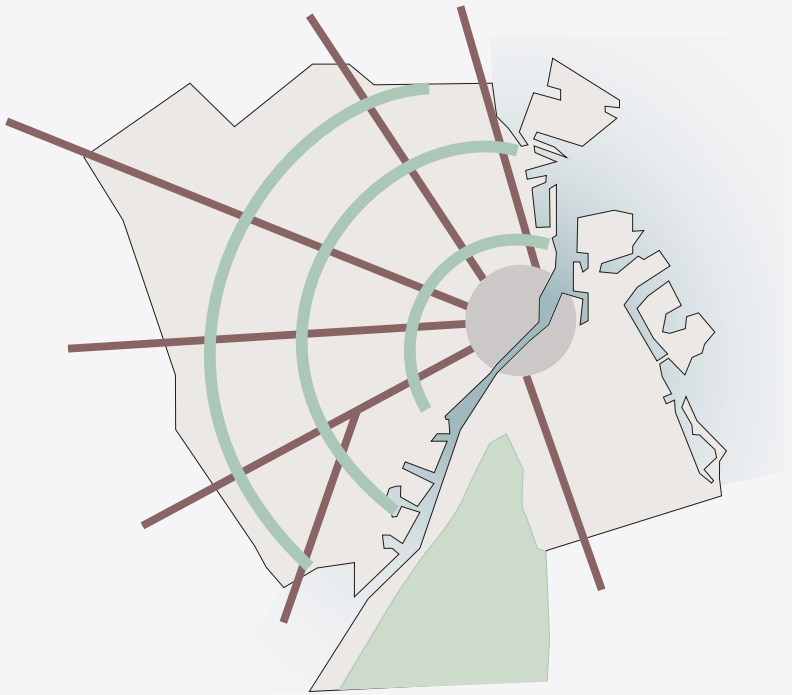
The city's uniqueness

Copenhagen's uniqueness is made up of respectively, the built and the grown environment. Copenhagen's special urban identity is made up of: the harbour and water, the homogenous city with towers and turrets, the fortified city, original approach roads, the green rings, the commons and the unique neighbourhoods (City Atlas Copenhagen/Byatlas København, 1996).

Where climate adaptation projects are linked to the city's green rings and original approach roads, urban nature holds the potential to make the experience of the city's structure and coherence more sensory and present. More noticeable.

FACTS

The Copenhagen Neighbourhood Atlas from 1996 was drawn up with the aim to provide a fundamental understanding of Copenhagen's uniqueness through the mapping and registering of architectural qualities and listed buildings in Copenhagen.



Copenhagen's logo: A special urban identity is created by the fortified city, the three arches that form the concentric green structure and the city's original approach roads that form the radial pattern. (City Atlas Copenhagen, 1996)

The neighbourhood's uniqueness
The city's special character giving urban structure can be highlighted and seen in correlation with the climate adaptation projects.

Development of the city's unique urban structure can be strengthened by sending the future climate adaptation projects out to tender in groups, so that they promote uniqueness on a neighbourhood level, instead of delivering one project at a time. The city's variety and diversity will be emphasised and will create new narratives and historical traces.

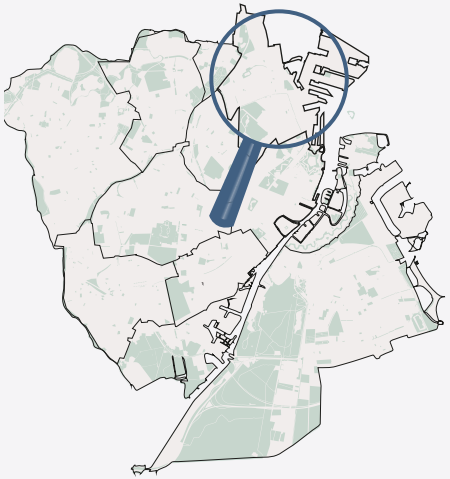
The Climate and Investment Report/Klima- og investeringsredegørelsen from 2015 contains descriptions of the neighbourhoods' green features, buildings and city structure. This is an essential tool for understanding the neighbourhoods' uniqueness in Copenhagen.

The urban spaces' uniqueness
The individual urban space has its own conditions and local uniqueness, while it continues to be an important part of the whole. The city fits together and the individual urban space is always a part of a pattern.

Urban nature's role is to reinforce and develop the place's special characteristics and its interaction with the neighbourhood's other urban spaces.

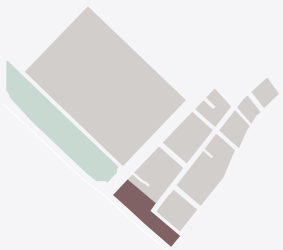
A uniqueness analysis on an urban space level must involve everything from citizen's wishes and resources, connections, functional and recreational opportunities, to biodiversity, microclimate, underground infrastructure, and to soil conditions and historical traces. In this exercise, the urban space's challenges and potential are identified, which gives a qualified foundation for selecting the ecosystem services that can be put into play and thereby answer the question: What will urban nature be able to do?

CITY



NEIGHBOURHOOD

URBAN SPACE



10.

CLOUDBURST TYPOLOGIES

The cloudburst plan for Copenhagen divides surface solutions into four different typologies: stormwater roads, detention roads, green roads and detention areas (Cloudburst Management in Copenhagen/Skybrudssikring af København, 2014) The solution typologies have various hydraulic properties but common to them all is that they can be configured according to local needs and are vital to urban space improvement. The solution typologies can be combined in concrete projects.

In Copenhagen, a whole new alternative infrastructure must be built to manage rainwater and thus bypass the sewers. Rainwater in Copenhagen is divided into two categories: cloudburst and everyday rain. Cloudburst rain is fed directly into the lakes and the harbour, while everyday rain must be purified before it can be released into the lakes and harbour. This new infrastructure will combine above ground cloudburst management with underground cloudburst pipes, which will collectively retain and lead the water away to the lakes and harbour. The principle for the infrastructure has been planned and consists of approximately 300 projects to be implemented over the next 20 years.

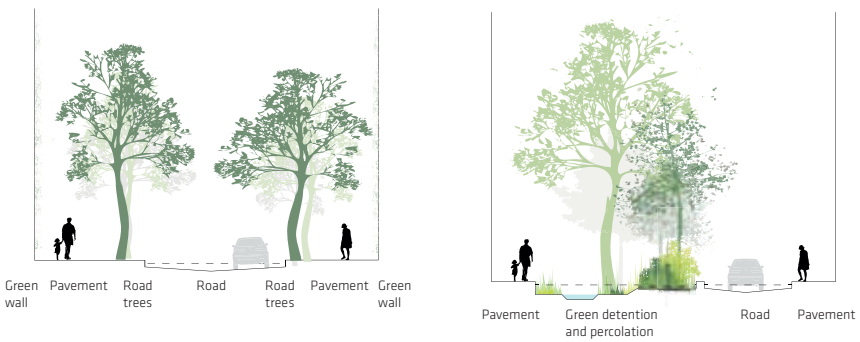
The cloudburst plan's four different typologies are put together here and illustrate the potential for an expanded green and blue infrastructure, which supplements Copenhagen's existing green areas.

STORMWATER ROADS

Typology
The stormwater roads' main hydraulic function is to divert water. Stormwater roads are established by reprofiling the roads, making terrain changes or raising the kerb. Vegetation has not been incorporated in stormwater roads in the first instance.

Potential for urban nature
Stormwater roads are characterised by long thoroughfares. Stormwater roads are often combined with detention roads. Even though planted areas will not be incorporated in the stormwater roads, urban nature has a potential to help regulate the road's microclimate, reduce air pollution and contribute to our sensory experience of the stretch of road.

In the case of a road profile that leaves minimal space for urban nature, a vertical strategy must be used by incorporating building facades and crown cover in stormwater roads.



Principle section of a stormwater road (Green Climate Adaptation, 2014)

KEIO UNIVERSITY ROOF GARDEN, JAPAN

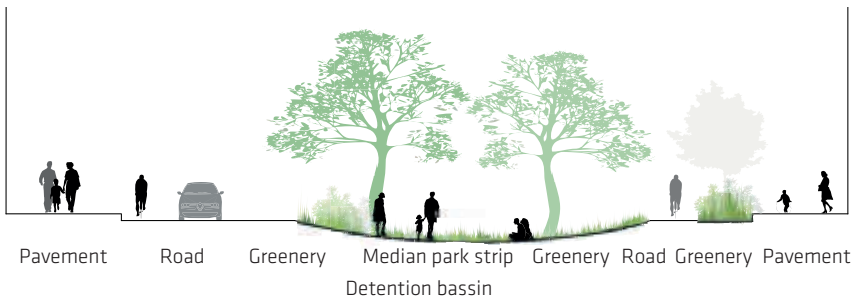
The project shows potential for urban nature in limited spatial conditions. It is possible to integrate urban nature in all types of the cloudburst plan's typologies. It is often in the streets and urban spaces where space is most limited that urban nature performs well with regards to utility value and amenity value – reinforced by the strong contrast between the built and the grown environment.

DETENTION ROADS

Typology
The detention roads' main hydraulic function is to detain and store water by integrating various detaining elements in the road, such as roadside beds, rain beds, permeable surfaces and the like.

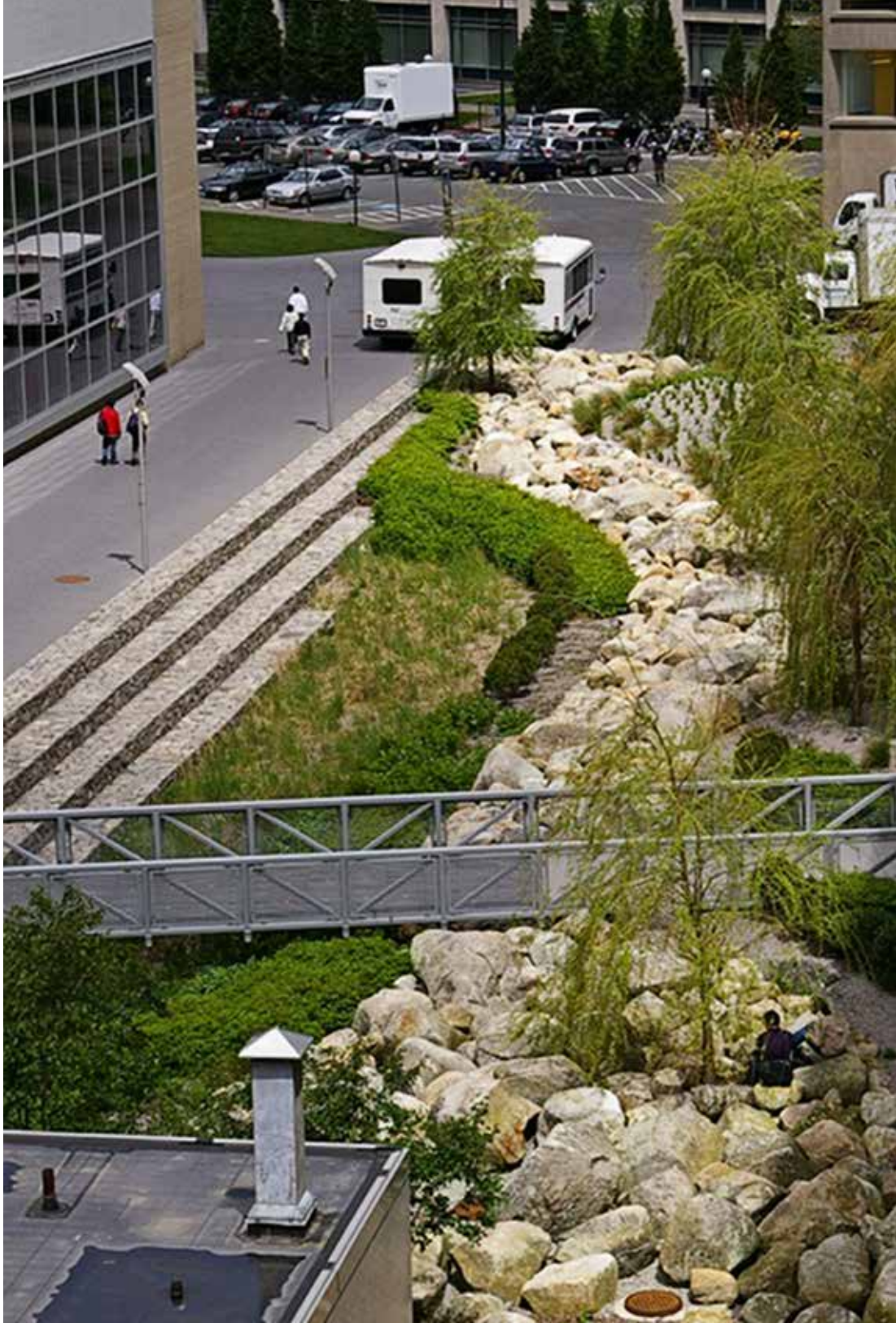
Potential for urban nature
Detention roads are characterised by long thoroughfares, but unlike stormwater roads, they hold great potential for integrating urban nature in the road as small resilient ecosystems. In addition, those ecosystems hold hydraulic functions, support microclimate regulation, reduce air and noise pollution and filter water.

Detention roads provide urban nature with a great opportunity to increase the amenity value of the Copenhagen roadways. In addition to increasing the sensory value of the roads, detention roads also hold the potential to be stepping stones for the city's fauna and flora. Copenhagen's roadways can be given additional identity that strengthens local affiliations.



Principle section of a detention road (Green Climate Adaptation/Grøn Klimatilpasning, 2014)

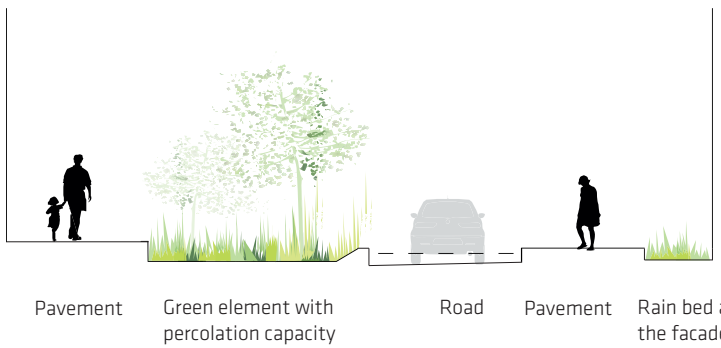
RAY AND MARIA STATA CENTER LANDSCAPE, MIT CAMPUS, USA
The project combines cloudburst proofing with purification and recycling of water from roads and roofs. The detention basin appears as a sunken riverbed overgrown with indigenous plants.



GREEN ROADS

Typology
Green roads detain and store water, typically on small privately owned side streets.

Potential for urban nature
Green roads are characterised by a large number of short roadways. Urban nature can potentially promote the local belonging, which is connected to the road's private ownership. Therefore the local feeling of ownership and local initiators are values, which urban nature has a special opportunity to support with the green roads. In addition to the typology's hydraulic function, there is particular potential for utility values such as food cultivation, microclimate regulation and water purification depending on the urban context.



Principle section of a green road (Green Climate Adaptation/ Grøn Klimatilpasning, 2014)

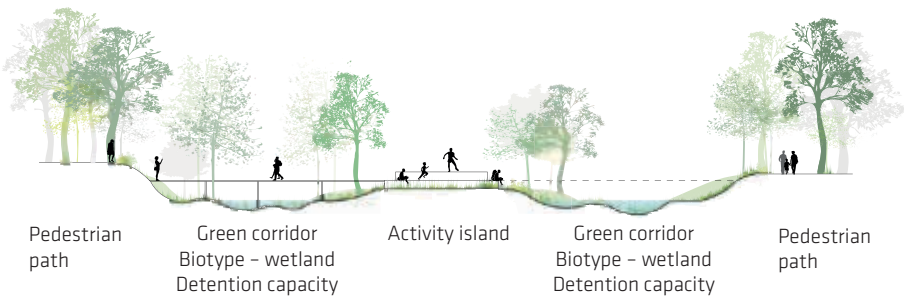
NEBINGER SCHOOL, USA

Philadelphia city is implementing an ambitious plan for cloudburst proofing under the name "Green City Clean Waters". The plan is aimed at citizens, businesses and the municipality's own administrations and gives instructions for the installation of concrete typologies for green infrastructure from rain barrels to rain beds and permeable surfaces. The success criterion is that each fortified hectare of the city be transformed to retain 80-90% rainwater, 'a green acre'. The whole project is measured in environmental, economic and social benefits. It is expected that the plan will be realised over 25 years.

DETENTION AREAS

Typology
Detention area's main hydraulic function is to detain and store water by creating basin volumes. Detention areas can advantageously be designed as multifunctional urban space elements, that on an everyday basis function as for example parks, squares, sports fields or the like.

Potential for urban nature
Detention areas will be placed in the city's existing structure of squares, parks and wetlands. Where the roadway would be ideal as a corridor for life in the city, detention areas have potential to be hubs for life. Urban nature has the potential to make room for ecosystems and thereby will perform well in all the Copenhagen services depending on the typology's local conditions.



Principle section of a detention area (Green Climate Adaptation/Grøn Klimatilpasning, 2014)

TANNER SPRINGS PARK, USA

Located on a former industrial site, Tanner Springs Park unites the city with its original nature, the wetland. Rainwater is detained, purified and filtered with the help of the park's natural ecosystems, which is made up of indigenous vegetation. While the one end of the park has a permanent water table, the remaining recreational part of the park only floods when there is heavy rainfall.

11.

INVOLVEMENT

Bryggervangen & Skt Kjelds Square

1. Development
Copenhageners help decide where to implement urban nature and provide input on relevant biotopes to highlight their neighbourhood.

2. Realisation
Copenhageners should get as much soil as possible under their nails in connection with the future urban nature. Local participants will be involved in cultivating the soil, sowing seeds and planting trees.

3. Care
Copenhageners will be given responsibility for a large part of the maintenance and further development of urban nature in their local areas. It is also Copenhageners job to keep an eye on how life develops in the new nature.

4. Communication
Copenhageners' commitment to future urban nature will further enhance an increased awareness of nature's processes. However, there will be a pronounced need for communication regarding what urban nature is and why is looks like it does. Informative workshops will be arranged so as to create an increased interplay between people and nature, including a deep understanding of why nature's services are central to the Copenhagen of the future.

5. Sharing
Copenhageners are inspired to work with sharing on many different levels. From the exchange of knowledge, skills and experiences to barter exchanges for biotopes and seeds, to local business models that are based on circular or social economic principles.

Tåsinge Square
Tåsinge Square has been developed in collaboration with 'Klimakvarteret' (Climate Neighbourhood) and local landowners. Prior to programming, neighbourhood renewal enabled the gathering of inspiration from local parties, some of the city's passionate souls and educational institutions to find out what the square should be used for. It is a process that has contributed to the local area becoming aware of the square's potential and needs, and thus what the square should be able to accomplish in the future and which elements it should contain. One potential element was the unused shop front facing the square, where renewed focus contributed to a café being opened there.

Prior to start-up and programming
Before the implementation of the project, the green area was looked after by a scythe mowing group during the growing season, and the local environmental hub contributed to the fact that plant boxes were constructed for growing herbs and vegetables, and that flea markets where introduced etc. Various networks and artist groups have also defined and decorated the square.

During programming and construction
The process has been divided in two: on the one hand, neighbourhood renewal has worked together with representatives from each of the five adjacent landowners formalising collaboration and the concrete program writing. The landowners have in this process been at the table while the tender project description was being created. On the other hand, there have been a number of temporary projects that have helped test the initiatives we have intended for the square. For example, more comprehensive wild nature, interesting lighting, activity equipment and so on. It has been both the existing neighbours and potential future users who have tested Tåsinge Square prior to its realisation.

Care and operation
An agreement regarding the social and cultural operation of the square has been drafted between the landowners and the City of Copenhagen. Operation of the road area remains private, as it is a private shared road. Operation of the green climate adaptation area will be managed by the contractor for the first three years and financed by the City of Copenhagen and HOFOR.

POSSIBLE ROLES
Copenhageners help define the purpose
Copenhageners help with operations
Copenhageners help with realisation

Copenhageners support local wishes
Copenhageners facilitate voluntary initiatives
Copenhageners ensure professionalism and ongoing gathering of user experiences

12.

TENDER & OPERATION

The city's users will help develop the city and urban nature. At the same time, urban nature will play a major role in the work to address climate change and environmental challenges, improve our quality of life in the city and satisfy our need for proximity to nature. If Copenhageners are to have more urban nature, quality must be improved and biodiversity strengthened. Urban nature provides a positive contribution to solving diverse needs. All of these demands on urban nature call for a new way of thinking, The Copenhagen Model, as well as new tools.

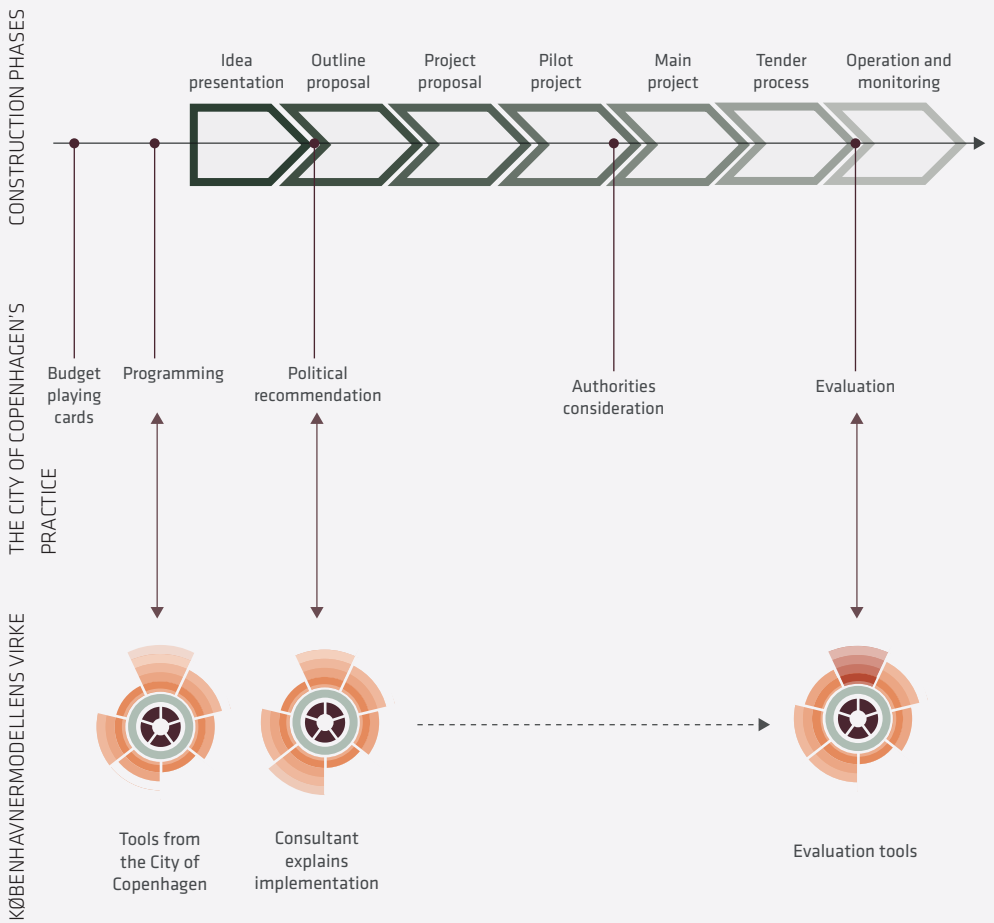
For urban nature to succeed, The Copenhagen Model needs to be integrated as a development tool in the process, from programming to the care of urban nature. It also requires a holistic approach, with a comprehensive design approach, construction and operation.

The Copenhagen Model as a development tool
The Copenhagen Model lays out a common direction for urban nature, which aims to ensure a high quality. This requires that The Copenhagen Model be integrated into certain areas of the project's phases.

Programming
The Copenhagen Model will be used by the City of Copenhagen in this phase to prioritise urban nature's ecosystem services, using the project's framework and site-specific conditions.

Political recommendation
In this phase, the consultant will use The Copenhagen Model as a starting point to explain how the design proposal serves urban nature's objectives, explained by the City of Copenhagen in the brief.

Evaluation
The Copenhagen Model will be used as a dialogue tool between the contractor, consultant and operator to ensure that the green project's initial intentions are carried on to the future running and monitoring of urban nature.



A holistic approach

In order to provide urban nature with the best possible conditions, there is a need for a comprehensive approach to planning, design, construction and operation. Urban nature is dynamic and the division between new green areas and subsequent operation should be eliminated. This distinction is a remnant from the concept that the grown environment is the same as the built.

Construction and operation must be planned over a 10 year period. An extended establishment phase with long-term partnerships between contractors, consultants and operators, will enable a dynamic care phase where vegetation health, dynamic development and good growing conditions are encouraged by all parties.

The illustration on the right depicts the extended establishment phase, followed by a dynamic care phase. The care phase is dynamic since the vegetation is not bound to one expression, but defined by other qualities like well functioning ecosystem services, biodiversity or spatial concepts that vary according to the course of events and the seasons.

13.

THE COPENHAGEN MODEL AS A DEVELOPMENT TOOL

The Copenhagen Model for Climate Adaption & Urban Nature is used as a dialogue and prioritisation tool from the decision of implementation to construction and operation of the project. The model is used as a starting point for development and realisation of urban nature based climate adaptation.

The Copenhagen Model as a development tool promotes and qualifies the decision making process in all project phases. The following parameters ensure that urban nature's potential is realised within the framework of the individual climate adaptation project.

1. Place

Framework
Which solution typologies provide the framework for the project?
Which other features should be integrated into the project, and how can urban nature support this?

Uniqueness
How can the city's overall uniqueness and the neighbourhood's local identity be reinforced by urban nature?
What else defines the area?

2. Purpose

Amenity value
How can urban nature's amenity value be brought into play in relation to the specific location? What are the success criteria?

Utility value
How can urban nature's utility value be brought into play in relation to the specific location, including which ecosystem services are relevant and how they should be prioritised in the project? What are the objectives for the chosen prioritised features?

Biodiversity
How can the project promote biodiversity?
How can biodiversity support the project's amenity value and utility value?

3. Involvement

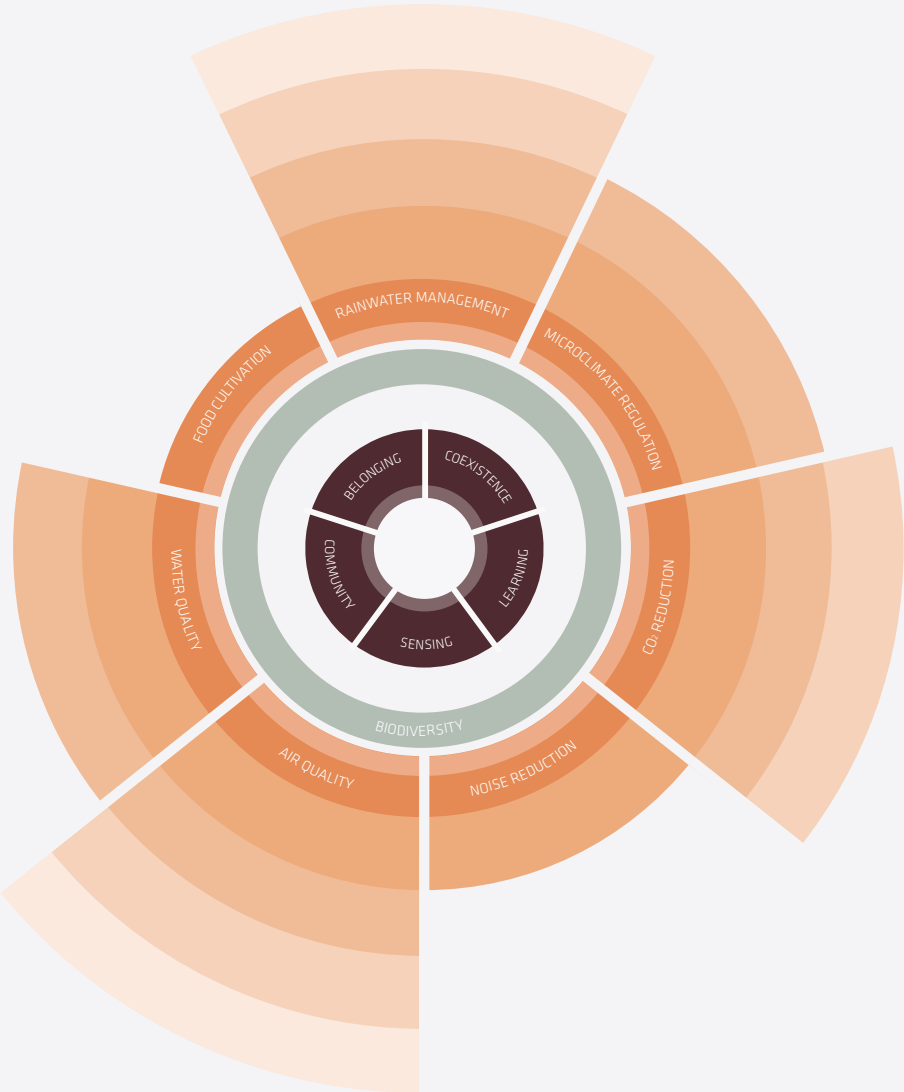
How can Copenhageners be involved most effectively before, during and after the project?
Which roles does the administration take on before, during and after the project?

4. Tender & operation

Which specific initiatives should be prioritised in the project - in relation to innovation, joint tender and the integration of construction and operation?
How will communication be tackled during the different stages?
How will gathering of user experiences and subsequent knowledge sharing be ensured?

5. Funding

Description of partnerships and budget.
Clarification of the interface between rate financing and tax financing of urban nature.



CASES

14.

COPENHAGEN CASES

The Copenhagen Cases are intended to illustrate how four of the selected City of Copenhagen's climate adaptation projects relate to urban nature. The Copenhagen Model is used as the focal point for the discussion.

Based on concrete projects, the importance of urban nature as a platform for climate adaptation is discussed. This is however not a design view of the individual projects. Due to the nature of the projects, it is impossible to review them from a urban nature based climate adaptation stand point, which has only been described after the preparation of the four cases.

All the selected Copenhagen cases are based on the cloudburst plan and execute climate adaptation of a high standard. The selected cases are: Tåsinge Square, Enghave Park and Bryggervangen & Skt. Kjelds Square.

The conclusion is that urban nature can be the foundation for all of Copenhagen's future climate adaptation projects. However, this requires that urban nature be incorporated as the foundation of the project brief, as well as being incorporated in the proposal.

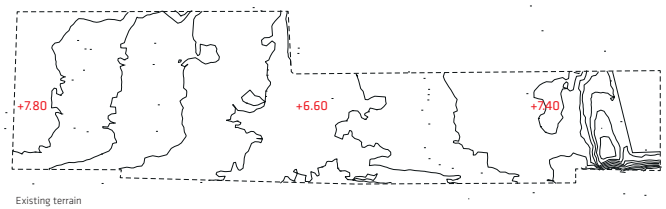
15.

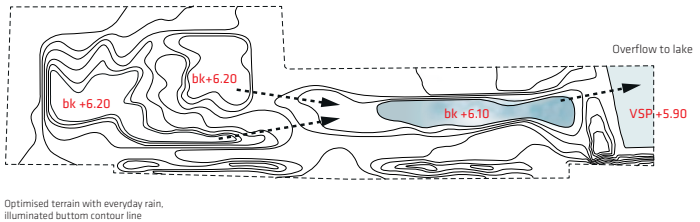
FREDENS PARK

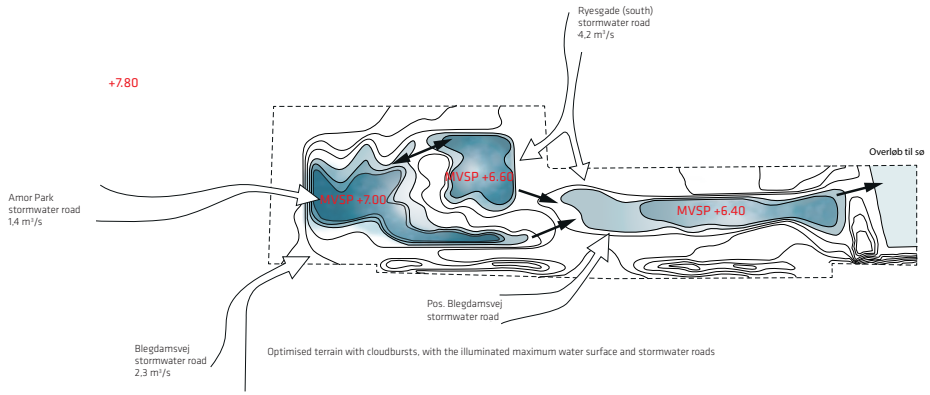
The design proposal for Fredens Park was developed as a case study on the development of new urban nature in Copenhagen, but during the process it developed into a prototype for The Copenhagen Model project, where urban nature, city life and ecosystem services are integrated in rainwater solutions. Fredens Park combines a number of amenity values and quality of life seeking initiatives for the many people who play, walk, bike and drive in a car or bus through the area on a daily basis, with climate adaptation and environmental improvement for a particularly exposed part of the city.

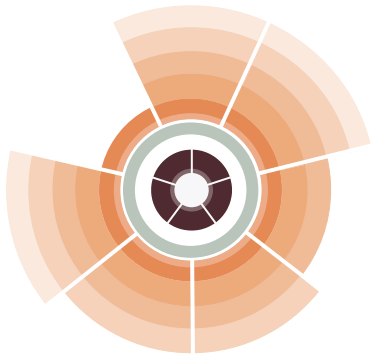
The project works actively to create a wide range of amenity values. The project's urban nature restores Fredens Park's slightly lost sense of belonging by restoring its relationship to the inland lakes in Copenhagen, as a single unregulated wetland with surrounding meadows. Urban nature reintroduces this landscape signature, which at the same time gives the park a strong nature based sensory potential and offers a feeling of coexistence – both historical and naturally. The proposal does not address the potential for urban nature's social communities, but the park's multi-functional design and easy accessibility will be able to create a basis for a broad community across many different groups.

The project's urban nature works explicitly to maximise the utility value in The Copenhagen Model. It is thus a matter of nature based climate adaptation that is integrated in nature's ecosystem services in its design. Rainwater management takes place by both detaining and directing rainwater through a series of hollows.









When percolation is not possible, the water is collected in the last hollow towards the lakes, from which the water is cleaned and discharged into Sortedamssøen. In this way, the project's many cloudburst typologies positively contribute to the water quality and an optimised microclimate. The existing peripheral rim of horse chestnuts, facing the busy Fredensgade, will be reinforced by additional vegetation, which will provide noise reduction and better air quality. Food cultivation will not be a part of this project due to the park's exposed location.

Urban nature in Fredens Park is robust and varied, and it strengthens and enhances biodiversity in the nutrient poor, sandy and calcareous soil conditions that make up the area's uniqueness. Urban nature's water management strategy divides the park in both wet and dry areas. These areas are further differentiated with varying biotopes.

Fredens Park hence works explicitly with urban nature's amenity value and utility value, ecosystems and biodiversity despite the fact that the proposal was drawn up before the think tank's work with urban nature and the development of The Copenhagen Model.

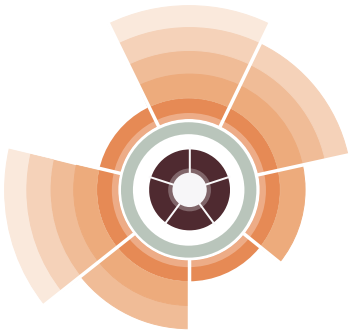
FACTS
Location: Nørrebro, Copenhagen
Developer: The City of Copenhagen
Area: 13.000 m^2
Cloudburst capacity: 6.000 m^3
Consultant: SLA
Status: Pending

16.

TÅSINGE SQUARE

Tåsinge Square is the City of Copenhagen's first climate adapted urban space. A previously tarmac dominated square has been transformed into a climate adapted urban renewal space. The project is both an investment in local rainwater management and an investment in improved city life that is locally based. Tåsinge Square was developed and constructed before the drafting of The Copenhagen Model. Nevertheless, Tåsinge Square is today one of the nature based climate adaptation projects.

A number of The Copenhagen Model's *amenity values* are present in this project. The sloping terrain lends a distinct feature to the urban space typology and urban nature's distinctly green character gives it a clear sense of *belonging,* which also binds itself to the rest of the city through the use of the Copenhagen pavement and Copenhagen lamps. Urban nature's ability to create *coexistence* and promote *sensing* is slightly hampered by urban nature's demarcated and not so 'designed' expression, although this is partly offset by urban nature's vast seasonal variation. Rainwater is very visible in the project and staged through a number of distinctive urban space installations (park umbrellas and raindrop shaped water tanks), which in a very direct way inspire water games and *learning*. Tåsinge Square has been developed in close dialogue with local residents, where temporary solutions are tested before they become permanent elements in the urban space, which has added a great sense of *community* to the process and the project.



The project's utility value effectively makes use of rainwater as a resource. Rainwater will be collected, detained and percolated. Excess water will be channelled via the cloudburst system once it has been expanded. Rainwater from the surrounding roofs and park area is directed to rain beds, where the water is detained and percolated. Road water is detained in salt tolerant rain beds along the roadsides, which improves water quality. Both urban nature and the urban space activity equipment contribute to microclimate regulation. Urban nature's attributes within CO2 reduction, noise reduction, air quality and food cultivation are not directly included in the project.

The vegetation on Tåsinge Square exploits the potential of the sloping terrain's various wet and dry conditions and creates urban nature that is robust and diversified, with focus on food for birds and insects that gives the project a high degree of biodiversity. The project, with its distinctive kind of urban nature and topology, also contributes to the uniqueness of the neighbourhood and the urban space.

Tåsinge Square is a nature based climate adaptation project, which comprises a series of exciting initiatives. Although both the amenity value and the utility value could be heightened with additional development of urban nature, with regards to activating more of The Copenhagen Model's ecosystem services.

FACTS
Location: Østerbro, Copenhagen
Type: Project Competition
Developer: The City of Copenhagen, HOFOR, Skt. Kjelds Neighbourhood renewal Area: 7.000 m^2
Cloudburst capacity: Bypasses road water from 2.700 m^2 and roof water from 1.600 m^2
Total construction costs: 16 mio. kr.
Consultant team: GHB, Orbicon, Malmos A/S, Via Trafik, Feld Studio for Digital Craft
Status: Implemented in 2014

17.

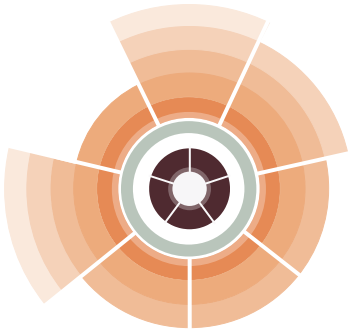
BRYGGERVANGEN & SKT. KJELDS SQUARE

Bryggervangen and Skt. Kjelds Square is one of the City of Copenhagen's key projects within climate adaptation and stormwater management. The project will serve as a landmark for how we work with climate adaptation in the City of Copenhagen. (Competition program for Bryggervangen and Skt. Kjelds Square, 2015)

Bryggervangen and Skt. Kjelds Square is a distinct nature based climate adaptations project that incorporates urban nature and ecosystem services at the core of the proposal. All climate adaptation solutions are designed and implemented according to both their 'measurable' and 'tangible' properties, and it is a declared ambition that all solutions must include both properties.

All five qualities from The Copenhagen Model are addressed under the 'tangible' (amenity value) properties category. *Belonging* is created through biotopes that have their functional starting point in a series of Copenhagen nature areas like for example, Kongelunden and Utterslev Mose, which creates a distinctive Copenhagen urban nature. *Coexistence* and *Sensing* are reinforced through the project's focus on urban nature's aesthetic natural force and its restorative and procedural qualities. The project has a special focus on *community* and *learning*, by placing a high degree of co-creation and citizen involvement in both design, selection, and establishment of new urban nature. The project thus includes involvement strategies for development, realisation, care, dissemination and sharing.

The 'measurable' (utility value) properties in The Copenhagen Model are also addressed in the project. All *rainwater management* will be dealt with on the surface and retained and percolated as far as possible, in order to create better water balance and water quality, and to create better *microclimate regulation* in the neighbourhood. CO_2 *reduction, noise reduction* and *air quality* are not explicitly addressed in the project, but will be direct consequences of the project's strong focus on urban nature as the central site for climate adaptation. Finally, food cultivation plays a key role in the project's focus on 'using nature in the city' – although to a lesser extend, as Klimakvarteret (climate neighbourhood) is already very involved in this area (Østergro, Klimakarré etc).



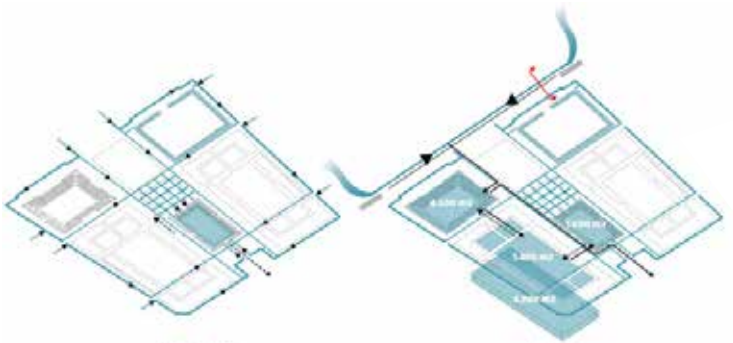
Urban nature in Bryggervangen and on Skt. Kjelds Square will be designed in a way that will allow for maximal *biodiversity* - partly by a large variety of trees and plants and partly through the animals and insects that urban nature invites into the city. The project's high degree of biodiversity will make for robust urban nature and allow it to thrive and deliver value (both amenity value and utility value), even when it is not working with rainwater management.

The project also combines multiple *cloudburst typologies* and urban nature plays a vital role in the city's, neighbourhood's and the urban space's uniqueness: as an example of a very specific kind of Copenhagen urban nature, and by cementing Bryggervangen and Skt.Kjelds Square's status as Copenhagen's climate resilient neighbourhood.

FACTS
Location: Østerbro, Copenhagen
Type: Project Competition
Developer: The City of Copenhagen
Area: 34.900 m^2
Total construction costs: 50 mio. kr.
Consultant team: SLA, Alectia, Jens Rørbech
Status: Project design phase, expected to be realised in spring, 2018

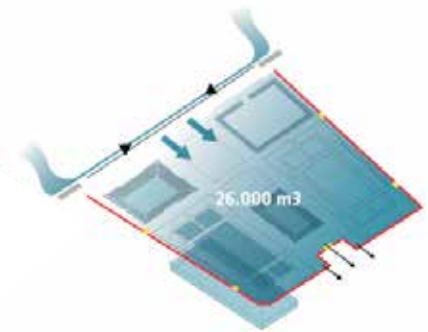
18.

ENGHAVE PARK



EVERYDAY RAIN

10-YEAR RAINFALL



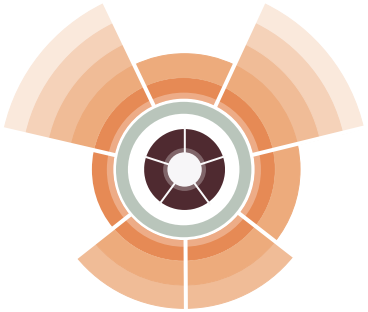
100-YEAR RAINFALL

The goal with the renewal of Enghave Park is to combine respect for Vesterbro's modern outdoor life and the park's existing structure with the need to cloudburst proof Vesterbro. Central to the proposal, is the desire for renewal within the conservation requirements of the neoclassical park. The qualities of the project proposal can be found in the innovative use of rainwater as a recreational element and as an enhancement of the park's uniqueness, by preserving the existing spatial structure. Nevertheless, Enghave Park is not an example of urban nature based climate adaptation in the sense of The Copenhagen Model, as the ecosystem services are not fundamental to the proposal.

Enghave Park possesses great amenity value. With its loyal renewal of an old and much loved park, the project creates a great feeling of *belonging*. Expanding and fortifying vegetation creates a basis for *coexistence*, *learning* and *sensing*, which is to some degree impeded by the requirement to preserve the park's strict neoclassical structure. Allotments will be established in the narrow space between the dyke and the road, which will bolster Enghave Park's *community* identity.

Enghave Park's greatest utility value is rainwater management. Rainwater will primarily be managed on paved surfaces and in a closed underground reservoir, or (in the case of extreme rain) establishing dykes in the park's three lowest sides. Nature based climate adaptation does not apply here, as the water will primarily be managed on paved surfaces or in the underground reservoir and will bypass the grown environment. However, this does not detract from the project's rainwater solutions that will be able to handle 24.000 m^3 water.

The dense vegetation will to some extent improve the park's *microclimate regulation*. *Noise reduction*, CO_2 *Reduction* and *air quality* are not explicitly addressed in the project but will be enhanced to some extent by the increase in vegetation. *Food cultivation* will be an integrated part of the project with the establishment of allotments.



Enghave Park's *biodiversity* is enhanced by the increase of nature within the neoclassical framework of the park. In terms of *cloudburst typology*, the park acts like a large basin, which makes rainwater's recreational qualities very visible and present in the park.

Enghave Park is an example of skilful and efficient climate adaptation, based on cultural heritage conservation. Due to this premise, the park is not an example of nature based climate adaptation, as the park's grown environment is not designed to realise The Copenhagen Model's ecosystem services, but instead emphasises the park's historical qualities and structural characteristics. This is not meant as criticism, but simply as a statement of the fact that Enghave Park's character, program and brief has not chosen to pursue and implement urban nature as it is described in The Copenhagen Model – and that urban nature is therefore not a fundamental part of the proposal.

FACTS
Location: Vesterbro, Copenhagen
Type: Prequalified competition
Developers: The City of Copenhagen, HOFOR, Neighbourhood renewal of central Vesterbro
Area: 35.000 m^2
Cloudburst capacity: 24.000 m^3
Total production costs: 105 mio. kr.
Consultant team: COWI, Tredje Natur and OAN with Ellen O'Gara
Status: Under development

APPENDIX

19.

THE THINK TANK'S RECOMMENDATIONS

Below are the recommendations from 'The think tank for green identity and urban nature' that aim to define what is needed for Copenhagen to succeed at urban nature based climate adaptation, particularly in relation to the cloudburst plan's 300 projects that were passed in November 2015.

The think tank believes that the recommendations, including The Copenhagen Model for Climate Adaption & Urban Nature and the associated development catalogue can create a foundation and direction for all Copenhagen's future urban nature and climate adaptation projects, as well as underpin the efforts for the further development of the city's existing green areas.

1. COPENHAGEN'S GREEN IDENTITY IS URBAN NATURE

Copenhagen must develop and climate adapt with urban nature as its starting point. Climate change and extreme rainfall pose a major challenge today, due to the volume of rain that ends in urban spaces. By making room for more urban nature, we do not only achieve better rainwater management, but also better climate adaptation and a more environmentally friendly city. Moreover, we can achieve a city that provides an enhanced contribution to biodiversity. And, at the same time we will have a Copenhagen with a far greater amenity value. Therefore urban nature is at the heart of Copenhagen's future green identity. An identity that is created from an understanding of nature in the city, and that improves Copenhageners' life quality.

1.1. The think tank recommends that the administration uses The Copenhagen Model to set a common direction for urban nature

The Copenhagen Model should be the starting point for all activities relating to the development and realisation of future urban nature climate adaptation projects. The model is to be used as a dialogue and prioritisation tool from the moment of conception until the project is adopted and operational. This includes the budget memorandum, political recommendation, programming, procurement, planning, execution and evaluation of the project.

2. COPENHAGENERS ARE CO-CREATORS OF FUTURE URBAN NATURE

Copenhageners are ready to embrace urban nature and create their new city together with their fellow citizens. This momentum in urban nature and co-creation among Copenhageners can be utilised fully in connection with the 300 climate adaptation projects, if there is also focus on the development of a new practice where the administration and locals can co-create the city's grown environment.

2.1. The think tank recommends that the administration develops scenarios that describe how Copenhageners can become involved before, during and after the realisation of urban nature projects
In each project, roles are to be coordinated between the administration and the citizens, so that there is consistency between the project's overall objectives and the degree of citizen involvement.

2.2. The think tank recommends the establishment of a contract model for how Copenhageners can be included in operation
Collaboration will be rooted in either the local operation staff or an employee from City Operation/Byens Drift, who can facilitate citizen driven initiatives that promote the grown environment.

3. ADMINISTRATION PROCESSES TO BE MODIFIED IN LINE WITH MANAGING THE GROWN ENVIRONMENT

The methods used to develop and implement grown environments are not the same as the ones used to create built environments. Copenhagen's future urban nature will be developed based on a holistic way of thinking, where everyone involved in the concrete project – from idea development, to selection of consultants and subsequent operation etc. – works with a comprehensive approach to design, planning, construction and care.

3.1. The think tank recommends that there is room for experimentation and systematic knowledge gathering
Urban nature based climate adaptation requires knowledge and requires trust between the developers and the authorities. It must be possible to test new practices in individual projects, so as to develop new knowledge about how to create urban nature that is robust enough to withstand both floods and drought. It should also be possible to, in dialogue with environmental and health authorities, achieve new standards within for example rainwater usage and recreation in climate adaptation projects.

3.2. The think tank recommends that the administration identifies specific innovation projects to act as eye-opening pioneer projects for the whole city
Construction and operation must be tackled in a cohesive manner over a 10 year period. Consultants and contractors will enter into a long-term partnership and be included in the development of projects at an earlier stage. The window for innovative thinking must be kept open for several years and there must be room for the solutions above ground to develop over time. The success criterion is that the projects will contribute to informing the administration, consultants and Copenhageners about urban nature in general and urban nature based climate adaptation in particular.

3.3. The think tank recommends that the administration, in collaboration with HOFOR, develops various design approaches for urban nature solutions
There is a need for a common direction within the administration and HOFOR, about where and when it is possible to create urban nature, based on rate financed solutions, and when it is necessary to supplement fixed rate solutions with financing from tax funds. It must be easy to understand which design approaches should be used when the conditions are set by respectively rate financing or tax financing.

3.4. The think tank recommends the establishment of an interdisciplinary forum to maintain the conversation about the development of urban nature
The administration should establish an interdisciplinary urban nature forum where stakeholders such as supply companies, consultants, contractors, and researchers can meet with the Technical and Environmental Administration and Copenhageners in order to share knowledge and develop a common understanding of urban nature based climate adaptation. The urban nature forum's job is to further develop the work that the think tank helped to perform in autumn, 2015.

3.5. The think tank recommends that the administration adapts and develops the City of Copenhagen's operations manual so that it promotes urban nature and Copenhageners new role and co-creators of urban nature
Urban nature based climate adaptation is a new area for the administration. Furthermore, Copenhageners will play a much more active role in the care of the city's grown environment than we are used to with regards to existing parks and squares. This makes new demands on the operation of the city.

4. URBAN NATURE AS THE STARTING POINT FOR CLIMATE ADAPTATION WILL CHANGE COPENHAGEN

Copenhagen faces a historical change, which we have not seen the likes of since 1857, where the city gates fell and use of the ramparts were discontinued. The 300 climate adaptation projects will, with urban nature as the starting point, create a new version of Copenhagen over the next 20 years. There won't just be more nature or better nature. It will affect and enhance the city's structure and identity. This applies to the city's overall coherence, local neighbourhoods and the individual areas.

4.1. The think tank recommends that the administration launches common tender of climate adaptation projects, which support the city's overall identity and the neighbourhoods' local identities
On a city level, more projects will be developed with a holistic approach, which will be responsible for strengthening Copenhagen's overall uniqueness. In order to set the framework for design, a comprehensive outline proposal will be prepared initially, after which project proposals will be compiled on an ongoing basis in the order in which they are passed in the project packs. Joint tenders will reach across typologies, such as green roads, detention areas and roads, as well as stormwater roads.

4.2. The think tank recommends that new urban nature should be explained to Copenhageners
Copenhagen will have a more diverse expression within a few years, which will develop over time. The city's existing expression will be supplemented by lush and wild urban nature and will vary from place to place. A significant part of the communication initiative in general and operational efforts in particular, must therefore be adjusted to communicate urban nature's role and function, as well as a more refined concept of nature for Copenhageners.

20.

MEMBERS OF THE THINK TANK

External members

Annika Agger, Lecturer, RUC, aagger@ruc.dk

Ole Fritz Adeler, Distribution Director, HOFOR, olad@hofor.dk

Stig L. Andersson, Design Director & partner SLA, sla@sla.dk

Simon Bentholm, Behavioural Designer & Partner, Kl.7, simon@kl7.dk

Jörgen Edström, Section Leader of Strategy & Development, HOFOR, joed@hofor.dk

Søren Gabriel, Development Manager, Environment and Sustainability, Orbicon, sgab@orbicon.dk

Peter Steen Mikkelsen, Professor, DTU Miljø, psmi@env.dtu.dk

Philip Hahn-Petersen, Co-founder of Habitats, philip@habitats.dk

Thomas B. Randrup, Adj. Professor, Swedish University of Agricultural Sciences, thomas.randrup@slu.se

Hans Peter Ravn, Senior Researcher, Forest & Landscape, University of Copenhagen, hpr@ign.ku.dk

The City of Copenhagen, The Technical and Environmental Administration

Tina Saaby Madsen, City Architect, Chairman of the think tank, Z04i@tmf.kk.dk

Anders Asmind Andersen, Unit Manager, City Construction Change, CL8U@tmf.kk.dk

Brian Hansen, Centre Manager, City Development, brian@tmf.kk.dk

Casper Harboe, Unit Manager, City Development, BT54@tmf.kk.dk

Jens Ole Juul, Unit Manager, City Operations, jenjuu@tmf.kk.dk

Hans Christian Karsten, Centre Manager, The Centre for Environmental Protection, Bf5a@tmf.kk.dk

Lykke Leonardsen, Head of Climate Unit, City Development, lykleo@tmf.kk.dk

Karen Margrethe Krogh, Centre Manager, City Construction Change, Z17H@tmf.kk.dk

Anders Melamies, Centre Manager, City Operations, A49Q@tmf.dk

Ole Vissing, Unit Manager, City Development, olevis@tmf.kk.dk

21.

COPENHAGEN SERVICES

The knowledge field of ecosystem services comes from economic science, where at the beginning of the 1990s one began to put value on goods from nature that were not tradable on the market. This field is called environmental economics.

In 1997, the book "Nature's Services", edited by Gretchen Daily was published, as the first text that dealt mainly with services provided by nature's functions enjoyed by people. The term 'ecosystem services' subsequently became more widespread. The UN report, "Millennium Ecosystem Assessment" (2005) in particular, put ecosystem services on the international agenda.

Other science disciplines have since begun to conduct research in ecosystem services. Research in ecosystem services can therefore also have a purely economic approach, which develops methods to put a price on nature's services, a biological approach with focus on how ecosystem services fit together with the functions of an ecosystem, and a societal approach with focus on nature's benefits for people's everyday life. Common to all the approaches, is that the value of ecosystem services are defined in relation to man; whether it is quality of life or economic value. Several of the approaches are often included in the analysis of ecosystem services.

2005	2011	2013	2016
Millennium Ecosystem Assessment	**The Economics of Ecosystem Services and Biodiversity**	**NOU, Natural benefits – on the values of ecosystem services**	**Climate Adaptation & urban nature**
Global, General, Organic	Global, General, Organic, Economic	National, General, Organic, Economic	The Copenhagen Model Local, Urban, Organic
Provisioning services			
Food	Food	Drinking water	Food cultivation
Fibre	Raw materials	Food manufacture	
Fuel	Medicinal resources	Art/toys	
Genetic resources	Fresh water		
Biochemicals and medicinal products			
Decorative resources			
Fresh water			
Regulating services			
Air quality maintenance	Local climate regulation	Pollination and seed dispersal	Rainwater management
Climate regulation	Air quality regulation	Water management	Microclimate regulation
Water regulation	Carbon sequestration and storage	Erosion control	Co_2 reduction
Erosion control	Moderation of extreme events	Local climate regulation	Noise reduction
Water purification and	Waste-water treatment	Soil remediation	Air quality
waste treatment	Erosion prevention	Water filtration and purification	Water quality
Regulation of human diseases	Maintenance of soil fertility	Air purification	
Pest and rodent control	Pollination	Co_2 sequestration and retention	
Pollination	Biological control	Noise reduction	
Environmental damage regulation			
Cultural services			
Cultural diversity	Recreation	Recreation	Belonging
Spiritual and religious values	Mental and physical health	Mental and physical health	Sensing
Knowledge systems	Tourism	Aesthetics	Learning
Educational values	Aesthetic appreciation and	Education	Coexistence
Inspiration	inspiration for culture, art/design	Cognitive development	Community
Aesthetic values	Spiritual experiences and sense	Place identity	
Social relations	of place	Cultural heritage	
Sense of place		Tourism	
Cultural heritage			
Recreation			
Ecotourism			
Supporting services			
Soil formation	Habitats for species	Biodiversity	Biodiversity
Photosynthesis	Maintenance of genetic diversity		
Primary production			
Nutrient cycle			
Water cycle			

22.

REFERENCES

Bolund P. & Hunhammar S. 1999. *Ecosystem services in urban areas*. Ecological Economics 29, p. 293-301.

–

Bühler, O., Tøttrup, C., Borgstrøm, R., & Jensen, M. B. (2010). *Urban heat island i København: beskrivelse af fænomenet, vurdering af omfang i København, input til strategi for håndtering*. Forest & Landscape, University of Copenhagen.

–

Constanza et al. 1997. *The value of the world's ecosystem services and natural capital*. Nature, vol 387, p. 253-60.

–

Daily et al 1997. Ecosystem services: *Benefits supplied to human societies by natural ecosystems*. Ecological Letters 2.

–

de Vries S et al. 2003. *Natural environments – healthy environments? An exploratory analysis of the relationship between greenspace and health*. Environment and Planning, volume 35, p. 1717 – 1731.

–

Doick K & Hutchings T. 2013. *Air temperature regulation by urban trees and green infrastructure* - Research note. Forestry Commission, UK.

–

European Environmental Agency 2011, *Green infrastructure and territorial cohesion. The concept of green infrastructure and its integration into policies using monitoring systems.*

–

Fryd O. et al.: 2011 *The role of urban green space and trees in relation to climate change.*

–

Fuller RA et al. 2007. *Psychological benefits of greenspace increase with biodiversity.* Biology Letters, Community ecology 3, p. 390–394.

Goméz-Baggethun E et al. 2013. *Urban Ecosystem Services. Ch. 11 IN T. Elmqvist et al. (editors), Urbanization, Biodiversity and Ecosystem Services: Challenges 175 and Opportunities: A Global Assessment*. Springer.

–

Goméz-Baggethun E. & Barton DN. 2013. *Classifying and valuing ecosystem services for urban planning*. Ecological Economics 86 p. 235-243.

–

Gordinier J. 2015. *René Redzepi Plans to Close Noma and Reopen It as an Urban Farm*. The New York Times (14/09/15).

–

Kals E et al. 1999. *Emotional affinity toward nature as a motivational basis to protect nature*. Environment and Behavior, Vol. 31 No. 2, p. 178-202.

–

Københavns Kommune 2010. Arkitekturby København.

–

Københavns Kommune 2015. *Bynaturstrategi 2015-2025.*

–

Københavns Kommune (forventet 2016) *Biodiversitet* i københavn.

–

Københavns Kommune 2015. *Fællesskab København.*

–

Københavns Kommune 2014. *Grøn klimatilpasning, ved Tredje Natur.*

–

Københavns Kommune 2012. *KBH 2015 klimaplanen - en grøn, smart og CO_2-neutral by.*

–

Københavns Kommune 2015. *Klimatilpasnings- og Investeringsredegørelsen.*

Københavns Kommune 2013. *Københavns første klimakvarter.*

–

Københavns Kommune 2013. *Ren luft til Københavnerne..*

–

Københavns Kommune 2014. *Skybrudssikring af København*

–

Københavns Kommune 2014. *Tåsinge plads 2014*

–

Louv R. 2005: *Last Child in the Woods.*

–

Magid J & Lekfeldt JDS.2013. *Vurdering af muligheder og begrænsninger for byhavebrug i København.*

–

Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-Being: Synthesis.* Island Press.

–

MIND. 2007. Ecotherapy: *the green agenda for mental health.*

–

NINA - Norwegian Institute of Nature Research. 2015. Barton, D.N., E. Stange, S. Blumentrath, N. Vågnes Traaholt. *Economic valuation of ecosystem services for policy - A pilot study of green infrastructure in Oslo.*

–

NOU – Norges offentlige utredninger: 10. 2013. *Naturens goder – om verdier av økosystemtjenester*

–

Nowak DJ & Dwyer JF.: 2007 *Understanding the benefits and costs of urban forest ecosystems.*

–

Raquel Moreno-Peñaranda: 2011. *Japan's Urban Agriculture: Cultivating Sustainability and Well-being.*

Skov- og Naturstyrelsen 1996. *Byatlas København, Bevaringsværdier i byer og bygninger.*

–

TEEB - The Economics of Ecosystem Services and Biodiversity. 2011. *Manual for cities: Ecosystem Services in Urban Management.*

–

Tidball KG & Krasny ME. 2010. Urban Environmental Education From a *Social-Ecological Perspective: Conceptual Framework for Civic Ecology Education.*

–

Wells NM. 2000. *At home with nature: Effects of greenness in Children's cognitive functioning.*

–

Westphal LM. 2003. *Urban greening and social benefits: A study of empowerment outcomes.*

23.

CREDITS

Photo, p. 4-5: Magnus Klitten/©SLA
Photo, p. 8: Magnus Klitten/©SLA
Photo, p. 13: TagTomat.dk / Mads Boserup Lauritsen
Photo, p. 19: ©SLA
Photo, p. 23: Morten DD Hansen
Photo, p. 25: Mette Frandsen
Photo, p. 27: TagTomat.dk / Mads Boserup Lauritsen
Photo, p. 29: Habitats
Photo, p. 31: ©SLA
Photo, p. 35: Camilla Berner
Photo, p. 39: Vesterport 1857
Photo, p. 45: F. Ingemann Hansen
Photo, p. 47: hannaswalk.com
Photo, p. 49: Joachim Adrian/POLFOTO
Photo, p. 51: Fod
Photo, p. 53: Henning Thomsen
Photo, p. 57: tianjin qiaoyuan wetland park
Photo, p. 61: ©SLA
Photo, p. 63: Butong
Photo, p. 65: Atelier de Paysages Bruel-Delmar
Photo, p. 67: Tom Fox / SWA Group
Photo, p. 69: Kings cross pond club
Photo, p. 71: ©Brooklyn Grange, www.BrooklynGrangeFarm.com
Photo, p. 73: Dirk Franke
Photo, p. 85: Tokyo roofgarden
Photo, p. 89: Ray and maria stata center
Photo, p. 93: nebinger shool
Photo, p. 97: Tanner spring park
Photo,p. 113: GHB Landskabsarkitekter / Photographer Steven Achiam
Photo, p. 123: GHB Landskabsarkitekter / Photographer Steven Achiam

Illustration, p. 37, 81, 83, 87, 91, 95: TMF grafisk design / SLA
Illustration, p. 82, 86, 90, 94: TMF grafisk design & Tredje Natur, /SLA
Illustrationer, p. 120-121: GHB Landskabsarkitekter a/s
Illustrationer, p. 129, 131: Tredje Natur

©SLA for illustrations not named in the credits section.