

NATURE-BASED CITIES



CONCITO

NATURE-BASED CITIES

Report

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PREFACE

This report gathers knowledge on climate challenges in cities and presents new perspectives to the debate on cities of the future and why urban nature is key to the development of climate resilient, climate neutral, and livable cities.

The report takes a closer look at nature-based solutions and argues for a deeper nature-based thinking as the core of future urban planning and development.

The key message is that a systemic integration of nature in both thinking and practice can help counteract climate and biodiversity challenges that cities in both Denmark and the rest of the world are experiencing, and at the same time improve urban health and well-being, sense of ownership, and the natural environment in cities.

The report should not be seen as a manual or handbook, but as a contribution to a broader understanding of nature-based urban planning and development. As the report initially was written to a Danish audience, there is a section dedicated to Danish cases.

It is our hope that the report will inspire urban planners and practitioners working to create the green and climate-resilient cities we all want to live in. At the same time, we hope that the report will provide knowledge and spark ideas for others interested in sustainable urban planning.

Cover image: Niklas Winther-Have

SUMMARY

The future of humanity is urban. Currently, more than half of the world's population lives in urban areas, and urbanization is continuing.

Cities drive the global economy and serve as hubs for development and innovation. However, cities account for 75% of global CO₂ emissions. At the same time, cities are vulnerable to climate change in terms of rising temperatures, droughts, flooding, etc.

The development of the world's cities is accomplished at the expense of local nature and ecosystems, which are being replaced by paved surface areas such as roads and buildings. The consequences of our urban design are far-reaching and include increased climate vulnerability, habitat loss and degradation of ecosystems on which cities and the health of citizens depend.

As opposed to the impermeable city, nature-based solutions harness nature. Due to their ability to generate co-benefits for livability and resilience of cities, nature-based solutions are increasingly being recognized and promoted as part of the response to the climate and biodiversity crisis.

Despite the obvious benefits, nature-based solutions are often realized as isolated projects instead of systemic, strategic urban initiatives. Therefore, we find it necessary to focus on the processes before, during and after the implementation of nature-based solutions in cities. Moreover, nature-based solutions must be a part of a broader vision of long-term urban development.

In this report, we introduce the mindset of *nature-based thinking* as a contribution to the development of nature-based cities of the future.

Nature-based thinking means a new role for nature in cities. Nature is considered from the very beginning and throughout planning and development processes, and nature has space to thrive. It requires all stakeholders - from concept to financing, planning and operation - to work towards local anchoring across sectors and disciplines. Nature-based thinking recognizes that nature does not exist to solely serve human needs. Nature is important for sustaining ecosystems and the natural environment in cities.

CONCITO invites readers of this report to explore nature-based thinking and defines five guiding principles for planning and developing nature-based cities:

1. Recognizing the values of nature for both people and ecosystems.
2. Working systemically and strategically with nature in urban planning and development.
3. Prioritizing a locally embedded and inclusive urban development.
4. Ensuring capacity building at all levels.
5. Working across sectors and disciplines for climate resilient cities.

In our view, the future is both urban and nature-based. With a nature-based approach, cities can act as frontrunners in a sustainable transition that reduces our impact on the planet and creates climate resilient cities where both people and ecosystems thrive.

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1 THE FUTURE IS URBAN

The future of humanity is urban. Urbanization is defined by the UN as one of four demographic megatrends, which also include global population growth, population ageing and international migration¹.

The world's cities are growing. Since 2007, over half of the world's population is living in urban areas, hence urban living and working has become the norm¹. Almost 50% of city dwellers live in urban areas with less than 500,000 inhabitants, while one in eight lives in one of the world's 33 megacities with over 10 million inhabitants¹.

Since 1970, the share of people living in cities of less than 1 million inhabitants has declined globally in favor of growth in the largest cities. The rate of urbanization is highest in megacities, both globally and in Europe. Additional 10 megacities are expected to emerge by 2030, most of them are in developing countries. It is expected that all global population growth by 2050 will be urban, with Africa and Asia accounting for 90% of the growth. This means that 68% of the world's population will live in urban areas by 2050.

Urbanization has generally been a positive force for economic growth, poverty alleviation and human development. Cities drive the global economy and serve as hubs for development and innovation. City dwellers are typically younger, more highly educated and have greater access to jobs, housing and social services compared to the general population². Urban dwellers often live in smaller homes, which at best are supported by green energy supply. In addition, people in cities typically live closer to educational institutions and workplaces, and they have better access to public transportation³.

The high level of activity and consumption means that cities account for about 75% of global CO₂ emissions⁴. In the most developed countries, the expansion of urban areas tends to outpace population growth^{4, 5}. So even though cities currently occupy only about 3% of the Earth's land, the concentration of people in cities and the layout of cities means that cities not only impact but are also impacted by challenges such as climate change, pollution and biodiversity loss.

Therefore, cities play an important role in the transition to a climate-neutral and climate-resilient society. At the same time, it is crucial that the development of cities is steered toward sustainable urban futures where people experience good quality of life. This becomes even more important as more and more people will be living in cities in the future. In the following chapter, we take a closer look at the climate-related challenges facing the world's cities.

2 THE CHALLENGES OF THE IMPERMEABLE CITY

Due to the acceleration of urbanization, natural spaces are increasingly being replaced by paved areas and hard, dark surfaces. Urban paved areas are mainly roads and squares, sidewalks, parking lots and built-up areas with dark rooftops and facades. They often consist of materials such as asphalt, concrete, metal and glass, which are energy-intensive in their production and depend on scarce resources such as sand, which is extracted and consumed far faster than it is renewed⁶.

These materials dominate cities because they are durable, cheap, versatile and effective to use in construction projects. However, paved surfaces have a range of properties that pose challenges for urban climate adaptation. Large amounts of paved surfaces result in soil sealing which creates heat islands and prevents water from percolating. Instead, surface runoff occurs.

WHAT ARE PAVED AREAS?

"A paved area is an area with a surface that is completely or partially impermeable to water, as well as areas where activities take place that may pollute the water runoff."

[6]

Photo: Maria Orlova



2.1 HEAT ISLANDS AND RISING TEMPERATURES IN CITIES

The 10 warmest years in modern record have all occurred in the period 2014-2023⁷ and the trend is expected to continue. Globally, 2023 has been the warmest year on record. The global average temperature in 2023 fell just shy of the 1.5°C warming limit as agreed in the Paris Agreement, and all indications are that we are to expect higher temperatures and more extreme weather with new heat records every year⁸.

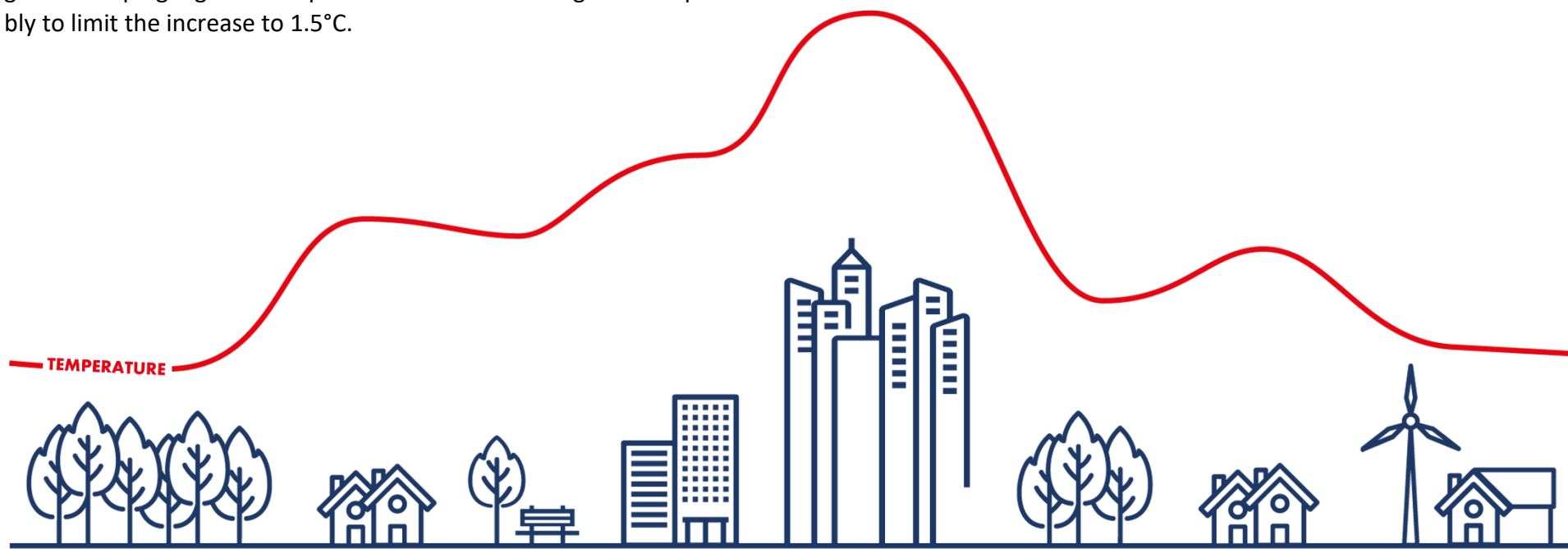
Research shows that surface temperatures in the world's cities are rising twice as fast as the global average⁹. This is largely due to the so-called heat island effect, which is occurring particularly in urban areas, where the combination of a high proportion of heat-absorbing paved surfaces, low vegetation cover and high human activity causes higher temperatures compared to surrounding areas¹⁰.

It is estimated that the temperature in the world's cities will rise by an average of 4°C by 2100¹¹. This is more than double the Paris Agreement's goal of keeping a global temperature rise below 2 degrees and preferably to limit the increase to 1.5°C.

As city growth continues and extreme weather events and high temperatures increase, more and more people are exposed to the effects of climate change. The rise in urban temperatures has devastating consequences for a wide range of factors, putting particularly the healthcare sector under pressure.

It is expected that the proportion of urban dwellers exposed to summer temperatures above 35°C will increase by 700% to 1.6 billion by 2050¹². The impacts of rising temperatures and heat islands often intertwine with socio-economic parameters such as income, age, gender and ethnicity, thus vulnerable groups are suffering the most¹³.

The coming sections will unfold both the causes and consequences of the urban heat island effect.



BACKGROUND ON THE HEAT ISLAND EFFECT

The design of cities contributes to higher surface temperatures compared to surrounding areas. This is largely because of the predominant materials and surfaces in cities absorbing and retaining heat. However, human activities and the way cities are designed also contribute to making cities warmer.

URBAN DESIGN

The most used materials in cities typically have low albedo, which is a measure of how much of the sunlight is reflected from Earth's surface. Dark and hard surfaces like asphalt and concrete have a low reflectivity and instead, they absorb solar energy during the day¹⁴. They release heat significantly slower than more reflective materials and vegetation^{15, 16}. As a result, the temperature difference between urban and rural areas is often greatest at night¹⁷. At the same time, paved areas drain water away instead of retaining it. This means that the solar energy heats up the materials instead of causing the water to evaporate, which would otherwise help to lower the temperature in the area^{18, 19}.

The physical design of cities, including closely built structures and construction materials, means that they have a higher heat capacity and thermal mass, allowing them to store heat inside the urban canopy. The density of urban structures also means that the heat is "trapped" between buildings where the heat radiation is both reflected and absorbed multiple times²⁰. Buildings can also change wind direction and strengthen or block winds that could otherwise lower surface temperatures²¹. The high proportion of paved surfaces leaves less space for green areas which can make significant contributions to lowering surface temperatures through shading and evaporation.

ANTHROPOGENIC HEATING

Human activity in cities, including transportation, artificial cooling and industrial processes, also contributes to higher temperatures in urban areas. On a global scale, air conditioning has a major impact on the heat island effect during the hot summer months.

It is estimated that the use of air conditioning in some cities increases the temperature by more than 1°C²² by night as air conditioning absorbs heat from the buildings and releases it into the atmosphere, exacerbating the heat island effect. The growing need for cooling increases energy production, which once again can increase both greenhouse gas emissions and heat emissions.

Transportation is another source of anthropogenic heat. This is partly because transportation is often based on combustion engines, which are energy inefficient as a large proportion of the energy is converted into heat energy. Exhaust emissions from the transportation sector also causes air pollution, which changes the optical properties of surfaces that it covers and reduces the ability of surfaces to reflect sunlight (albedo)¹⁴. Altogether, this contributes to the formation of urban heat islands.

CONSEQUENCES OF HEAT ISLANDS

Population growth and climate change mean that more and more people are being affected by the heat island effect and rising temperatures. The energy consumption for air conditioning is steadily increasing and the high temperatures have major consequences for public health. Typically, it is the most vulnerable who are affected the most by high temperatures. Unless action is taken, water supplies, people and ecosystems will come under pressure.

ENERGY CONSUMPTION AND PRODUCTION

Rising urban temperatures and demand for air conditioning are increasing energy consumption and putting pressure on production of energy. Despite improvements in cooling technology, global emissions from mechanical cooling have more than doubled from 1990-2021 and today, cooling technologies account for almost 16% of the construction industry's energy consumption on a global level²³. Particularly during heat-waves and extreme heat events, the demand for cooling rises. When the temperature in buildings increases by 1°C, energy demand increases by an average of 3.7%.²⁴ Especially in the hottest countries, the need for air conditioning will impact and put pressure on infrastructure. In India, it is expected that cooling will account for 45% of total energy consumption during peak loads by 2050.²⁵

However, the demand for cooling is not only increasing in tropical climate zones. A report from Harvard University (2022) estimates that up to 92% of the population in Germany may need air conditioning during extreme weather events in the future²⁶ despite the country having a temperate climate. According to an analysis from 2018, emissions from air conditioning used alone in households could increase the global average temperature by about 0.5 degrees Celsius by 2100.²⁷

Although the figures do not apply to cities specifically, it is expected that the need for air conditioning and thus increased energy production will be particularly high in cities due to the heat island effect.

HEALTH

Warmer cities can pose significant challenges to public health, which is already under pressure from climate change. Extreme heat reaching temperatures above 35°C significantly increases the risk of heat-related mortality. It is estimated that the heat island effect contributes up to 40% of heat-related mortality during heat waves in European cities²⁸. In general, a correlation between urbanization and heat-related mortality has been demonstrated²⁹⁻³¹.

Higher temperatures increase blood flow to the skin and sweat production to cool the body, significantly increasing cardiac activity, which in the worst cases can lead to heart failure, cardiac arrest and death³². Prolonged exposure to high temperatures can also lead to dehydration, heat stroke, impaired blood vessel function, blood clots and organ failure. In addition, an increase in hospitalizations associated with mental health conditions has been linked to higher temperatures³³.

SOCIAL INEQUALITY

Globally, the impact of heat affects particularly vulnerable groups, including children, the elderly and low-income groups³⁴. Socio-economic inequalities are especially the reason for this, as low-income populations are often the most vulnerable to the negative impacts of rising temperatures due to a lack of access to air conditioning, shading and green spaces. Low-income neighborhoods generally have the least green space, which increases the risk of heat-related deaths³⁵.

Rapid population growth and unplanned urban growth often characterize developing countries and further exacerbates the problem. Unplanned and poor areas are characterized by low canopy cover from vegetation and deprived infrastructure, including substandard buildings. This can lead to higher temperatures. But even in American cities like Portland, Oregon, up to 11°C difference in temperature have been observed when comparing different neighborhoods, and a correlation between low-income neighborhoods and higher temperatures has been found³⁶.

A study from the US also shows that the risk of heat-related deaths of low-income migrant workers is three times higher than the average American³⁷ likely due to working conditions and limited access to healthcare.

WATER POLLUTION AND WATER SCARCITY

Urban water flows are typically warmer than non-urban water flows due to the heat island effect and limited shade and canopy cover from trees³⁸. Paved surfaces heated by the sun can transfer the heat to rainwater runoff, which is passed on to natural ecosystems. Changes in water temperature threaten the quality and availability of habitats for aquatic life. These stressors can ultimately affect and contaminate ecosystems and drinking water. Increased temperatures in cities can also lead to an increase in water consumption for both irrigation and cooling, putting further pressure on local water resources³⁹.

ECOSYSTEM IMPACT AND BIODIVERSITY LOSS

Ecosystems are being pressured and disrupted by rising urban temperatures. Many species need certain conditions and temperatures to thrive in their ecosystems. Heat islands can create harsh conditions that limit and alter organisms' essential activities such as metabolism and reproduction. Elevated temperatures can also significantly reduce animals' access to food, shelter, and water.

Conversely, heat can also make cities more attractive to nature and, for example, attract wildlife to cities, as seen with flying dogs in Melbourne, Australia⁴⁰. Non-native animals that thrive in the changed conditions are often seen as pests that out-compete native species.

2.2 URBAN FLOODING AND WATER MANAGEMENT

Urban flooding is one of the biggest climate threats and affects global development. It is estimated that over 1.8 billion people are exposed to significant flood risk⁴¹. Of the world's 33 megacities, 21 are in low-lying coastal areas that are particularly prone to flooding⁴².

In addition to endangering lives and destructing homes and urban infrastructure, there is a growing fear that extreme weather events such as heavy rainfall could recur due to climate change. While the risk of flooding is already significant, climate change and rapid urbanization in low-lying areas is likely to further increase the risk in cities.

Flooding is an increasing problem in many cities around the world. For C40 Cities, flooding is already the highest reported climate hazard, with 92% of cities experiencing flooding from rainfall or storm surges⁴³. The IPCC's 2022 report confirms that urban flooding will become both more frequent and more severe as a result of climate change⁴⁴ and the European Environment Agency estimates that the frequency of extreme rainfall events in Northern Europe will increase significantly regardless of the emissions scenario⁴⁵.

This makes it more likely that urban areas will experience flooding, including when heavy rains or other extreme weather events overflow urban sewer systems, causing water to run off onto streets and accumulate in basements and other low-lying areas.

Urban flooding can have serious consequences, including damage to buildings and infrastructure. Moreover, marginalized and vulnerable populations are disproportionately affected. Flooding can also pose a risk to public health as floodwaters can, for example, contain sewage and other pollutants or provide a breeding ground for disease-carrying pests.

BACKGROUND ON URBAN FLOODING AND WATER MANAGEMENT

Cities do not only contribute to climate change, which in turn increases the frequency and intensity of heavy precipitation. Cities are also exposed to flooding, mainly due to the physical design of cities. Urban development and the design of urban infrastructure prevent rainwater from infiltrating and instead causes flooding.

URBAN DESIGN AND INFRASTRUCTURE

Urban development is a major factor contributing to the frequency of urban flooding. As cities grow and develop, more area is covered by buildings, roads and other impermeable surfaces. When rain falls on a paved surface, it cannot infiltrate into the ground. Instead, it runs off the surface and into urban drainage systems or the landscape, which can cause flooding and erosion.

Furthermore, runoff often contains pollutants such as harmful chemicals from surfaces or sewage. When stormwater runs into streams and rivers, it can cause water pollution and damage ecosystems.

Urban development and urban planning can cause changes to flood plains that further affect risk of flooding. Flood plains are flat areas along rivers that are often flooded and formed by river deposits. As cities expand and flood plains change, the natural "buffers" such as wetlands and vegetation that help retain and manage water flows are removed or destroyed. This can lead to increased runoff and higher water levels during storms and flooding as there is less capacity to absorb and retain water.

The current gray stormwater infrastructure such as sewers, downspouts and drains cannot always cope with heavy rainwater events. The high degree of paved surface areas means that large amounts of rainwater are conveyed to the sewerage systems, which are then overflowed, and the water instead finds its way to basements and low-lying areas.

THE IMPACT OF HEAT ISLANDS ON PRECIPITATION

Higher temperatures in cities affect the local climate, including the amount and patterns of precipitation⁴⁶. Higher temperatures can lead to more frequent and intense thunderstorms, which can cause heavy rainfall and increase the risk of flooding. Heat islands can also change the patterns of precipitation, leading to more extreme precipitation events of short-time duration which in turn increase the risk of overflowing gray infrastructure and flooding.

CONSEQUENCES OF URBAN FLOODING

Urban flooding has devastating consequences for both public health and well-being, and as it was the case with the heat island effect, the most vulnerable populations suffer the most. Flooding causes major social and economic challenges and can create fatal changes to ecosystems.

HEALTH AND SOCIAL IMPACTS

Globally, urban flooding is a threat to especially public health and well-being. When heavy rains or other natural disasters cause flooding, it can lead to contamination of drinking water sources with bacteria, viruses and other contaminants that can cause waterborne diseases such as diarrhea, cholera and typhoid.

Floods can also increase the spread of waterborne diseases such as malaria and dengue fever, which are transmitted through the bites of infected mosquitoes and insects or through contact with contaminated water.

When large volumes of water rush through cities, it can lead to physical injuries and increase the risk of drowning, especially for children. Floodings can also be associated with significant mental health challenges such as stress, anxiety and other negative emotional states, as people may have to move from their homes and communities.

SOCIAL INEQUALITY

Urban flooding can have a significant impact on inequality, and especially affect poor and marginalized communities adversely. This is partly because these groups have less access to information and utilities, as well as other socio-economic conditions increasing the exposure to hazards⁴⁴.

For example, poor and marginalized communities are more likely to live in flood-prone areas such as low-lying neighborhoods or areas with inadequate or poorly maintained drainage systems⁴⁷. They are also more likely to live in substandard housing, which is more prone to flood damage, and they typically have fewer resources to repair and rebuild after a flood⁴⁴.

Furthermore, poor and marginalized communities are more exposed to flood-induced health risks. Typically, they live in areas with more environmental health risks and have less access to clean drinking water and healthcare. They may also be more likely to experience negative economic consequences of urban flooding, such as lost income.

LOSS AND DAMAGE

Urban flooding causes massive destruction and damage to both people and property, including buildings, roads, bridges and other critical infrastructure. In addition, floodings lead to increased costs for healthcare and restoration of damaged ecosystems, among other things.

In Denmark, for example, the damage cost of coastal floodings is estimated to more than US\$ 10 billion by 2100⁴⁸. Extreme precipitation events such as cloudbursts also have high socio-economic costs. After the big cloudburst event in Copenhagen on July 2, 2011, the insurance costs alone were estimated to be more than US\$ 1 billion⁴⁹. Moreover, the flooding of roads and railways imposed constraints on commuters and transportation of goods, hence causing significant production losses.



ECOSYSTEM IMPACTS AND POLLUTION

Urban flooding can have significant impacts on ecosystems and biodiversity. One of the most notable consequences is the alteration of natural habitats, which can have adverse effects on the plants and animals that depend on them. When heavy rains or other natural disasters cause flooding, floodwater can wash away or bury plants and animals, as well as alter the structure of the habitat.

The nutrient-rich water from, for example, cropland or sewage systems can also have a negative (and in very specific cases positive) impact on ecosystems. As some species may not be able to adapt to the new conditions, inflow of nutrient-rich water can lead to biodiversity loss.

As stormwater flows through the city, it can transport sediment, oil and grease from roads, chemicals from industrial areas, and nutrients and bacteria from untreated or partially treated wastewater. When stormwaters flow into natural habitats, the pollutants and materials can have negative effects on the plants and animals that depend on these habitats. For example, sediment can make it difficult for sunlight to reach aquatic plants, reducing their ability to photosynthesize and grow. Oil and grease can build up on water birds' feathers, reducing their ability to swim, fly and insulate from the cold. Chemicals and nutrients can be toxic to fish and aquatic life in general and can generate an overgrowth of algae, which produce toxins that can be harmful to humans and animals.

SUMMARY

In recent decades, the widespread conversion of natural ecosystems to densely built-up and impermeable areas have put cities and their surroundings under increasing pressure. In addition, rising global temperatures have led to an increase in the frequency and intensity of natural disasters such as floods, droughts and heatwaves, making densely populated areas, their citizens and critical infrastructures particularly vulnerable. Rising temperatures and flood risk pose a threat to both people and ecosystems around the world.

The consequences of the way we design our cities are far-reaching. Whether planned or unplanned, urban development causes a loss of habitat. This affects the ecosystems on which cities and the health of citizens depend. Biodiversity is key to maintaining healthy ecosystems that are resilient to climate change. In addition, decreased access to nature also means that we lose the basic social and psychological benefits associated with nature.

In the next chapter, we turn our attention to nature-based solutions as a concept and take a closer look at both international best practice and experiences with nature-based solutions in Danish cities.

3

NATURE-BASED SOLUTIONS IN CITIES

When planning with sustainability in mind, cities can help reduce our footprint on the planet and meet a range of societal needs. We are in the midst of both a climate and biodiversity crisis, and while it is commonly accepted in both scientific circles and among policy makers that the crises are interconnected, they are often tackled separately⁵⁰. There is a need for integrated urban action that addresses both crises.

In the future, cities will need to further densify and adapt to climate change. Therefore, it is important that these actions do not exacerbate the issues, but instead help to address them while taking the opportunity to create better, more sustainable and inclusive cities.

In the light of the climate and biodiversity crises, green-blue approaches to urban development are increasingly recognized and promoted. These are solutions that address climate change and societal challenges and potentially create synergies between urban development and nature. A fundamental view is that nature and ecosystems provide a number of basic services for humans that we cannot and should not do without.

The idea of cities has long revolved around humanity's attempt to create a place as an alternative to nature and 'the wild'. Rather, nature-based solutions argue that smart, sustainable and resilient cities should harness the potential of nature.

This perspective particularly makes nature-based solutions interesting and relevant to the climate and biodiversity crises. As a response to the conventional approaches of the impermeable city, nature-based solutions use nature and ecosystem services as an effective and adaptive approach to enhancing climate resilience, addressing societal challenges and achieving benefits for both people and nature. At the same time, nature can capture and store CO₂, and nature-based approaches can contribute to reduction targets.

This chapter will examine the concept of *nature-based solutions* in both an international and national context. It also explains why nature-based solutions are relevant to cities and which challenges occur when designing, implementing and managing nature-based solutions.

WHAT ARE ECOSYSTEM SER-

Ecosystem services are the societal benefits and resources provided directly or indirectly by natural ecosystems and are often divided into four categories: *supporting*, *regulating*, *provisioning* and *cultural*¹²². See figure 1.

We rely heavily on a wide range of these ecosystem services, which provide everything from clean drinking water and treatment of disease to recreation and appreciation of nature. The annual economic value of the world's total ecosystem services is estimated at US\$ 125 trillion¹²³ of which a large share is not commercialized.

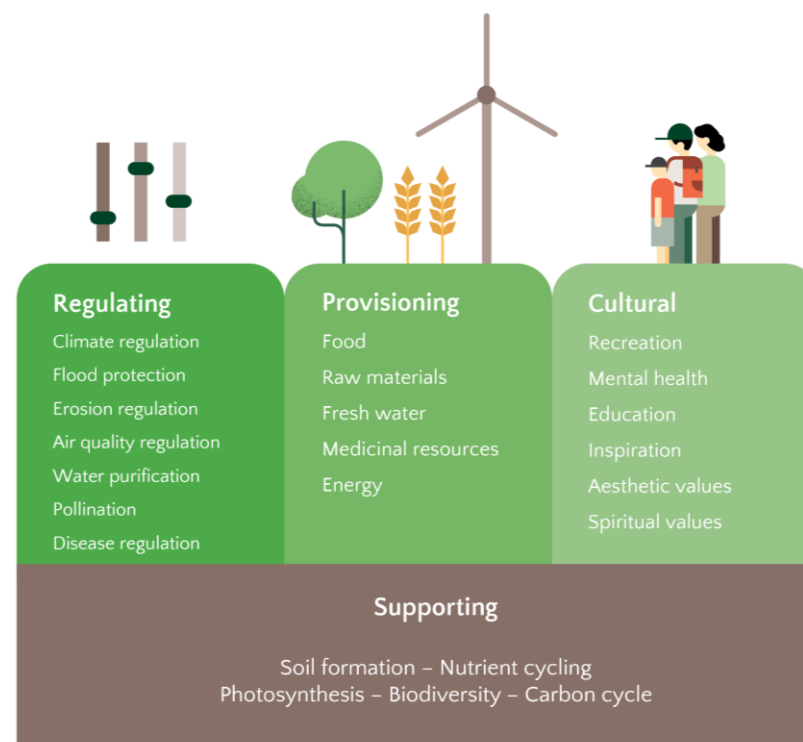


Figure 1: The impact of biodiversity on future land use, CONCITO (2023).

3.1 NATURE-BASED SOLUTIONS AS A CONCEPT

In an urban context, nature-based solutions are often considered an umbrella term covering already established concepts including ecosystem-based adaptation, green-blue infrastructure and ecosystem services. These all highlight the potential of using nature in cities to reduce greenhouse gas emissions and adapt cities to climate change, rather than relying solely on technical solutions. However, the concepts have different areas of focus, with ecosystem-based adaptation, for example, having a narrow focus on strategic climate adaptation⁵¹ compared to nature-based solutions focusing on multifunctionality.

The concept of nature-based solutions was first mentioned in 2008 and is therefore relatively new. Although nature-based solutions are considered effective approaches to creating resilient and sustainable cities, nature-based solutions are used to a limited extent⁵². This is partly because of ambiguity surrounding the concept and fear in nature conservation circles that the term is another buzzword that only superficially promotes biodiversity⁵³.

Due to different aims and interests in relation to the use of the concept, there are two dominant definitions of nature-based solutions made by the European Commission and the International Union for Conservation of Nature (IUCN) respectively⁵⁴:



"Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience."

- European Commission



"Nature-based Solutions are actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits."

- IUCN

Both definitions have the same overall objective: to solve societal challenges based on nature and ecosystems. However, they frame the role of nature differently.

The European Commission includes solutions inspired by nature which makes the approach to nature-based solutions broader compared to IUCN seeing nature-based solutions as something that is based in ecosystems. By using the concept of ecosystems, IUCN suggests that nature-based solutions are systemic and concerned with connectivity and interaction between larger areas and natural processes rather than individual and isolated solutions.

The European Commission focuses on nature as cost-effective solutions that can create sustainable development, increase resilience and work for human needs. As an international nature conservation organization, IUCN focuses on ecosystem protection. While recognizing that ecosystems provide a range of services that can effectively address societal challenges, IUCN emphasizes that the starting point for nature-based solutions is actions that protect and manage nature in a way that enables it to provide ecosystem services.

However, the European Commission and IUCN agree that nature-based solutions have multiple functions and create benefits for both society and the environment, although they describe these benefits differently. The definition suggested by the European Commission is based on the three dimensions of sustainable development; environmental, social and economic sustainability, while the IUCN definition is based on enhancing biodiversity and human well-being.

IUCN has been one of the driving forces for the promotion of nature-based solutions and has worked to make it easier to realize nature-based solutions on a practical level. In addition to their definition, they have developed a global standard for nature-based solutions that can be applied before, during and after the implementation of nature-based solutions.

The standard provides a framework for the design of nature-based solutions and is used to measure their effectiveness and ensure proper implementation⁵⁵.

For the same reason, and to ensure consensus on the definition of nature-based solutions, the UN Environment Assembly (UNEA) adopted a broad and internationally accepted definition of nature-based solutions in March 2022⁵⁶. This builds on the definitions made by the European Commission and IUCN. The UNEA definition reads:



"Nature-based solutions are actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits."

- United Nations Environment Assembly (UNEA)

The UNEA definition is based on the ecosystem concept, nature conservation and the three dimensions of sustainable development. Furthermore, it emphasizes that nature-based solutions must provide benefits for human well-being, ecosystem services, resilience and biodiversity. The UNEA definition came in the wake of nature-based solutions being included in the draft text of the agreement from COP26 in Glasgow, but was eventually removed⁵⁷.

SUMMARY

A review of the previous three definitions shows that nature-based solutions must meet a number of characteristics.

Four common features of nature-based solutions are that they:

1. are inspired and supported by nature and ecosystems
2. address societal challenges
3. are efficient and adaptive
4. achieve benefits for both people and nature

Based on these common features, this report understands nature-based solutions as:

NATURE-BASED SOLUTIONS

"Nature-based solutions are actions inspired and supported by ecosystems, that effectively and adaptively address societal challenges to achieve benefits for both people and nature."

3.2 NATURE-BASED SOLUTIONS IN CITIES

Cities play a special role in relation to nature-based solutions as they are particularly vulnerable to climate change and at the same time cities are powerful actors. Nature-based solutions in cities are recognized as "low-regret" measures for climate adaptation and disaster risk reduction⁴⁴. This means that they are seen as cost-effective measures under future climate scenarios and that the cost of implementing them now is low compared to their benefits and costs avoided in the long term. Nature-based solutions in cities can take many forms and create a variety of benefits.

Nature-based solutions in cities can provide natural shade, reduce the heat island effect and reduce the need for air conditioning. They can support water management, increase water infiltration, reduce flood risks and improve health and well-being by reducing air pollution and increasing access to recreational areas.

Urban nature-based solutions can create green corridors and connectivity between natural areas and improve conditions for biodiversity in and around cities. They can store CO₂ and create buffer zones that increase cities' resilience to extreme weather events and protect cities from flooding.

Since urban and rural areas are not isolated from each other and nature-based solutions ought to be systemic, the interaction between nature-based solutions in different zones can be utilized to increase the supply of services in both urban and rural areas⁵⁸. This means that nature-based solutions in rural areas can deliver benefits to cities and vice versa. Therefore, they should be considered in a broader context and create synergies between urban and rural areas.

Nature-based solutions in cities can help create greener, cooler and more resilient cities and improve conditions for biodiversity, but this requires prioritizing nature in cities. Not only because nature-based solutions are effective for climate adaptation and increase biodiversity, but also because they generate a wide range of societal co-benefits.

EXAMPLES OF NATURE-BASED SOLUTIONS IN CITIES

- Green catchment areas that provide clean water, store CO₂ in the ground and cool cities.
- Green facades and roofs which reduce the heat island effect and the need for air conditioning.
- Urban wetlands which increase water infiltration and reduce flood risks.
- Parks and street trees which create natural shade, reduce air pollution and noise, and create green corridors for people and animals.
- Urban gardens and urban farming that connect city dwellers with food production and reduce transportation.

3.3 INTERNATIONAL BEST PRACTICE

Cities around the world are preparing for a wetter, wilder and warmer future. Cities already experience climate change in the form of droughts, heat waves and extreme precipitation, with serious consequences such as forest fires, water shortage, landslides and flooding. Climate hazards also affect public health, safety and social justice. Nature-based solutions are one of the planning approaches used to counteract and mitigate rising temperatures, increased water volumes and social impacts.

Chinese cities such as Shanghai, Tianjin and Wuhan apply the "sponge city" approach using nature-based solutions that, like sponges, absorb water for later use, prevent flooding and cool the cities at the same time. Key measures include large green spaces and parks, as well as improved water management using urban rivers and mangroves. The approach has since spread to cities in other parts of the world, including Cardiff (Wales) and New York (USA)⁵⁹.

The Asian Development Bank has collected experiences and identified barriers to the use of sponge cities. Shifting political priorities are an obstacle to ensuring ongoing and long-term investment in climate adaptation. Funding for pilot projects is often limited and sponge city measures are often implemented on a small scale. This means that the measures do not have sufficient impact and coverage.

In addition, nature-based solutions require continuous operation and maintenance after establishment. This requires long-term thinking when planning and financing solutions. In Chinese sponge cities, the experience is that they have not succeeded in allocating responsibilities in local administrations⁶⁰.

Other cities have adopted and implemented plans to plant more trees and establish green corridors. Trees can play a role to several different targets, as trees can contribute to climate resilience, CO₂ storage, improved air quality and increased well-being, among other things. Trees are highlighted as a simple but effective way to achieve protection from high temperatures in cities, as evaporation and shade from trees have a cooling effect.

In 2016 in Medellín, Colombia, the establishment of 30 green corridors through the city began. After just three years, the surface temperature in the city was reduced by 2°C. In addition, the corridors were established to promote biodiversity and improve air quality. Melbourne, Australia, has adopted an Urban Forest strategy that aims to increase the area of urban tree canopy cover from 22% to 40% by 2040. Besides cooling the city, the tree strategy focuses on the diversity of tree species. In recent years, Freetown, Sierra Leone, has been hit by several severe climate events, and the consequences of these events have been exacerbated by deforestation. In Freetown, tree planting is now part of minimizing the risk of flooding and landslides. Since 2020, Freetown has planted more than 500,000 trees, prioritizing high-risk and low-income areas⁶¹.

The World Resources Institute founded the [Cities4Forests](#) program, which supports cities around the world to protect, restore and maintain forests in and around cities. The alliance assists in policy development, citizen engagement, and technical and economic analysis. Cities4Forest works on a wide range of projects, including climate adaptation, water resources protection and improving local people's access to green spaces⁶².

In Cape Town, South Africa, nature-based solutions have been used to mitigate drought, water shortages and high temperatures. By propagating native species, Cape Town has succeeded in protecting drinking water reservoirs and reducing the risk of wildfires⁶³. In addition, water spray parks have been established in low-income areas prone to high temperatures. The parks can both help city residents to cool off and serve as recreational zones⁶⁴.

Several cities are systematically increasing green infrastructure and urban design. In Toronto, Canada, large development projects are required to install a minimum area of green roofs. Barcelona, Spain, has developed guidelines for citizens to support local initiatives for more green roofs that can collect rainwater, promote biodiversity and create community spaces. Rotterdam, the Netherlands, is in the process of converting the roofs of public buildings into green roofs and is also providing support to private actors who want to establish green roofs. Public squares are also being transformed into rainwater basins that can retain large amounts of rainwater. When the squares are not flooded, they offer recreational activities and serve as meeting places for the inhabitants.⁶⁵.

During COP28 in December 2023, [The Urban Nature Program](#) was launched. The program is co-led by the World Bank in partnership with the World Resources Institute, International Union for Conservation of Nature (IUCN), C40 Cities and the European Commission, among others. The program aims to support policy development, financing and implementation of nature-positive development in cities and regions. The program showcases lighthouse cities that exemplify global leadership and will build a pipeline of ambitious cities that intend to leverage green urban infrastructure and nature-based solutions to address the impacts of climate change.



3.4 NATURE-BASED SOLUTIONS IN DENMARK

In Denmark, the concept of nature-based solutions has not previously been clearly defined. Nor has the concept been integrated at a national level in legislation, strategies or plans⁶⁶.

Despite the lack of implementation and use of the concept of nature-based solutions, there are several national initiatives, especially related to the environment, that meet IUCN standards. However, these are not targeted at cities. Instead, similar concepts such as green-blue infrastructure dominate. However, due to pressure from the EU, it is expected that nature-based solutions will be prioritized by decision-makers in the future.

At the municipal level, however, nature-based solutions are mentioned in the Danish climate action plans, climate adaptation plans, municipal plans and other plans, especially in relation to water management and biodiversity. Many Danish municipalities and cities have already implemented nature-based and multifunctional solutions that help mitigate climate-induced challenges while creating attractive urban spaces and urban areas. We take a closer look at Danish experiences in the next section.



NATURE-BASED SOLUTIONS IN DANISH CITIES

Many Danish cities are leading the way in creating more climate-resilient and sustainable urban communities. Through projects with nature-based solutions, urban areas, urban spaces and roads have become more resilient to extreme rainfall, rising seawater, rising groundwater and loss of biodiversity as well as greener and more attractive for both citizens and wildlife.

Vejle, a coastal city, has adopted the strategy of inviting the water into the city by channeling it through canals to ponds, lakes and green urban spaces. Vejle is located between Vejle Fjord and river valleys, and the city is threatened by rising water levels and storm surges. Water is part of the city's identity and qualities, but at the same time poses a huge challenge. Climate resilience and water management is the focal point of *Fjordbyen* (City of the Fjord), one of the lighthouse projects in Vejle's resilience strategy from 2016. Safety and security for vulnerable road users, a safe urban environment and good quality urban spaces for everyone are some of the sub-goals that have been incorporated into the strategy based on citizen dialogues.

Copenhagen has used nature-based solutions as part of the city's climate adaptation initiatives for many years. The City of Copenhagen Cloudburst Management Plan 2012 kickstarted 300 cloudburst projects targeting roads, squares and parks and aiming for surface solutions that increase green and blue elements in the city. *Klimakvarter Skt. Kjelds* (Climate Neighbourhood St. Kjelds) is the first and most well-known cloudburst project in Copenhagen, which shows the way to a climate-resilient and green city with nature-based solutions. In addition, *Fremtidens Gårdhaver* (Courtyards of the Future) are well-known demonstration projects for nature-based solutions in Copenhagen.

KlimaByen (Climate City) in Middelfart is another of Denmark's major demonstration projects that uses nature-based solutions for climate adaptation. The solutions have multiple functions and contribute to making everyday life greener, healthier and more enjoyable for the citizens. Rainwater is considered an asset and green urban spaces have been created by establishing rain gardens placed in the roadside that also serve as traffic harassment. Several of the solutions have been developed in collaboration with the local residents.

In Randers, a 74 meter long and 10-meter-wide rainwater basin has been established along the city's main street Østervold. The basin is surrounded by green beds with various perennials, a "lake bank" with water purification plants has been established and trees have been planted with better growing conditions than the previous trees. In addition, wooden terraces have been established at each end of the basin for seating and outdoor dining, and small green seating areas have been made along the basin, which have been very popular since the opening of the project.

In Billund, a more natural course of the stream has been restored in connection with the LEGO HOUSE Experience Centre. The project has created three new squares in the city center that can handle rainwater in both everyday situations and during cloudburst events and act as a fauna passage through the city. The squares provide the opportunity to stay close to water and the water becomes a resource, an aesthetic element and part of the playfulness and learning that is one of the characteristics of Billund – home to the *Capital of Children*.

In Kokkedal, a flooding of a single-family home area became the starting point for a large climate adaptation project that would both delay rainwater on its way to the creek Usserød Å and make the area safer. The project consisted of 35 sub-projects that, among other things, created new green spaces including a water garden, water basin and facilities inspired by amphitheaters. Moreover, a dead parking lot was transformed into a green activity place for all age groups. Another project broke with the district's long, straight paths that could feel unsafe. Today, Kokkedal is a greener and safer place to live, move and spend time, partly because of the complex strategic project.

Frederiksberg is an example of how to manage rainwater and promote biodiversity on a city street level. A “water delay road”, Bülowsvej, is one of the cloudburst projects in the municipality, ensuring that rainwater does not infiltrate into the ground before running into the sewer. Instead, water is collected in a green swale that provides good growing conditions for plants to the benefit of insects, birds and residents alike. In addition to managing rainwater, the project has given the area a green renovation with a varied and natural planting scheme designed to optimize living conditions for bees and other pollinators.

The number of Danish cities and municipalities working with nature-based solutions is long. The key message is that nature-based solutions are used strategically by subnationals to solve multiple challenges at the same time. When investing in expensive climate projects, co-benefits and multifunctionality should always be a central part of the solutions.



3.5 MULTIFUNCTIONALITY

The multifunctionality and effectiveness of nature-based solutions in generating co-benefits that increase urban liveability, carbon storage and resilience to climate change are driving the increasing use of nature-based solutions in cities. The co-benefits include a wide range of environmental, social and economic benefits for people, including physical and mental health and climate regulation, as well as a range of benefits for nature and its ecosystems. The multifunctional approach and co-benefits that nature-based solutions generate often make them more cost-effective and impactful climate actions than traditional solutions⁶⁷.

Due to the cooling effect from tree shade and evaporation, the average surface temperature in green urban spaces is between 8-12°C lower compared to surrounding urban areas.

A study across several European countries has shown that for people living in very green areas, the likelihood of being more physically active is more than three times as high, and the likelihood of being overweight and obese is about 40% less.

A report by the World Economic Forum (2022) estimates that the trees in the world's ten largest cities are worth \$482 million annually in reduced healthcare costs alone due to their ability to reduce air pollution.

REDUCTION OF THE HEAT ISLAND EFFECT

Nature-based solutions in cities increase urban vegetation such as street trees, parks, green facades and roofs, that help to mitigate the heat island effect and lower temperatures in both public and private areas of the city. Increased shading and evaporation are the primary mechanisms that help reduce the surface temperature, which is crucial for staying comfortable when moving outdoors and for keeping temperatures low inside buildings.

Due to the cooling effect from tree shade and evaporation, the average surface temperature in green urban spaces is between 8-12°C lower compared to surrounding urban areas⁶⁸. This temperature-regulating effect is particularly effective in cities, where the cooling effect of trees is greater than in rural areas⁶⁸. The effect of urban green spaces also extends beyond their own areas and can create a cooling 'belt' that reaches further afield. A study of a central park in Madrid found a temperature reduction of 1.6°C at 130 meters and 0.9°C at 280 meters from the park⁶⁹. The range of the cooling effect is greatest in larger contiguous areas, but even small green spaces have a proven temperature-regulating effect.

Green facades and roofs can also significantly reduce the surface and indoor temperature of buildings, especially by minimizing the heat absorption of surfaces. If green facades and roofs are established in cities on a larger scale, they can reduce the surface temperature of cities by up to 3°C⁷⁰. A study from New York shows that the average surface temperature of roofs was 19°C lower on green roofs compared to standard roofs, resulting in the temperature inside buildings being 2°C lower on average compared to buildings without green roofs⁷¹.

FLOOD PROTECTION

Urban parks, green roofs and green and blue stormwater treatment facilities help manage both stormwater and wastewater in cities. They can act as a buffer and reduce rainwater runoff, reduce surface flooding, reduce pollution of runoff and are often more efficient than traditional solutions.

Nature-based solutions also have the potential to act as coastal and storm surge protection against flooding, where, for example, seaweed belts, coastal vegetation and natural dikes can protect against rising water levels and damages caused by waves⁴⁴.

In the period 2007-2011, Singapore reduced the size of flood-prone urban areas from 3200 to 32 hectares by transforming gray water infrastructure such as canals and reservoirs into green and blue areas, streams and lakes that were integrated into the city⁷². This resulted in an estimated annual water saving equivalent to US\$ 390 million, while creating recreational areas with increased biodiversity, improved water quality and enhanced quality of life for city residents.

Green roofs can retain rainwater in densely built urban areas and assist sewage systems. A study from the UK shows that on average, each green roof retains 34% of the rainwater and reduces peak runoff by 57%⁷³. The same study also estimates that green roofs can reduce annual runoff by 300 mm compared to runoff from conventional roofs.

In Italy, nature-based solutions in the forms of urban green spaces and urban wetlands have been found to reduce the risk of downstream flooding by 10% compared to gray stormwater solutions⁷⁴.

In general, there is evidence that nature-based solutions are cost-effective for stormwater management^{75, 76}, especially in cities facing modernization or upgrading of existing infrastructure⁴⁴.

HEALTH

Green and blue urban spaces generate important mental and physical health benefits. Access to natural areas is statistically associated with reduced mortality and better health⁷⁷. The quality of green space is more important than the size of the area, especially to mental health⁷⁸. The link between mental health and nature can be explained by the concept of biophilia, which describes a person's connectedness to nature.

Access and connectedness to nature is believed to reduce recovery time during hospitalization⁷⁹, increase immune system function⁸⁰ and reduce the risks of diabetes, heart disease and depression⁸¹. A study conducted in nine Swedish cities found that the more time people spend in urban nature, the less stressed they are, regardless of gender, age and socio-economic status⁸². Learning ability, memory and mental focus are also affected by nature. In a study from Stanford University, participants who spent 50 minutes in nature performed significantly better on a number of cognitive tests than participants who did not have the same exposure to nature⁸³.

There are clear indications that urban green infrastructure is an important resource for public health, as nature both motivates and enables people to be physically active⁸⁴. Green infrastructure and transportation corridors promote active modes of transportation by making routes more attractive and inviting.

A study across several European countries has shown that for people living in very green areas, the likelihood of being more physically active is more than three times as high, and the likelihood of being overweight and obese is about 40% less⁸⁵. A national study from Finland found a strong correlation between physical activity in nature and mental well-being, while no significant correlation was found when the same activity was performed indoors⁸⁶.

WATER AS A RESOURCE AND CLEAN DRINKING WATER

Nearly a third of the world's 105 largest cities rely on nearby natural areas to provide drinking water⁸⁷. Therefore, protection and sustainable management of these water catchment areas are crucial.

Nature-based solutions in cities create the opportunity for rainwater to be seen as a resource and encourage reuse. For example, cities can minimize their resource consumption by using rainwater to water plants or purify and use it for laundry instead of groundwater.

Mexico City, a city of 22 million people, is currently experiencing water shortage. This is due to a combination of geography, urban development, inadequate infrastructure and climate change. In recent years, Mexico City has experienced significantly less rainfall, longer periods of drought and high temperatures. Several neighborhoods are without water and authorities have imposed restrictions to save water. It is feared that the city is approaching 'Day Zero' by June 2024, the day when the city will run out of water⁸⁸.

In the period 2015-2018, Cape Town was also approaching 'Day Zero' when the city was hit by a drought equivalent to a 400-year event. Government authorities responded to the water crisis by minimizing losses in the water supply and significantly reducing the population's water consumption through campaigns. Among other things, locals were encouraged to take short baths and avoid using water for garden irrigation⁸⁹.

BIODIVERSITY

Nature-based solutions, and in particular native species, can provide benefits to local biodiversity. A study from Melbourne, Australia, found that increasing vegetation from 10% to 30% increased the number of bats, birds, bees, beetles and insects by up to 130% and had a particularly large impact on native fauna⁹⁰. The latter is interesting because native fauna especially is challenged in cities⁹¹ whereas non-native, exotic and invasive species are more likely to thrive in cities⁹².

While urban nature can help promote biodiversity, efforts in cities should not be at the expense of biodiversity initiatives at larger national and regional scales. Vast contiguous areas have the potential to increase biodiversity and create valuable habitats that protect against the direct and indirect impacts of urbanization on biodiversity^{93, 94}.

NATURE EDUCATION AND CONNECTEDNESS

An EU survey (2019) shows that Danes know the least about biodiversity compared to other nations in EU⁹⁵. The Danish Biodiversity Council emphasizes the importance of nature connectedness, which is related to learning about nature.

The Danish Biodiversity Council sees increased knowledge and awareness of biodiversity as crucial for us as a society to become better at caring for and appreciating nature in general. The opportunity to see, experience, protect and restore nature and biodiversity is important for nature connectedness⁹⁶.

While the biodiversity crisis cannot be solved with urban nature, nature-based solutions in cities have the potential to create a more biodiverse local environment. From this perspective, cities play an important role, as most Danes live in cities. In this way, the relationship between people and nature can be strengthened, and hereby, our ability to take better care of nature, both inside and outside of cities⁹⁷.

EMISSIONS REDUCTION POTENTIAL

IPBES, an international nature and environmental organization, estimates that nature-based solutions worldwide can contribute 37% of the reduction efforts needed until 2030 to reach the Paris Agreement targets^{98, 99}. In Mexico City, which has approximately 35,000 m² of green roofs, it is estimated that each square meter of green roof stores 1 kg of CO₂ per year¹⁰⁰. Another study shows that the CO₂ payback time of green roofs are between 5-15 years after installation, meaning that green roofs then begin to store more CO₂ than emitted during their production¹⁰¹. In addition, there are emissions reduction potential of greenery compared to gray infrastructure, as building materials and construction processes have a significant climate footprint.

Nature-based solutions can play an important role in reduction efforts, but more urban nature and nature-based solutions will not solve the climate crisis alone. However, connectedness to nature is crucial for our understanding of the climate crisis and for shifting our behavior toward a more climate-friendly path.

A literature review from Harvard (2021) shows that the more time we spend in nature, the more environmentally friendly we become in both attitudes and actions¹⁰². This emphasizes the importance of increasing urban nature, which has the potential to reach a large part of the population. Hereby, the emissions reduction potential of nature-based solutions goes beyond their direct impact.

AIR POLLUTION AND NOISE

Trees and vegetation along streets can reduce both noise^{103, 104} and particulate pollutants. The latter is the air pollutant with the highest global health impact¹⁰⁵. A report by The Nature Conservancy and C40 Cities (2016) estimates that street trees can reduce the concentration of air pollutants by up to 37%¹⁰⁶.

Trees can also reduce ozone concentration in cities¹⁰⁷ and indirectly affect air quality through reduced emissions from energy production due to shade and thus reduced need for air conditioning¹⁰⁸. However, it is important that urban planners choose tree species with low allergen pollen production and high air pollution uptake, otherwise they can exacerbate the problem¹⁰⁸.

ECONOMIC BENEFITS

Nature-based solutions are particularly interesting in an urban context as countless needs and interests are competing for urban land. Therefore, maximizing value per square meter is ideal, which becomes even more important in the light of global urban population growth and densification.

Nature-based solutions are generally cheaper and less resource-intensive to implement than traditional gray infrastructure. In addition, they generate environmental and social co-benefits making them economically beneficial in the long term⁶⁷.

A report from the World Economic Forum (2022) estimates that nature-based solutions are 50% more cost-effective than gray alternatives¹⁰⁹ and that trees in the world's ten largest cities are worth US\$ 482 million annually in reduced healthcare costs alone due to their ability to reduce air pollution¹¹⁰.

Nature-based solutions can also create local employment and business opportunities. In a report by WRI (2021), ecosystem restoration is the most job-creating investment of all investment types¹¹¹. Singapore's first Prime Minister Lee Kuan Yew, who introduced the city-state's Garden City vision, called the greening of Singapore "the most cost-effective project he ever launched"¹¹².

Property values often increase when green and blue spaces expand and improve urban environments^{113–115}. However, it should be noted that nature-based solutions and green initiatives can contribute to urban gentrification processes that reinforce inequalities^{113, 114}. It is therefore important to involve the local population in nature-based projects¹¹⁶.

3.6 BARRIERS AND ENABLERS OF NATURE-BASED SOLUTIONS

Cities should be frontrunners creating more nature of high quality. Nature has both aesthetic value and a wide range of functions that generate co-benefits for society. There is growing interest in the potential of nature-based solutions in cities, but implementation on a larger scale is not something that happens by itself. Nature-based solutions need to be planned, financed and established, which requires local communities, consultants, contractors, municipalities and national authorities to work together to make it happen.

Collaboration between actors, both within and across sectors, is highlighted as the most important enablers of successfully implementing nature-based solutions in cities⁵². Nature-based solutions address challenges that affect many stakeholders; hence partnerships are needed to ensure a fair process. The involvement of citizens and local stakeholders in development process is essential to create successful solutions, increase trust in local authorities, strengthen citizens' sense of responsibility for nature conservation and promote climate-friendly behavior. Partnerships can add financial resources and skills to a project and ensure that important perspectives are considered in planning processes, thereby increasing legitimacy.

However, we need to get used to urban nature often looking differently when high ecosystem function is the focus and that, for example, dead trees in green urban spaces are not merely a result of poor management. In this context, participation is also necessary, as knowledge can help shifting norms and our understanding of nature and what nature can and should look like.

Nature-based solutions are based on complex systems and require new skills and ways of operating. From a functional perspective, working with nature sets new requirements for the disciplines involved in urban development and demands a more transdisciplinary and holistic approach than before.

Uncertainty about implementation is one of the biggest barriers to the use of nature-based solutions. This is partly due to nature-based solutions being a quite new concept and research and evaluations having had academic focus in particular⁵². As nature-based solutions are breaking away from "urbanization as usual" and instead take natural systems as their starting point, there is a need for competence building at all organizational levels, from management to planners to operational staff.

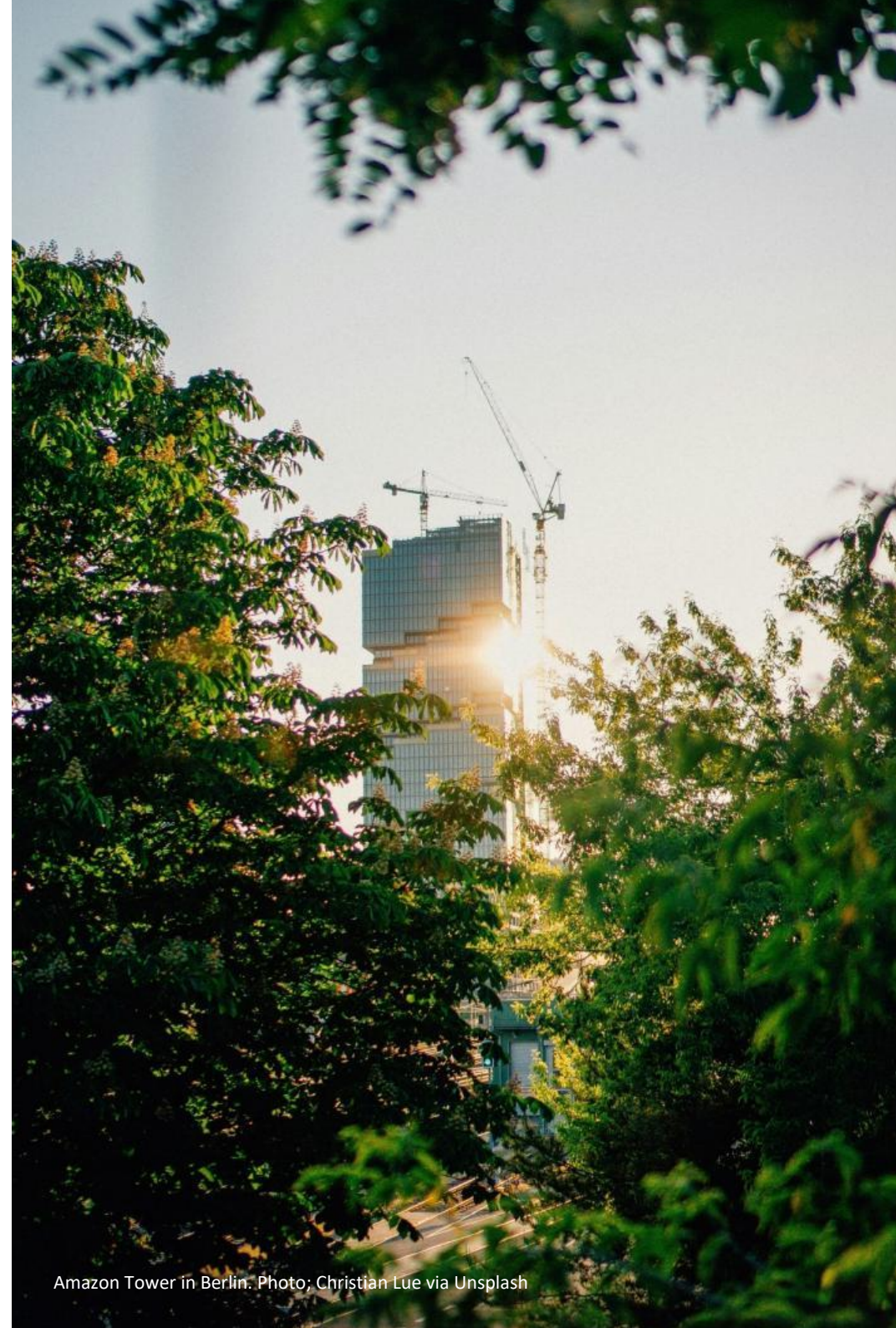
Nature-based solutions are context-dependent and systemic and cannot be applied as universal solutions without considering the social contexts and ecosystems they are part of. Thus, there should be an increased focus on data, documentation and evaluation, which should also be reflected in project funding. This can be used to promote nature-based solutions, quantify their effects and share best practice experiences.

Project development including nature-based solutions also places new demands on consultants, who must increasingly include specialists, work across disciplines and take the local context into account. Nature-based solutions may require more nature-like operations to ensure their functionality, which calls for new practical skills and adjustments in operation budgets.

For example, there may be a need for new skills in relation to selection of plants and greenery or knowledge about climate change impacts on ecosystems. It is particularly problematic when nature-based solutions are challenging existing systematized operations. An example is road trees that can collect and clean rainwater but at the same time the trees cannot tolerate road salt and therefore need special management.

There is a need for a holistic understanding of nature-based solutions, the systems they are part of and the new practices and skills they require. Developers and project owners also need to know what requirements to set and how to ensure that projects deliver the required services. Projects should not only be evaluated based on their construction and project development costs but should also consider the long-term benefits they generate.

This is especially difficult in organizations working in silos where budgets and funding are kept separate. Urban nature-based solutions generate benefits and economic value across sectors but are rarely co-funded. In general, nature-based approaches are both undervalued and underfunded in urban development^{44, 117, 118} accounting for only 0.3% of global urban infrastructure investment in 2021¹⁰⁹. This is partly because the impact of nature-based solutions is harder to quantify, especially in relation to multifunctionality, and their impacts are generally less documented.



3.7 FROM SOLUTIONS TO THINKING

Despite the obvious advantages and co-benefits that nature-based solutions bring into cities, their use could be much more widespread. While more examples of nature-based solutions in cities continue to emerge, the focus is often on practical implementation and solutions are individual projects rather than systemic initiatives^{42, 119}.

Projects with nature-based solutions can be useful in addressing local challenges, creating awareness and valuable lessons learned, but working with urban nature on an ad hoc basis will not enable the transformation needed. Only through a systemic approach can the interaction between climate challenges, ecosystems, solutions and those who grant, plan and manage urban projects take solutions to the next level.

Nature-based urban planning requires us to think across sectors and disciplines, incorporating nature from the start and see urban greenery in a new perspective. Working with nature-based solutions is not just a matter of implementing individual solutions, but instead requires us to change the way we think, design and proceed when developing our cities.

Nature-based thinking is a new mindset that challenges our priorities and routines when working with nature in the city. Focusing on an integrated and long-term approach, nature-based thinking advocates working with processes rather than with projects. In the next chapter, we take a closer look at nature-based thinking.

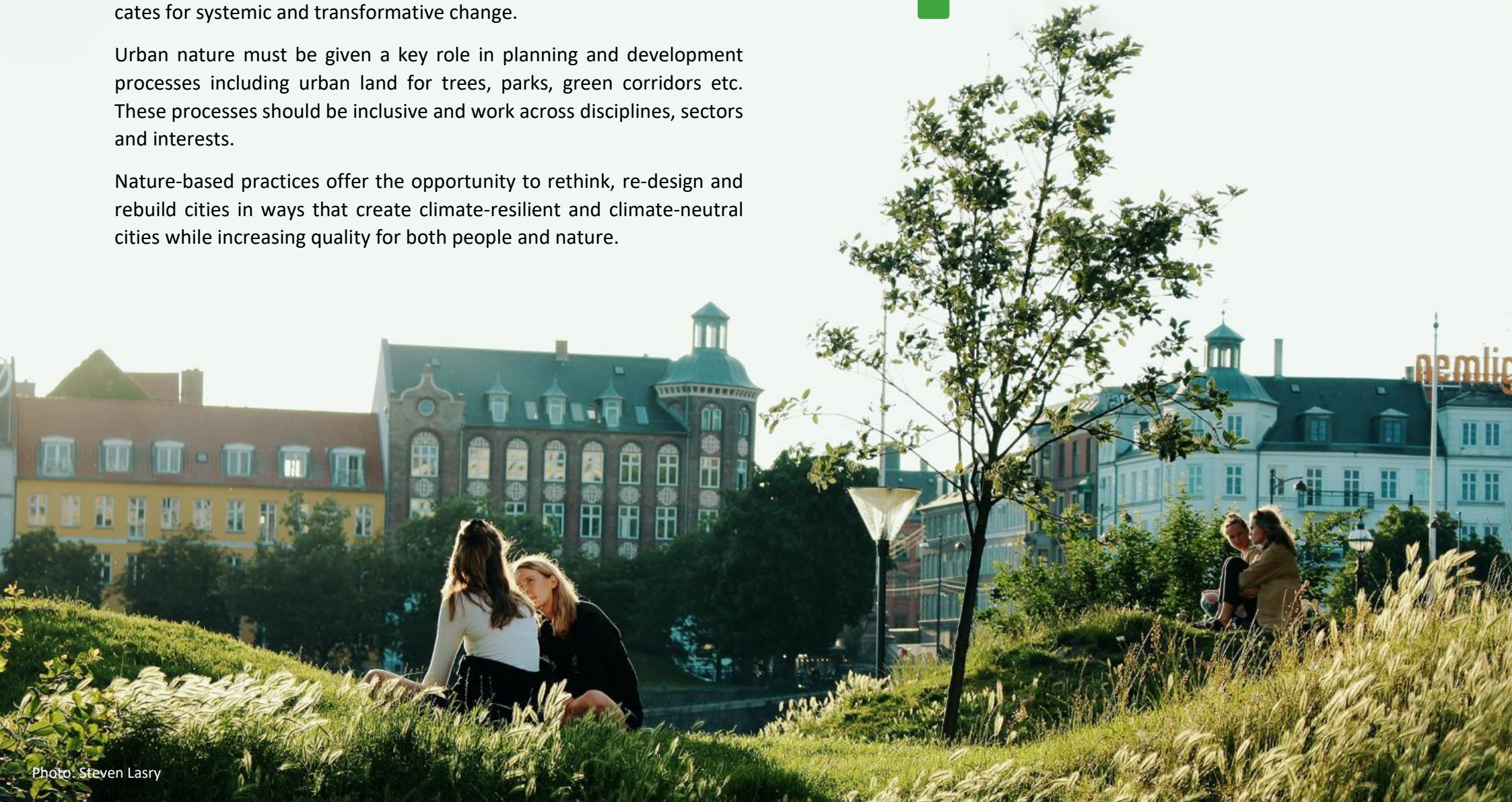
THE NATURE-BASED CITY

4

Cities serve as hubs for development that enable them to act as front-runners and effectively address a wide range of social, economic and environmental issues. With *nature-based thinking*, cities can be advocates for systemic and transformative change.

Urban nature must be given a key role in planning and development processes including urban land for trees, parks, green corridors etc. These processes should be inclusive and work across disciplines, sectors and interests.

Nature-based practices offer the opportunity to rethink, re-design and rebuild cities in ways that create climate-resilient and climate-neutral cities while increasing quality for both people and nature.



4.1 NATURE-BASED THINKING

If politicians, planners, developers and citizens are to truly embrace nature and its potential, radical change is needed to move beyond approaches that focus on individual projects and human needs. Nature-based solutions must be placed within a more holistic framework for development, design and management of our cities.

Nature-based thinking is one way to achieve this. To ensure that nature-based solutions deliver the desired benefits for both people and ecosystems, it is necessary to take a holistic approach to sustainable urban planning and development.

In this section, we unfold nature-based thinking as a mindset and foundation of creating sustainable nature-based cities.

NATURE-BASED THINKING AS A MINDSET

Nature-based thinking as a mindset was introduced by Randrup et al. (2020) as an attempt to support and strengthen the use of nature-based solutions and create a more transformative mindset¹²⁰. Nature-based thinking is described as:

"...an approach to urban inclusive planning, being inspired by nature to act socially, environmentally as well as economically in the transition towards sustainable cities."

- Randrup et al (2020)

The starting point is to balance social and ecological values in inclusive planning processes. A balanced socio-ecological relation recognizes the importance of long-term perspectives. Nature requires space and time to develop and thrive, and relationships with local communities should not be limited by short-term projects and engagements.

The organizations responsible for urban development are to foster and coordinate long-sighted perspectives. This includes a shift from standard investment procedures focusing primarily on the construction phase to planning for and financing long-term place-keeping of urban spaces. Randrup et al. see the interaction between urban developers, nature and local communities as the core of developing more sustainable cities.

To understand nature-based thinking fully, we have defined a number of characteristics based on Randrup et al. (2020).

Nature-based thinking is:

1. Systemic, transformative and long-sighted
2. Locally embedded and inclusive
3. Transdisciplinary and cross-sectoral

1. Systemic, transformative and long-sighted

If we are to work nature-based, we need to prioritize nature and build in more space for ecological processes. At the same time, our ideas of what cities and urban nature are – and what they should look like – must change and expand. A nature-based approach is both systemic and transformative. It challenges traditional development and management of cities and requires new skills and ways of organizing.

Today, nature is adjusted and customized to fit within our cities and often as a supplement if we find the space, both physically and in the budgets. For a long time, urban nature has been recognized mainly for its aesthetic values. Nature-based thinking emphasizes that urban nature also has functional and intrinsic values and can contribute to

more sustainable cities with good quality of life for both people and ecosystems. Therefore, the view on nature needs to change. We need to prioritize nature as we prioritize other societal values. We need to secure favorable environmental conditions that enable urban nature to work for both people and ecosystems, not least biodiversity - even if it means letting go of control and changing our ways of working.

This can only happen if we broaden our understanding of nature and recognize that nature has values regardless of its ability to be functional and provide services to humans. Nature-based thinking assumes that nature's needs are equally important as human needs.

Nature and local communities should be included as part of long-sighted urban development and management to create climate-resilient and sustainable cities for both people and nature. This challenges the way urban nature is often governed, managed and instrumentalized. Prioritizing more diverse urban nature requires different ways of working and new skills. Moreover, budgets and financial models need to be expanded to not only include the construction phase but also the long-term management. A systems thinking approach requires increased collaboration across administrations and sectors. In the long term, working transdisciplinary and cross-sectoral has the potential to promote more sustainable urban development.

2. Locally embedded and inclusive

A nature-based approach should be locally embedded, inclusive and pay attention to the relationship between nature and people. This is to be understood in two ways:

1. Nature must be prioritized and included so that ecological values are weighted and considered equally important as other societal needs and

values. This requires a more holistic understanding of nature recognizing that we interact with an unpredictable nature and that nature needs space to develop on its own terms. This requires future urban development to focus on a long-sighted and dynamic relationship between nature, places and people.

2. Local communities must be involved to ensure a locally embedded and just transition for both people and nature. Nature-based thinking involves co-creation and attention to the local ecological, social and cultural context. To strengthen the relationship between local communities and urban nature, local stakeholders should be involved in the initial planning and later in the day-to-day operations and management of urban green spaces. To achieve this, private developers, public authorities and citizens need to work together.

3. Transdisciplinary and cross-sectoral

A systemic and inclusive thinking include a transdisciplinary and cross-sectoral approach to planning, design, construction and long-term management of urban nature. Such an approach challenges the way cities are traditionally planned and operated and requires dialogue, training and new skills.

Collaborating across sectors means that different administrations focusing on, for example, mobility, welfare, water infrastructure, health and green space shaped by their different expertise and disciplines come together to coordinate and integrate holistic and multifunctional nature-based solutions in the city.

Nature-based solutions can be used to address multiple concerns and interests. Therefore, evaluation and monitoring should consider more elements than recreational and aesthetic values. Visions for urban

nature and cities in general must embrace values across sectors and not just focus on green technical facilities. For the same reason, co-funding could support a more comprehensive implementation of nature-based solutions. Securing long-term funding is a prerequisite for success.

Working in a transdisciplinary and cross-sectorial way means that all parties - planners, consultants, developers, operational staff and local communities - work together to create shared visions and integrated solutions for cities and urban nature. It requires city authorities to be open and able to manage unpredictable participatory processes and outcomes.

Along the way, opportunities and challenges may arise and it is important to stay focused on the long-term vision. Processes often has stronger community support than specific solutions. It is possible to actively involve citizens in the management and care taking of green and blue areas. However, this requires that citizens have or acquire green skills to care of nature according to nature’s own principles.

Hence, capacity building is another focal point of nature-based thinking. This is because both practices and organizational structures are different due to a transdisciplinary and long-sighted approaches. Therefore, focus should be on capacity building and expanding transdisciplinary skills of various groups such as urban planners, project and construction managers, contractors and operational staff.

Long-sighted nature-based solutions rely on more nature-like development, construction and day-to-day operations. In addition, it is necessary to understand the systems in which the solutions are embedded and include all affected stakeholders and perspectives from the beginning.

SUMMARY

Nature-based thinking is a new approach that challenges the typical focus and purpose of nature-based solutions. Nature-based thinking is a *mindset* that - inspired by nature - aims for a radical, large-scale and long-term commitment to sustainable cities rather than isolated, human-centered solutions.

Based on the previous sections, this report understands nature-based thinking as:

NATURE-BASED THINKING

"Nature-based thinking is a systemic prioritization of nature and the socio-ecological systems it is part of. Inspired by nature, societal challenges can be effectively addressed to achieve equitable benefits for both nature and people."

THE POTENTIAL OF NATURE-BASED THINKING

Nature-based solutions have the potential to transform our cities while at the same time addressing urgent societal issues. In this perspective, it is important to steer cities towards a more sustainable, inclusive and equitable path benefitting both people and nature.

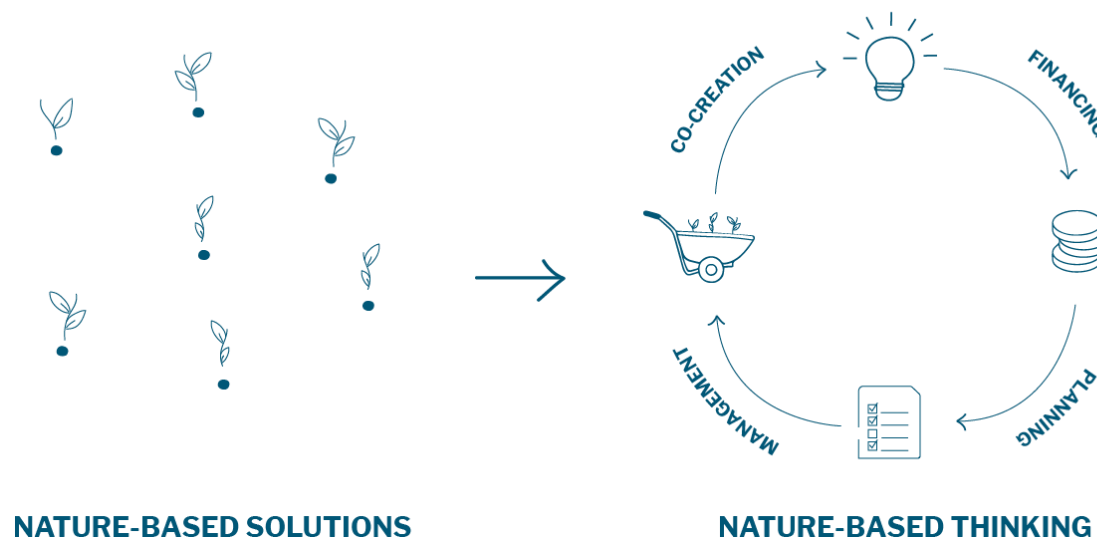
Nature-based thinking is a new mindset that attempts to move nature-based solutions beyond the human-centered and solutions discourse. At the same time, it poses a shift from focusing on the individual project to the overall vision for our cities. This involves recognizing that the way we organize, how we involve local communities, and how our view of nature are all interconnected dimensions.

"It's really about changing routines. We need to do things differently. We all need to exercise more long-sighted and process-oriented thinking."

- Randrup (2024)

It is important to emphasize that urban nature alone cannot avert the biodiversity crisis. Here, large areas outside of cities play a crucial role, but urban nature can help promote biodiversity and a wide range of co-benefits that create better and healthier cities. This is important because more and more people will be living in cities in the future. In addition, proximity to nature can strengthen people's connectedness to and caring for nature.

As a mindset, nature-based thinking is not fully developed and there is no one-size-fits-all way to put this new thinking into practice. But as a mindset, it can provide a strong basis for critically examining traditional urban planning and development and setting a new, greener and more inclusive discourse. For this reason, we see nature-based thinking at the core of developing the cities of the future and as an important part of achieving climate-resilient and climate-neutral cities.



BARRIERS TO NATURE-BASED THINKING

Nature-based thinking is a relatively new approach and there is still little experience from practice to draw from. Therefore, we have sought inspiration in articles and interviews with Thomas Randrup, professor at the Swedish University of Agricultural Sciences (SLU), who has contributed to the development of the new mindset.

According to Randrup, one of the obstacles to nature-based thinking lies in the organization of public administrations and business models behind the financing and management of urban green space. We are used to optimizing, streamlining, measuring, quantifying and controlling. This goes against the fundamental points that nature is unpredictable and that nature has intrinsic values that cannot only be calculated in monetary terms.

The values of nature for people are well-documented, but the long-term perspective - the management and place-keeping - is rarely prioritized when allocating resources for the many core services that cities must also handle, including eldercare, child and youth policies, integration and health. Policy makers continue to want to see evidence of the effectiveness of blue-green solutions, but this is challenged by the unpredictability of using nature as a solution or “instrument”.

Another challenge is that urban development projects often focus on the design and construction phases, while the local embedding of projects is rarely ensured or financed. Nature-based thinking requires long-sighted, vision-based political, organizational and financial action. A concrete example of this is that it should be possible to plan, design, construct and manage new nature-based solutions over a 10-year period. Planners, designers, construction firms and operational staff, possibly together with local residents, could form a new consortium. Based on a strong

WHAT ARE THE OBSTACLES?

- Multiple needs and interests competing for urban space
- Business as usual thinking and practices
- Silo mentality
- Time and resources for participatory processes
- Short-term perspectives in both visions and funding
- Lack of documentation reduces political support
- Legislative barriers
- Funding over 10 years is difficult to secure politically

vision, partnerships like this can ensure development, anchoring, growth and success. However, current organizational structures and regulatory frameworks put limits on such visions.

Nature-based thinking requires us to break with project and silo mentality. Nature and ecosystems do not adhere to administrative boundaries or disciplines, and we need to increase attention to processes and local contexts. If nature-based thinking is to be activated in the way we work, we face a major challenge of changing our routines.

Nature-based thinking is a *mindset*. This report is about taking a step back and consider our approach to cities and how we design and use them. Nature-based thinking is what we want to see the planning of future cities move towards. But how do we get there?

We'll take a closer look at this in the next chapter.

5 THE WAY FORWARD

How do we take the first steps towards integrating nature-based thinking into the way we develop, plan and manage cities? How do we turn visions into practice when nature-based thinking requires us to organize, think and work differently?

Five guiding principles for nature-based practices could be:

1. Recognizing the values of nature for both people and ecosystems.
2. Working systemically and strategically with nature in urban planning and development.
3. Prioritizing a locally embedded and inclusive urban development.
4. Ensuring capacity building at all levels.
5. Working across sectors and disciplines for climate-resilient cities.

In the following sections, we will take a closer look at each guiding principle and suggest how to work with them in practice. However, it should be emphasized that creating a tree policy or setting a target for biofactor, for example, are isolated initiatives that do not ensure a radical, large-scale and long-term effort for nature-based cities alone. Each of the initiatives described is just one of many steps on the path toward a new, nature-based urban planning and development.

Nature-based cities must be created by a wide range of actors, and in Denmark, municipalities play an important role as authorities and facilitators. Various initiatives can be implemented now, but there is a need to further develop the overall frameworks and processes for planning and urban development.



5.1 RECOGNIZING THE VALUES OF NATURE FOR BOTH PEOPLE AND ECOSYSTEMS

To recognize the values of nature for both humans and ecosystems, it is crucial to raise more attention and knowledge. In addition, we need to understand the values of nature as more than just financial calculations. Measures to clarify the importance of nature and strengthen the basis for nature-based planning can include:

- **HABITAT QUALITY AND PROTECTION IN PLANNING DOCUMENTS**

Habitat quality and protection can be incorporated into official strategies for planning and municipal and local spatial plans to clarify shared visions and land-use frameworks for cities and local areas.

- **VALUATION OF URBAN NATURE**

Prior to engaging politicians and developers on future urban development or urban transformation, the monetary value of green spaces, trees and urban nature can be estimated.

- **MAPPING ECOSYSTEM SERVICES**

Both private and public developers can be encouraged to map ecosystem services in potential project areas, describe the possible impact of urban development and plan monitoring of ecosystem services after project completion.

- **NATURE BOARD**

In urban development projects, a “Nature Board” of experts can be formed to assess projects and ensure favorable environmental conditions for nature and ecosystems.

VALUATION OF URBAN NATURE IN PRAC-

In 2023, senior researcher Toke Emil Panduro at Aarhus University and four Danish pilot municipalities developed a valuation tool that can calculate monetary estimates of the recreational values of parks and nature. The tool makes co-benefits visible and helps to find solutions that create the most welfare for as many people as possible¹²⁵.

MAPPING ECOSYSTEM SERVICES IN PRAC-

Lomma Municipality in Sweden maps ecosystem services and values of nature at the start of construction projects. By doing so, the municipality clarifies what values exist in the area and how they can be protected. Examples of ecosystem services and values of nature are recreation, important habitats and noise mitigation¹²⁴.

NATURE BOARD IN PRACTICE

In a case study of a Danish urban development project, a nature board of six biodiversity experts was set to qualify the landscape design. The inputs from the board influenced rainwater management, flora selection and the design of transitions between zones, among other things⁹⁷.

5.2 WORKING SYSTEMICALLY AND STRATEGICALLY WITH NATURE IN URBAN PLANNING AND DEVELOPMENT

Goals, requirements, and indicators can be used for systemic and strategic integration of urban nature. They can guide nature-based urban development and ensure continuous collection of knowledge. Providing space for nature to thrive and moving beyond project level to city scale are key to nature-based thinking. Measures to targeting and increasing urban nature can be:

- **REQUIREMENTS IN LOCAL PLANS**

Guidelines for the share of build-up and green area can be determined in local spatial plans that are developed for new urban areas.

- **TREE POLICY**

A municipal tree policy can protect existing trees, ensure diversity and set a concrete goal to increase the number of trees.

- **TREE CANOPY COVER**

The shade created by tree canopy cover has an impact on the local climate. A target can be set for how much tree canopy cover a city should have (percentage of the city's area).

- **THE 3-30-300 RULE**

On a strategic level, the 3-30-300 rule can be applied as it includes targets for trees in the city and proximity to green spaces. At the same time, the rule makes it possible to measure, evaluate and compare targets, both nationally and internationally.

TREE POLICY IN PRACTICE

In 2018, Frederiksberg Municipality adopted a tree policy. It contains goals such as protection of trees that are over 25 years old and ensuring that at least one tree can be seen from every home in the municipality¹²⁴.

THE 3-30-300 RULE IN PRACTICE

In 2021, Dutch professor Cecil Konijnendijk introduced an evidence-based rule of thumb for developing greener, healthier and more climate-resilient cities¹²⁰. The rule is called "3-30-300" and is based on urban forest in particular and how urban forest can help create better urban spaces. It is based on knowledge that links the visibility, presence, accessibility and proximity of trees and green spaces to climate adaptation and public health benefits.

The 3-30-300 rule has received much attention and several cities have formally or informally introduced the rule as part of their urban nature programs¹²⁰. The rule states that every citizen should have access to:

3 TREES VISIBLE FROM HOME



30% TREE CANOPY IN EVERY NEIGHBORHOOD



300 METERS TO THE NEAREST PARK



There are other examples of urban nature targets that can be used to develop climate-resilient, attractive and green cities, including:

- **GREEN SPACE PER CAPITA**

A target can be set for how much urban nature citizens should have access to on average (square meters per capita).

- **MAXIMUM DISTANCE TO URBAN NATURE**

Setting a concrete maximum distance to a green space of a certain size can promote a greener city and proximity to nature.

- **MINIMUM BIOFACTOR**

The biofactor of an area is a measure of how green it is. Setting a target for minimum biofactor can ensure a certain level of urban nature when planning new urban areas or projects, for example.

- **GREEN SURFACES**

Green surfaces can be green roofs, green facades and nature-based climate adaptation. Setting requirements for new construction projects or encouraging the construction of green surfaces can promote a certain level of greenery when planning and developing an urban area.

It is preferable to combine different objectives. However, it is important to be aware that *quantity* objectives do not necessarily promote the *quality* of habitats in an area (see quality of nature on page 44).

BIOFACTOR IN PRACTICE

The biofactor of an area can be calculated and there are different calculation models and scales. The basic principle is that different types of areas such as grass, scrub, trees and asphalt are assigned an amount of biofactor points based on how green the area is. The greener the area, the more points. In this way, the total score of an area can be calculated. In Berlin, there are minimum requirements for new residential areas. Using a scale from 0.0 to 1.0, the minimum biofactor requirement for new residential areas is 0.6¹²⁴.

GREEN SPACE PER CAPITA IN PRACTICE

Since 1973, local authorities in Germany have had common goals for public green space per capita. In Berlin, for example, the goal is 7 square meters of green space per capita¹²⁴.

GREEN SURFACES IN PRACTICE

Since 1986, Stuttgart has been subsidizing green roofs. As a result, the city has become a leader in the field with more than 2 million square meters of green roofs. Moreover, there are requirements for new buildings with flat roofs. If the roof is larger than 100 square meters, it is a requirement that the roof is green. In addition to green roofs, it is possible to receive grants of up to US\$ 12,000 for green facades¹²⁴.

5.3 PRIORITIZING A LOCALLY EMBEDDED AND INCLUSIVE URBAN DEVELOPMENT

It is important to prioritize high-quality nature and work for local anchoring both in the planning phase and the subsequent use and operation of the city's green spaces. Initiatives to strengthen nature quality and the link between nature and local communities can be:

- **MINIMUM QUALITY OF NATURE**

The quality of nature in an area is an expression of the quality level of natural spaces and habitats. Examples of elements that can be included in targets for nature quality are individuality, climate adaptation, biodiversity and recreation. Setting a minimum target can ensure a certain quality of nature when planning new areas or projects, for example.

- **CITIZEN INVOLVEMENT IN DEVELOPMENT OF PLANS**

Involving citizens and local associations in urban development can create locally situated plans that protect and promote urban nature.

- **GREEN COMMUNITIES**

Space for nature and communities can be incorporated into the development and transformation of urban spaces. Projects that promote urban nature often provide the foundation for green communities. For example, urban gardens, reorganizing areas into wild nature or blue and green areas for climate adaptation.

QUALITY OF NATURE IN PRACTICE

The City of Copenhagen works with a greening tool that includes both a biofactor and quality of nature. The biofactor is weighted with achieved quality of nature, which includes individuality, climate adaptation, biodiversity and recreation. In this way, Copenhagen assesses both the amount and quality of nature created in the city¹²⁴.

CITIZEN INVOLVEMENT IN PRACTICE

Since 2011, authorities in Melbourne have been working closely with local communities to develop strategies and action plans for trees in Melbourne's ten districts. The process has received a lot of interest, and alongside the *Citizen Forester Program* has been developed. In this program, citizens can learn about and care for nature in the city through activities and workshops¹²⁶.

GREEN COMMUNITIES IN PRACTICE

The report *Climate Action Together (Klimahandling i fællesskab)* presents concrete suggestions for citizens, associations and local communities who want to initiate joint climate initiatives. It could be planting a Miyawaki forest or establishing a vegetable garden¹²⁷.



5.4 ENSURING CAPACITY BUILDING AT ALL LEVELS

Nature-based thinking may require new practices and approaches, and therefore new skills. Measures to ensure the necessary skills in both development, planning and management of cities can be:

- **CONDITIONS IN TENDER DOCUMENTS**

Tender documents may require the tenderer to account for the competencies of the operational staff in nature-based care and continual upskilling.

- **TRAINING IN NATURE-BASED CARE**

Both operational staff and citizens involved in the management of green and blue areas can be trained in more nature-like operations.

- **EDUCATION OR UPSKILLING**

Different groups such as urban planners, project and construction managers, contractors and operational staff can build and expand their skills to promote nature in the city through planning and operations.

CONDITIONS IN TENDER DOCUMENTS IN PRACTICE

Aarhus Vand A/S has focused on how the management of their areas can increase biodiversity. Their tender for green maintenance and operation from 2023 includes requirements for the competencies of future employees. In addition to relevant professional skills and experience, the supplier must present a plan for upskilling. This can be achieved through education, knowledge sharing and skills upgrade courses. In this way, Aarhus Vand A/S strive to ensure continued increase of biodiversity and that employees are updated with knowledge and ideas¹²⁸.

5.5 WORKING ACROSS SECTORS AND DISCIPLINES FOR CLIMATE-RESILIENT CITIES

Nature-based thinking requires action across sectors and disciplines. Measures to promote transdisciplinary and cross-sectoral work for climate-resilient cities include:

- **TRANSDISCIPLINARY SKILLS**

Transdisciplinary skills can be sought when recruiting planning and construction professionals. In addition, a wider range of disciplines, such as biologists and anthropologists, can be involved in urban development to ensure a focus on biodiversity and broad involvement.

- **CROSS-COLLABORATIONS**

Collaborations can be established with public, private and civil actors to work towards long-term visions for urban nature that promote climate resilience, quality of nature and co-benefits.

- **NATURE-BASED CARE**

Guidelines can be developed for more nature-like operations on municipal areas. It can be clarified how nature-based care can address various challenges such as flooding and how changes in operations can promote co-benefits such as recreation and health.

CROSS-COLLABORATION IN PRACTICE

The City of Kildedal (Kildedal By) is an urban development project, where nature, community and sustainability are core values. Its nature quality program aims to ensure values of nature and recreational experiences, among other things. This will be accomplished in partnership with landowners, experts, the Danish Society for Nature Conservation, the Danish Outdoor Council and the Green Council in Ballerup Municipality. All investors commit to protect and strengthen biodiversity and comply with the programs and strategies¹²⁹.

CO-BENEFITS OF URBAN NATURE

When nature is invited into the city and urban greenery increases, positive effects come with it. These co-benefits can be:

- Reduced risk of flooding and contamination of water sources and hence better quality of drinking water
- Cooling of the city and shade
- Better air quality and less noise
- Active modes of transportation like walking and cycling
- Biodiversity and ecological resilience
- Physical and mental health
- Play, learning and interaction with nature
- Social meetings in blue and green areas
- Increased aesthetic value and a stronger sense of belonging to one's city or neighborhood

5.6 HOW TO ENSURE THE OVERALL FRAMEWORKS?

The goal is to move beyond isolated nature-based solutions oriented towards human needs. Instead, we need to develop nature-based cities for both people and ecosystems. This involves systemic change and new ways of working, and requires concise legislation and different types of funding, ideally across sectors.

Although climate and biodiversity have reached the political agenda in recent years, the Danish Planning Act still provides limited opportunity to set conditions for urban nature. Therefore, it is important to understand how to work strategically with the different conditions that can be included in regulations. For example, if a noise screen is to be established in an area, it is obvious to choose natural shielding instead of a wall.

In the fall of 2023, the Danish Agency of Planning and Rural Areas issued a bill on changes in the Planning Act, which, among other things, focuses on urban nature¹²¹. The bill came into force on January 1, 2024 and clarifies how municipalities can ensure urban nature in local plans.

In addition to concise legislation, it is desirable to have guidelines that specify the possibilities for nature-based planning. Moreover, the government can set an overall goal or standard for more urban nature of high quality.

Nature-based thinking can open the way for a range of positive effects that enhance climate-resilient cities where both people and ecosystems can thrive. This requires cross-collaboration. Therefore, it is necessary to consider different types of funding and how barriers to collaboration and co-financing can be broken down.

WHAT DOES THE PLANNING ACT SAY ABOUT URBAN NATURE AND BIODIVERSITY?

The Planning Act explains the aim of ensuring coherent planning that, among other things, helps to protect nature and support biodiversity in Denmark.

As of July 1, 2023, the Law on Planning was expanded to include climate¹³⁰, but there are no apparent options to formulate new types of binding requirements in municipal and local plans.

Section 15 sets out the content of local plans. It is possible to make the following regulations that relate specifically to nature and green spaces in the city:

- The share of built-up and green spaces in new urban areas.
- Preservation of vegetation and matters on vegetation in general.
- Provision of shared facilities, which can be green spaces, among other things.
- Establishment of noise screens such as natural shielding.
- Establishment of flood mitigation measures such as vegetated infiltration basins.
- Founding of homeowner associations in urban transition zones that are obliged to establish, operate and maintain shared areas and facilities.

5.7 WHO SHOULD TAKE ACTION?

Nature-based thinking calls for a shift in urban planning and nature management. New organizational structures and new types of collaboration with external parties are both needed.

Cities should increasingly work across sectors to create synergies between the various strategies, plans, objectives and investments. Also, cities should collaborate and partner with a wide range of stakeholders involved in the planning, development and use of cities. This includes developers, contractors, utility companies, associations, investors, businesses, citizens and others.

Nature-based thinking requires that citizens and many types of users are involved from the very start and that a framework is provided allowing citizens to contribute as co-creators and managers of the blue and green urban areas where they live, move and thrive.

Nature-based thinking must also serve as the strategic foundation for collaboration with developers and constructors. Through dialogue, guidelines, requirements and strategic initiatives, cities can make it relevant and attractive for other actors to acquire knowledge and skills on nature-based urban development. The most progressive ones have already taken the first important steps, as the case on the right shows.

PENSIONDANMARK'S BIODIVERSITY STRATEGY

In May 2022, the pension fund PensionDanmark launched its first biodiversity strategy, committing that all investments in urban areas and new construction projects must have a positive impact on biodiversity by 2030. They have committed to meet the DGNB minimum requirements for nature and biodiversity and to gradually meet the EU taxonomy environmental objectives for biodiversity and ecosystems. The biodiversity strategy is based on a pledge and a set of principles followed by action points that cover the entire value chain, from land acquisition, project development, construction, operations and evaluation.

NEW PUBLICATIONS AND GUIDES

In March 2024, Lotte Nystrup Lund published the report *Biodiversity Tactics* as part of her PhD. The report guides urban developers in understanding and promoting biodiversity in cities. Among other things, the aim is to broaden the reader's perspective and approach to urban planning to include *other-than-humans*.

In the same month (March 2024), Habitats, in collaboration with Molio, published the catalogue *Biodiversity in Construction and Urban Development*. The catalogue provides an overview of relevant rules and frameworks and inspiration on how to integrate biodiversity in construction and urban development, both on a strategic level and in practice.

5.8 THE FUTURE IS NATURE-BASED

Cities have always served as hubs of innovation and will continue to do so. As cities are vulnerable to climate change, they need to utilize their innovation capacity to meet future challenges and improve quality of life in cities.

Nature can be the center of a new approach, as nature-based thinking harnesses the abilities of nature to tackle various urban challenges. At the same time, green and blue solutions generate co-benefits making them more efficient and attractive than traditional approaches to urban development.

Working with nature in cities is not necessarily straightforward and calls for new skills and practices. A nature-based approach also requires us to challenge the human need for control, which can be difficult in a time of climate crisis, resource scarcity, inflation, war and pandemic.

Instead of controlling nature, we should learn to support the processes that enhance favorable conditions for both people and ecosystems. This means moving from local nature-based solutions to an integrated nature-based thinking. By making space for urban nature, we can create more climate-resilient and climate-neutral cities where people and nature thrive.



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