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CITIES, NATURE AND INNOVATION | **NEW DIRECTIONS**

NATURVATION
cities — nature — innovation

HOW CAN NATURE HELP US DESIGN AND BUILD OUR CITIES?

Nature-based solutions have the potential to provide multiple benefits across a range of sustainability challenges facing cities. They can help to limit the impacts of climate change, enhance biodiversity and improve environmental quality while contributing to economic activities and social well-being. Read on and learn more about nature-based solutions in an urban world!

CONTEXT FOR
NATURE-BASED SOLUTIONS

This compendium connects together the key themes of nature, cities and innovation. It discusses how to assess what nature-based solutions can achieve in cities. It examines how innovation is taking place in cities. And it analyses the potential of nature-based solutions to help respond to climate change and sustainability challenges. This compendium combines both technical knowledge and the social sciences to better understand nature-based solutions in a holistic perspective. New governance arrangements, business models, financing and forms of citizen engagement will be needed to make the promise of nature-based solutions a reality.

▶CHANGING CONDITIONS
In the face of climate change and increasing environmental, economic and social pressures, sustainable development has become a strategic issue for cities in Europe and around the world. No longer a "nice to have" addition to development-as-usual, sustainability is now central to the response to climate change and in enabling growth, security and social well-being.

▶ENABLING SUSTAINABILITY
Nature-based solutions are seen to hold significant promise in enabling the urban transition to sustainability. They have potential to provide multiple benefits across the range of sustainability challenges facing cities – from managing flooding to securing improved health outcomes for different groups of society. They offer flexibility in the face of a changing climate.

EXAMPLES OF
NATURE-BASED SOLUTIONS

The use of grey infrastructure dominates urban development. But nature-based solutions, which use the natural properties of ecosystems, are emerging in cities everywhere. They have the potential to limit impacts of climate change, enhance biodiversity and improve environmental quality while contributing to economic activities and social well-being.

Examples are green roofs and city parks that limit heat stress, city lagoons that store water and permeable surfaces, vegetation and rain gardens to intercept storm water. Yet despite their significant potential, the use of nature-based solutions remains marginal, fragmented, and highly uneven within and between cities.

- **Building greens, such as green roofs and green walls**

- **Urban green areas connected to grey infrastructure, such as alley and street trees, railroad bank, house gardens, green playgrounds and school grounds**

- **Parks and (semi)natural urban green areas, including urban forests**

- **Allotments and community gardens**

- **Green indoor areas**

- **Blue areas, such as rivers, lakes, seacoasts and wetlands**

- **Green areas for water management, such as rain gardens or sustainable urban drainage systems**

- **Derelict areas and abandoned spaces with patches of wilderness**

MELBOURNE
– URBAN FOREST STRATEGY

The Urban Forest Strategy is a timely and effective response to sustainability challenges in Melbourne. Its aim is the systematic provision and maintenance of green space in combination with soft and grey infrastructure approaches to improve the liveability of the city and the health and well-being of its inhabitants.

CHAPTER 1

− TRANSFORMING CITIES THROUGH NATURE-BASED SOLUTIONS

By studying this chapter you can gain an increased knowledge and a deeper understanding of nature-based solutions in an international and European context. The concept of nature-based solutions is presented and discussed with examples that explore the opportunities, benefits and challenges associated with mainstreaming nature-based solutions.

KES MCCORMICK

To break the dominance of grey infrastructure, new approaches are needed for the development, implementation and mainstreaming of nature-based solutions. We need to better understand assessment methods, governance strategies, business models and innovation pathways for urban nature.

Nature-based solutions are an increasingly popular means for tackling urban sustainability challenges, and the idea that we can work with nature to improve our cities is now seen as vital.

HARRIET BULKELEY

INTRODUCING
NATURE-BASED SOLUTIONS

At the core of this development is the idea that nature is able to provide services and values that can contribute to wider goals for economic, social and environmental sustainability.

This belief that cities should become more sustainable is now very widespread, it is actually a relatively new idea. It was in the 1980s that the Brundtland Report, *Our Common Future,* put cities at the heart of the sustainability debate.

Since then, a central challenge that cities have grappled with is how they can address climate change – both by reducing the greenhouse gas emissions that contribute to changing the global atmosphere, and by ensuring that they are resilient to the impacts of climate change itself. The Paris Agreement, reached in 2015 emphasised the increasing importance of cities in achieving global targets for climate change. *The Sustainable Development Goals* that were also agreed by the global community in 2015, have shown that addressing urban sustainability also means realising other important goals, like protecting biodiversity, reducing pollution, and enabling equity and social justice.

These challenges can sometimes appear to be in conflict with one another and to compete for political attention, public interest and resources. But as cities have started to take action on climate change and sustainability, it has become clear that some of the most effective responses are those that have multiple benefits – for example, reducing greenhouse gases and improving local air quality,

or enhancing resilience and also creating areas of public space in the city. And the importance of finding approaches that can address multiple urban sustainability challenges at the same time has led to a growing interest in nature-based solutions.

The term nature-based solutions was coined in the European Union, and is an umbrella term for a number of different approaches that use nature to improve urban sustainability, like green infrastructure, green space, restoring rivers, ecosystem services, and ecosystem based adaptation.

For the European Commission, nature-based solutions are defined as:

"solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions"

For the International Union for the Conservation of Nature, a non-governmental organisation that promotes nature conservation, nature-based solutions are:

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

While these two definitions vary, both see nature-based solutions as deliberate interventions that seek to use the properties of nature to address societal challenges. And in both cases, it is the potential to provide multiple benefits that is seen to be key to the value of nature-based solutions.

Like for example from managing flooding to securing improved health outcomes for different groups of society, or building green roofs and city parks that limit heat stress, city lagoons that store water and permeable surfaces, vegetation and rain gardens to intercept storm water.

Yet despite attracting increasing interest, the use of nature-based solutions remains marginal, fragmented, and highly uneven within and between cities. And grey infrastructure and technology-driven solutions continue to dominate urban development, from the design of wastewater systems to efforts to improve energy efficiency in the built environment.

The NATURVATION project, funded by the Horizon 2020 Sustainable Cities and Communities programme of the European Union, is developing our understanding about how nature-based solutions are currently being used. We have developed the Urban Nature Atlas to show just how nature-based solutions are being implemented in 100 cities in Europe.

Our work shows that it is clear that nature-based solutions are an increasingly popular means of tackling many urban sustainability challenges.

But there is more limited evidence that nature-based solutions are becoming *mainstreamed* within urban planning, policy and development. Enabling the wider uptake of nature-based solutions means tackling four key issues.

The first issue is, *assessment methods.* Although there is a growing body of evidence about the ecosystem services that nature can provide, we have a limited understanding of how this works in an urban context. Many of our assessment tools focus on the ecological benefits of nature, and its economic, social and cultural values can be neglected. We therefore need new approaches for assessing nature-based solutions that are able to also take these different, and sometimes conflicting, values into account.

The second issue is *business models.* The benefits of technologies or behaviour changes to improve sustainability are relatively easy to calculate. And this has led to business models which can capture these benefits in economic terms and ensure that there is a return on investment for those involved. For example, the 'rent a roof' approach has been a popular model for rolling out solar panels in European cities.

Nature-based solutions do not come with ready-made business models, and often the value created is distributed between different actors – such as the private firm that installs a green wall for insulation and the local community that benefits from reduced air pollution. We need to experiment with new business models that can work for nature-based solutions and create the means through which these can be replicated in different urban contexts.

The third issue is *governance strategies.* Municipal governments are important for addressing urban sustainability. Yet our work suggests that they cannot act alone. The capacity to address urban sustainability challenges relies on multilevel governance structures, as well as the development of different modes of governance. This means that municipal governments need to work with stakeholders and communities to create the partnerships, resources, plans and demonstration projects needed to accelerate the uptake of nature-based solutions.

We need to examine the different governance strategies being used to advance nature-based solutions in cities and consider the ways in which they are able to address conflicts and inequalities that may emerge from their implementation.

And the fourth issue is *innovation pathways.* Mainstreaming nature-based solutions requires that we understand the key challenges and opportunities that are facing projects on the ground. Any innovation has to go on a journey – from the initial idea and its demonstration, to its wider uptake within policy, industry and society. Along this journey, getting the assessment of the value of nature-based solutions, the business models required, and the governance strategies that can support their uptake will be critical. But perhaps most important is identifying the *combination* of measures that support successful nature-based solutions: we call this combination of measures the innovation pathway.

By understanding the conditions that enable nature-based solutions to become established in our cities and towns, and how their benefits can be shared by society, we hope to contribute to developing sustainable cities for the future. ∎

Nature-based solutions have the potential to address many sustainability challenges that cities face today. They can for instance help us address climate change impacts, like floods, heat waves, drought, windstorms and landslides. But how can nature-based solutions for climate change adaptation be mainstreamed in urban governance and planning?

MAINSTREAMING NATURE-BASED SOLUTIONS

CHRISTINE WAMSLER

First we need to understand what is adaptation mainstreaming. Then we can add nature-based solutions to the "equation". In simple terms, adaptation mainstreaming refers to the inclusion of climate adaptation considerations into sector policy and practice in order to reduce climate risk.

The concept has mainly two origins: On the one hand, it developed from risk reduction mainstreaming, which has been strongly promoted since the World Conference on Disaster Risk Reduction in Kobe in 2005, and which builds on mainstreaming experience in other cross-cutting or mainstreaming domains like HIV/Aids and gender.

On the other hand, it originates in environmental policy integration, and more specifically climate policy integration, which has been promoted since around 1997. The initial objective of climate policy integration was to integrate reductions in greenhouse gas emissions into other sectoral policies, but the focus has gradually broadened and nowadays also includes adaptation considerations.

So why is knowledge on mainstreaming relevant for supporting nature-based solutions? Well, it is because although nature-based solutions for climate change adaptation are widely advocated, they have so far not been implemented systematically. And it remains widely unclear to many local authorities and other stakehold

ers what they can do to change this situation – to main stream this new approach into their daily work.

So how can nature-based solutions for climate change adaptation be systematically mainstreamed into urban planning and governance? At the local level, mainstreaming requires the consideration and combination of 4 types of measures to reduce climate risk.

First, we can either reduce or avoid hazard exposure. The aim here is to keep climate hazards away from human settlements …. by not moving into hazard areas, or reducing hazard exposure on-site.

Second, we can reduce the vulnerability of the area that is exposed to a climate hazard. Here, we are not trying to keep the hazard away from human settlements, instead we create an environment that is able to live with hazards, without losing its main functions.

Third, we can ensure an effective response to climate hazards. Here we prepare response mechanisms and structures, before a potential hazard strikes.

And finally, the fourth type of measure aims to ensure effective recovery from the impacts of a hazard. Here, we need to prepare recovery mechanisms and structures, again, before a potential hazard strikes. Depending on the

climate hazard the specific activities can change. But conceptually speaking, the 4 types of measures do not change.

So what would be some concrete examples for nature-based solutions? Well there are ample examples from the NATURVATION project. We can for instance avoid hazard exposure through the establishment of nature protection areas or parks designed to inhibit the development of housing in risk areas. We can reduce exposure to floods as well as reduce erosion through beach nourishment, restoring or managing mangroves, or improving water management in the outskirts of urban areas. In the case of landslides, we can stabilize the slope by planting new trees to hold the soil in place.

Regarding vulnerability reduction to floods, examples are the creation of buffer zones, retention ponds or increasing the extent of permeable surfaces, for instance through the promotion of green roofs, urban agriculture or greening laneways.

Regarding vulnerability reduction to heat, there is the use of drought-resistant plants and improved insulation. Another important element of vulnerability reduction is including redundant elements in urban design to reduce dependency on only one urban system, for instance, heating, transportation, or drainage systems, where green infrastructure can provide redundancy.

When it comes to response preparedness measures, one of THE most typical measures are early warning systems and preparations for temporary refuge. Here, properly-designed green areas can provide space for temporary shelter or temporary protection if necessary, for example elevated green platforms during flash floods.

Another example is the preparation of mechanisms or structures that provide cooling, for instance through mobile planting systems or fountains, which can be used during heatwaves.

When it comes to recovery preparedness, an example is to use green infrastructure elements that can easily recover or be replaced after climate impacts. In addition, we can prepare for post-disaster assistance. For example, we can stipulate green areas that can be used for accommodation during reconstruction, and prepare to clear or re-use rubble, including 'green material'.

In this context, support for greening private lots is an example of a multi-purpose measure with positive impacts on health and psychology. Other preparedness measures are awareness-raising campaigns and guidance on what to do after certain climate events, which can for instance be displayed in so-called climate parks. But why is it important to know and ultimately address all 4 measures through nature-based solutions? It is important because local climate resilience depends on the level of inclusiveness and flexibility of the combined set of adaptation measures employed rather than the effectiveness of a single measure or activity.

By inclusiveness I mean the use of not just one or two but all of the 4 adaptation measures. Flexibility relates to the number and diversity of activities implemented for each type of measure, which have to include both grey and green infrastructure approaches as well as social and economic measures.

But sustainable change will remain elusive as long as our understanding of mainstreaming remains naïve. Organisations themselves need to change, rather than simply 'mainstreaming' change in selected on-the-ground measures or activities.

In fact, all of the examples I have mentioned so far apply at the local or operational level. But if we want to assure their sustainable implementation, there must also be changes at the institutional and inter-institutional levels. This requires us to apply a set of mainstreaming strategies, their aim is to institutionalize adaptation and nature-based approaches so that their integration at local level becomes a standard procedure – including monitoring and the creation of structures for learning.

The mainstreaming strategies also aim to ensure that organisations themselves can continue to function during climate change impacts. Finally, they support the creation of a multilevel governance system for adaptation and nature-based approaches that includes citizens and, where possible, drive improved education on mainstreaming, as well as related science–policy integration.

Put together, there is a total of 6 mainstreaming strategies that operate at the three levels: the local, the institutional and the interinstitutional level. These 6 strategies need to be combined to enable the sustainable integration of nature-based solutions for climate change adaptation.

The first two strategies focus on the local or household level and relate to how the four types of measures can be integrated in on-the-ground initiatives. This can be done by adding such measures to the implementing body's sector work, or by modifying it in such a way that it also addresses risk.

Three mainstreaming strategies focus on the institutional level. They address the implementing body's internal organization and cooperation as well as its policies and regulations to ensure, rather than hamper, the implementation of nature-based solutions for climate change adaptation. This can include the modification of managerial and working structures, mandates, job descriptions, the configuration of sections or ▶

departments, as well as personnel and financial assets. It also involves the modification of formal and informal planning strategies and frameworks, regulations, and related instruments.

The sixth mainstreaming strategy focuses on the inter-institutional level. It addresses external cooperation with other governmental and non-governmental organizations, educational and research bodies and the general public to generate shared understanding and knowledge, develop competence and steer collective issues of climate change adaptation and nature-based solutions.

This involves the modification of public interventions and policies to support and complement nature-based solutions of citizens and private actors.

Mainstreaming thus needs to take place at all three levels – the local, institutional, and inter-institutional level – in order to achieve sustainable change.

To sum up, the three key messages, are as follows: First, mainstreaming nature-based approaches for climate change adaptation requires the combination of 4 types of measures to reduce climate risk at the local level. These measures should consider not only the reduction of climate risk, but also other sustainability challenges.

Second, their sustainable implementation requires the combination of mainstreaming strategies at local, institutional and inter-institutional level.

And third, taken together, these measures and strategies have the potential to foster resilience by challenging common attitudes and paradigms at multiple levels of governance. Therefore, mainstreaming nature-based solutions for climate change adaptation can be seen as an important pathway to foster urban resilience. ∎

STRATEGIES AND LEVELS OF MAINSTREAMING NATURE-BASED SOLUTIONS

ADD-ON MAINSTREAMING (1)
The establishment of specific on-the-ground projects or programmes that are not an integral part of the implementing body's sector work but directly target adaptation or related aspects.

PROGRAMMATIC MAINSTREAMING (2)
The modification of the implementing body's sector work by integrating aspects related to adaptation into on-the-ground operations, projects or programmes.

MANAGERIAL MAINSTREAMING (3)
The modification of managerial and working structures, including internal formal and informal norms and job descriptions, the configuration of sections or departments, as well as personnel and financial assets, to better address and institutionalize aspects related to adaptation.

INTRA- AND INTER-ORGANIZATIONAL MAINSTREAMING (4, 6)
The promotion of collaboration and networking with other departments, individual sections or stakeholders (i.e., other governmental and non-governmental organizations, educational and research bodies and the general public) to generate shared understanding and knowledge, develop competence and steer collective issues of adaptation.

REGULATORY MAINSTREAMING (5)
The modification of formal and informal planning procedures, including planning strategies and frameworks, regulations, policies and legislation, and related instruments that lead to the integration of adaptation.

DIRECTED MAINSTREAMING (7)
Higher level support to redirect the focus to aspects related to mainstreaming adaptation by e.g., providing topic-specific funding, promoting new projects, supporting staff education, or directing responsibilities.

LET'S HEAR ABOUT NATURE-BASED SOLUTIONS FROM THE CITY OF MALMÖ IN SWEDEN
We are currently working on a neighborhood in Malmö called Sofielund, which is an already developed area where there is ongoing urban densification and regeneration.

This is a diverse area, with rental and privately-owned apartments, villas and industries. It has an ethnically mixed population and the socio-economic level is lower than the Malmö average. And in some parts of the area crime rates are high, which is a major concern for the local inhabitants. And large parts of the area is also prone to inundation from downpours.

Sofielund is currently engaged in a so-called BID process, and BID stands for Business Improvement District and this collaboration approach on urban development exists in several countries. It is a partnership between the city, businesses and civil society, where we are working together to improve urban development in a geographically defined area.

To develop the BID process, we have formed the Association of Property Owners Sofielund, where property owners, housing associations and companies work together with Malmö city, associations and residents to develop this area. Under the umbrella of the BID we have several projects focusing on Agenda 2030 to develop blue-green structures. And an important focus for us is to ensure that these structures support the overall goal of the BID Sofielund, which is to improve the well-being, security and cohesion of its inhabitants.

HOW HAS MALMÖ INTEGRATED NATURE-BASED SOLUTIONS TO SUPPORT URBAN SUSTAINABILITY AND CLIMATE ADAPTATION?
So far we haven't integrated any nature-based solutions on a larger scale. But there are several property owners that have included blue green solutions when they have developed their property, such as the inclusion of green roofs, rain gardens and small solutions like check valves in the basement.

There are several challenges related to increasing the amount of blue green solutions in an already built area, and we are therefore engaged in a step wise process. The collaboration with Lund University is extremely important, and it has given us both support and analysis of what solutions that are available for the area. But we have more work to do.

WHAT ARE THE MAIN DRIVERS THAT SUPPORT THIS INTEGRATION?
For us this is an easy question to answer- we need to improve the area to make it a better and more secure place for the inhabitants.

External funding has facilitated the process and made it possible for researchers from Lund University to cooperate with us. And this is a key factor for us before we do practical tests.

To implement blue green solutions in an already built area means that collaborative networks need to be developed and that takes time. But the BID organization and the work we have done in other areas is a good basis!

WHAT ARE THE MAIN BARRIERS FOR FURTHER INTEGRATION?

There are three main barriers as far as we see it. First, how to integrate the work with solutions on public and private land. Second, how to solve the financing and maintenance of such collaborative solutions on public and private land. And third, how to ensure that these new blue green solutions are accepted by local inhabitants.

WHAT IS THE VALUE OF WORKING WITH OTHER STAKEHOLDERS TO FOSTER NATURE-BASED SOLUTIONS?

The findings of the Malmö Commission, had around 100 recommendations for the future development of Malmö, and one key finding was that "knowledge alliances" is the best way for sustainable development. So collaboration with other actors and especially the academic world is very important.

In these "knowledge alliances" we are able to see that several of our challenges and problems are actually quite similar. Collaboration with other actors involved in a similar process is encouraging, especially when you sometimes can feel exhausted by some of the hurdles. We can learn a lot from each-others mistakes. And successes. ∎

BOSTON
– EAST BOSTON GREENWAY

Boston is undergoing rapid population growth and economic transformation, while struggling to address water pollution and climate change. The newly-adopted climate plan addresses these two key sustainability challenges. At the same time, bottom-up initiatives, such as the East Boston Greenway tackle social inequalities through green space provision.

CHAPTER 2

– ASSESSING THE VALUE AND IMPACTS OF NATURE-BASED SOLUTIONS

By studying this chapter you can gain an increased knowledge and a deeper understanding of possibilities and challenges for valuing and assessing the impacts of nature-based solutions. Assessment and valuation methods are presented and discussed in the context of different perspectives on nature, cities and innovation.

HELENA HANSON

To support decision making in relation to the implementation of nature-based solutions we need to assess what kind of social, environmental and economic benefits they can deliver.

ASSESSMENT METHODS

Today more than 50% of the global population lives in cities. Cities are attractive, with job opportunities and cultural experiences, but the increasing urbanisation also put pressure on cities and lead to many urban sustainability challenges.

For example, the old water and sewage systems were built during a time when the population was much smaller and cities covered less area. Many cities therefore lack capacity to handle major cloudbursts, which may result in floods.

Another example is the high number of commuters in and out of cities, which cause congestion and an increase in air pollution. We also have an increasing competition for urban land that puts a high pressure on green space, which affects both human wellbeing and the urban biodiversity.

To reduce the pressure on the city we can work with grey solutions, like putting new sewage and waste water pipes into the ground, but we can also work with nature-based solutions to solve some of these challenges.

Examples of urban nature-based solutions include parks, street trees, ponds, green roofs, urban and domestic gardens. To support decision making in relation to the implementation of nature-based solutions we need to assess what kind of social, environmental and economic benefits they can deliver.

If we want to use nature-based solutions for storm-water management for example, one option is to build a pond that can hold water to prevent floods. This is an example of an environmental benefit.

And when we prevent floodings, we prevent damage to surrounding properties, which would be an example of an economic benefit.

But the pond may not only contribute to storm-water management, it could also provide social benefits by be-ing an opportunity space for recreation, social activities and sport, ponds are for example used for ice-skating in cities where it gets cold enough during winter time. But we also need to consider that nature-based solutions may create negative impacts. For example, a pond can be considered dangerous to children, or if it's not properly managed, it can become contaminated with different kinds of pollution.

In decision-making it's important to consider both the positive and the negative impacts that can be created by nature-based solutions.

There are several different ways to assess how nature-based solutions can contribute to different urban sustainability challenges. Depending on what and how you assess you will get quantitative, qualitative or monetary values.

We can take street trees as an example. If we are interested in assessing how the trees contribute to local climate regulation, it's possible to quantify temperature differences between surfaces with and without tree shadow.

But if we are interested in how trees contribute to human well-being we may ask citizens about their perceived benefits of the trees. Like providing shade or being aesthetically pleasing. Here we could get both quantitative and qualitative values depending on how the question is formulated.

Another way to assess the values of street trees could be to estimate their economic value. For example, the cost to put trees cities, or how much people would be willing to pay for trees outside their house or apartment, or energy savings due to a decrease in temperature in urban area. ▶

To do assessments we need indicators. If we take local climate regulation for example, indicators might be changes in temperature or perceived thermal comfort experienced by people. It's important to select indicators that are both scientific and relevant.

Depending on what the assessment is about, we will need different types of data. For example, if we want to study water retention of ponds, we could use climate data concerning precipitation, but it could also be that we need to measure the retention capacity of an area.

In contrast, if we study local climate impacts of urban vegetation, we could use citywide geographical data about green space cover, or measure the temperature reduction by street trees in a field study.

It takes time and money to conduct assessments. Therefore, it's ideal if we can generalise the results from one place to another. For some nature-based solutions and benefits, this might be possible. For example, we can assume that urban street trees will reduce the air temperature in a similar way given the same climatic conditions.

But for many benefits it's not possible to generalise across different contexts. For example, the perceived social and cultural benefits from a park are only valid for the target population. But even though we cannot generalise the results, it might still be possible to generalise the assessment methods across different contexts.

Another factor that should not be overlooked is that many assessment methods require an expertise for both extracting and analysing the data, something that might be a limiting factor, at least outside academia. It's therefore important that researchers do not only develop assessment methods that can only be used by researchers, but also methods that can be used by different types of practitioners working with urban development.

In conclusion, assessment methods can be used to evaluate the contribution of nature-based solutions to sustainability challenges. But depending on which benefits we assess, or do not asses and which, methods and indicators we choose for the assessment, the result will differ. This might influence how we understand and value the benefits provided by nature-based solutions, and in the long run the decision-making process.

The extent and scope of the benefits varies with the conditions in which nature-based solutions are introduced, how they are designed, and the ways in which they are maintained over time.

Nature-based solutions can bring a variety of benefits to cities. Understanding the economic and financial value of these benefits is important if they are to be taken into account in decision-making processes and their overall worth compared to traditional forms of infrastructure and urban development.

At the same time, nature is seen to have values that are difficult to account for in economic terms but nonetheless important to society, such as contributing to well-being, as well as being inherently valued in their own right. ∎

FRAMEWORKS FOR ASSESSING NATURE-BASED SOLUTIONS

Assessing the value and potential of nature-based solutions requires an approach that can take account of the multiple benefits that they can provide and the different criteria against which they can be evaluated. NATURVATION will develop an assessment framework that brings together different kinds of knowledge, integrates the contributions of multiple initiatives and assesses the value of nature-based solutions in relation to the goals of urban sustainability.

BIOPHYSICAL & ECOLOGICAL ASSESSMENT
Nature-based solutions can provide ecosystem services for cities – providing resources, regulating environments, creating habitats, and generating social and cultural activities. The extent and scope of these services varies with the conditions in which nature-based solutions are introduced, how they are designed, and the ways in which they are maintained over time.

ECONOMIC & FINANCIAL ASSESSMENT
Nature-based solutions can create bring a variety of benefits to cities. Understanding the economic and financial value of these benefits is important if they are to be taken into account in decision-making processes and their overall worth compared to traditional forms of infrastructure and urban development.

SOCIAL & CULTURAL ASSESSMENT
The benefits of nature-based solutions can also be social and cultural – from providing spaces for social interaction to forms of recreation. At the same time, nature is seen to have values that are difficult to account for in economic terms but nonetheless important to society, such as contributing to well-being, as well as being inherently valued in their own right.

LET'S HEAR ABOUT NATURE-BASED SOLUTIONS FROM THE CITY OF HÖGANÄS IN SWEDEN
The project we are analyzing in Höganäs is the redevelopment of a park called "Folkparken". We wanted to densify the area while at the same time securing and improving some of the area's natural and recreational values. The redevelopment of the park is in line with the municipality's development goals, that are stated in the comprehensive plan and in the city's urban vision. Our goal is that at least half of all new buildings in Höganäs are developed within the existing urban area.

HOW HAS HÖGANÄS INTEGRATED NATURE-BASED SOLUTIONS TO SUPPORT URBAN SUSTAINABILITY AND CLIMATE ADAPTATION?
Well our project has aimed to compensate the impacts of the densification by securing and improving some of the area's green and recreational values. For example, the remaining park was improved by increasing the quality and diversity of the vegetation, and green solutions like retention ponds were used for water treatment.

WHAT ARE THE MAIN DRIVERS THAT SUPPORT THIS INTEGRATION?
Well for example, to solve the water management in a sustainable manner, it was the combination of a strong political will and a strong knowledge base that made it possible. All the developments in this area were based on an assessment of the cultural and natural values. This assessment then laid the foundation for the planning work, and the integration of nature-based solutions.

WHAT ARE THE MAIN BARRIERS FOR FURTHER INTEGRATION?
The current lack of a general working approach is the biggest challenge for integrating nature-based solutions into the planning process. There are no clear mechanisms, structures or processes for this purpose. And there's also a lack of national legislation on nature-based solutions. If we had better national policies and legislation, it would make it easier for us at the municipal level to consider ecosystem services and nature-based solutions. This would make it easier for us to address climate change impacts and other urban challenges.

WHAT IS THE VALUE OF WORKING WITH OTHER STAKEHOLDERS TO FOSTER NATURE-BASED SOLUTIONS?
This form of cooperation allows us to learn from each other, and it also allows us to link research and practice. We have different backgrounds and knowledge, that we bring together to better integrate the issues of nature-based solutions and climate change adaptation in municipal planning. The discussions we have had are of immediate relevance and it has really motivated us to push nature-based solutions and climate adaptation further! ■

CAPE TOWN
– EDUCATION TRUST

Cape Town is located in a global biodiversity hotspot and it has both stark in-equity and high levels of unemployment, all of which make equity, job creation and nature conservation key challenges for the city. There are many nature reserves within Cape Town that protect endangered species and ecosystems. The Education Trust forms an important foundation for working with nature and biodiversity in the city.

CHAPTER 3

– DEVELOPING POLICY AND GOVERNANCE STRATEGIES FOR NATURE-BASED SOLUTIONS

By studying this chapter you can gain an increased knowledge and a deeper understanding of governing the implementation of nature-based solutions. The concept of governance is presented through examples and the role of collaboration and engaging citizens and communities is highlighted.

YULIYA VOYTENKO

In cities, governance processes are important when steering the planning, use and maintenance of common goods like public green and blue spaces as these processes offer opportunities to find the smartest ways to benefit citizens and urban nature.

GOVERNANCE STRATEGIES

Governments around the globe are starting to integrate nature-based solutions into decision-making processes because of their potential to respond to climate change, enhance biodiversity and improve environmental quality while contributing to economic regeneration and social well-being.

In cities, nature-based solutions are often seen as an alternative and complementary ingredient to traditional technical solutions and the expansion of grey infrastructure.

They hold significant promise in enabling the urban transition to sustainability. At the same time, nature-based solutions are placed in socially and economically uneven urban landscapes, which are bound by existing infrastructure.

But if we want to increase the implementation and development of nature-based solutions, we need to understand the governance structures that enable them.

So what is governance then? Well, while government refers to formal structures, systems or institutions by which a state, a region or a municipality is organised and governed, governance is a broader term. Governance refers to the act of governing rather than government in its narrow sense.

It involves multiple public and private actors that engage in debates and compete with each other for gaining and maintaining power over an issue that is being governed.

At the same time, it offers opportunities to strategically integrate policy instruments and connect different sectors, as well as engage multiple stakeholders in a dialogue that can enhance collaboration for sustainability.

In cities, governance processes are important when steering the planning, use and maintenance of common goods like public green and blue spaces as these processes offer opportunities to find the smartest ways to benefit citizens and urban nature.

Traditionally urban green initiatives have been managed by the government. But over the years their governance has been complemented by experimentation with multi-level governance schemes. And there are two types of multi-level governance, Type I and Type II. Type I can be divided into vertical and horizontal coordination, where vertical coordination is the relationship between municipalities,

regional authorities, national and supra-national governments. And horizontal coordination describes the relationship between different agencies and policy divisions within municipal governments.

Type I multi-level governance refers to governance by Governments at different levels. While Type II multi-level governance involves networks and partnerships that operate between and across political levels. It includes sub-national collaboration between government agencies, public and private actors, and civil society.

Type II also includes transnational municipal networks, like for example ICLEI, a global sustainability network of more than 1,500 cities, towns and regions, and 100 Resilient Cities, a network that is working to make cities more resilient to physical, social and economic challenges.

These types of transnational municipal networks have become an important driver for municipal action on advancing nature-based solutions. They can facilitate the exchange of information and experience between cities, catalyse learning, provide access to expertise and external funding, and can offer political credibility to individuals and administrations seeking to promote actions internally. ICLEI has for example, established a global online platform called CitiesWithNature. It provides a shared space for cities and their partners to engage and connect, working with a common commitment towards a more sustainable urban world with nature.

In addition to different types of governance we can also talk about different forms of governance. Depending on the origins and degrees of power exercised by a particular group of actors in governance initiatives, they can be split into three broad categories: top-down, bottom-up and collaborative governance initiatives.

Top-down governance initiatives are started and led by government actors like politicians, planning and regulation authorities and decision-making experts. An example of this is the redevelopment of an avenue "Passeig de

Sant Joan" in Barcelona, into a green corridor. The corridor was promoted and implemented by the "Ecology, Urban Planning and Mobility Area" at the city council in collaboration with district offices.

Bottom-up governance initiatives are started and led by grassroots movements, citizen and community groups or non-governmental organisations. For example in Edinburgh, the Square Metre for Butterflies project was initiated by the Royal Botanic Garden in partnership with Butterfly Conservation. These organisations provide time, knowledge, and materials. And implementation is done jointly with the participants. The project has been developed in consultation with the municipality, environmental organisations and knowledge institutions.
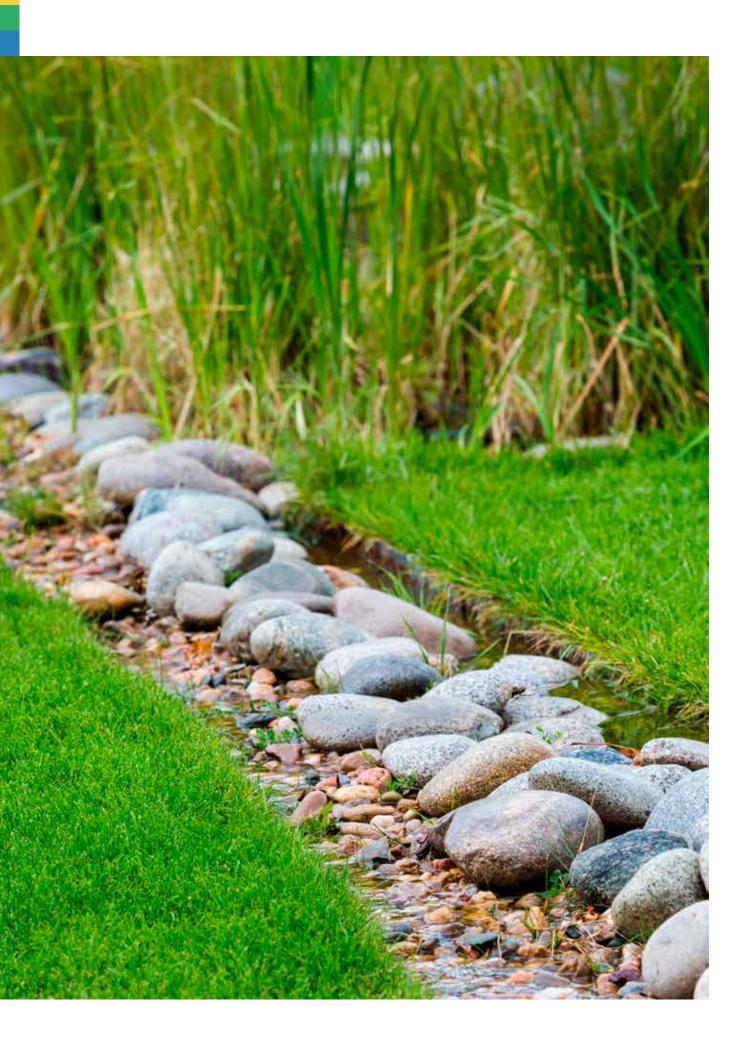
Collaborative governance initiatives are collaborations between stakeholders that are from different sectors, but hold similar interests. An example here is the establishment of the Water Fund in Mexico City to mobilise financial capital in order to strengthen water security through protection of ecosystem features. The development of the Water Fund was initiated by The Nature Conservancy Mexico on behalf of the Latin American Water Funds Partnership, together with the Inter-American Development Bank, the Mexico City government, and businesses.

So what's next for governance of nature-based solutions? Well as we can see, governance can take various forms and shapes. But there is no universal approach as to which form of governance is needed to enable sustainability. In fact, a balance between different types and forms of governance is needed.

In the implementation of nature-based solutions, different types of governance can be used together depending on the local situation and context. What works in one city, may not be the right governance approach in another city. But research of about 1000 examples of nature-based solutions in 100 European cities indicates an overall trend of transforming existing governance schemes from traditional top-down approaches to collaborative approaches.

Partnerships are essential for the implementation and governance of nature-based solutions, but there is a risk that the interests of some stakeholders are not taken into account. For example the interest of citizens can be left out if other more powerful actors are making the decisions. But at the same time, bottom up, citizen-centered initiatives for nature- based solutions can have a hard time to sustain themselves in the long run, and can find it hard to scale.

Many governance actions that promote the implementation and use of nature-based solutions are on their way, but there is still room to improve the integration of nature-based concepts into governance processes. We also need to find new ways to secure long-term funding to ensure the implementation and maintenance of nature-based solutions in cities. And we need to increase our knowledge in order to secure wider awareness and support of nature-based solutions as a multifunctional approach to addressing societal challenges. ∎

LET'S HEAR ABOUT NATURE-BASED SOLUTIONS FROM THE CITY OF KRISTIANSTAD IN SWEDEN

The focus of our project is the integration of nature-based solutions during the zoning of a new development area in Åhus, in the municipality of Kristianstad. This development includes 300 new apartments and houses, as well as new preschools, healthcare facilities and office facilities. And the site covers 27 acres that today mostly consist of municipal owned farming land.

HOW HAS KRISTIANSTAD INTEGRATED NATURE-BASED SOLUTIONS TO SUPPORT URBAN SUSTAINABILITY AND CLIMATE ADAPTATION?

We based the development of the zoning on the local ecosystem services and habitat. To do this we first conducted an analysis of the existing ecosystem services, and the flora in Åhus is unique. The soil is sandy and rich of calcium carbonate which provides ideal conditions for sandy meadows and unique plants, so we wanted to design the parks and the recreational areas, to create a natural habitat for local species. Besides the mandatory zoning procedures, we decided to also develop an additional quality and design program, which helped to ensure that our goals to support ecosystem services and to integrate nature-based solutions were fulfilled throughout the whole planning process, the implementation and the maintenance. Nature-based solutions were seen as critical to support recreational needs, stormwater management, and biodiversity.

WHAT ARE THE MAIN DRIVERS THAT SUPPORT THIS INTEGRATION?

In Kristianstad, the integration of nature-based solutions is supported by the municipality's set goals and local policies. These require that all municipal departments consider ecosystem services in their work. We also have very knowledgeable staff that drive this integration. Another driver is the institutional setting. Apart from the environmental department, we also have a biosphere department that has the task to increase nature values and associated knowledge. But the biggest driver was probably the inter-departmental working structure that we established for developing this area. We joined efforts and resources to support the planning process in different ways, for instance through setting clear development goals and commissioning an analysis of existing ecosystem services.

WHAT ARE THE MAIN BARRIERS FOR FURTHER INTEGRATION?

A barrier for further integration of nature-based solutions is the fact that the municipality has little influence on private land. Private stakeholders cannot be forced to implement certain measures, but we can raise people's awareness and knowledge, for example on how to best design private gardens. A change in regulations could help to support nature-based solutions also on private land.

WHAT IS THE VALUE OF WORKING WITH OTHER STAKEHOLDERS TO FOSTER NATURE-BASED SOLUTIONS?

The city-to-city learning project has given us extra time to focus on these issues and to learn from the other participants, it is an eye opener to meet people from different background and get to know how they approach the same subject. When you meet often in a small tight knit working group during a longer time period, you get to know each other well, which foster a greater understanding for each other. This way you get more meaningful conversations and you end up with a great network for the future. ∎

MEXICO CITY
– WATER FUND

Water represents an existential challenge for Mexico City, which is threatened by both water scarcity and flooding. The solutions lie in its existing natural assets. Reminders come each year when heavy rains bring flooding. At other times water scarcity is a problem and subsidence due to water extraction is ongoing. The Water Fund is a critical initiative.

CHAPTER 4

− CREATING BUSINESS MODELS FOR NATURE-BASED SOLUTIONS

By studying this chapter you can gain an increased knowledge and a deeper understanding of enabling finance and developing business models for nature-based solutions. The importance of business models and role of financing is investigated and illustrated through examples and experiences with nature-based solutions.

HELEN TOXOPEUS

One way to deliver urban nature-based solutions is to develop business models that take the multiple benefits and values of nature-based solutions into account.

BUSINESS MODELS

One of the ways to address the many societal challenges facing our cities is by using the multiple benefits of nature. And to do this we have to integrate this strategically into our urban planning. The term nature-based solutions suggests that nature holds a diversity of benefits, and one way to realise nature-based solutions is by building business models around these benefits.

Many of the benefits of nature-based solutions are public, meaning that we all profit from this together. But sometimes, some people benefit more than others. If we build a new park in a city, all the inhabitants of the city can benefit from the increase in biodiversity, but only the people living close to the park benefit from a nice view. So nature-based solutions create different types of value to different people at the same time.

So nature-based solutions can provide many benefits to a lot of people, but then a crucial question arises: who should pay for them, and why? Well traditionally, we look at the public sector to pay for public benefits. In this case we could leave the delivery of nature-based solutions to municipalities, water boards or governments. But there are at least three important challenges.

The first challenge is that there are often not enough public funds. The funding needed to reach urban sustainability goals cannot be met by governments alone, especially when countries are affected by a recession or austerity.

The second challenge is that the public sector is not always in the best position to deliver nature-based solutions. Sometimes the knowledge about what is needed is embedded in local citizen networks. And often land is privately owned, so governments do not have the mandate to develop nature-based solutions in this space.

The third challenge is that a single actor, like a department within a government, often focuses only on one type of value when investing in nature-based solutions, like water management, air quality or social cohesion. But nature-based solutions often have multiple benefits, and if we take a narrow focus, we underestimate the value they deliver.

So since governments cannot do it alone, one way to deliver urban nature-based solutions is to develop business models that take the multiple benefits of nature-based solutions into account.

So what is a business model? Well a business model describes how firms create and capture value through their activities. And there are three important parts to a business model. First, the value proposition: what value is being created and for whom? Second, how is this value being delivered, with what resources and partners? And third, how is value being captured, so what are the costs and revenue streams? And that brings us back to the question: who will pay for the value that is provided?

So if we take a business model approach to scale up nature-based solutions, we should remember that nature-based solutions create multiple types of value, so there may be multiple value propositions, perhaps to different people or customer groups. This means that there can be multiple revenue streams as well. Also, it may not be a single actor who delivers or pays for nature-based solutions but instead several actors. This means that we need to take a broad perspective on business models when we try to use it for upscaling nature-based solutions.

Let us look at an example of nature-based solutions together, namely green roofs. In this case, green roofs contain different value propositions for different people. For the owner of a building, a green roof improves the energy efficiency of the building by providing isolation, both for cooling and for heating. And if a green roof is installed in combination with solar panels it increases their efficiency. A green roof can also double the lifetime of the roof itself, which saves maintenance and roof replacement costs. It also reduces noise and improves air quality.

But green roofs also offer value to the city as a whole. They prevent flooding by holding rainwater, they help sustain biodiversity and they reduce the urban heat effect by cooling the city. On top of that, neighbouring residents and employees with a view of the green roof profit from increased health benefits and a nice view.

So we can see that different actors capture different types of value from green roofs. And each actor may have a

certain willingness to pay for a green roof based on these benefits. This shows why a successful business model for green roofs may require value propositions based on multiple benefits, or even multiple value propositions, for different actors.

A municipality may be willing to provide a subsidy for green roofs based on its water management, air quality and biodiversity goals. And neighbours may be willing to pay to improve their view and air quality. This funding could make the remaining costs of the green roof low enough for the building owner to pay the rest of the costs for the green roof, based on the benefits they get from the roof. Each actor captures and pays for the value they care about the most. The gardening firm that delivers the green roof can deliver the green roof profitably due to these different value propositions and revenue streams.

So how does this approach work in practice? Well let us look at Melbourne in Australia as an example, where the municipality set up the Urban Forest Fund, a pool of funds from different departments and real estate firms to stimulate private greening in the city. Both citizens and businesses in Melbourne can develop plans to green their premises and they can propose these plans to the Urban Forest Fund. This fund covers half of the project costs of eligible projects. So the municipality pays half of the

costs and provides the public benefits, like cool spaces for hot summers, biodiversity and water management for the city. Citizens and business pay the other half because the greening project increases their quality of life by providing outdoor relaxation, a nice view and social cohesion between neighbours.

We can also look at Amsterdam in the Netherlands, where the organisation Rooftop Revolution helps individuals to set up a crowdfunding campaign to fund the greening of their roofs. In these campaigns, building owners request funding from the neighbours who have a view of their roof. Since they are likely to benefit directly, they may be willing to contribute. This is an example of an initiative that seeks to re-think business models for nature-based solutions.

Using a business model perspective can help us to scale up nature-based solutions in cities. And if we understand how nature-based solutions create value for different actors, we can build business models that let each actor pay for the value they obtain. In this way, public and private actors can deliver nature-based solutions together. At the same time, it is important that public actors like municipalities are still involved to pay for the public benefits of nature-based solutions and to make sure that all citizens can profit from nature-based solutions in an equal way. ∎

LET'S HEAR ABOUT NATURE-BASED SOLUTIONS FROM THE CITY OF LOMMA IN SWEDEN
Here in Lomma we have recently analyzed two of our nature-based solutions projects. The first is a coastal flood protection barrier with integrated ecosystem services. And the second is a school and a pre-school where we made ecosystem services an integral part of the building process.

HOW HAS LOMMA INTEGRATED NATURE-BASED SOLUTIONS TO SUPPORT URBAN SUSTAINABILITY AND CLIMATE ADAPTATION?
When we designed the coastal protection project, it was not only designed as a way to reduce flood risk, but we also wanted It to be a recreational space for our citizens, and on top of that we wanted to make room for biodiversity. In order to do so, we built natural beach meadows sown with natural dune species, but in the areas with more structured lawns we also made patches of natural dune meadows. The goal was to create an area that was both high in biodiversity while at same time having high accessibility.

When we built the school, climate change adaptation was addressed by a range of different multi-purpose measures. We tried to minimise the impact on existing trees and green spaces, and the school is basically built in between existing trees with green roofs on all the buildings. We also kept a part of the school yard as sort of a wilderness to increase biodiversity and environmental education, and to promote nature-based solutions and climate adaptation.

WHAT ARE THE MAIN DRIVERS THAT SUPPORT THIS INTEGRATION?
The main driver has been a change in how we think about these issues. We have for example improved our internal working structures and we have developed a method for ecological compensation. This has meant that different professions collaborated more than they usually do, and in the end a lot more greenery was saved and a lot more natural species were introduced to urban areas. Biodiversity is often overlooked as a relevant factor in urban developments, but working with this can really increase quality of life in cities.

WHAT ARE THE MAIN BARRIERS FOR FURTHER INTEGRATION?
Regulations on a national level have to change to better support nature-based solutions and climate change adaptation in both urban and rural areas. Currently, the state gives the municipalities a monopoly on planning, but at the same time it restricts and regulates the possibilities to fulfill national and local goals at the local level. This is a problem, and in the long term this situation will lead to deterioration regarding land use, biodiversity and our possibilities to protect the wellbeing of our citizens. If we can solve this problem it will help us support nature-based solutions to address climate change.

WHAT IS THE VALUE OF WORKING WITH OTHER STAKEHOLDERS TO FOSTER NATURE-BASED SOLUTIONS?
Since both this approach for knowledge co-creation, and the planning for nature-based solutions and climate adaptation are fairly new, we must learn together. Every place is different and has different problems that need solving. So the creation of processes for interacting with other cities and stakeholders is very valuable and inspiring. This is important for supporting nature-based solutions in our cities and to help us better address climate change. ∎

TIANJIN
– ECO VALLEY

Air pollution, traffic congestion, lack of green space, water retention to combat droughts and intense rainfalls, loss of agricultural land and soil organic matter content are considered pressing environmental challenges in Tianjin. Green space development and the Eco Valley in Tianjin is fundamentally important to liveability.

CHAPTER 5

– INNOVATING IN PRACTICE
WITH NATURE-BASED SOLUTIONS

By studying this chapter you can gain an increased knowledge and a deeper understanding of innovation pathways for nature-based solutions. The role of visions and pathways is discussed with examples of nature-based solutions and different ways of working with nature, cities and innovation.

BERNADETT KISS

It is critical to understand how innovation is supported through different governance strategies, institutional settings and financial arrangements, and it is also important to see what the enabling conditions and driving forces are for nature-based innovations in the context of urban sustainability transitions.

INNOVATION PATHWAYS

Nature-based solutions are emerging on the political agenda not only as a potential climate adaptation strategy, but also as a popular means to build urban resilience while tackling the multiple sustainability challenges cities are facing. For instance, open stormwater management systems, including sunk parks, trees, rain gardens, open canals, permeable surfaces and green roofs can reduce and manage flooding and – at the same time – can limit heat stress as well as provide recreational spaces for different societal groups ... this in turn can secure improved health outcomes and can eventually reduce health costs for society.

The example of stormwater management shows that multiple benefits and multiple functions are the key value of nature-based solutions. Yet, despite the recognized benefits and functions, the use of nature-based solutions remains marginal and grey infrastructure continue to dominate urban development. In order to break this grey dominance, new approaches are needed for the development, implementation and mainstreaming of nature-based solutions.

Our work on nature-based solutions in the NATURVATION project shows pieces of evidence of innovative governance types and forms, innovative financial arrangements, novel business models, new institutional settings, and combinations of these. These examples all hold the potential for mainstreaming nature-based solutions within urban planning, policy and development across the globe.

But any innovation is a journey: from the initial idea, all the way to its broader uptake within policy, industry and society at large. And along this journey, it's critical to understand how innovation is supported through different governance strategies, institutional settings and financial arrangements, and it's also important to see what the enabling conditions and driving forces are for nature-based innovations in the context of urban sustainability transitions.
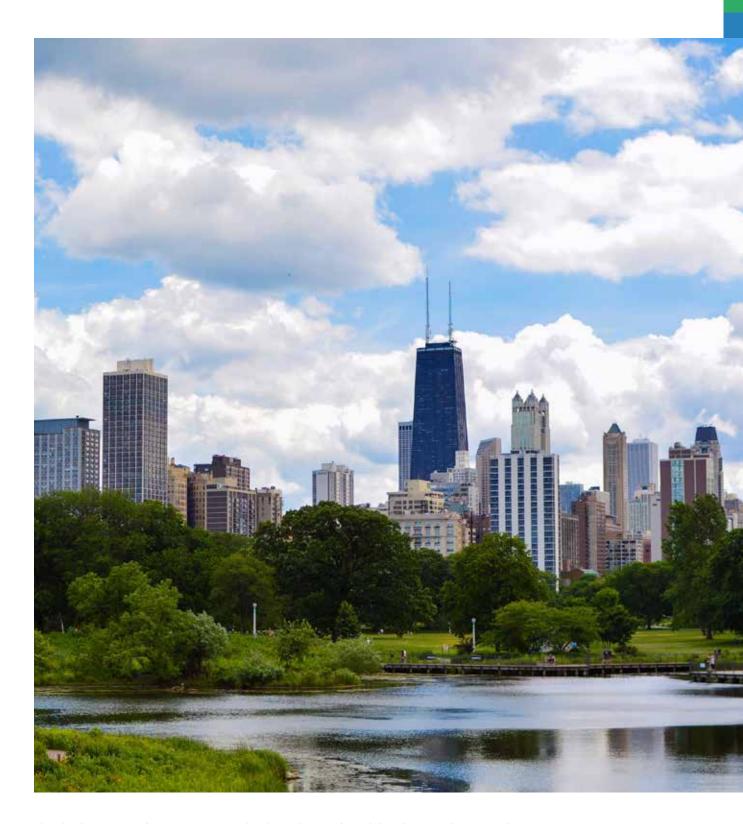
But wait a minute, what do we actually mean by innovations? Do we mean new ideas, creative thoughts, new imaginations, new forms of devices or new methods or application of better solutions that meet new requirements, unarticulated or existing market needs or something original and more effective and, as a consequence, new, that "breaks into" the market or society?

No matter the definition, the literature agrees on at least one important thing: Innovations evolve in systems to make a meaningful impact in the market

or society. Yes, successful nature-based innovations in the context of urban sustainability transitions, rely on a system. A system, which can be broadly defined as "a set of elements or parts that is coherently organized and interconnected in a pattern or structure that produces a characteristic set of behaviors, often classified as its function or purpose". A successful nature-based innovation relies on a system, which consists of actor networks, institutions and infrastructure. A system that with all of its interconnected parts supports the development and diffusion of nature-based solutions.

To better understand the key components of the emergence of nature-based innovations, we will first look into the different types of innovations. And then, I will introduce you to the Nature-Based Innovation System Framework (NBISF). Both the innovation typology and this innovation system framework have been developed by researchers in the NATURVATION project.

Now, let us first see what types of nature-based innovations are out there. We can differentiate among four main types: ecological or physical, social, technological and system innovations. The first type is ecological innovations, which are concerned with (a) the creation of new green or blue natural spaces, such as green roofs and parks, (b) the management of existing green and blue spaces, and (c) the restoration of ecosystems and their functionality to deliver a wider range of ecosystem services and benefits.

The second type is social innovations, and it refers to new or significant changes in public policy or cultural frameworks, governance or economic arrangements, or methods for generating knowledge about nature in the city. A good example is the digital tree map, the so-called Urban Forest Visual, developed by the City of Melbourne, Australia which monitors the city's tree stock while also engaging with citizen science.

The third category of innovations is technological innovations, this includes product, process and infrastructure innovations. The BiodiverCity project in Malmö, Sweden is an example for product and process innovation. In this project, multidisciplinary actor groups developed a more biodiverse and attractive low-maintenance intensive green roof by introducing new processes and new plant species as an alternative to the traditional moss roof.

And last but not least, we have system innovations. System innovations lead to systemic changes, and can enable ecological, social and technological innovations, as well as the interaction between them. For example, developing a new master plan for large-scale transformation of urban neighborhoods that integrates multi-functional nature nature-based solutions will require major changes, not only in ecological and technological innovation, but also changes to municipal working practices and organisational structures. ▶

So what is driving nature-based innovations? Well, with the help of the nature-based innovation system framework we will explore the different driving forces behind the emergence of nature-based solutions. This framework categorizes innovation drivers in eight dimensions: 1) Agency, 2) Discourse and vision, 3) Policies, 4) Governance structures, 5) Collaborative arrangements, 6) Learning, 7) Resources and 8) place-based factors. And now let us see what the different dimensions entail.

(1) Agency refers to the capacity for actions that individuals and organizations take to influence nature-based innovation pathways. Driven by agents of change, organizations may demonstrate leadership and power in the development and uptake of nature-based innovations. Best practice interventions, particular planning processes and the introduction of new forms of environmental regulations can exemplify institutional commitments to sustainability.

(2) While agency plays a key role at individual and group levels, collective worldviews do so at the level of society. Discourses and visions of urban sustainability like "eco city", "green city" or "innovative city" often translate into norms of action, which in turn can build up the 'social momentum for change'.

(3) Discourses and visions also interact with different policies, like strategic plans, legislation and regulations, which can be used to directly and indirectly steer sustainable practices, stewardship, financing and public engagement enhancing nature-based solutions.

(4) Governance structures determine nature-based innovation pathways, as the actors involved and the distribution of power and responsibilities across stakeholders strongly influence the degree to which these actors have   a strategic overview, available budgets and capacity for collaboration.

They will also influence the institutional capabilities for collaboration and learning in this domain, two factors that are essential to overcoming challenges associated with fragmentation across scales and between sectors.

(5) Collaboration takes place in professional networks and partnerships among different stakeholders, but collaboration also refers to public participation, the engagement of citizens, which is becoming an increasingly dominant urban practice. The empowerment of civil society is particularly important in the implementation phase of nature-based solutions, especially in cities with high levels of private land ownership. Citizen engagement has a great potential to improve the public support of sustainability interventions, and ultimately to leverage sustainability transformations.

(6) Learning is another key dimension that supports capacity building for nature-based urban development. Education and training can improve understanding of the multiple benefits of nature-based solutions among different stakeholders. Research and evaluation can improve and refine nature-based interventions, while experimentation can contribute to new forms of governance approaches.

(7) Another critical driver for nature-based innovations is resources. As nature-based solutions need to be adapted to socio-ecological contexts, knowledge about local conditions and how they interact with nature-based solutions, is crucial. And diverse financial sources and "sound financial planning" are essential to the success of nature-based interventions. Today, institutionalized spending, grant programs and subsidies are prominent financing instruments for nature-based solutions. The development of technologies is another important condition for some types of nature-based solutions, like green roofs.

(8) In addition, place-based factors also strongly influence the availability and scope of nature in cities, as well as the functioning of nature-based innovations. The built environment influences, for instance, the diffusion of green roofs, as cities with large areas of low-rise development are more suitable for extensive green roofs given easier rooftop accessibility and less space occupied by building infrastructure.

Natural processes, like plant productivity is influenced by local soil and climatic conditions, which are important considerations when planning green infrastructure. Societal processes similarly influence the availability and scope of nature in cities. Urbanization may lead to environmental degradation, yet could also prompt demand for nature-based innovations by stimulating processes of economic transformation and urban revitalization.

Finally, local cultural frames of reference shaped by historical and geographical processes also influence the diffusion of nature-based innovations. Like consumption habits, business orientation, levels of trust, attitudes to co-production, artistic activities, or aesthetic preferences.

Our work in the NATURVATION project shows evidence of successful nature-based solutions. But despite attracting increasing interest, the use of nature-based solutions remains marginal, fragmented, and highly uneven within and between cities. Traditional solutions continue to dominate urban development. Therefore, it's now especially important to identify the combinations of measures, governance approaches, financial arrangements and underlying driving forces that support successful innovation pathways for nature-based solutions. ∎

LET'S HEAR ABOUT NATURE-BASED SOLUTIONS FROM THE CITY OF ESLÖV IN SWEDEN
The aim of our project in Eslöv is to identify the areas within the city where urban densification can take place with relatively low impacts on ecosystem services. We also want to identify areas that need to be protected from future densification. These types of assessments are new for us, and we are still testing different approaches on how we can best link these new assessments to the formal planning system in our municipality.

HOW HAS ESLÖV INTEGRATED NATURE-BASED SOLUTIONS TO SUPPORT URBAN SUSTAINABILITY AND CLIMATE ADAPTATION?
Identifying areas for densification and areas for protection, help us to guide our future work. With the help of this information, we have already managed to include certain new rules for supporting nature-based solutions in our planning, like the protection of trees and storm water retention. We are also working with ecological compensation to decrease the negative impacts that urban development can have on ecosystem services. This means that we are trying to compensate negative impacts from development by providing new values within the municipality through both municipal and private investment.

WHAT ARE THE MAIN DRIVERS THAT SUPPORT THIS INTEGRATION?
Within the municipality, two things that so far has supported the process, is the municipal comprehensive plan, which explicitly includes the protection of ecosystem services as a key goal. The co-financing through the private sector is then ensured through formal agreements. The other key driver for advancing nature-based solutions has been the increasing interest and the competence of different stakeholders. But overall, the interest in nature-based solutions as well as the knowledge is still rather low.

WHAT ARE THE MAIN BARRIERS FOR FURTHER INTEGRATION?
There are multiple barriers. One barrier is the lack of understanding of the long term benefits of nature-based solutions among politicians and other stakeholders. It is a common situation that developers or citizens favour short-term profitable solutions to the disadvantage of urban sustainability. And politicians sometimes just let it happen. Another barrier is the lack of municipality-owned land within the city centre. This land is mostly owned by the private sector, and we are currently working with them to formalise agreements that will help us integrate nature-based solutions even in private development projects. A problem in general is also a high turnover among staff, which means a loss of knowledge and experience, both for the municipality, and for other stakeholders.

WHAT IS THE VALUE OF WORKING WITH OTHER STAKEHOLDERS TO FOSTER NATURE-BASED SOLUTIONS?
The value to us is enormous. To encourage future integration of nature-based solutions and adaptation in urban planning and governance, there is a necessity to identify common challenges and barriers and get general ideas about potential solutions. Learning from other stakeholders with different backgrounds and perspectives is very helpful in this process. ■

WINNIPEG
– RIVER FRONT

Winnipeg is a river city and yet public waterfront access and development have been limited by increasingly frequent and severe floods, erosion, loss of vegetation and land ownership patterns. However, over the last decade, interest in the city River Front has grown significantly after investments to better use this space.

PROTECT

Urban nature in cities and their surrounding landscapes are home to important wildlife. Protecting urban nature can create havens for plants and animals and ensure that endangered and rare species are conserved. Protecting urban nature can also offer cities resilience to the changing climate and improve air and water quality for citizens.

RESTORE

Urban nature has often been degraded by pollution and waste. Restoring river valleys, urban parks and green spaces in the city can improve the conditions for wildlife in the city and generate new spaces for people to enjoy. Restoring urban nature can also help cities to protect themselves from flooding or droughts and contribute to economic regeneration.

THRIVE

Urban nature contributes to the health, well-being and livelihoods of citizens. Connecting to urban nature allows communities and individuals to thrive, boosting mental health and creating new opportunities for work and leisure. Urban nature allows cities to thrive by enabling economic regeneration, enhancing environmental quality and creating community well-being.

naturvation
cities – nature – innovation