

**Nadja Kabisch, Jutta Stadler, Simon Duffield,  
Horst Korn and Aletta Bonn (Eds.)**

**Proceedings of the European Conference  
“Nature-based Solutions to  
Climate Change in Urban Areas and their  
Rural Surroundings“**



# **Proceedings of the European Conference “Nature-based Solutions to Climate Change in Urban Areas and their Rural Surroundings“**

**Bonn, Germany, 17 - 19 November 2015**

**Organised by the German Federal Agency for Nature Conservation (BfN) in co-operation with the European Network of Heads of Nature Conservation Agencies (ENCA) and the Helmholtz-Centre for Environmental Research – UFZ / German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig**

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**Cover photo:** Green walls are effective means for nature-based solutions to climate change in urban areas while providing a range of co-benefits to society (Creative Commons CC0, [www.pixabay.com](http://www.pixabay.com), Photographer: sunsan).

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This publication is included in the literature database “**DNL-online**” ([www.dnl-online.de](http://www.dnl-online.de))

BfN-Skripten are not available in book trade but can be downloaded in a pdf version from the internet at: [http://www.bfn.de/0502\\_international.html?&no\\_cache=1](http://www.bfn.de/0502_international.html?&no_cache=1)

Publisher: Bundesamt für Naturschutz (BfN)  
Federal Agency for Nature Conservation  
Konstantinstraße 110  
53179 Bonn, Germany  
URL: <http://www.bfn.de>

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Printed by the printing office of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety.

Printed on 100% recycled paper.

ISBN 978-3-89624-193-1

DOI 10.19217/skr456

Bonn, Germany 2017

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## **Preface**

With about 75% of all Europeans living in cities now, effects of climate change on urban inhabitants are an important issue already and will become even more relevant in the future. On the other hand, urban areas with their high demand for energy and other resources are, though often indirect, major emitters of green-house gases. Thus, cities have to take a lead in climate change mitigation and adaptation actions.

Not only urban residents but also urban nature is impacted by climate change in various ways. Both have to cope increasingly with heatwaves as well as stormwater runoffs and floods. However, urban nature is not just affected by climate change: It is part of the solution, as management of urban ecosystems and their rural surroundings offers sustainable and cost-effective ways of climate change mitigation and adaptation while contributing to human well-being.

To highlight the importance of nature-based solutions for climate change mitigation and adaptation in urban areas and their rural surroundings, the German Federal Agency for Nature Conservation (BfN) in co-operation with the ENCA Interest Group on Climate Change and the Helmholtz Centre for Environmental Research (UFZ) / German Centre for Integrative Biodiversity Research (iDiv) organized the conference on “Nature-based solutions to climate change in urban areas and their rural surroundings – Linkages between science, policy and practice”, which took place from 17-19 November 2015 in Bonn, Germany. In addition, emphasize was given to the potential of nature-based approaches to create multiple benefits regarding ecological, social and economic aspects. The conference was part of a series of biannual European Conferences on Biodiversity and Climate Change (ECBCC) which started in 2011.

On behalf of the organizing team, I would like to thank the speakers, poster authors, session chairs, and all participants for their excellent input, lively discussions and contributions in the interactive sessions.

The conference proceedings included in this volume attempt to reflect the great variety of the presentations and discussions. Abstracts of oral presentations and posters provided by scientists and practitioners from all over Europe are complemented by a summary of the discussions held during parallel sessions and in plenary. Based on these outcomes, the ENCA Interest Group on Climate Change elaborated conclusions on how to foster the implementation of nature-based solutions to climate change in cities during a meeting which was held back-to-back to the conference. These recommendations were endorsed by the ENCA network at its 19<sup>th</sup> plenary meeting in Bern.

The conference outcomes and recommendations can serve European nature conservation agencies, municipalities, city planners, decision makers on several political levels, non-governmental organizations as well as applied science to further nature-based solutions to climate change in urban areas - for the benefit of nature and society.

Prof. Dr. Beate Jessel

President of the German Federal Agency for Nature Conservation (BfN)

# 1 Introduction

The joint BfN/ENCA European Conference on “Nature-based Solutions to Climate Change in Urban Areas and their Rural Surroundings” was held in Bonn/Germany on 17-19 November 2015. It was the third event in a series of biannual “European Conferences on Biodiversity and Climate Change, ECBCC”, which started in 2011<sup>1</sup>. The German Federal Agency for Nature Conservation (BfN) organized the conference in co-operation with the Interest group on Climate Change of the Network of Heads of European Nature Conservation Agencies (ENCA), the Helmholtz-Centre for Environmental Research – UFZ and the German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig. A wide range of European experts from science, policy and practice convened to discuss the importance of nature-based solutions (NBS) to climate change in urban areas and their rural surroundings. Further emphasis was placed on the potential of nature-based approaches to also create multiple-benefits. Some of the latest scientific findings on effects of nature-based solutions to climate change mitigation and adaptation and their multiple co-benefits were presented in the plenum sessions. This was followed by interactive sessions focusing on eight specific themes ranging from “The role of biodiversity conservation for nature-based solutions for climate change”, to “Integrating grey, blue and green solutions” and “Rural-urban linkages” as well as “The role of social cohesion”, “Nature-based solutions from a transitions’ perspective” and “Economic aspects”. In addition, “Urban gardening and urban agriculture” were addressed. A special session was also dedicated to “Municipalities adapt to climate change”, where the focus was on good practice examples and the sharing of experience among community level actors. Finally, discussions considered current European policy in implementation of nature-based solutions, leading to recommendations for putting nature-based solutions into action.

## Structure of the conference

The three-day event, which was attended by more than 230 participants from 27 countries comprised keynote sessions with presentations and time for questions and discussion, a poster session, eight parallel workshop sessions and a final panel discussion. Overall, 55 presentations were given in plenary and the interactive sessions, complemented by 36 posters that were displayed during the conference.

The conference was opened by Beate Jessel, President of the German Federal Agency for Nature Conservation (BfN), and Simon Duffield, ENCA Climate Change Group, who warmly welcomed the participants and provided an overview of the scope and background of the conference. Following this, Hans Bruyninckx, Director of the European Environment Agency, gave a keynote presentation on how nature can help to mitigate and adapt to climate change in a special ecosystem: the city. He emphasized that urban areas drive climate change but are also increasingly affected by climate change. Wilhelm Krull, chair of the European Commission expert group on nature-based solutions and re-naturing cities and Secretary General

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<sup>1</sup> The first conference held in Bonn in 2011, explored options to enhance communication and co-operation between science, policy and practice and identified research priorities (see: [http://www.bfn.de/0103\\_conferenzce-biodiversity.html](http://www.bfn.de/0103_conferenzce-biodiversity.html)). The second conference held in 2013, focused on adaptation of main European ecosystems and led to recommendations for climate change-adapted nature conservation in Europe (see: [http://www.bfn.de/0103\\_conferenzce-biodiversity0.html](http://www.bfn.de/0103_conferenzce-biodiversity0.html)).

of the Volkswagen Foundation, then explained the potential contribution of public and private research funders to sustainability and responsibility related to nature-based solutions. He argued that NBS may be implemented on multiple levels – from EU level with Horizon 2020 to city level and through foundations. These two presentations were followed by eleven scientific keynote presentations. At the beginning, Georgina Mace, Director of the UCL Centre for Biodiversity and Environment Research CBER, gave an excellent overview of results from investigating the direct effects from increased exposure of vulnerable people to direct effects from storms, drought, floods and heatwaves. She concluded that future anthropogenic climate change and demographic change are likely to increase exposure of people and their assets to extreme weather. However, she also came up with possible solutions, particularly different defensive options, the role of governance, and interventions in the financial system. This keynote session was complemented by a talk by Christine Wamsler, Lund University Centre for Sustainability Studies, who introduced the mainstreaming of climate change adaptation in urban governance and planning. The afternoon keynote session included contributions from Ingo Kowarik, Technical University Berlin, Dagmar Haase, Humboldt-Universität zu Berlin, and Franz Essel, Environment Agency Austria. These speakers focused on the impacts of climate change on biodiversity as well as on the opportunities for employing specific natural ecosystems and biodiversity management to combat and adapt to climate change and as nature-based solutions in an urban context. Ingo Kowarik, in particular, presented first results from a study on biocultural diversity coming from the EU FP7 project GREEN SURGE ([www.greensurge.eu](http://www.greensurge.eu)). On the basis of case studies he showed that people in different European cities are more in favor of green spaces with higher biodiversity levels than with less biodiversity. Erik Gómez-Baggethun, Norwegian Institute for Nature Research, afterwards referred to an economic perspective of nature-based solutions and presented valuation methods for ecosystem services. He concluded from this presentation that a policy mix should be used to regulate capacity, flow and demand of urban ecosystem services. This policy mix may include prescriptive policy regulations such as car free zones, pollution caps, but also economic instruments, such as taxes on emissions and private transport, subsidies to low emitting transport. In the second afternoon session, Vera Enzi, University of Natural Resources and Life Sciences Vienna, illustratively presented significant results to show that cities can adapt to climate change by implementing green roofs and green walls on buildings. Green roofs and walls can have significant effects on local outdoor and indoor climates. The final scientific keynote session on the first conference day focused on social science research related to nature-based solutions. Tanja Wolf from the World Health Organisation (WHO) introduced WHO's perspectives on urban environmental health and climate change, which includes among others the "WHO programme on climate change and health", "WHO 12th programme of work (2014)" and the "Sustainable Development Goals and 2030 agenda". Taking this up, Catharine Ward Thompson, Edinburgh College of Art, linked urban nature to well-being and quality of life of city residents, differentiated for different age groups. She finally concluded that a city of well-connected green spaces that offer opportunities for children and older people, for active commuting and high-energy sports as well as for relaxation and social contact, is likely to be a resilient city. Niki Frantzeskaki from the Dutch Research Institute for Transitions introduced transformation processes as opportunities for nature-based solutions. By presenting results from the EU Project ARTS (<http://acceleratingtransitions.eu/>) she explained the role of NBS in transition processes. In particular, she referred to NBS as disruptive innovations that reroute on-going developments and plans as well as act as turning points within transformative pathways. She further ex-

plained NBS as conforming innovations that are adjacent to existing plans and on-going developments and potentially reinforce existing urban sustainability and resilience agendas. Finally, Nadja Kabisch, Helmholtz Centre for Environmental Research-UFZ, completed the scientific keynotes and discussions with a presentation on potential barriers and opportunities of NBS to climate change mitigation and adaptation. By referring to scientific study results based on the city of Berlin as a case study, she referred to three needs for future research: 1) building evidence of NBS for climate change adaptation and mitigation, 2) adapting for governance challenges in implementing NBS, and 3) considering socio-environmental justice and social cohesion when implementing NBS. The first conference day ended with an evening reception hosted by BfN, which took place after a public evening lecture by Dirk Sijmons, formerly Delft University of Technology, who was speaking on the global challenge of urbanization and its conflicts and synergies with nature.

Kristina Ina Nowak, City of Ljubljana, opened the second conference day with a keynote talk. She introduced the city of Ljubljana as new European Green Capital 2016 and highlighted the enormous efforts of the Slovenian capital to make the city greener and more sustainable. These efforts included the creation of an ecological zone in the inner city area to keep automobile traffic outside the city centre. As an outcome of this strategy carbon emissions were reduced by 58%. This presentation was followed by a keynote talk by Wolfgang Teubner, ICLEI – Local Governments for Sustainability, Regional Director for Europe. Wolfgang Teubner presented several international cases where nature-based solutions projects were successfully implemented in urban areas. For the remainder of the day, the focus was on eight parallel interactive workshop sessions with four short input talks each and group discussions respectively and a poster session at midday. The eight parallel interactive workshop sessions are summarised below (section 2.3). The main messages from the workshops were presented in plenary in the late afternoon and informal discussions and networking continued at the conference dinner that evening.

The third conference day was dedicated to policy and business issues for the implementation of nature-based solutions under climate change. Kurt Vandenberghe, Director of Directorate Climate action and resource efficiency, DG Research and Innovation/European Commission, started with a keynote discussing the contribution of the EU research and innovation policy agenda for nature-based solutions and re-naturing cities. In particular, he introduced the current Horizon 2020 calls for NBS as innovation and communication action. Stefan Leiner, acting Director, Natural Capital, DG Environment/European Commission, complemented the discussion of the European Commission's perspectives on nature-based solutions by referring to spatial green infrastructure planning and its links to EU policy. Chantal van Ham, International Union for Conservation of Nature, IUCN, referred to IUCN's perspective on nature's solutions for urban resilience. She concluded that NBS can support economic development and social well-being, but that there is still a need to better understand of when, where and how investment in nature-based solutions make good social and economic sense. Innovative partnerships may be one option to improve the implementation of NBS when some key elements are considered. These key elements include a) an increased recognition of the value of ecosystems for climate adaptation and mitigation; b) the enlargement of an evidence base on the services that ecosystems provide as well as the business case among policy makers and the private sector; collaboration, breaking down silos, working across sec-

tors for the implementation of nature-based solutions; c) and a collaboration of business, urban planners and civil engineers with environmental engineers and ecologists, governments, scientists and communities to develop solutions jointly. The two final keynote talks focused on economic and business impacts related to nature-based solutions. Luise Noring, Copenhagen Business School, explained the potential of business and investment for nature-based solutions to govern cities in the future. She referred to the example of the city of Copenhagen and explained that Copenhagen's real success in implementing NBS is grounded in its ability to leverage local power and capacity in long-term planning, in collaboration with the national government and the private and civic sectors. Bernd Hansjürgens, Helmholtz Centre for Environmental Research-UFZ, presented results from the TEEB study (The Economics of Ecosystem Services and Biodiversity) for Germany (<http://www.naturkapitalteeb.de>) and presented a question at the beginning of his talk: How can an economic perspective support urban green infrastructure decisions? He referred to this question by concluding that an economic perspective means considering trade-offs; and recognizing, demonstrating and capturing the values of green infrastructure. He showed that economic valuation methods are used by urban decision makers as economic arguments, but that they are only useful, if an integrative perspective is taken. He finally concluded that economics can provide decision support, but that there are still huge knowledge gaps.

The conference ended with a lively panel discussion on options and future challenges to put forward the implementation and distribution of nature-based solutions for climate change mitigation and adaptation in urban areas and their rural surroundings. In particular, Beate Jessel, President of the BfN, Chantal van Ham, IUCN, Stefan Leiner, EC, Marco Fritz, EC, DG Research and Innovation, and Dagmar Haase, Humboldt-Universität zu Berlin, as panel participants discussed how nature-based adaptation and mitigation measures could be integrated in cross-sectoral policies. They highlighted that this may be achieved by sharing positive and negative experiences especially targeted to the needs and interests of different stakeholder groups (decision makers, business or public); and by a communication of a detailed description of the process, benefits, the solutions for certain problems, mistakes made and lessons learned to avoid them, specific context, and stakeholders involved. One of the major discussion points focused on future research agendas to foster comprehensive research and monitoring of multiple benefits that are created by NBS. These multiple benefits comprise economic, ecological and social benefits. They further discussed the need for an extended evidence base about the effectiveness of NBS implementations by providing good practice examples that clearly demonstrate the multiple benefits. This not only includes NBS benefits related to climate change adaptation and mitigation, but also benefits related to the conservation of biodiversity and in particular enhancement of human health, to mention just one prominent example of the further socio-economic benefits.

### **This issue**

This BfN-Skript presents the major outcomes of the conference with an overview of the discussions in the workshop sessions (section 2) and the plenary (section 3). The core of these proceedings form the abstracts of the oral and poster presentations, which the majority of presenters have kindly contributed (section 4 and 5). Most authors have included their contact details as well as key literature and useful web links. Building on information presented in talks, posters, workshops and panel discussions during the conference, the BfN/UFZ/iDiv team and the ENCA Climate Change Group developed a set of conclusions and recommen-

dations for putting nature-based solutions to climate change adaptation and mitigation into action in urban areas and their surrounding landscapes. These recommendations were endorsed by the ENCA network at its 19<sup>th</sup> plenary meeting in Bern (Annex 1).

The slides of most presentations as well as an online version of this report can be downloaded from the conference documentation website at

<http://www.bfn.de/23056+M52087573ab0.html>

## **2 Outcomes of the conference workshop sessions**

### **2.1 Integrating the grey, blue and green – Nature-based solutions for climate change adaptation and mitigation as complementary or alternative measures to engineering approaches**

SESSION CHAIR: WERNER LANG

*Technical University of Munich, Institute of Energy-Efficient and Sustainable Design and Building*

While climate-change mitigation appears to be a well-accepted strategy in urban environments throughout Europe, the adaptation of cities to climate change and its effects with regard to urban heat islands is just at the beginning. An integrated approach is needed, where climate change adaptation and mitigation are seen as complementary strategies. In this context, the development of nature-based solutions and their implementation on an urban scale seem to be a logical choice, where the building sector (grey), water and storm-water management strategies (blue) as well as ecosystem services (green) are looked at in a holistic manner. The goal must be to develop effective and cost-efficient solutions to increase the resilience of cities to climate-change while enhancing the quality of life in urban developments, reducing the negative impact on the environment and improving the biodiversity in cities and their immediate surroundings.

Following the presentations of session 1, a workshop was conducted to discuss the following three questions in relation to the role of NBS to enhance sustainable rural - urban relationships:

1. How effective are nature-based solutions compared to technology-based solutions for climate change adaptation and mitigation in urban areas?
2. Are there complementary effects in a way that technical solutions are improved by nature-based solutions for climate change adaptation and mitigation?
3. What are good practice examples and how have they been communicated?

#### **1. How effective are nature-based solutions compared to technology based solutions for climate change adaptation and mitigation in urban areas?**

In order to answer the question about the effectiveness of various solutions it was discussed, whether climate change adaptation and mitigation have to be based on single objectives, or whether multiple goals have to be taken into account. The conclusion of the discussion was, that multiple goals have to be followed by taking a systemic view, where direct as well as indirect benefits have to be taken into account. With regard to governance it seems to be clear that citizens have to declare ownership by accepting responsibility for the development and implementation of the measures. ‚Grey‘ measures appear to be more effective in achieving singular goals compared to NBS, but NBS can address multiple goals and thereby achieve multiple benefits.

## **2. Are there complementary effects in a way that technical solutions are improved by nature-based solutions for climate change adaptation and mitigation?**

The discussion resulted in a common view, that nature-based solutions (NBS) offer the key for a holistic and truly sustainable approach, which ultimately creates a wide range of benefits for the whole community. While technical solutions might offer the chance to provide a quick answer to certain challenges, such as providing shade for outdoor spaces, NBS very often take longer to develop their full potential. While trees take years before they provide full shading of a certain area, they offer a wide range of additional benefits, such as evaporation cooling, CO<sub>2</sub> storage, creating a habitat for numerous animals, and add to the beauty and quality of urban environments. Taking this into account, technical solutions are to be regarded as short-term solutions, while NBS should be integrated from the beginning of a problem-solving approach onwards, as they offer additional benefits to solving certain challenges. Examples for complementary effects of technical solutions and NBS are for instance retention ponds or water-sheds, which can be regarded as technical as well as nature-based solutions.

## **3. What are good practice examples and how have they been communicated?**

One of the keys to creating and maintaining multiple benefits of NBS is the involvement and ownership of the solution by local communities and relevant stakeholders. Examples for such integrated approaches are the 'green roof programme' and the 'tidal wetlands' by the City of Hamburg, or the urban agriculture programme at the 'Princess Gardens' at Moritzplatz in Berlin Kreuzberg. Another example can be found at the City of Copenhagen, promoting 'green mobility' by creating bicycle routes throughout the city. On a more international scale, the Seoul river restoration project is another good example for NBS, which also had been backed-up by intense PR activities. A good example for the communication of knowledge in this field is the project 'INKAS' (Informationsportal Klima Anpassung in Städten) by the 'Deutscher Wetterdienst', which is a web-based information service for stakeholders and (urban) planners as well as a wider public. Another example for the dissemination of good-practice examples is the ELCA Trend-Award "Building with Green" of the European Landscape Contractors Association.

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## 2.2 Nature-based solutions for climate change adaptation & mitigation and the role in fostering social-environmental justice in cities

SESSION CHAIR: DAGMAR HAASE AND NADJA KABISCH

*Humboldt Universität zu Berlin, Helmholtz Centre for Environmental Research, German Centre of Integrative Biodiversity Research - iDiv, Germany)*

In 2014, over half of the world's population resides in cities (UN, 2014). In line with ongoing urbanization, urban ecosystem services are highlighted in social-ecological research to define those benefits residents obtain from urban ecosystems. Nature-based solutions are instruments in research, management and policy to highlight the contributions of nature and ecosystems to quality of life of urban residents and their resilience to climate change. These can be attained e.g. through ensuring an appropriate functioning of urban green and blue infrastructure such as parks, green walls and roofs, allotments or different types of water bodies. The intelligent use of nature in cities may help to climate change adaptation and mitigation and to improve health of city residents. The contribution to environmental justice, however, is not yet fully understood. It is not clear, if all benefits urban ecosystems provide are distributed equally across social groups or, what is more, have to be equally distributed to generate group/age/gender-crossing benefits; and how the implementation of nature-based solutions impact on or even foster social-environmental inequalities.

Four presentations addressed the social justice issue in the context of implementing NBS in urban areas to be used for climate change adaptation and mitigation. The following interactive discussion rounds addressed then three questions to discuss the relation between NBS and socio-environmental justice in an urban context further:

1. What is the relation between the implementation of urban green or blue infrastructure and displacement of people considering side-effects such as gentrification? What are strategies to overcome them?
2. How do we share experiences related to nature-based solutions for climate change adaptation and mitigation to other cities of context with different cultures, mental models?
3. What is the role in fostering social-environmental justice in cities when considering integrative participation in planning processes?

### **1. What is the relation between the implementation of urban green or blue infrastructure and displacement of people considering side-effects such as gentrification? What are strategies to overcome them?**

A number of issues were discussed among the interactive groups. The session participants agreed that implementing, developing but also maintaining existing green space is important in urban development. Whenever a part of a city will be regenerated, green space development should be automatically considered as an integral part in complex development projects realized in complex environments. Opportunity windows that allow for a creative implementation of green space should be used. However, what is important in an implementation but also maintenance process is that a certain quality of green space needs to be guaranteed. To avoid potential displacement of people or to set off rounds of gentrification, green space standards and political targets should be implemented combined with social housing standards in a holistic approach where the planning of the entire city is considered. What

does that mean? For example, whenever possible, ensure quality green space everywhere and in combination with social housing standards namely urban green space standards (minimum) and political targets. Be humble what NBS ensure in terms of society in cities – not all problems can be solved automatically by implementing NBS. Whenever parts of a city will be regenerated, green space should be somehow considered. That means when NBS are in the focus and used as promotion or argumentation tool supporting decisions in favor of the installation of urban natural spaces, it should be clear that NBS cannot solve all problems related with climate change.

## **2. How do we share experiences related to nature-based solutions for climate change adaptation and mitigation to other cities of context with different cultures, mental models?**

Diversity was discussed as a main issue (we didn't see it as an issue, but we were looking more for the needs) when sharing experiences of NBS with other cities. Within diversity main trends were discussed in the interactive session: The first one is to rethink attitude towards experience exchange. There is obviously a need to go out of the comfort zone, acknowledge what is already there, listen to needs, ensure continuity, society-policy-research, use communicators/knowledge brokers. When NBS experiences are translated to other examples major requirements are to involve people with diverse backgrounds in culture and education and to find suitable settings and language. In this regard, DIVERSITY was highlighted as to be most important when sharing NBS implementation experiences.

## **3. What is the role in fostering social-environmental justice in cities when considering integrative participation in planning processes?**

In general, the participants of the group agreed that social issues and environmental issues need to go together in planning processes. One of the main requirements when implementing urban green or blue space projects is the continuity in personnel and financing. There was also the requirement for a certain involvement of the state while at the same time acknowledging the responsibility and engagement of local groups. Results of participation processes need to be seen in the respective context.

The group came also up with some new discussion points, which could not be finally discussed during the interactive session. This included the question on how we deal with a general non-participation and how to use the opportunities of the social media to increase participation.

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## **2.3 Urban (allotment) gardening and urban agriculture as local community based approaches of small-scale climate change adaptation and mitigation in urban areas**

SESSION CHAIR: DIETER RINK

*Helmholtz Centre for Environmental Research – UFZ, Department Urban and Environmental Sociology, Leipzig*

Urban gardening and agriculture have become an intensively discussed issue related to new urban trends, but as well related to issues like food provision, climate change and biodiversity. It was the aim of this workshop to address these topics and to relate them to each other. Based on the presentations a number of questions have been raised.

The workshop participants discussed the following three major questions:

1. How can urban gardening activities including allotment and community gardens support climate change adaptation and mitigation?
2. What are successful examples of using community gardens for environmental education?
3. Do allotment gardens and other forms of urban gardens have co-benefits in terms of increasing social stability?

### **1. How can urban gardening activities including allotment and community gardens support climate change adaptation and mitigation?**

There are many direct and many co-benefits of urban gardens for climate change mitigation and adaptation, particularly for the regulation of the micro climate through heat reduction and increased evapotranspiration. Urban gardens, especially of bigger size, also decelerate wind speed, regulate water flow (reduce run-off) and play an important role in air purification. Additionally, the gardens (artificially) host many native but also alien plant species and serve as retreat areas for different animal species, in particular birds, who find a diversity of food plants and ideal places for breeding.

The effects of mitigation and adaptation can be raised and go beyond the garden area itself if the gardens are sustainably managed. In many cases, though, it remains unclear what are available tools and instruments (investments) to invest in working with nature for people, to empower people and encourage multi-sectoral partnerships.

### **2. What are successful examples of using community gardens for environmental education?**

The talks and subsequent discussions outlined successful examples of how urban gardens and in particular community gardens serve as a space to build communities that not only want to grow their own food but want to learn, exchange and apply gardening techniques, botanical knowledge as well as ways of an environmentally compatible life. In sum community gardens serve as an instrument for environmental education. In general, all urban gardens are places for socially and inter-culturally inclusive activities and improved interactions and acceptance. Besides, shown by one talk, there are initiatives to promote awareness for so

called “climate-gardening” by demonstrating and supporting gardening techniques which support climate adaptation and mitigation.

### **3 Do allotment gardens and other forms of urban gardens have co-benefits in terms of increasing social stability?**

The participants of the workshop clearly approved that question. Allotments and all kind of urban garden activities (e.g., community gardens) provide space and time slots for social interactions (among gardeners). Besides, the gardens may also serve as a safe physical place and build or enhance identification of the gardeners, with gardening, nature, and with themselves. In particular, community gardens often feature a strong cohesive community of people, and are used for social and cultural events. Owning a garden may also serve as insurance under (financial) crisis situations especially for low-income population/citizens. Due to the overall agreement on the question, an alternative one was worded: “How social stability can be improved in urban gardens?”. However, only few answers were given, such as extending public access to allotment colonies and liberalizing the gardening/club codes to attract more people, especially younger generations and families. In addition, it has been raised that gardens could be a source of conflict of interests as regards land-use planning and city development, not at least since garden projects increasingly are under threat by new constructions.

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## **2.4 Municipalities adapt to climate change by effective use of green infrastructure for nature-based solutions and existing actor networks**

BIRGIT GEORGI

*European Environment Agency, Copenhagen*

The aim of session 4 was to make a practice check and explore current experience when implementing nature-based solutions at local level. Four presentations provided input and inspiration for the discussion on 3 questions:

- The situation of urban adaptation in the Czech Republic at the example of three pilot cities – Prague, Brno, Pilsen
- A review of German projects on the use of nature-based solutions in adaptation planning
- Adaptation planning and nature-based solutions in the city of Neuss, Germany and the inter-municipal network “Municipalities for biological diversity”
- The green roof programme in Hamburg, Germany

### **1. What are successful municipal-led examples and strategies of effective implementation of NBS?**

The participants named many different examples that they consider as successful cases. However, the key question was: How do we define success? Actually, there are no specific guidelines yet, but the participants agreed that successful nature-based solutions are implemented based on a systematic assessment of the situation in the city or the site. A baseline and a target are defined and a frequent monitoring established to measure the benefits for adaptation and mitigation. The monitoring would also reveal needs for adjustments of the measure to better meet the targets and providing evidence of the effectiveness.

Other important criteria are the high connectivity of the different green urban areas, the use of native plants, and participation of local stakeholders in the planning process and maintenance work. Good examples do not always require much finance; sometimes, low cost measures can be very effective and stable, like citizens’ urban gardening.

### **2. How to handle the challenges of funding – short-term versus long-term needs?**

It is important to acknowledge that different stakeholders and investors are involved in the implementation of measures. They all have different interests, including different time horizons of working and for the return of the investment. Therefore, an array of different investment propositions is necessary to serve the various types of investors. They require specific incentives and financing models.

It is necessary to communicate clearly the costs of inaction or delayed actions. Early adaptation comes usually at much lower costs as it can be integrated in the urban design and design of nature-based solutions instead of being added later. The costs of delayed or inaction need to be included in cost-benefit considerations.

To overcome the obstacle of short-term policy cycles and long-term financing needs, the design of sequential measures that are implemented step by step could help. A long-term strategy or plan in which the measures are embedded would be helpful.

The participants exchanged further arguments related to the financing of nature-based solutions for climate change adaptation and mitigation. When developing measures that have

adaptation benefits only in the long-term, it is important to demonstrate other values that capitalize already short-term, like the recreational effect of green areas. It is important to make the multiple benefits of nature-based solutions visible to get a buy-in from decision-makers.

Other options to finance nature-based solutions in the times of scarce municipal budgets could be to apply for national and European funding, create a tax for adaptation, mainstream adaptation into other budget lines like water management or disaster risk reduction. Crowdfunding, public-private partnerships and providing incentives for private actors like shown in the presentation on the green roof programme for Hamburg, where private owners could have some tax or fee reduction when establishing a green roof, are important means.

### **3. How to scale up successful projects and how to transfer them to other cities?**

If projects had been successful, the most important element to upscale them is to have a good and comprehensive strategy/plan in place that includes among other issues proper funding opportunities. It should, furthermore be based on a participatory approach that involves all relevant stakeholders and considers their specific interests and culture. The participants recommended networking and a regional cooperation as success factors. It helps if the project is embedded or strongly linked with other existing initiatives.

Good communication was mentioned as another key element. It should describe the benefits, the solutions for certain problems and share the positive experience as well as the mistakes made and lessons learned to avoid them. A detailed description of the good examples should include the description of the process, specific context, stakeholders involved, success and limiting factors etc. Such information enables followers to learn from and to transfer the good practice. Good communication includes awareness raising which can also come bottom up: Citizens groups can create public awareness and thus push the local authorities to take action.

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## **2.5 The role of biodiversity conservation for nature-based solutions in climate change adaptation and mitigation**

CHAIR: DR. SONJA KNAPP,

*Helmholtz-Centre for Environmental Research - UFZ*

The session aimed at answering three questions:

1. What is the significance of biodiversity in cities for the adaptation and mitigation to climate change?
2. What is the role of biodiversity in providing ecosystem services? Which aspect of biodiversity is relevant for ecosystem service provision (habitat diversity, species richness, functional diversity, else)?
3. Can nature-based solutions (NBS) be successful for ecological restoration in urban landscapes?

Our main answers are

### **1. What is the significance of biodiversity in cities for the adaptation and mitigation to climate change?**

High-diversity systems have a higher resilience than low-diversity systems, which makes biodiversity central to climate change adaptation. This is the case even though biodiversity might not promote all NBS-related ecosystem services. Indeed, whether high biodiversity has positive, negative or no effect on single ecosystem services or nature-based solutions remains to be answered. This means that NBS do not automatically promote biodiversity. But, as diversity increases resilience, NBS should in any case be designed in a biodiversity-friendly way.

### **2. What is the role of biodiversity in providing ecosystem services? Which aspect of biodiversity is relevant for ecosystem service provision (habitat diversity, species richness, functional diversity, else)?**

Along the same lines, NBS should not be based on short-term but on long-term considerations and should include raising the awareness for biodiversity and the value of biodiversity (including the value of its own). Raising the awareness for biodiversity can help in the creation of multifunctional (urban) green spaces, where biodiversity finds its place, too (e.g. in urban parks primarily focused on recreation).

### **3. Can nature-based solutions (NBS) be successful for ecological restoration in urban landscapes?**

NBS will enable successful ecological restoration with benefits for biodiversity if they consider connectivity (urban – rural; matrix - habitats), local conditions (e.g. native species) and do not exclusively focus on adaptation as an anthropocentric goal. Cities are no closed systems and should therefore not be thought as standing on their own. Rather, connecting urban and rural green areas will promote NBS (such as temperature regulation) and biodiversity (by connecting urban and rural plant and animal populations and decreasing the spatial isolation among them). The same is true for connecting matrix (built-up areas) and habitats (green areas) within cities with each other: existing green areas should be protected and comple-



mented by green elements within the matrix (e.g. by green roofs, green facades, bioretention swales, green stripes along roadsides). This will again promote ecosystem services and biodiversity. The local context is important here: for example, native habitats and native species should especially be protected and native species should preferably be used for NBS.

## 2.6 Nature-based solutions for climate change adaptation and mitigation from a transition perspective

CHAIR: ANIA ROK AND LEEN GORISSEN

*Local Governments for Sustainability (ICLEI), Flemish institute for technological research (VITO)*

Our cities are experimental grounds on re-creating public spaces and renaturing areas with the aim to get social, ecological and economic benefits. In this effort, policy efforts are complemented and even steered by bottom-up initiatives. These initiatives come in multiple colours and shapes, led by public, civil and business sectors and by partnerships between them, vary in sizes and in missions. With a great number of European cities experiencing a plethora of those initiatives that take up local action for climate adaptation and mitigation as well as for bringing sustainable practices and services to life, there are new questions that arise when looking closer on the impact these initiatives bring about. With a specific focus on those transition initiatives that promote and realize nature-based solutions in cities, the session focussed on how they establish different relationships, different institutions and how they alter urban economies by engaging with a great array of actors and establishing new transaction rules. The aim was to have a dialogue over these new urban realities that nature-based solutions are bringing to the cities with an explicit focus on transition initiatives; the actor-networks behind the solutions. We want to unpack the impacts, the barriers and drivers they face by looking across sectors (public, business and civil society) and across scales (within city-regions and across city-regions). These aims are also addressed in the ARTS research project ([www.acceleratingtransitions.eu](http://www.acceleratingtransitions.eu)) bringing together policy-makers from different levels of governance, researchers and representatives of transition initiatives to benefit theory, policy and practice related to accelerating sustainability transitions.

At the beginning of the session, the chairs introduced the main objectives of the ARTS project and the interactive set-up of the session. Four presentations addressed nature-based solutions for climate adaptation and mitigation, drawing upon different disciplines and local contexts. Afterwards the participants were invited to approach the speakers directly with questions and contributions, in a format of four parallel corner talks. Following the presentations that focused on the different models of cooperation between transition initiatives and the local administration, the participants were asked to explore further three key questions:

1. Nature-based solutions can be understood as larger systematic interplay in a multi-actor process: what are new actor-networks created by nature-based solutions?
2. How do these new actor-networks (e.g., transition initiatives) instigate transformations in cities with and through nature-based solutions? What are the lessons learnt from policy and practice about nature-based solutions?
3. What are the ways to share and aggregate lessons from existing practice without shadowing the unique characteristics and motivations that drive nature-based solution networks and practitioners?

### **1. Nature-based solutions can be understood as larger systematic interplay in a multi-actor process: what are new actor-networks created by nature-based solutions?**

The question immediately raised another valid question: what comes first? Nature-based solutions or actor networks? It is however clear that NBS require “business-as-Unusual” net-

works and that they need to be very diverse so that they can be enabling, inclusive and transformative. These actor networks should not be isolated from other existing official networks but collaborate with them without losing their capacity to ‘stretch and transform’, i.e. explore and develop alternative paths. To achieve that, public authorities need to develop a new role and become facilitators that enable transformative change. The new networks should at first be open to more radical thinking (by including young people and giving them a mandate to do things differently) and protected from vested interest and business-as-usual thinking (while being well-informed about how incumbents react to NBS). Once these are well-established and strong enough, they should open the dialogue to include incumbents and actors from networks involved in nature-harming activities to offer them alternative NBS for the activities they enrol. In conclusion, the new actor-networks need freedom and a mandate to explore and develop new ways of thinking, doing and organising in a space protected from mainstream thinking. They need an enabling environment that allows them to professionalize, grow strong and be well-informed before they open the dialogue to incumbents and actors doing the opposite of NBS.

## **2. How do these new actor-networks (e.g., transition initiatives) instigate transformations in cities with and through nature-based solutions? What are the lessons learnt from policy and practice about nature-based solutions?**

The discussion focused on how transition initiatives and the local administration can collaborate in design and implementation of nature-based solutions. The participants indicated communication, both external and internal, as a key enabling factor. In terms of communication between the initiatives and the local administration, it is important to acknowledge that activists and city employees often speak different languages and driven by different agendas. To help find a common ground, being open and listening to each other is essential for both sides. Silo thinking within the local administration can represent a major obstacle for transition initiatives, especially when their projects are addressing topics dealt with by more than one department. Improved internal communication is essential for integrated and participatory urban development. One solution proposed was to establish a cross-sectoral team to manage the interface between citizen-driven transition initiatives and local administration. This team could then keep an overview of all relevant processes and decisions, acting as a cooperation hub.

## **3. What are the ways to share and aggregate lessons from existing practice without shadowing the unique characteristics and motivations that drive nature-based solution networks and practitioners?**

The discussion focused on how to achieve the right mix between online and offline sharing tools, making sure the tools selected are always adapted to the needs of the audience. Offline formats, particularly face-to-face meetings, can be effective in conveying the complexity of lessons learned and in establishing personal connections that could inspire future sharing. On the other hand, they are usually relatively small-scale, require considerable time and money investment and their effectiveness often depends on factors beyond the organizers’ control (how to find the right people at the right time?). Online formats discussed included various types of databases, repositories and communities of practice. These can be easily accessible to anyone, provide different levels of description and search functions. On the other hand, their maintenance requires commitment and funding which are often difficult to ensure in the long-term. The emphasis was on moving away from standard best practice databases to richer, more nuanced information, including e.g., perspectives of different

stakeholders, examples of failed initiatives, long-term consequences of actions taken, as well as making use of new communication tools and formats, such as social media, visual storytelling, wiki-type tools, etc.

## **Conclusion**

The overall conclusions from the discussion rounds can be summarized as follows: The new actor networks are working in niches and they need to grow out of them and need changing governance structures. Nature-based solutions require business as unusual networks: inclusive, enabling and transformative, to share and aggregate knowledge, adapt to your audience and scale: a good mix of personal contacts, social networks and systematic description is recommended. The session ended with the launch of the Resilience Connections Network, a virtual space for interaction between global and local thought leaders, transition entrepreneurs, resilience science experts, and practitioners. Through this online networking platform, individuals working or interested in resilience and sustainability transitions can share insights and experiences, find and connect with potential future collaborators, contribute to a shared library of resources, engage in dialogue, and learn best practices in building resilience and making sustainability happen.

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## **2.7 Rural-urban linkages of nature-based solutions for climate-change mitigation and adaptation and planning perspective**

CHAIR: STEPHAN PAULEIT

*Technical University of Munich, Chair for Strategic Landscape Planning and Management*

Urban development in Europe and elsewhere has led to the emergence of large rural-urban regions which are comprised of urban, peri-urban and rural zones (NILSSON et al. 2013). Planning and implementation of nature-based solutions (NBS) to develop a coherent and multifunctional green infrastructure at this regional scale will be of critical importance for more sustainable and climate resilient development. However, this task is extremely challenging due to the political fragmentation of rural-urban regions, the diversity of stakeholders and conflicting policy agendas.

Four presentations addressed a broad range of issues within the rural-urban continuum, from implementing nature-based solutions in densifying inner city locations, assessment of the climatic functions of agriculture at the urban fringe, approaches to multifunctional land management in rural areas to tools supporting overall regional planning.

The following workshop then discussed three questions in relation to the role of NBS to enhance sustainable rural urban relationships:

1. What are good practices of nature-based solutions for sustainable rural – urban relationships?
2. How to deal with conflicts when planning for NBS?
3. What are suitable and successful approaches to governance of NBS that enhance rural-urban linkages?

### **1. What are good practices of nature-based solutions for sustainable rural – urban relationships?**

A number of approaches were considered to establish beneficial linkages between urban and rural areas. These included strategies for urban farming and organic farming (e.g., in Munich) and multifunctional urban woodlands. Moreover, spatial concepts and instruments were considered as important to develop coherent systems of multifunctional green infrastructures such as green rings and regional parks. It was stressed that such approaches need to be supported by effective communication to raise awareness of the importance of NBS. Regular media coverage was considered important, e.g., to highlight the need for climate change action after floods events but also success stories should be presented to emphasise the important role of NBS e.g., via floodplain restoration. Nature-based solutions should also be regarded for city branding. Good practice cases of such a strategy would be Frankfurt's Grüngürtel and the Rhein-Main Regional Park.

### **2. How to deal with trade-offs and conflicts in planning of NBS?**

Rural-urban regions and in particular the peri-urban are arenas for potentially intense conflicts between a diverse range of actors. The planning and implementation of NBS in such a situation should be based on development of a long-term visionary approach which should involve main stakeholders. Developing such an approach may help to clarify priority of objec-

tives and provide clear orientation for deployment of multi-functional green infrastructures that enhance NBS. Tools such as scenario planning combined with comprehensive assessment of environmental, social and economic impacts and costs were mentioned as important tools supporting this process. Moreover, better linking planning at different scales is important to align regional with urban goals and thus reduce conflicts in developing NBS.

### **3. What are successful governance approaches for developing NBS that enhance rural-urban relations?**

Successful development of NBS in rural-urban regions requires both strong top-down government and bottom-up governance (AALBERS AND PAULEIT 2013). Inclusive planning and citizen science were considered as potentially powerful approaches to better meet the demands of the diversity of stakeholders and develop truly multifunctional NBS.

Moreover, implementation of the EU Green Infrastructure Strategy (EC 2013) should be promoted as an instrument to enhance development and implementation of NBS in an integrated way.

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## **2.8 Innovative nature-based solutions for cost-effectiveness and economic viability to enhance climate change mitigation and adaptation**

SESSION CHAIR: BERND HANSJÜRGENS

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Innovative nature-based solutions (NBS) are decisive elements for improving the quality of life in urban areas and for attracting new businesses within the city jurisdiction. In addition, they can create synergies between urban green on the one hand and climate change adaptation and mitigation on the other. However, fostering NBS in urban areas is extremely challenging due to the “invisibility” of the benefits (“ecosystem services”) of nature-based solutions and due to the lack of innovative and implementable policy instruments.

Three presentations addressed a broad range of issues within the economic perspective on NBS, from valuation efforts with regards to carbon sequestration of urban forest systems to specific economic policy instruments, such as payments for urban groundwater ecosystem services. Not only the potential, but also the limits of economic valuation studies were stressed in these presentations.

The following workshop discussed four major questions in relation to the role of NBS to enhance sustainable rural urban relationships:

1. How can nature-based solutions be assessed economically?
2. What are available tools and instruments (investments) to invest in working with nature for people, to empower people and encourage multi-sectoral partnerships?
3. How can cities’ economic performance be stimulated by using nature-based solutions? What are successful examples? How could they be up-scaled?
4. Can economic valuation and related results give introduction and implementation of NBS more justification and power in administrative budget deliberations?

### **1. How can nature-based solutions be assessed economically?**

A wide range of economic valuation approaches and tools was considered addressing NBS in cities. Some of these approaches are directly oriented towards nature’s benefits, for example, tools related to identifying the change of property values that go along with changes of nature in the vicinity of private properties; or approaches that seek to illuminate citizens’ preferences by asking for their ability to pay for NBS in their district. Other approaches are directed towards identifying the costs that could be avoided by implementing NBS, such as costs of climate mitigation or adaptation measures (e.g. the climate change induced temperature increase within cities can be reduced by fostering nature-based solutions). Travel cost methods that seek to identify values of nature by using persons’ travel costs for visiting cities were also discussed as a potential tool to make the value of NBS visible.

### **2. What are available tools and instruments (investments) to invest in working with nature for people, to empower people and encourage multi-sectoral partnerships?**

Available tools and instruments to invest in NBS include strategies embedded in urban planning methods, such as green spaces or urban gardening strategies. Furthermore, providing additional information about ecosystems and their values was seen as a major “instrument” to foster NBS. Economic arguments can be seen as a major input to transform such infor-

mation into arguments that are not only understood by those responsible for urban green, but also by those responsible for business, finances, infrastructure planning, etc. In addition, there was a discussion about the role of economic incentives, such as payments for ecosystem services. There are many examples where such payments are financed by upper level governments within joint programmes.

### **3. How can cities' economic performance be stimulated by using nature-based solutions? What are successful examples? How could they be up-scaled?**

Cities' economic performance could be stimulated by attracting new (and sustaining existing) business firms and highly qualified employees. A rich and diverse green infrastructure gets more and more important as a decisive component in interjurisdictional competition processes. It is of high importance for cities to offer attractive benefit-cost-ratios. This holds not only for their built infrastructure, but also for their green infrastructure. The opinion was that NBS may play an increasing role in such competitive processes in the future.

### **4. Can economic valuation and related results give introduction and implementation of nature-based solutions more justification and power in administrative budget deliberations?**

The answer to this question was “yes”, *if* economic valuation is undertaken with care. Economic perspectives were seen as an important argument to support NBS, however, obviously not the only argument. There are also arguments to promote NBS that lie beyond the economic perspective. It is therefore important to take into consideration the whole range of ecosystem service benefits that are provided by nature. In the eyes of the participants it would be a fault to focus only on selected ecosystem services and the benefits they provide, or – even worse – to focus solely on those benefits that can be measured in monetised form. The sentence the workshop contributors agreed upon was: “Identify *all* externalities and benefits, focus on priorities, and recognise the payer/funder and benefit discontinuities (i.e. who pays vs who benefits) and seek to extend/attract new funding accordingly and to take an integrated approach”.

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### 3 Conference plenum discussion summary

The final plenum discussion focused on options to put forward the implementation and distribution of nature-based solutions (NBS) for climate change mitigation and adaptation in urban areas and their rural surroundings. In particular, the three interlinked questions were addressed:

1. What are the recommendations to European policy-makers? (How can nature-based adaptation and mitigation be integrated in other policies /cross-sectoral policies? What are finance opportunities?)
2. What are the recommendations to European urban environment practitioners? (How can we share best practice? How can we address barriers to implementation?)
3. What are the recommendations to researchers? (How can we communicate and work with uncertainties? How can research help in implementation or principles?)

Horst Korn (BfN) chaired the panel. Panellists included Chantal van Ham (IUCN), Beate Jessel (BfN), Dagmar Haase (Humboldt-Universität zu Berlin), Stephan Leiner (EC, DG Environment) and Marco Fritz (EC, DG Research and Innovation). Here we summarise the main points.

To get NBS into action, panellists highlighted the importance of an evidence base on the effectiveness of nature-based solutions. Providing examples of best practice that demonstrate the multiple benefits of NBS may be one option how this could be achieved. The term multiple benefits was used to show that positive effects of NBS may not only be limited to climate change adaptation and mitigation but simultaneously generate additional benefits such as the conservation of biodiversity and the improvement of human well-being, in particular mental and physical health.

An evidence base should build up a repository of good practice case studies and the methodology on how to evaluate them. An important point here is to synthesize existing and new information and communicating this effectively to all audiences from society, policy and science. Case studies then should be analysed in terms of governance, including how the right people were reached, which kind of people were part of the implementation project, who finally took the decision to implement. The evidence base may then also include a presentation and analysis of failure e.g., why actors do not take decisions in favour of implementing nature-based solutions.

The increase of evidence was further discussed related to the need for research and monitoring to determine the best species assemblages to achieve the most efficient nature-based solutions while optimizing the multiple benefits and exploring the potential trade-offs that may be created by NBS comprising economic, ecological and social benefits. From a science perspective, it was highlighted that new data collection in the field and the use of remote sensing is important to promote benefits rather than relying on few existing case studies and data. To increase evidence could further be achieved by focusing on complementary effects of NBS and technological solutions. Conservation and construction may both offer solutions, and scientific evidence is needed to quantify their relative performance in terms of ecological functioning. This includes research that combines effects of the construction sector (grey), water and storm-water management strategies (blue) as well as ecosystem services (green) and looks at them in an integrative manner. In addition, the full range of social and economic impacts should be fully taken into account by studying the monetary and non-monetary val-

ues of NBS projects. This should also focus on the cost of inaction as well as the possibility of catastrophic failures of purely technical solutions.

Finally, the proof of the co-benefits of NBS for human health and well-being was highlighted a number of times during the plenum discussion. Questions were raised such as: What is the health impact of social-environmental improvements generated by nature-based solutions and who benefits most and who benefits least? One point would be to advocate 'health' as a central benefit of NBS and 'not only' a co-benefit. There is, however, more research needed, which covers the 'complete picture', thus, also investigating trade-offs, offsite-effects and focusing on the entire city – and the societal context.

Panellists concluded that scientific evidence is indispensable, but even more important is to initiate implementation processes out of evidence that is putting NBS into practice. At the science-policy-interface, institutions like the German Federal Agency of Nature Conservation already intent to foster the implementation of NBS by providing scientific input into the policy level but also by widely disseminating the results through various networks and different means of communication. For the wider application of NBS a crucial point is, however, to outreach examples especially targeted to the needs and interests of different stakeholder groups including decision makers, business but also the wider public including different groups from society. Here experiences may already exist but need to be shared. To foster the wider application of NBS by partners from society and policy, best practice examples should be up-scaled and transferred to other cities. This would need good communication processes among different stakeholder groups (e.g., decision makers, business, society) including a detailed description of the NBS implementation process, the full range of benefits, the solutions for certain problems, but also mistakes made and lessons learned to avoid them. In order to get non-conventional partners for NBS implementation from sectors formerly not involved in NBS, alliances with different actors including stakeholder groups from society and policy may be most successful in implementing NBS projects when aligning with their interests (e.g., health issues),. This can be fostered by creating positive narratives that investments in nature lead to (specific and general) gains for society. Here would be a new story to tell and to share an interesting way to proceed.

Implementation into practice with local groups can further be achieved by increased investment in new partnerships with businesses and society. This would include community groups and people with diverse background in culture and education to find suitable settings and language. However, a sufficient financing and continuity in personnel and financing when implementing NBS projects should be guaranteed (e.g., by joint ownership of decision makers and practitioners). When implementing NBS strategies, trade-offs and off-site effects to society and the societal context should be considered. Potential displacement of people should be avoided. In particular, green space standards and political targets combined with social housing standards should be implemented in an integrative approach for the entire city. A strong top-down led implementation, including the implementation of the EU Green Infrastructure Strategy but also bottom-up governance with inclusive planning and maintenance strategies and citizen science can act here as powerful approaches to better meet the demands of the diversity of stakeholders and develop truly multifunctional NBS.

## **4 Abstracts of oral presentations**

### **4.1 Opening address**

#### **Nature-based solutions to climate change in urban areas and their rural surroundings – Activities of the German Federal Agency for Nature Conservation (BfN)**

BEATE JESSEL, JUTTA STADLER, ALICE SCHRÖDER, KATHARINA DIETRICH

*German Federal Agency for Nature Conservation (BfN)*

With about 75% of all Europeans living in cities now, effects of climate change on urban inhabitants are an important issue already and will become even more relevant in the future. Also, urban nature is impacted by climate change. Residents and urban nature have to cope increasingly with heatwaves and droughts on the one hand side as well as stormwater runoff and flooding on the other. But urban nature, in connection with the rural surroundings, can also offer sustainable and cost-effective solutions to climate change mitigation and adaptation in cities in various ways, while also creating multiple co-benefits.

#### **BfN's role as "science-policy-interface"**

The German Federal Agency for Nature Conservation (BfN) is one of the government's departmental research agencies. It provides the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) with professional and scientific assistance in all nature conservation and landscape management issues on the national level and in international cooperation activities. BfN furthers its objectives by carrying out own research which is no target in itself but dedicated for certain practical and political purposes. Beyond that, it also has several enforcement functions and is also in charge of a number of funding programmes. Thus, the BfN plays a central role as "science-policy interface" since it links science and policy at the national, the European, and the international level.

Hereinafter we briefly describe some selected examples of BfN's activities related to climate change and urban nature.

#### **BfN research and development project: „Awareness of Urban Nature“**

In the fourth representative German Nature Awareness Survey, conducted by the German Ministry for the Environment and the BfN in 2015 (BMUB & BfN 2016) urban green is one of the focus areas. The answers of the respondents revealed a high degree of appreciation for urban nature. The question "How important is nature in the city for climate change mitigation and adaptation?" was answered by 91 per cent of all respondents with "very important" and "important". Only 6 per cent responded "unimportant" and 1 per cent "not important at all". This indicates that the broader public clearly recognizes the important role of nature in cities for climate change mitigation and adaptation. Moreover it demonstrates high acceptance of nature-based solutions to climate change in urban societies.

### **BfN research and development project: „Urban Nature and Climate Change“**

The research project "Urban Nature and Climate Change" (MATHEY et al. 2011) examined the cooling effects of green open spaces in the city of Dresden. The results clearly show their potential as adaptation measure. Measurements and modelling emphasised not only that big green spaces have higher cooling effects than small ones but also that the cooling effect increases with the amount of green volume. Moreover they revealed the different climatic effects of urban vegetation during day and night, and that open space systems with large connected open spaces can have slightly higher cooling effects than systems with many single small open spaces. Nevertheless, networks of small open spaces are important for bioclimatic functions.

### **BfN research and development projects: „Ecosystem-Based Approaches“**

Two projects have been collecting case-studies for ecosystem-based approaches to climate change adaptation and mitigation from all over Europe (DOSWALD & OSTI 2011) as well as specifically from German-speaking countries (NAUMANN et al. 2015). Many of the case studies deal with nature-based solutions to climate change in urban areas. The aims of the projects have been to promote good practice examples, to analyse the success factors as well as obstacles encountered and to foster exchange of ideas and experiences. Therefore, the scientific studies are complemented by an online project database<sup>2</sup>, information material for the public<sup>3</sup> and specific guidelines for project managers (NAUMANN & KAPHENGST 2015).

### **BfN testing and development project „Urban forests“**

Practical implementation issues of urban forests in the city of Leipzig are the focus of the research project "Urban forests". The afforestation of urban forests on derelict land introduces a new type of urban green and offers an ecologically, economically and socially viable alternative to costly designed green spaces (BURKHARDT 2008). In the long term, the urban forests shall be managed like forests and at the same time serve as neighbourhood parks. In a thorough process suitable sites for urban forests in the inner city area were selected. By now, two of them have been afforested. The implementation of the project is accompanied by a comprehensive research design which shall clarify the effects of urban forests on the urban climate, biodiversity, recreation, population and urban redevelopment<sup>4</sup>.

### **Transfer of Results**

BfN pursues various paths to spread project results within policy, science and practice. One example is "Natural Capital Germany - TEEB DE", a national follow-up of the international study "The Economics of Ecosystems and Biodiversity" (TEEB). In this project a meta-analysis on "Natural Capital and Climate Policy - Synergies and Conflicts" has been pub-

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<sup>2</sup> „Pro Natur & Klima“ – project database: <http://www.bfn.de/22714.html> (German only)

<sup>3</sup> Brochure (in German): "Naturbasierte Ansätze für Klimaschutz und Anpassung an den Klimawandel": [http://www.bfn.de/fileadmin/BfN/biologischevielfalt/Dokumente/BfN\\_Naturbasierte\\_Loesungen\\_brochure.pdf](http://www.bfn.de/fileadmin/BfN/biologischevielfalt/Dokumente/BfN_Naturbasierte_Loesungen_brochure.pdf), Brochure (in English): „Nature-based approaches for climate change mitigation and adaptation“ [http://www.bfn.de/fileadmin/BfN/biologischevielfalt/Dokumente/BfN\\_Nature-based-solution\\_brochure.pdf](http://www.bfn.de/fileadmin/BfN/biologischevielfalt/Dokumente/BfN_Nature-based-solution_brochure.pdf)

<sup>4</sup> For more informations see: [http://www.bfn.de/0202\\_urbane\\_waldflaechen+M52087573ab0.html](http://www.bfn.de/0202_urbane_waldflaechen+M52087573ab0.html)

lished in German (NATURKAPITAL DEUTSCHLAND - TEEB DE 2014) and English (Natural Capital Germany – TEEB DE 2015). A report on “Ecosystem Services in the City - Protecting Health and Enhancing Quality of Life” has been launched in May 2016 (NATURKAPITAL DEUTSCHLAND – TEEB DE 2016). The BfN also contributed to the Green Book „Green in the City“ (BMUB 2015), which was presented by the Ministry for the Environment in June 2015. At the moment we work on the related White Book, which will illustrate a federal action programme to promote urban green infrastructure. It is foreseen to be published in 2017.

In the urban context the most important partners to implement nature conservation measures and nature-based solutions to climate change in planning are cities and municipalities. Therefore, in 2010 BfN initiated a dialogue process with all German municipalities and cities aiming at the comprehensive consideration of biodiversity in decision-making processes on local level. Based on the declaration “Biological Diversity in Municipalities”, the municipalities founded an “Alliance for Biodiversity” in 2012, which has more than 100 members by now and is a platform for the inter-municipal cooperation. Climate change is a very important topic for the alliance.

The examples given above show an extract of joint activities of BfN with various actors from science, policy and practice to develop and to promote nature-based solutions to climate change. Moreover they show how this joint work supports the development of truly sustainable cities with a rich and diverse nature and a high quality of life.

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## 4.2 Plenary presentations

### **Nature-based solutions and resilience to climatic change - contribution of nature conservation to human well-being**

GEORGINA M. MACE

*University College London*

It is through extreme weather that the most people, now and in future, are likely to first experience the impacts of climate change. In recent years, devastating floods and storms have caused widespread loss of lives and livelihoods, as well as extensive suffering across the world, including rich and poor countries. In future, according to climate model projections, these events will increase in frequency and intensity. We undertook a review of the contribution of different defensive options to reducing the impacts of extreme weather (floods, heat-waves, droughts) using a semi-structured expert assessment that compared engineered, hybrid and nature-based solutions. We evaluated different interventions to each type of extreme weather impact and scored them for effectiveness, cost and whether the (unintended) side-effects were generally positive or negative. Overall the hybrid solutions were most cost effective and some were very effective at local scale (e.g., beach and dune nourishment). Engineered solutions (e.g., dams, levees) tended to be more expensive, especially once maintenance costs were included, but were more effective. When they fail, however, engineered interventions fail catastrophically. Nature-based solutions were cheaper and often less effective, but had the advantage that when they failed, it was a slowly unfolding failure that was more manageable. They also tended to have local management engagement because of the co-benefits which provide an additional advantage to this approach. Overall it was clear that the evidence base is weak for comparing the effectiveness of different local interventions. There needs to be a clearer set of measures of success which can be used to organize existing evidence, but there is also a pressing need to monitor and evaluate different interventions, and to organize the information on costs and benefits, co-benefits and the beneficiaries. The details of the evaluation can be found online at <https://royalsociety.org/topics-policy/projects/resilience-extreme-weather/>

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## Mainstreaming climate change adaptation in urban governance and planning

CHRISTINE WAMSLER

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The concept of mainstreaming climate change adaptation to foster sustainable urban development and resilience is receiving increasing interest. In particular, the need to mainstream nature-based solutions into urban planning and governance is widely advocated by both academic and governmental bodies.

Adaptation mainstreaming is the inclusion of climate risk considerations in sector policy and practice. It is motivated by the need to challenge common ideas, attitudes, or activities and change dominant paradigms at multiple levels of governance. The process works toward sustainability and resilience by expanding the focus – from preventing or resisting climate hazards – to a broader systems framework in which we learn to live and cope with an ever-changing, and sometimes risky, environment.

The presentation introduced the origins of the concept, illustrated potential mainstreaming measures and strategies at different levels and discussed their application in urban planning practice with a focus on nature-based solutions.

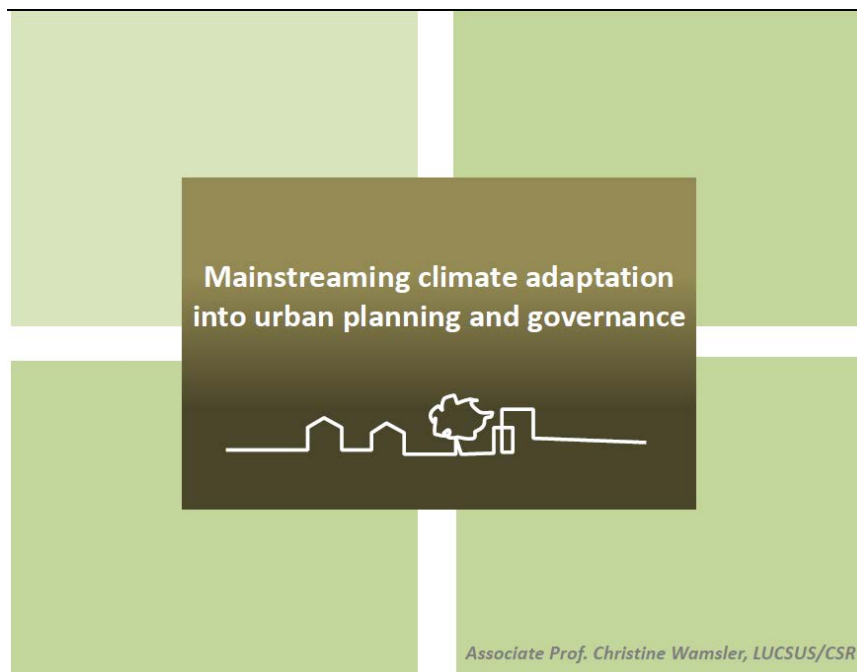


Figure 1: Guideline for mainstreaming/integrating climate change adaptation into municipal planning and governance (WAMSLER 2015). The guideline can assist in 'translating' the mainstreaming theory to the specific context of local authorities. It assists in both assessing and progressing the mainstreaming of climate change adaptation into planning and governance mechanisms.



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# Valuing ecosystem services for urban planning

ERIK GÓMEZ-BAGGETHUN AND DAVID N. BARTON

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Technological progress has fostered the conception that urban societies have become increasingly independent from ecosystems. However, demand on natural capital and ecosystem services keep increasing steadily in parallel with global urbanization. Decoupling of cities from ecological systems can only occur locally and partially, thanks to the appropriation of vast areas of ecosystem services provision beyond the city boundaries. Conserving and restoring ecosystem services in urban areas can reduce the ecological footprints and the ecological debts of cities while enhancing resilience, health, and quality of life for their inhabitants. We synthesize knowledge and methods to classify and value ecosystem services for urban planning (GÓMEZ-BAGGETHUN et al. 2013). First, we categorize important ecosystem services in urban areas. Second, we describe valuation languages (economic costs, socio-cultural values, resilience) that capture the societal importance of urban ecosystem services. The paper discusses ways through which urban ecosystem services can enhance resilience and quality of life in cities and identifies economic costs and socio-cultural impacts that can derive from their loss. We conclude by identifying knowledge gaps and challenges for the research agenda on ecosystem services provided in urban areas.

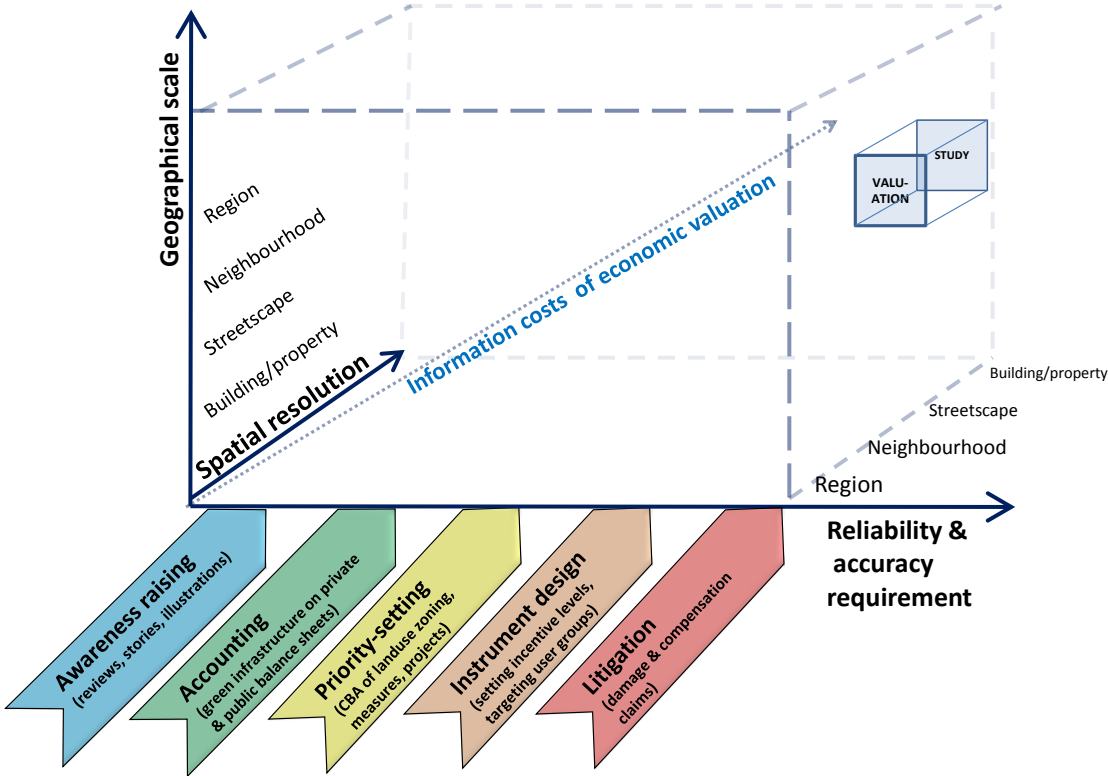


Figure 1: Decision contexts in which valuation of ecosystem services can inform urban planning include awareness raising, economic accounting, priority-setting, incentive design and litigation (extracted from GÓMEZ-BAGGETHUN & BARTON 2013)

## **Main messages**

Three main insights can be extracted from our review (GÓMEZ-BAGGETHUN & BARTON 2013). First, there is growing evidence on the positive impacts of urban ecosystem services on quality of life in cities. Regulating and cultural services, including air purification, noise reduction, urban cooling, runoff mitigation, and recreation showed to be of special importance in urban areas. Even if urban ecosystems provide only a fraction of the total ecosystem services used in cities, high density of beneficiaries relative to existing green infrastructure implies that the social and economic value of services provided locally by urban ecosystems can be surprisingly high.

Second, loss of ecosystems in cities can involve long-term economic costs and severe impacts on social, cultural, and insurance values associated to ecosystem services. Economic costs derive from restoring and maintaining public services through built infrastructure as similar services provided by urban green infrastructure are lost. Further social costs derive from the loss of cultural values, including sense of place and community, social cohesion, and local ecological knowledge. Loss of green infrastructure can also lead to decreases in resilience and ecosystem's insurance value, increasing the vulnerability of cities to heat waves, flooding events, storms, landslides, and even food crises. It should be noted, however, that urban ecosystems do not only provide ecosystem services but also disservices such as pollen causing allergies and tree roots breaking up pavements. Rigorous valuation exercises should not only take into account benefits from ecosystem services, but also costs from ecosystem disservices.

Finally, our review reveals knowledge asymmetries in our capacity to understand and capture different ecosystem services and values. A relative abundance of biophysical and economic studies contrasts with the scarcity of studies addressing non-economic values, including social, cultural, and insurance values. Although formally recognized in the ecosystem services literature, non-economic values are rarely addressed at the operational level and little has been said on how the ecosystem approach may contribute to better incorporate these values in urban planning. Research on urban ecosystem services should broaden its focus to better capture and articulate non-economic values in decision making and planning. A further challenge for the research and policy agenda concerns the way different and often irreducible values of urban ecosystem services can be combined and consistently integrated to support decision-making.

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## **Nature-based solutions as inclusive spaces: Links to people's health, well-being and quality of life**

CATHARINE WARD THOMPSON

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People's access to urban green spaces is of interest to planners and policy-makers because of its potential contribution to addressing major health challenges in the context of wider concerns about the effects of environmental degradation and climate change. Across Europe and beyond, there are alarmingly rapid rises in levels of obesity, Type 2 diabetes, cardiovascular disease, cancer, and mental illness, and they have practical consequences not only for individual well-being but also for the cost of healthcare and the productivity of the workforce. Many such illnesses reflect changes in lifestyle, with many people leading considerably more sedentary lives than previous generations, and the changed nature of the socio-ecological context in which decisions occur. Urban green spaces and natural environments, as part of a wider environmental context, have the potential to help address problems 'upstream', in a preventative way, rather than simply focusing on dealing with the 'downstream' consequences of ill-health.

### **Historical and contemporary context**

While the therapeutic and salutogenic effects of certain gardens and natural landscapes have been recognised from earliest times, the value of public parks was particularly highlighted in the rapidly industrialising cities and towns of the nineteenth century, when they were frequently termed 'the lungs' of the city (WARD THOMPSON 2011). Such ideas became marginalized in the pharmaceutically focused and high-technology world of post-war 20<sup>th</sup> century medicine. However, more recent epidemiological evidence on disease has demonstrated a positive association between health and access to natural environments, 'green space' in particular. Studies of the association between green space and mortality rates in England, for example, found that populations exposed to the greenest environments had the lowest level of health inequality related to income deprivation; this suggests that greener environments may be not only salutogenic – health enhancing – but also 'equigenic', i.e. that they contribute to reducing socio-economic-linked health inequalities (MITCHELL et al. 2015).

### **Recent research findings**

There are multiple ways that landscapes might support health, above and beyond the fundamental ones of being the ultimate source of all food, drink and medicine. These include the capability of vegetation to remove pollutants from the atmosphere and/or the soil; the temperature regulation afforded by green and blue space, which may be particularly important in moderating the urban heat island effect; the potential for physical and psychological relief from noise, particularly traffic noise, in urban environments; the possibility that landscapes might enable or encourage physical activity; the potential of certain landscapes to offer a pleasurable experience and relief from mental stress and illness; the opportunities for social activities and connections offered by the landscape; and the opportunity to grow one's own fruit and vegetables that access to cultivable land can offer.

My work in OPENspace research centre has included a study undertaken for the Scottish Government, that explored evidence of physical as well as psychological benefits to be gained from good access to green space. In a sample of unemployed people aged 35-55 (n=106), we used salivary cortisol measures over the course of the day as a biomarker of

stress levels, and combined this with a questionnaire to explore people's perceived stress levels and normal levels of physical activity, as well as their general health. The findings showed that higher levels of green space in the local area can predict lower levels of stress in people who are not in work and living in deprived urban contexts (ROE et al. 2013).

In a separate study in different locations in Scotland, we undertook a 'natural experiment', involving a longitudinal study of an intervention to improve the quality and accessibility of local woodlands near a community of high socio-economic deprivation. This was a rare pre-post study in green space, using intervention and comparison sites to investigate differences over time. The findings demonstrated how improvements to accessibility and maintenance of a local urban woodland were associated with significant differences in woodland use patterns, and possibly in outdoor activity levels (WARD THOMPSON et al. 2013). The study provided the basis for a longer and more robust study, still ongoing, of the effect of such woodland improvements on the mental well-being of deprived communities, and particularly on their stress levels, funded by the UK's public health research organisation (National Institute for Health Research) (SILVEIRINHA DE OLIVEIRA et al. 2013).

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## Spatial planning of Green infrastructure in a changing climate - Links to EU policy

STEFAN LEINER

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The EU environment agenda is embedded in the **EU Treaty**. Environment is a key policy area and consecutive **Environmental Action Programmes** were aimed at moving the environmental agenda forward. The current Programme is the 7<sup>th</sup> EAP on *'Living well, within the limits of our planet'*<sup>5</sup> which sets out a vision on where it wants the Union to be by 2050. It identifies three key objectives: to protect, conserve and enhance the Union's natural capital; to turn the Union into a resource-efficient, green, and competitive low-carbon economy; to safeguard the Union's citizens from environment-related pressures and risks to health and well-being. It identifies four so called "enablers" which will help Europe deliver on these goals: better implementation of legislation; better information by improving the knowledge base; more and wiser investment for environment and climate policy; full integration of environmental requirements and considerations into other policies. It also has two additional horizontal priority objectives completing the programme: to make the Union's cities more sustainable and to help the Union address international environmental and climate challenges more effectively. Many of these elements are directly or indirectly related to nature-based solutions which can significantly contribute towards implementation of environmental policies and legislation.

The Mid-term review of the EU biodiversity strategy to 2020<sup>6</sup>, just released, found that despite some important progress made, overall, biodiversity loss and the degradation of ecosystem services in the EU have continued since the EU 2010 biodiversity baseline. This has serious implications for the capacity of biodiversity to meet human needs in the future. While many local successes demonstrate that action on the ground delivers positive outcomes, these examples need to be scaled up to have a measurable impact and reverse negative trends.

The review showed that it is still possible to achieve the biodiversity targets, but a lot more needs to be done to that end in particular in the following areas:

Firstly, the implementation of environmental legislation, especially the nature directives, and strategies needs to be significantly stepped up. The current fitness check of the EU nature

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<sup>5</sup> The 7th Environment Action Programme (EAP) will be guiding European environment policy until 2020. In order to give more long-term direction it sets out a vision beyond that: *"In 2050, we live well, within the planet's ecological limits. Our prosperity and healthy environment stem from an innovative, circular economy where nothing is wasted and where natural resources are managed sustainably, and biodiversity is protected, valued and restored in ways that enhance our society's resilience. Our low-carbon growth has long been decoupled from resource use, setting the pace for a safe and sustainable global society."* <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013D1386>

<sup>6</sup> [http://ec.europa.eu/environment/nature/index\\_en.htm](http://ec.europa.eu/environment/nature/index_en.htm) ; <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015DC0478>

legislation is not aimed at reducing ambition, but will provide a good insight in what is needed to improve implementation.

It will be important to do further work on the Mapping and Assessing of Ecosystems and their Services (MAES) as well as on natural capital accounting (NCA) so that biodiversity and its value are fully recognised and better integrated in the wider economic systems.

Member States need to establish clear roadmaps (or prioritisation frameworks) on how to achieve in concrete terms the 15% restoration target.

It will be necessary to develop a no net loss policy ensuring that we maintain or obtain a net gain for biodiversity.

Integration of biodiversity in other related policies such as on Climate Change mitigation and adaptation, CAP and Regional policy needs to be further enhanced.

And the financial instruments of the EU need to better eliminate potential harmful subsidies while enhancing support to biodiversity. There are several financial instruments which can help this mobilisation. Those include the Structural Funds (European Regional Development Fund & European Social Fund), Cohesion Fund, European Maritime and Fisheries Fund, European Agricultural Fund for Rural Development, LIFE+, & research funding programmes (Horizon 2020). The recently set up Natural Capital Financing Facility (NCOFF) will provide loans to investments in natural capital projects, including Green Infrastructure (GI), which generate revenues or save costs and contribute to nature, biodiversity and climate change adaptation objectives. Private sector funding will also need to be enhanced.

Green Infrastructure can make a significant contribution to the implementation of all of the above mentioned actions.

The Green Infrastructure Strategy is a contribution to implementing Target 2 of the EU Biodiversity Strategy ("by 2020, ecosystems and their services are maintained and enhanced by establishing Green Infrastructure and restoring at least 15% of degraded ecosystems"). Green Infrastructure is also contributing to all other targets of the EU Biodiversity strategy – in particular the full implementation of the Birds and Habitats Directive (target 1) – and to maintain and enhance biodiversity in the wider countryside and the marine environment (targets 3 and 4). The **Commission Communication on Green Infrastructure**<sup>7</sup> describes Green Infrastructure (GI) as a tool for providing ecological, economic and social benefits through nature-based solutions, for helping to understand the advantages nature offers human society, and for mobilising investments that sustain and enhance these benefits. It is a strategically planned network of natural and semi-natural areas that delivers multiple functions, services and benefits on the same spatial area, to enhance human well-being and quality of life. GI options create sustainable jobs and support sustainable economic growth.

This contrasts with grey infrastructure options, which typically fulfil single functions such as drainage or transport, and which are often more costly in the long term.

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<sup>7</sup> Communication on Green Infrastructure (GI) — Enhancing Europe's Natural Capital COM(2013)249 (<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52013DC0249>)



Green Infrastructure should become a standard component of territorial development and **spatial planning** across the EU. In this context, the Commission is launching a contract on the potential of spatial planning for the protection of the Natura 2000 network, aimed at better understanding how spatial planning can support GI and collect best practices examples. A workshop will be organised in the second half of 2016.

As regards **Climate Change**, biodiversity and ecosystem services play a key role in the climate system. We are currently in a vicious circle - more climate change leading to less biodiversity and less biodiversity leading to more climate change. Promoting and implementing green infrastructure, nature-based solutions at local, national, regional and international levels can help to break the vicious circle.

**Cities** have a key role, as many people already live in cities and the urban population will continue to grow. Cities can become a powerful mobilisation factor for the transition to a low carbon economy. Green infrastructure in cities provides multiple benefits to citizens and society: economic growth, job creation, better air and water quality, recreation, social links, etc.

With a view to scaling up the deployment of Green infrastructure in Europe, and pursuant to the GI strategy, the Commission is also looking at the possibility of developing a trans-European Green Infrastructure (TEN-G) initiative, similar to that already in place for large-scale EU transport (TEN-T) and energy (TEN-E) networks. Developing an instrument for a trans-European Green Infrastructure in Europe would not only have significant benefits for securing the resilience and vitality of some of Europe's most precious ecosystems but could also act as an important flagship for promoting GI at national, regional and local levels and boosting the importance of GI in policy, planning and financing decisions.

Mr Leiner ended his presentation by referring to a recent remarkable development outside the EU related to the efforts of President Obama to ensure that Federal investments are climate resilient and made with anticipated future conditions in mind: On 29 October 2015 the **Obama administration** released a new memorandum **directing Federal agencies to factor the value of ecosystem services into Federal planning and decision-making**. The memorandum directs all Federal agencies to incorporate the value of natural, or "green," infrastructure and ecosystem services into Federal planning and decision making. Agencies shall develop and institutionalize policies that promote consideration of ecosystem services, where appropriate and practicable, in planning, investment, and regulatory contexts. It also establishes a process for the Federal government to develop a more detailed guidance on integrating ecosystem-service assessments into relevant programs and projects to help maintain ecosystem and community resilience, sustainable use of natural resources, and the recreational value of the Nation's unique landscapes.

# Nature's solutions for urban resilience – in search of innovative models of engagement

CHANTAL VAN HAM

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Nature-based solutions offer sustainable and cost-effective solutions to climate change mitigation and adaptation while contributing to human well-being, social development and economic prosperity.

Cities are wonderful incubators for green solutions and it is important to create enabling conditions for cities that are constrained in resources to share best practices and examples to strengthen the awareness and use of nature-based solutions.

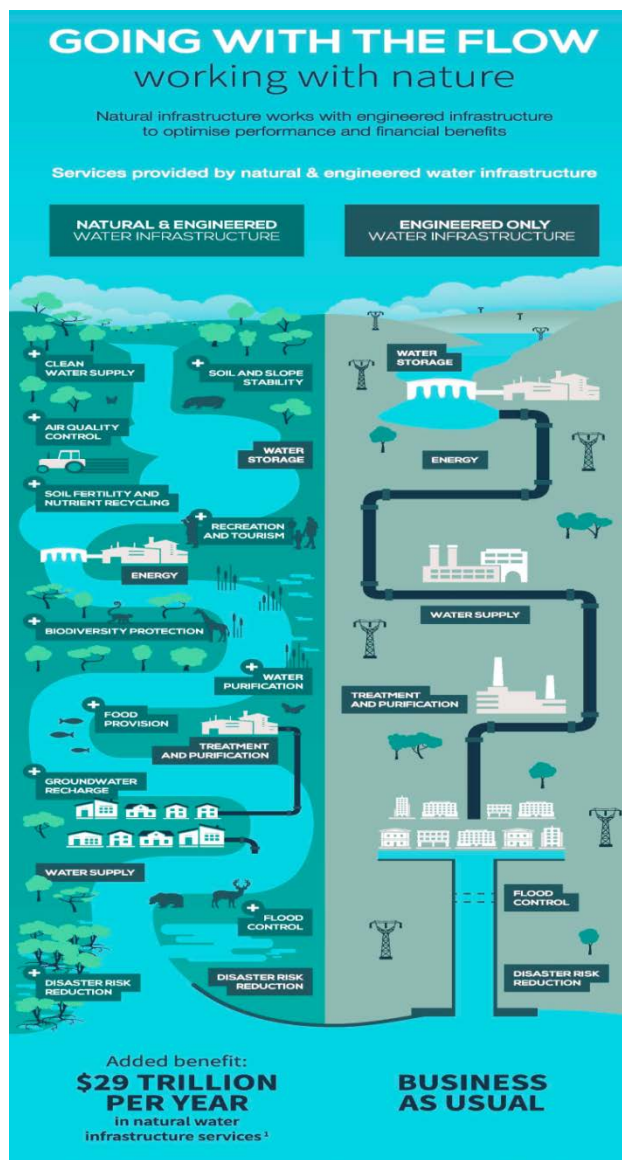


Figure 1: Infographic, ©IUCN Water ([www.waterandnature.org](http://www.waterandnature.org))

## Key messages

**Business as usual is not an option.** Subnational governments play a strategic role in addressing climate change and making the transition to a sustainable future. They are drivers for innovation and through new partnerships and innovative engagements they can play an important role in strengthening the implementation of nature-based solutions.

**Co-operation between non-conventional partners.** Create innovative partnerships for implementation with those we normally do not engage with, e.g., scientists, business, civil society, governments, private investment are essential to jointly develop appropriate financeable deals for the conservation, restoration and effective management of ecosystems.

**Innovation can only develop with a long-term perspective.** Strengthening the evidence base of the multiple benefits and the business case is essential for upscaling of nature-based solutions, and in particular to make this evidence accessible.

**Nature and economy cannot be separated.** Natural capital is the foundation of our economy. Natural ecosystems such as forests, oceans and peatlands store the vast majority of CO<sub>2</sub> emissions. Those countries and businesses that recognize nature's flows, ecosystem services and invest in sustainability and eco-innovation will be the ones to survive.

## Conclusion

The only road to that will lead to true and lasting prosperity is investing in natural capital. Nature's solutions are at our fingertips, they have been invented over millions of years and nature presents a perfect circular system, which has to date not been beaten by any other system available on the planet.

Nature-based solutions can support economic development and social well-being, but we need better understanding of when, where and how investments in nature-based solutions make good social and economic sense. The following elements are key to the successful development of innovative partnerships:

- Increased recognition of the value of ecosystems for climate adaptation and mitigation
- Gather and promote the evidence on the services that ecosystems provide as well as the business case among policy makers and the private sector
- Collaboration, breaking down silos, working across sectors for the implementation of nature-based solutions
- Business, urban planners and civil engineers must collaborate with environmental engineers and ecologists, governments, scientists and communities to develop solutions jointly

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## **Governing cities for the future using business and investment for nature-based solutions**

LUISE NORING

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Sustainable urbanization reflects one of the most critical areas for urban solutions today. Half of the world's population now lives in cities, and more than 80 percent of carbon emissions originate in cities. The unbalanced growth of mega cities like Beijing, Lagos and New Delhi is already precipitating severe levels of environmental degradation, air and water pollution, and deleterious health outcomes. Cities are part of the problem, and they are part of the solution. This is why COP21 of the Framework Convention on Climate Change and the UN's recent Sustainable Development Goals recognized that cities will need to be a key part of the world's response to climate change.

The presentation set out to identify and analyze the principal economic, environmental and demographic challenges that cities are confronted with and that influence their ability to govern. **It is argued that global megatrends influence how cities govern. The relationship between local cities and global megatrends is interconnected and mutually reinforcing.** Central to the argument is that our current economic activity is causing climate disruptions and subsequently migration. Several influences impact on this, so the argument is not linear. For instance, Western World societies are 'exporting' their economic activities to the developing world in the search for new investment opportunities, - in the process, the developing world is increasing their consumption leading to economic activities that disrupt climate change even further.

Cities are globally connected; in recognition of this, we have to understand the global mega trends, and how they influence cities locally. This will allow us to understand the complexity and disruptive nature of the task at hand facing city governments.

The presentation sets out to discuss and analyze the economic impact and strategies that city governments can pursue in order to meet the challenges of the 21<sup>st</sup> century. Secondly, environmental challenges, including climate induced disruptions and associated policies and city governance.

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### **4.3 Session I: Integrating the grey, blue and green - Nature-based solutions for climate change adaptation and mitigation as complementary or alternative measures to engineering approaches**

#### **Green roofs and living walls as tools of Green infrastructure against global warming**

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Roofs and walls are important space-resources in cities to transform urban environments from grey to green. As an example, currently up to 8% of roofs in Berlin are green roofs (KOEHLER et al. 2011). It can be easily greened up to 50% (BRIZ et al. 2015). At the moment around 85% of such green roofs are extensively greened, 15% are roof gardens (KOEHLER et al. 2012). Green roofs can be understood as a tool of urban water management, it can be seen as a bioclimatic “cooling” tool with ecosystem functions. Green facades are at the moment dominated by climbers. Living walls (see definitions in KOEHLER et al. 2012) are at the moment at the stage of beginning.

The function to cool down cities is connected with the evaporation of stored water within the green roof and the process of evapotranspiration is an energetic procedure delivered by the vegetation. These effects can be stated by infrared pictures in detail (see fig. 1). The evapotranspiration by vegetation cover is a smart way to reduce the urban heat island effect. In comparison, technical solutions, like air conditioning systems, need additional electricity, and all cooling produced on one side produces additional heat load on the other side, which finally heats up cities. The ecological effects are related to the quantity of the vegetation. An expansion of existing quantity of greenery is strongly recommended.

As example of a related current interdisciplinary project, the KURAS project is highlighted here. It includes a wide range of data collection on real green roofs and in a second part measurements and modelling for related situations in Berlin as a case study. The reduction of the urban heat island is an energetic process. The real evaporation measurements on roofs are used as a basic. The transforming these results on the level of buildings, the neighbourhood and on the City scale are further steps.

Fig 1 shows the roof lysimeter installation and presents one graph of a few days on transpiration of a typical extensive green roof. The average evaporation rate of a summer day is about 3 liter/sqmeter x day. Similar calculations for living wall systems conducted in a further project (KOEHLER et al. 2015) delivered numbers of 0.5 to 8.5 Liter/sqmeter x day.

Evapotranspiration is a combination between the effects of the plants and the wet surface material of the construction.

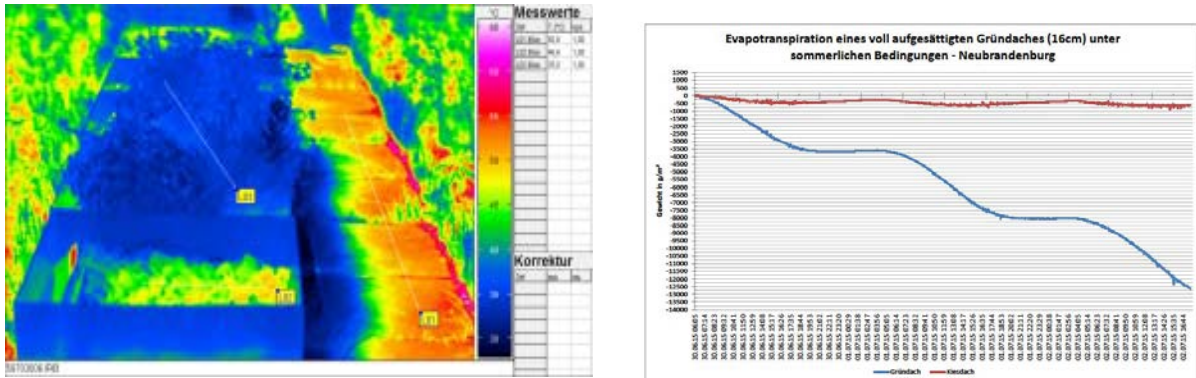


Fig. 1: IR-image of the green-roof lysimeter installation (left), the first lysimeter is filled with gravel as a typical roof layer. The evaporation by the vegetation has a cooling effect of around 5K. The diagram on the right hand compares the evapotranspiration effect, based on 3 summer days (blue line: Green roof), with the evaporation of a typical gravel roof (red line) (Source: Manfred Köhler).

## Findings

Green roofs and living walls as nature-based solution offer several eco-benefits. Cooling down urban heat islands of cities is one of these. Further countable benefits are capturing dust, delivering an opportunity for wildlife and biodiversity in cities. It will be the task of the planner to design the green roofs and living walls in such a way that they fit for the project with the most benefit to the urban environment. Cooperation between architects and plant specialists on an early stage will be important to achieve such goals.

Solutions like these are under development in many countries. The general solutions are similar, but the green roofs must be adapted to the local conditions. Green roofs as well as living walls are elements to enhance the quantity of evaporation surfaces in cities – one effective factor to cool down cities in summer heat stress times.

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Links:

KURAS: <http://www.kuras-projekt.de>

WGIN: [www.worldgreenroof.org](http://www.worldgreenroof.org)

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# **INKAS – a guidance tool for urban planners to assess the impact of climate adaptation measures**

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## **Introduction**

Adaptation to climate change impacts is necessary to improve resilience of cities against extreme weather events. The new information portal INKAS (<http://www.dwd.de/inkas>) provides guidance for urban planners to develop adaptation strategies against heat in cities. INKAS is based on a large set of idealized urban climate computer simulations for 9 different settlement types and 4 built-up or rural surroundings. At present, simulated adaptation measures include increased reflectivity of materials (albedo of roof, wall and impervious surfaces between buildings), implementation of green roofs, and changes in building height, built-up surface fraction or impervious surface fraction between buildings. The online guidance tool enables users to assess and compare the effectiveness of adaptation measures for varying degrees of implementation.

## **Urban climate model description**

The urban climate model MUKLIMO\_3 (SIEVERS & ZDUNKOWSKI 1985) has been used to carry out the computer simulations for INKAS. The model solves the 3-dimensional, Reynolds-averaged, non-hydrostatic Navier-Stokes equations in the presence of buildings with a generalisation of the stream-function vorticity method to three dimensions (SIEVERS 1995). Model physics include prognostic equations for atmospheric temperature and humidity, the parameterisation of unresolved buildings, short-wave and long-wave radiation, balanced heat and moisture budgets in the soil and a 3-layer vegetation model. The model utilises sub-grid scale surface fraction partitioning into built-up, impervious and pervious (vegetation canopy and bare soil) surface fractions (ZUVELA-ALOISE et al. 2014, BUCHHOLZ & KOSSMANN 2015).

The flow between buildings is parameterised using a porous media approach for unresolved buildings, where friction and radiative exchanges are calculated using a wall-area-index approach. The storage (or release) of heat into (from) the urban fabric is simulated by calculating the molecular heat fluxes from outer wall surfaces into the urban fabric (or vice versa).

## **Key findings**

About 2000 idealised urban climate model simulations have been carried out to quantitatively estimate the impact of adaptation measures for the reduction of high air temperature levels in cities during the summertime. Important findings from the INKAS urban climate simulations are:

- During the night, street-level air temperature reductions are marginal for increased wall and roof albedo but significant for increased pavement albedo, while during daytime hours, substantial reductions in air temperatures can be achieved by higher albedo of roof, walls and pavements.

- In general, small built-up and impervious surface fractions favour low maximum and minimum street-level air temperatures. Deviations from this behaviour are found in several cases with very high building density, where shading effects generate a reduction in the maximum air temperature.
- Reductions in street-level air temperatures due to increased roof albedo or due to green roof installations are strongest for settlement types consisting of low buildings and/or buildings with a high surface area fraction.
- From the summary of all MUKLIMO\_3 simulations in ternary diagrams, it can be concluded that urban summer air temperatures are particularly high if built-up surface fraction is greater than 40% and pervious surface fraction is lower than 20% (BUCHHOLZ & KOSSMANN 2015).

## Outlook

Additional simulations of the thermal impact of urban green (between buildings) and urban water surfaces are currently underway. The results will also be aggregated into the guidance tool to complement the applicability of INKAS for the design and optimization of adaptation strategies to secure or improve the quality of life, biodiversity, and prosperity in the city.

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# **Copernicus Sentinels observations as a tool to evaluate NBS implementation**

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*Foundation for Research and Technology Hellas (FORTH)*

## **Introduction**

The implementation of nature-based solutions (NBS) is expected to give urban planning the opportunity to play an important role in climate change mitigation/adaptation, at both local and city scales. The evaluation of the large scale implementation of NBS should be based on their sustainability potential, therefore on their environmental and socio-economic impacts. Concerning environmental impact, urban planners need to quantitatively estimate the modification caused by NBS implementation to the energy, water and carbon fluxes, as indicated by the FP7 project BRIDGE (CHRYSOULAKIS et al. 2015a). For example, green roofs implementation can have an impact on the temperature of rooftops, however no one knows how much this approach can cool a whole city. Only a few simulations have evaluated green roofs at that scale (HOAG 2015). Given that urban surfaces are complex mixtures of different materials, the magnitude of the energy, water and carbon balance components varies widely across a city, and it will almost certainly depart significantly from that measured by any in-situ instrumentation.

## **The approach for Sentinels exploitation in the NBS domain**

Earth Observation (EO) provides the advantage of large-area spatial coverage at high spatial resolution. The potential of EO to support our understanding of the role of NBS in energy, water and carbon balance modification still remains underexploited. To this end the H2020 project URBANFLUXES (CHRYSOULAKIS et al. 2015b) builds a methodology for energy flux estimation from Copernicus Sentinels. Similar approaches can be developed for water and carbon fluxes. In this way, EO-based assessment and monitoring tools can be developed capable of quantitatively estimating the modifications caused by NBS implementation of energy, water and carbon fluxes. EO-based approaches are easily transferable to any city since Sentinels cover the globe and they are capable of providing benchmark flux data for different applications, with emphasis in renaturing cities. It is therefore expected to further improve our understanding of the dynamics of urban systems so that EO can be a relevant and timely tool to help inform policy-making.

## **Expected impact**

The current requirements for climate change mitigation/adaptation and accounting for environmental issues in sustainable urban planning, as well as the expected scale-up of the use of NBS, have generated a need for city-scale monitoring tools. The proposed Sentinel-based approach is expected to improve the innovation activities related to the development of new products (EO-derived energy, water and carbon fluxes), new methods of production (EO synergistic observations analysis), new sources of supply (Copernicus data), and new markets (optimization/evaluation/monitoring of the implementation of NBS for sustainable urbanization). Therefore EO-based services will support the sustainable urban planning strategies, by taking into account the spatiotemporal modification of energy, water and carbon fluxes,

caused by NBS large scale implementation. Such demonstration initiatives of large scale will provide robust EU-wide evidence of NBS advantages.

## **Conclusions**

Here we discussed the development of EO-based assessment and monitoring tools, capable of supporting the evaluation of NBS implementation. This approach is expected to support the development of strategies to mitigate overheating, improving thermal comfort (social benefit) and energy efficiency (economic benefit).

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## **Sustainable Urban Drainage Systems – complementing grey with green for improved adaptation**

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Water management in urban areas represents an increasingly challenging issue, especially when considering the growing risks linked with flooding as a consequence of climate change. Sustainable Urban Drainage Systems (SuDS) can be a valuable tool for reducing Europe's vulnerability to these predicted changes by aiding urban adaptation efforts and offering a myriad of additional social, economic and environmental benefits.

The traditional solution to urban drainage in western cities has been 'grey' infrastructure solutions – piped drainage systems – which are mainly single-objective oriented designs to cope with rainwater as part of the wider urban landscape. Such an approach often lacks the capacity to keep pace with on-going urbanisation and the increasing rate of stormwater as a consequence of climate change. SuDS is a type of nature-based solution which can effectively and affordably complement these traditional solutions to urban drainage challenges by utilizing natural processes like evaporation, infiltration, and plant transpiration and elements such as permeable surfaces, filter and infiltration trenches, green roofs, detention basins, underground storage, wetlands, and ponds.

SuDS are being increasingly recognized as multifunctional solutions to urban drainage problems which can offer significant co-benefits. Benefits include, for example, reduced stormwater runoff and pollution as well as energy and water treatment costs, diminished impacts of flooding, improved public health, and reduced overall infrastructure costs, while also creating amenity values in urban areas. More concretely, it has been estimated that benefits obtained from the implementation of SuDS can exceed the benefits from piped drainage systems by up to 30 times (including prevented damage costs of flooding and water pollution, changes to property values, green jobs created, reduction in greenhouse gas emissions and reduced crime) (MWH 2013).

As part of the EU-funded RECREATE project<sup>8</sup>, the evidence basis for SuDS as an effective solution to urban flooding challenges has been gathered via expert consultation and building on European best practice examples of successful implementation projects. The presentation introduced the preliminary findings of this research, highlighting the potential effectiveness of SuDS to address Europe's increasing threat of urban damages caused by flooding on the basis of several case studies as well as the related challenges and potential barriers as compared to traditional engineered solutions.

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<sup>8</sup> <http://www.recreate-net.eu/dweb/>

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#### **4.4 Session II: Nature-based solutions for climate change adaptation and mitigation and the role in fostering social-environmental justice in cities**

##### **Nature-based solutions and a socially inclusive development of cities – some reflections from a social-environmental perspective**

ANNEGRET HAASE

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Nature-based solutions have become a major approach when discussing about the ecologically and resource-friendly sustainable future of our cities and urban areas. But what do they mean for people in cities? Do they lead automatically to socially just and inclusive developments as well?

In the presentation, some theses related to the first two leading questions of session 2 were discussed from a social science perspective and a research background that is based on a closed interdisciplinary social-environmental co-operation. First and foremost ideas around these theses were developed. For illustration, empirical evidence from different research projects on sustainable urban and neighbourhood development, re-urbanization, residential segregation, and diversification, where I have been involved in during the last years, were used, without presenting a consistent or full empirical case study.

##### **Theses (preliminary):**

1. Nature-based solutions are not inherently socially inclusive or just. In some cases/under certain conditions, by contrast, they might work as triggers for gentrification/displacement etc.
2. The focus on “solutions” might lead into a false direction since it promises “responses” and hides the complications that are often at play.
3. Nature-based solutions may foster a socially inclusive/healthier etc. development at different scales of the city but will not work as a blueprint for socially based problems/challenges.
4. Nature-based solutions should not be just focused on access to green or measured in per capita values; it has to be related to the everyday life and routines of people (of different groups), to their resources and capacities.
5. When discussing about and implementing nature-based solutions, the context of a city matters decisively: whether it is rich or poor, more or less segregated, growing or shrinking etc.; I think here of cities such as Detroit (US), Liverpool (UK), Bytom (Poland) or Leipzig (Germany). The same measure/“solution” might have very different effects in different contexts.

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# **The effects of urban green space on environmental health equity and resilience to extreme weather**

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## **Introduction**

Exposure to environmental hazards and beneficial factors varies with income and other socio-economic and demographic factors. The resulting environmental inequalities have direct and indirect impacts on health and well-being (WHO REGIONAL OFFICE FOR EUROPE 2012). Many environmental inequalities relate to natural and environmental features (such as quality of green spaces, air, water and soil). Evidence shows that exposure to environmental hazards is likely to be elevated in the most deprived population groups and the most disadvantaged areas, while exposure to environmental factors beneficial for health and well-being tends to be higher in affluent populations (ALLEN & BALFOUR 2014). In parallel, the health effects of climate change are unequally distributed as well (WATTS et al. 2015).

## **Nature-based solutions and their potential for health and equity**

Nature-based solutions have a potential to improve health and well-being of urban residents through improving the urban environment. Positive effects on health and well-being can result not only from reduced exposure to environmental hazards but also from psychological and physiological benefits resulting from urban residents' interaction with natural and vegetated areas, the active use of natural environment and green infrastructure with a shift to a more active lifestyle. The environmental benefits that ecosystems provide are related to absorption of air pollutants and buffering of noise, moderating influence on local weather extremes, and their water retention capacity (MILLENNIUM ECOSYSTEM ASSESSMENT 2005). Nature-based solutions also open opportunities to reduce significant environmental inequalities and related adverse health impacts in disadvantaged populations through strengthening and supporting focused environmental policies and technical interventions in target areas.

## **WHO work on urban green spaces and health in the European Region**

An ongoing WHO project has focused on developing tools for assessing the provision of urban green spaces as an important nature-based solution to sustainable urban development and climate change adaptation. A review of the health impacts of urban green space indicated that different types and sizes of urban green space are associated with varying health benefits.

- Observing or interacting with green spaces or other natural environments results in psychosocial benefits, such as relaxation and stress reduction, which are linked to a variety of health and well-being benefits including improved pregnancy outcomes, improved developmental and learning outcomes in children, and reduced morbidity and mortality.



- Active use of urban green areas leads to improved physical fitness and various health benefits such as prevention of cardiovascular disease, obesity prevention, mortality reduction.
- Reduced exposure to air pollutants and noise also results in a diverse set of health benefits, such as improved respiratory and cardiovascular health.
- Mitigation of urban heat island effect and heat waves has a potential to prevent heat-associated mortality.

On the other side, potential detrimental effects, such as an increased risk of allergies or injuries need to be considered as well.

Following the commitment of the Member States of the WHO European Region to “...provide each child by 2020 with access to (...) green spaces in which to play and undertake physical activity” (WHO REGIONAL OFFICE FOR EUROPE 2010), WHO has also evaluated various indicators of green space availability and accessibility in relation to their health relevance. The first indicator WHO suggested as a tool for assessing green space accessibility is the percentage of urban population living within linear distance of 300 m from the boundary of a green space of minimum 1 hectare. It allows the integration of socioeconomic and demographic data in order to identify potential inequalities in green space accessibility and facilitate targeted urban planning measures. Secondary indicators suggested were (a) Normalized Difference Vegetation Index (NDVI) data as a measure of total greenness within a city and (b) green space usage if data are easily available or collectable.

The project report, expected by early 2016, will provide an overview of public health benefits of urban green spaces and methods to quantify green space availability and accessibility, as well as a GIS toolkit for a selected indicator.

Disclaimers:

This abstract does not represent US EPA policy.

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#### **4.5 Session III: Urban (allotment) gardening and urban agriculture as local community based approach of small-scale climate change adaptation and mitigation in urban areas**

##### **Urban Climate-Gardens: an educational initiative in the model region of Berlin**

EVA FOOS, DR. THOMAS AENIS

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Urban areas are especially affected by climate change. The city of Berlin, for example, expects higher average temperatures by up to 2.5 degrees Celsius until 2050, more "hot days" and an increase in heavy rain days and a rise of rainfall in the spring and in the winter. Although the precipitation in the summer might barely change droughts are more likely because of concentrated heavy rains. The winters tend to become milder with less ice and snow. "Insecurity" is part of the climate models; exact predictions are not possible.

What does this mean for Berlin? Which impacts do climatic changes have on urban gardening? What can gardeners contribute to adaptation and mitigation?

The project "Urban Climate-Gardens: an educational initiative in the model region of Berlin" – funded by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety from 04/2015 till 03/2017 – aims at climate change adaptation in allotments, community gardens and neighbourhood initiatives. The purpose of the project is, to raise awareness about climate change and the importance of the gardens for the city, and to develop educational measures. The main target group is "multipliers" for the more than 70.000 allotment- and community gardeners in Berlin. They should be enabled to implement adaptation and mitigation actions in their gardens and carry on their knowledge to others.

The project implements a holistic approach to education, consisting of the development of "climate-educational gardens", trainings, and an online platform. Participation is seen as axiomatic for the success and usability of educational measures. Therefore all units are planned in an advisory board of garden associations, community garden initiatives, environmental organizations, scientists and the Senate Department for Urban Development and the Environment, and are evaluated by these experts as well as the end-users. The concretization of the project implementation is carried out on the basis of a situational and knowledge needs analysis which took place from May to November 2015. Literature was analysed; existing training courses and materials researched and a series of expert interviews and an online survey among gardeners in Berlin were carried out.

Initial results give evidence that "climate gardening" resembles organic gardening in many aspects. The current gardening praxis shows a diverse picture: on one side there are climate adaptive practices which are realized by the gardeners whereas on the other side left potentials become visible, for example concerning crop rotation, use of rain water, efficient irrigation and the ground cover. Regarding education the survey shows that gardeners learn mostly "by exchange" and "by doing". The respondents mostly state a big interest on learning more about climate change adaptation measures. Relevant educational materials on (organic) gardening exist but they rarely consider the relevance of specific measures against the background of climate change. Between the groups (allotment gardeners – community gar-

deners / age groups / groups of gardening experience and knowledge) there are several significant differences in the gardening practice and the interests on education, its topics and implementation.

Based on these results the current planning for the further process of the project envisages two main threads. One focuses on the extension of the survey on existing knowledge, educational measures and experts in the field of gardening and climate change and in the next step distribute the information in workshops and in the internet. The other concentrates on the creation of supplementing materials and workshops to bridge from gardening to climate change and especially to offer settings for further networking amongst the stakeholders such as science and praxis, allotment gardeners and community gardeners, education and gardeners, city council and gardeners. In terms of the core topics the focus will be on “species and varieties”, “soil: its conservation and improvement”, “water: dealing with lack and excess of water” and “gardens and their importance for Berlin in climate change”.

The report on the situation analysis will presumably be published in February 2016.

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## Assessing the contribution of urban gardens to ecosystem services and biodiversity in the city of Leipzig

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Urban gardens can contribute to nature-based solutions in promoting biodiversity and thereby ecosystem services, such as food provision, climate and water regulation, opportunities for leisure and recreation and to some extent also to social cohesion. We investigated the contribution of allotment and community gardens to urban ecosystem services and assessed differences in gardener's motivation respecting service demand and provision. We used the City of Leipzig as case study, since it has a long-lasting tradition of allotment gardening initiated by the *Schreber* movement in the late 19th century and comes up with the highest density of urban garden areas among European cities (2.8% of the city area and 16 m<sup>2</sup> per citizen) at this time. Additionally, Leipzig has an increasing number of community gardens propagating throughout the city area for the last 20 years.

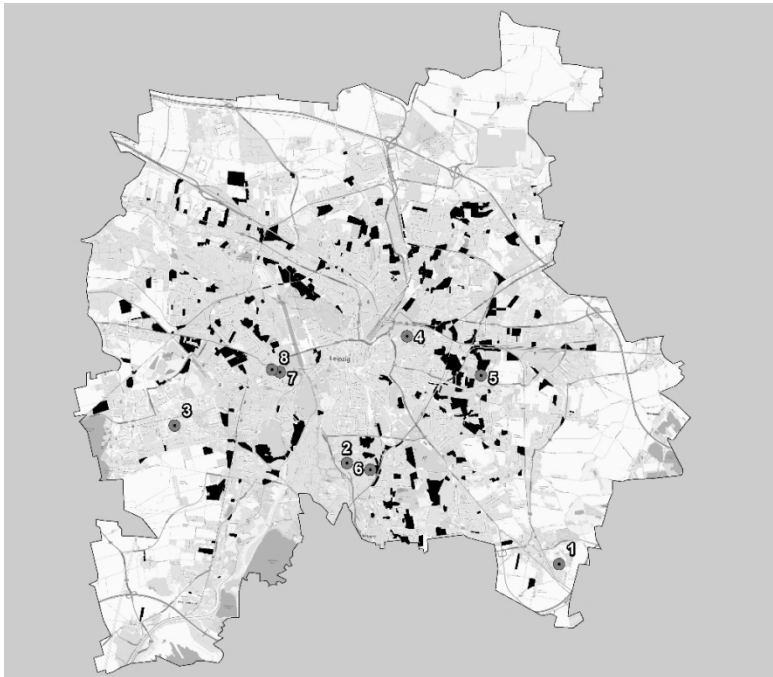


Figure 1. Leipzig allotment gardens (darker grey) and community gardens (numbered). (credit: Roland Kraemer)

We applied a combination of quantitative and qualitative methods to assess both the allotments and the community gardens according to their location in the city and to their managing intensity. Field surveys have been performed on 30 allotment garden plots out of 6 colo-

nies, as well as in 6 community gardens within the city boundaries. As a measure for biodiversity we sampled floristic community composition and species richness of spontaneous vegetation, while the composition of edible plant species served as a proxy for food provision. Microbial soil activity was measured as a supporting service, and remote sensing and ground tree surveys were used to assess climate regulation effects and tree/shrub diversity. In addition, interviews on gardening management techniques and motivation of gardeners were employed to assess social and recreational aspects as well as ecological awareness.

Our results show that community gardens feature a higher overall plant diversity compared to allotment gardens. Within each allotment colony, species richness of spontaneous vegetation was higher in the vacant and medium intensive managed plots than in gardens that featured a high intensive management. We could show that areas of urban gardens have a considerable share of unpaved and vegetated surface, almost 60% for allotments and 90% for community gardens, leading to important water regulating services. The old mature trees located on playgrounds have a high contribution for carbon storage and therefore for climate regulation. Soil microbial activity was slightly higher in community gardens and also in vacant plots within allotment gardens. Economic as well as health reasons drive the allotment gardeners, as opposed to community gardeners which value mostly gardening as a hobby and affinity to nature. Ecological amenities such as lakes, beehives and livestock shelters seem to be more present in community gardens than in allotments. Rainwater harvesting and composting seems to be standard throughout the different garden types, while near-nature approaches like permaculture as well as biodiversity awareness appeared to be more prominent among community gardeners.

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## **Interim green utilization of brownfields in Budapest as potential for mitigation of climate change - possibilities in our neighbourhood**

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In our parallel PhD researches at the Corvinus University of Budapest we elaborate the criteria of the success of brownfield revitalization, the application of the methods of interim utilizations of greeneries and the formation background and potential of urban agriculture. In order to trace the urban development possibilities in Budapest we focused on aspects of climate change causes and effects, we compared our systems of criteria in hope of extensive research conclusions and analysed brownfield revitalizations where the interim utilizations included community gardens, too.



Figure 1: Albertfalva Garden, Budapest 2016 (photo by FácZányi, Zs.).

### **Turning point for Budapest**

Budapest is rich in brownfields and underused areas representing a significant potential in the development of its green infrastructure. Considering the insufficiency of comprehensive decision making mechanisms and financial funds in urban development nature-based, low-budget, bottom-up self-supporting practices can effectively contribute to future green developments. A current research made at our University on the utilization of underused railway areas of Budapest showed that temporarily utilized brownfield areas can be effectively connected to the radial-ringed greenery system based on railway territories.

Regarding these focal points we intend to define functions which can be implemented in Budapest and locate suitable territories. Describing the potential functions has to be based on the analyses of the social layer besides the right territorial characteristics. Early results show that the population density and characteristics of social housing estates – built in the second part of the 20<sup>th</sup> century in the transitional zone of the city with underused brownfield areas in the neighbourhood – present the best breeding ground for creating community gardens. The users are the less affluent groups of people who came from the adjacent towns with an agricultural knowledge but without their own greenfields and separated from the agricultural are-

as. For them the residential communities which are formed in the meanwhile are of an even greater importance than the seed beds which can have practical benefits.

### **Importance and possibilities**

We concluded that such developments are very likely to create environmental and social added value. The gardens can be a part of the green infrastructure of the city and can fortify its positive effects regarding the mitigation of causes and effects of the climate change processes. These gardens can be also a place where the environmental consciousness is taught.

Even if the community gardens are temporary utilizations of the brownfields, they have a positive influence on the social stability and as greeneries they can also have a good impact on climate change. Our key message is that the early results of the valorization process are important by themselves but the perpetuation of interim land utilization holds even greater values.

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## **4.6 Session IV: Municipalities adapt to urban climate change - by effective use of green infrastructure for nature-based solutions and existing actor networks**

### **Public participation in developing urban adaptation strategies to climate change with ecosystem-based approaches: The case of three pilot cities in the Czech Republic**

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#### **Introduction**

Urbanised areas are becoming more vulnerable to climate change, because of unfavourable socio-demographic trends and gradual pressure on natural resources from urbanisation (EEA 2012). Currently 74% of the population in the Czech Republic lives in cities and the number of urban dwellers is estimated to increase to 90% by 2100 (CZECH STATISTICAL OFFICE 2015). Moreover, the share of the most vulnerable within a population, which is the number of people over 65 years of age, is expected to increase by 16% in 2050 (CZECH STATISTICAL OFFICE 2013). The future prognosis of climate change scenarios for the upcoming 30 years is that Czech cities are to expect extreme weather events, floods and heat waves more often as a result of continuously increasing temperatures.

In our contribution we present some of the preliminary outcomes of the UrbanAdapt project, which aims to initiate and promote the process of developing urban adaptation strategies in the Czech Republic, while proposing and evaluating suitable adaptation measures and actions with the support of nature-based approaches (<http://urbanadapt.cz/en>). The project is supported by the EEA Funds of Iceland, Liechtenstein and Norway and involves 8 partners including key stakeholders from pilot cities, non-governmental organisations and two universities. The coordinator is CzechGlobe (Global Change Research Centre, Academy of Sciences of the Czech Republic).

#### **Urban adaptation strategies in the Czech Republic**

In October 2015 the Czech Republic adopted the National Strategy for adaptation to climate change which serves as a framework for implementing adaptation strategies at regional and local levels. Since there are no urban adaptation strategies in Czech cities, the UrbanAdapt project addresses the gap between urban adaptation capacity building and strategies development in the Czech Republic. Besides the main project goal, the sub-goals are: climate change risk and vulnerability assessments at the local urban level, identification of relevant adaptation measures, quantification of the costs and benefits of the preferred adaptation

measures, preparation and formulation of adaptation strategies for cities in order to initiate the implementation process of adaptation strategies and its measures. The project framework is based on an adaptation cycle (Fig. 1), where a wide spectrum of local stakeholders is being involved in vulnerability assessments, evaluation of preferred adaptation measures as well as the design and formulation of long-term goals for future adaptation strategies, which would be adopted by the pilot cities in the near future.



Fig. 1. The adaptation cycle (Source: Eliška K. Lorencová, based on EEA, 2012; PROVIA, 2013)

**Participatory workshops**

Urban adaptation strategies cannot be developed without the active participation of different stakeholders. Two rounds of participatory workshops (2 in each city) are planned within the frame of 6 months, where a wide spectrum of local stakeholders participates in the adaptation process. During the first round of workshops, participants were asked to identify and evaluate which climate related impacts constitute a problem and how they anticipate this could change in the near future (in 2030). The preliminary outcomes show that stakeholders perceived heatwaves, heavy rains and storms, floods and high surface runoff as most relevant problems.

From the perspective of future adaptation strategies, it was important that participants developed a vision for adaptation in cities for 2030. The visions and goals were mostly related to addressing the problems of water scarcity, risks of floods and low awareness of climate related impacts. To address these problems, several ecosystem-based measures were assessed as most relevant, especially: green roofs, river restoration, riverbank revitalisation, permeable paving and surfaces, infiltration trenches and green soak-aways, sustainable drainage systems, catchment and re-use of rainwater for irrigation and household use (non-potable).

The second round of workshops is planned for the fall and winter months of 2015. The focus will be at providing feedback on the outcomes of the first round including a deeper insight into the institutional background of the adaptation process in each city and possible costs and benefits of the different most preferred adaptation measures, provide space for discussion among the participants on indicators and ecosystem based adaptation measures that could be possibly considered for future adaptation strategies and action plans.

## **Conclusions**

Workshops ran in Pilsen, Prague and Brno as well as other project related activities demonstrate a growing network of stakeholders interested in the topic of climate change adaptation in cities using ecosystem-based approaches. The project also aims to increase public awareness of this topic by means of media, brochures and short video spots. Although the project has started just recently, some of the proposed ecosystem-based adaptation measures are gradually being integrated into different local and regional strategic documents, adaptation strategies and hopefully also master plans of the pilot cities.

## **Acknowledgement**

UrbanAdapt project (EHP-CZ02-OV-1-036-2015) is supported by grant from Iceland, Liechtenstein and Norway. Supported by Ministry of Education, Youth and Sports of the Czech Republic within National Sustainability Program I (NPU I), grant number LO1415.

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# Nature-based climate adaptation in urban and regional planning: a review of research projects funded by the German government

SCHÄFER, ERNST & SCHEELE, ULRICH

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The “German Climate Adaptation Strategy” and the “Action Plan Adaptation” form the basis for the systematic analysis of vulnerability and adaptation to climate change in Germany. In 2015, the German Government submitted a progress report, including concrete steps aimed at further development and implementation of the adaptation strategy and of measures to foster resilience to climate change. The preparation of the report was accompanied by an extensive evaluation process of the research projects funded by Federal Ministries as well as subordinate Federal Agencies during the last 10 years.

Climate change is a global problem, but the impacts of climate change as well as the appropriate measures to adapt are primarily of local and regional nature. At the local level adaptation to climate change is usually related to land use. Adaptation to climate change therefore places greater demands on local and regional planning.

A consortium comprising the three bureaus `ecolo`, `Bioconsult` and `ARSU` evaluated main research projects and research programs focusing on climate change adaptation in cities and regions. Within this project a screening system was developed, to allow in addition to the qualitative evaluation also a quantitative evaluation of the projects. In this paper we use this test grid to carry out a quantitative evaluation of the research project findings with regard to the importance of nature-based climate adaptation measures.

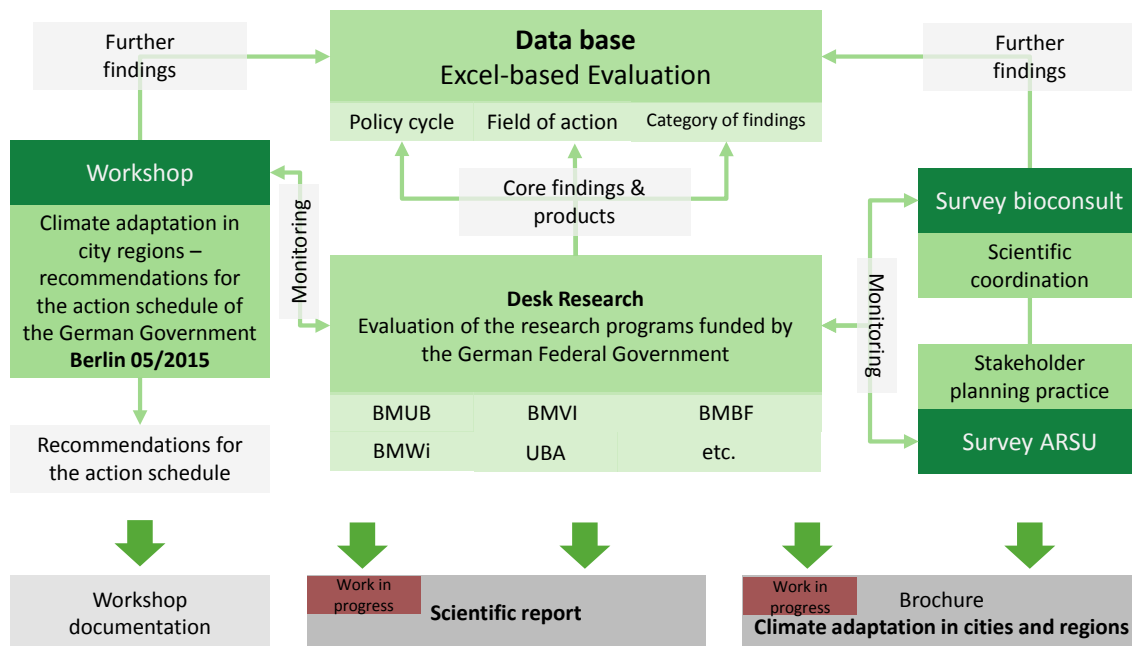


Figure 1: Research and evaluation design (Credit Schäfer & Scheele)

## Method

The evaluation starts by developing a screening grid that allows the collection of research projects and the corresponding research findings and research products (tools, guidelines, evaluation methods etc.). A total of 16 research programs and 68 projects funded by the German Federal Government were evaluated. For this purpose research reports, manuals, web tools, brochures, vulnerability analysis, action plans and adaptation strategies have been analysed. The database contains more than 1.800 entries to key research findings and more than 170 products that have been developed in the research projects. With regard to the quantitative evaluation of the role of nature-based solutions in climate adaptation, the key findings were divided into three categories: a) findings with direct reference to nature-based solutions – NB1 (e. g. concrete measures), b) findings with indirect reference to nature-based solutions – NB2 (e. g. statements regarding the regulatory framework for nature-based solutions) and c) findings without specific reference to nature-based solutions (NNB).

## Results

The quantitative analysis revealed that more than 32 % of the overall key findings were related to nature-based solutions, whereby 12 % of these findings are directly related to nature-based solutions (NB1). Figure 2 shows the nature-based related entries assigned to the different field of actions. Most of the findings with regard to nature-based solutions referred to the action fields “water economy and flood protection”, “coastal protection”, “spatial, regional and urban planning” as well as to “human health”.

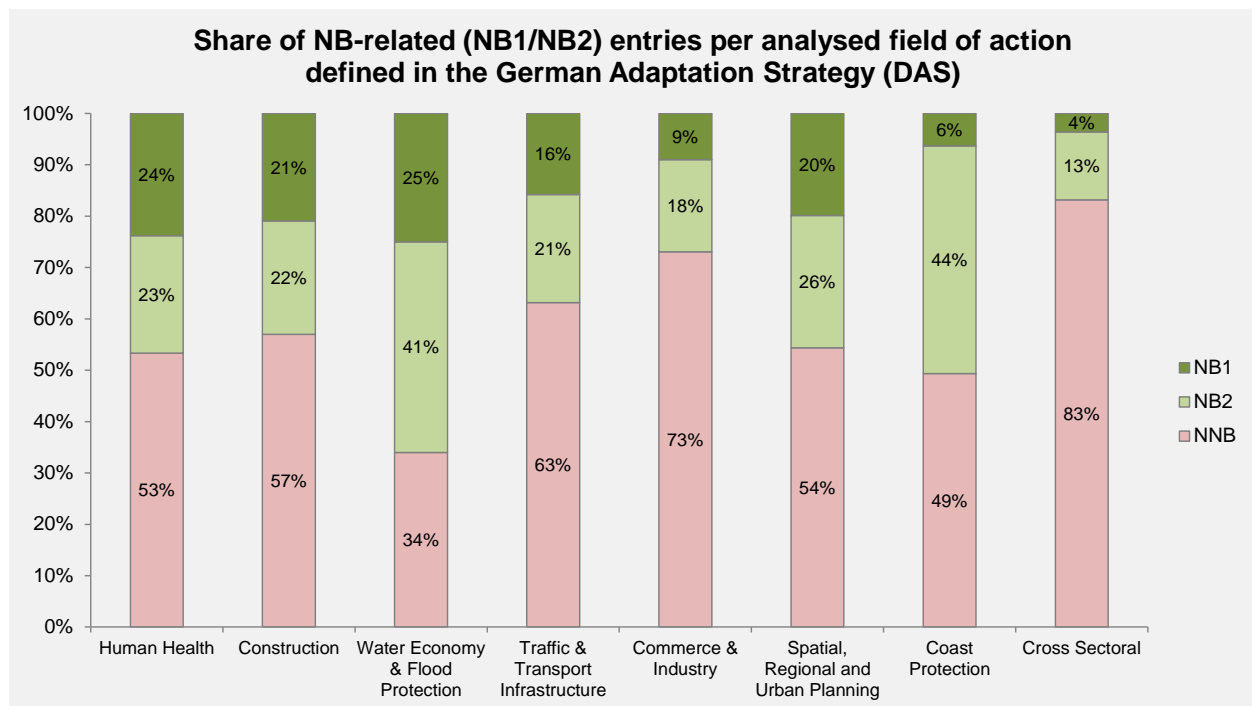


Figure 2: Share of NB-related (NB1/NB2) entries per field of action defined in the German Adaptation Strategy (DAS), (Credit Schäfer & Scheele)

## **Conclusion**

The quantitative analysis confirmed the qualitative analysis, which was in the focus of the evaluation process. Nature-based solutions seem to be of special relevance to dealing with the impacts of climate change. Regional and urban planning are the most relevant fields of actions. The evaluation has also revealed that there is a large discrepancy between the key research findings and the implementation of the concept into planning practice. The key barriers to implementation of nature-based solutions identified are: a) the inadequate consideration of the conflicts of interest and their interplay, b) an inadequate consideration of the cost benefit aspects of adaptation measures and a lack of respective economic instruments, c) an inadequate institutional anchoring of climate adaptation and a lack of defined responsibilities in local and regional governments, d) the inappropriate equipment and staffing of the spatial planning authorities as well as e) an insufficient realisation of the potentials of synergies and cooperative solutions.

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## Green Roof Strategy for Hamburg

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*Ministry of Environment and Energy, Hamburg, Germany*

Hamburg is to be greener – on top. The Hanseatic city is the first German city to have developed a comprehensive green roof strategy, aiming to plant a total of 100 hectares of roof surface in the next decade, and to deal with the challenges of flood management and to secure action in adaptation, biodiversity, and air quality. The current housing program is targeting to achieve the construction of 10.000 new housing units per year, which leads to the compression of boroughs and major effects on open spaces. Based on goals for sustainable, climate-friendly urban development, the Senate introduced the green roof strategy in 2014. The strategy is part of the existing city program 'Enhancement of open spaces', which tries to reduce the negative effects of the increased density in urban areas, and as an element of the city's RISA project - Rain InfraStructure Adaption, which is aiming to the sustainable management of rainwater. The green roof strategy has got a toolkit of four action points: promotion, dialogue, stipulation, and scientific support.



Green roof as recreational space for employees. © BUE. TH Treibhaus Landschaftsarchitekten

### Promotion

Hamburg's green roof promotion offers constructors special incentives to voluntarily opt for a green roof until 2019. The city will finance from 30 up to 60 per cent of the construction costs. Plants and substrate on greened roofs retain a large amount of rain water, which results in additional savings of 50 per cent on rain water fees for the owner. Photovoltaic systems work more efficiently on green roofs. The vegetation lowers the ambient temperature which increases the efficiency of the solar cells. Land owners get supplements when they combine solar cells with green roofs.

### Dialogue

The communication campaign is to raise awareness and knowledge of green roofs, and to conjoin with developers and housing corporations and advance interactive arrangements and responsibility. The open dialogue with the housing industry, logistics and architects enables to overcome hurdles in the construction and helps towards a widespread implementation.



Keyvisual: On your roofs, get set, green! Incentive program of Hamburg

© BUE Photo: L. Nahapetian, Aerial: M. Stalter, Mounting: B. Reichel

### Stipulation

This action point concentrates on developing and implementing ways to enforce rooftop greening through more regulation and by consistent use of legal instruments, such as the German Building Code, the Nature Conservation Act, the Hamburg Building Regulations and a Green Roof Regulation. Although the obligation to build green roofs is already quite common in new detailed development plans, there are still several challenges to be overcome.

### Scientific Support

The HafenCity University is providing scientific support for the green roof strategy. Amongst other things, the scientists are collecting data on water retention especially during heavy storm water and the water management effectiveness of green roofs (450 m<sup>2</sup>). Furthermore, the Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety supports Hamburg's green roof strategy as a pilot project within their programme "Measures for adaptation to climate change".



Vision: Green roof infrastructure in downtown Hamburg.

© BUE. Visualization: TH Treibhaus Landschaftsarchitekten, Aerial: M. Friedel



## **Conclusion**

Implementing the green roof strategy, Hamburg aims to transform the way the city treats the roofs by creating a green roof infrastructure.

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## 4.7 Session V: The role of biodiversity conservation for nature-based solutions in climate change adaptation and mitigation

### Natural succession or designing nature? The case of urban climate change adaptation and mitigation – the perspective of technology assessments

STEPHAN LINGNER

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The concentration of urban regions in Europe (cf. EUROSTAT 2013) gives reason for urban greening as an eco-sensitive means to cope with climate change and its impacts. However, the question emerges here, whether greening strategies should better aim at designing and tailoring nature in the cities or simply at allowing for natural succession processes. Especially the latter might improve urban biodiversity in the long run. However, letting nature and biodiversity grow without control could also compromise urban utilities to some extent (Fig. 1). This perspective has been inspired by a former academy's study on the societal dimensions of biodiversity (MARGGRAF 2001).

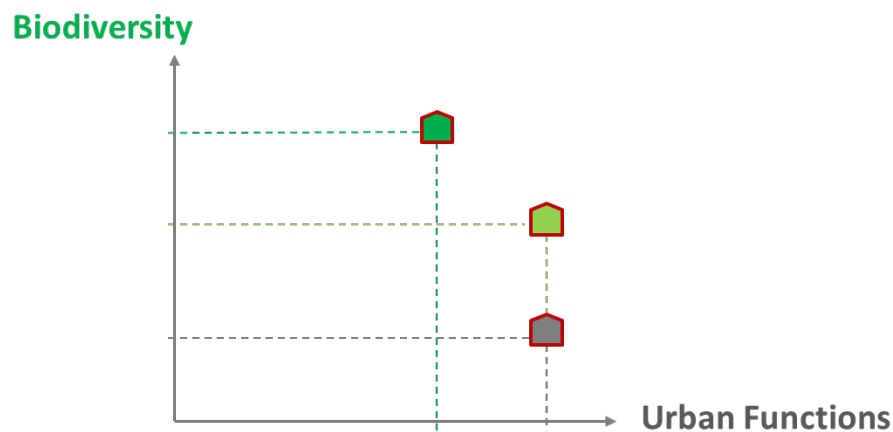


Figure 1: Urban greening trade-offs. Symbols: grey = current status, green = more or less ambitious greening strategies (source: Stephan Lingner)

#### Urban greening criteria

The evaluation of trade-offs becomes even more difficult when considering also other relevant objectives of urban life with respect to the built and natural environment and the local climate (Table 1). The multitude of different, often competing and even conflicting or debatable goals, principles and criteria complicates finding, formulation and advocating appropriate greening strategies.

Therefore, an evaluation matrix (see also OTT et al. 2004) might help here to achieve transparent assessment results in complex and ambivalent decision situations. Table 1 visualises a corresponding methodology by (tentative) valuing of both greening strategies at stake with regard to the relevant goals, principles and criteria after having assigned them to specific priority factors. The weighted sum of all values for each greening strategy might finally give – by comparison – overall and reproducible priority for one of the suggested strategies or for any hybrid solution not mentioned here. For instance, the criterion of timeliness could become decisive here, when adaptation to climate change via urban greening proves to be ur-

gent. Conversely, any attributed or intrinsic values of naturalness or aesthetics might be debatable, thus leading to different evaluations thereupon.

Table 1: Assessment matrix; grey values: tentative numbers for illustration (source: Stephan Lingner)

Aims & criteria	Priority factor	Designing urban nature	Natural succession
Urban functions	$p_u$	$1 \times p_u$	0
Climate adaptation	$p_c$	?	?
Biodiversity	$p_b$	$0.5 \times p_b$	$1 \times p_b$
Sustainable	$p_s$	0	$1 \times p_s$
Naturalness	$p_n$	0	$1 \times p_n$
Aesthetic	$p_{ae}$	$1 \times p_{ae}$	$0.5 \times p_{ae}$
Affordable	$p_a$	0	$1 \times p_a$
Timeliness	$p_t$	$1 \times p_t$	0
... others?	...	...	...
<b>Weighted total sum</b>		...	...

## Conclusion

The assessment results should enable reasonable opinion-forming of the stakeholders and rational choices of decision makers. However, the normative status of corresponding assessments depends upon societal consent on the criteria and their priorities. Therefore, three levels of claims from the assessments are generally conceivable: (1) they would allow for transparent *if-then* reasoning of the concerned parties if the relevant criteria and priorities remain debatable. (2) They might give strong reasons for intermediates in the field to advise the responsible actors if there is enough societal *consent* on the values of central criteria and priorities. (3) When there is broad consent on *all relevant* criteria and priorities, the assessments could even become part of justifications for binding regulations thereupon. However, expecting considerable plurality of societal perspectives on that problem and of related interests, the outcomes (1) and (2) seem to be most probable, meaning that societal dialogues on urban greening options and incentives have to be initiated before corresponding policies could be developed on the relevant administrative levels.

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## Nature-based solutions: delivery of biodiversity conservation and ecosystem based adaptation in urban areas

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### Introduction

Urban biodiversity is a core component of what we need for effective nature-based solutions (NBS) delivery and it has a crucial role in making urban areas liveable. The current state of many of our cities alone would make us think about replacing lost biodiversity and naturally functioning systems, but climate change brings an increased imperative.

Climate change will impact the urban population in a number of ways, flooding and the urban heat island (UHI) effect being particularly acute examples. Biodiversity in urban areas will also be affected by climate change, experiencing shifts in distribution, changes in phenology and changes in community composition. Biodiversity conservation in urban areas, delivered through multifunctional NBS, can deliver adaptation for both people and nature.

### Delivery principles

For NBS to be effective it has to be implemented at a range of scales. The Lawton Review (Lawton et al 2010) found that we do not currently have a coherent ecological network, a spatial plan to deliver this at a national level would be beneficial. The regional scale then acts at the landscape level providing connections and ecosystem services. At a local scale particular issues can be addressed, such as localised flooding, and the site level can provide small scale interventions that add up to provide a cumulative benefit.

The right design is also vital. The right location and the correct features are important, but providing multifunctional benefits is a crucial cornerstone of effective and sustainable NBS. It is long recognised that NBS, particularly in busy urban areas, provide a range of benefits for different sectors. Furthermore, delivery and maintenance is most successful when achieved through partnership, reflecting diverse needs and engagement.

### Delivery case studies

Regional scale - The Queen Elizabeth Olympic Park was designed as the centrepiece of a major regeneration project in East London, with many benefits designed to deliver the legacy of the 2012 Olympic and Paralympic Games. The site also provides ecosystem services such as flood protection and contact with nature for an area previously lacking in these. Since re-opening in 2013 the site has seen over 4.5 million visitors, it has flooded intentionally 9 times, protecting an estimated 5000 homes, and has recorded a wide range of biodiversity including one spider record that is new to Britain.



Figure 1: Queen Elizabeth Olympic Park (©S Taylor)

Local Scale - Work at Mayesbrook Park updated 50 year old flood management infrastructure using a NBS approach in an area of East London suffering from localised flooding and lack of natural space. The works restored natural meanders to the Mayes Brook, created new floodplains and provided new habitat areas, providing a multifunctional landscape more resilient to climate change for people and wildlife.



Site Scale - Victoria Business Improvement District (BID) wants to retrofit natural features to provide localised adaptation to climate change and to be an exemplar NBS project in a highly developed area. A green infrastructure audit found that most of the potential for delivery was at roof level so they identified the best opportunities for green roof provision to help prioritise action. If the mapped potential for green roofs is delivered, the green space in Victoria will increase by 80% or 25ha. Here, small, well planned interventions could add up to provide increased biodiversity and flood protection.

Figure 2: Retrofitted green wall in Victoria (©S Taylor)

## Conclusions

NBS delivery examples are exciting and inspiring, but they need to be applied consistently and we need more of them. There is also a question as to whether NBS need to be bio-diverse to provide ecosystem-based adaptation. I argue that biodiversity confers resilience and we should ensure NBS are truly multifunctional, including biodiversity, which underpins ecosystem services, provides cultural services and makes people feel good! It could be argued that reconnecting people with nature is the most important thing we can do, the benefits provided by multifunctional NBS in changing behaviours could be massive.

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## **A tale of two cities: developing floodplains for people and wildlife**

OLLY WATTS

*BirdLife / RSPB*

Two river estuaries located around cities in the UK are providing opportunities to integrate landscape scale habitat creation and restoration with a range of benefits for both people and wildlife.

The Inner Forth estuary near Stirling, Scotland is an internationally important area for wildlife, mostly designated as an SPA for migrating and wintering wildfowl and waders. Yet the wildlife is under pressure. Around half of the inter-tidal habitat of saltmarsh, mudflats and reed-bed, vital for the thousands of wintering wildfowl and waders, has been lost over the last 300 years. This has also eroded the estuary's natural capacity for absorbing flood waters.

Agriculture was the prime historical driver for land reclaim, more recently industry has eroded the estuary's natural features. Lagoons created to take ash from Longannet power station are one of the more extreme examples of land creation.

UK BirdLife partner the RSPB has a vision for habitat creation across 2,000 hectares of this floodplain, working in partnership with a range of organisations to create a network of new wetland habitats providing multiple benefits to people and wildlife. This started at RSPB Skinflats reserve with installation of regulated tidal exchange to show how new inter-tidal habitat can be created and provide natural flood defence. Yet the essence of the estuary's future lies beyond our own landholdings, encompassing nature-based solutions across the whole area to help nature and people. So our next step was to create a vision for the estuary, with the river sitting in a more naturally functioning flood plain. The special sites for biodiversity would become surrounded by nature, with new habitat areas helping communities adapt to climate change and giving local people access to wildlife and wild places. The vision also keys into current priorities along the estuary including the Central Scotland Green Network, Water Framework Directive, Special Protected Areas and sustainable flood management.

We identified 12 sites for habitat creation from land reclaimed for agriculture and for industry. Nine sites are for full scale inter-tidal habitat creation through managed realignment, with three to improve existing wetlands.

To achieve this, we formed the Inner Forth Landscape Initiative with local councils, NGOs and community groups. Work on the three existing wetland sites is now progressing. We've developed detailed plans for one of the farmland areas. Community work through schools, local groups and an Inner Forth Festival engages more people to support the vision.

The Greater Thames is London's tidal floodplain, covering 350sq km with £200 billion of property alongside 10 SPAs and 300,000 migrating birds. Increasing impacts from climate change is helping the development of intertidal habitat connectivity within the flood defence plans to protect London.



Green spaces along the estuary are helping to reduce coastal and fluvial flooding, and contributing to water storage in a densely populated area. Eleven RSPB nature reserves form a core resource for wildlife. Strategic habitat restoration and creation in partnership projects along the estuary is adding to this, bringing benefits to people and to wildlife. These include award winning habitat restoration at Great Bells Farm on the Isle of Sheppey where a 'green reservoir' protects neighbouring agricultural land from flooding and provides breeding wader habitat. Rainham Marsh has been restored from a military firing range to become a flagship RSPB reserve for wildlife, the local community and flood washland. Saltmarshes provide a natural barrier in front of built defences: in Essex 84% of the 440 km of seawalls rely on saltmarsh fronting to maintain flood defences. At Wallasea Island on the Stour estuary arable land is becoming a new multi-functional wetland, reshaping the island with spoil from London's new underground railway.

Wetland development also extends outside nature reserves. The RSPB and Natural England are working across north Kent giving landowners management advice. Alongside this, grazing, water level, and fencing management has increased breeding wader productivity. We're working for wider biodiversity with partners on invertebrate sites, with bumblebees a key focus. Extending multi-benefit wetlands continues and, as on the Inner Forth, the practical, tangible benefits build engagement with partnerships and urban communities.

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## **Habitat stylization in urban environments from a climate change adaptation point of view**

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### **Aim of stylization**

Stylization of a habitat or landscape is a common garden and open space design method that imitates nature and evokes the scenery, often applied in urban environments. A rarely proposed aspect of stylization is that it serves as a kind of adaptation tool to climate change since the method affords the possibility of preserving the physiognomy of those habitats that will likely vanish due to future climate change (BEDE-FAZEKAS & SOMODI 2015). Stylization has garden and open space design and dendrological significance, since it is not bound to the original location of the habitat and does not aim at contributing to habitat restoration. Natural habitats provide cultural ecosystem services (ES) amongst other types of ES, since their physiognomy is valued by humans. The aim of preserving or evoking the character of those habitats that might perish in the future due to climate change is therefore well-founded. The authors refer to stylization as an essential climate change adaptation tool that landscape architects can apply in urban environments.

According to the classification of ecologically informed ornamental planning designs (DUNNETT & HITCHMOUGH 2004) stylization can be viewed as a nature-imitating plant application which evokes the scenery rather than an ecological application which assists the processes and functions observed in the nature (BEDE-FAZEKAS & SOMODI 2015).

### **Substitute species**

In the course of stylization characteristic species of the original association are replaced by taxa with similar appearance compared to the original species (SCHMIDT 2003). Searching for a substitute species that is of similar physiognomy but is more tolerant to the predicted future climate has several alternative ways that are summarized in Table 1. The most basic and most limited approach is using the experience/knowledge of the designer or other expert (dendrologists, employees of arboreta or tree nurseries) (Method "By heart"). One can exhaustively study the species of the same genus or family of the original species (Method "Related"). Another method is searching for a plant species having a species name that refer to the original species or to one of the characteristics of the original species, using plant name databases (Method "Scientific name"). One can use a photo-based photo search method in general or specific photo databases to find species with similar morphological features (Method "Photo"). The most scientifically sophisticated approach is the search in plant trait databases for species that has visual traits similar to that of the original one.

Table 1. Methods of substitute species searching, their limitations, their type in terms of the stochasticity of the finding of substitute species, and some examples.

Method	Limitations	Stochastic/deterministic	Examples
By heart	needs much experience/knowledge	stochastic	<i>Fraxinus ornus</i> – <i>Tetradium daniellii</i>
Related	does not work in case of monospecific genera/families	deterministic	<i>Ulmus laevis</i> – <i>Ulmus minor</i>
Scientific name	needs a descriptive species name	deterministic	<i>Castanea sativa</i> – <i>Quercus castaneifolia</i>
Photo	needs characteristic morphological features (colorful flower or special fruit)	stochastic	<i>Alnus glutinosa</i> flower – <i>Corylus colurna</i> flower
Traits	needs large, searchable database with several visual plant traits recorded	deterministic	<i>Picea abies</i> – <i>Pseudotsuga menziesii</i>

Stylization of natural habitats encounters many challenges, especially in densely built and modified urban environments. Urban meso-climate and future climate change will jointly limit the assortment of ornamental plants that landscape architects can apply during stylization of climate change habitats. Since functional and visual traits of the plants are interdependent from each other, finding drought tolerant ornamental taxa which look similar to those of the evoked natural habitat is not always possible.

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## 4.8 Interactive Session VI: Nature-based solutions for climate change adaptation and mitigation from a transitions' perspective

### Transition practices incentive: fostering nature-based solutions

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Nature-based solutions are an emergent approach to reconcile humans and nature, providing opportunities to advance biodiversity conservation and increase human well-being in a changing climate.

We propose a conceptual trajectory for encouraging a transition from conventional practices to those that are aligned with biodiversity conservation. Therefore, the *Transition Practices Incentive* is supported by 'incentives' not focused on the monetary dimension, but on a platform and a network of practices and knowledge. It creates opportunities to locally foster a practice transition that could lead to a tipping point, with self-sufficient, sustainable and resilient socio-ecological outcomes. The implementation of such a mechanism can support some nature-based solutions as long as they follow some steps (MUNIZ & CRUZ 2015):

1. Think beyond an ecosystem services approach and the benefits of adaptation for humans.
2. Recognize a plurality of values and languages around nature and biodiversity regarding conservation and within the process of adaptation.
3. Foster a holistic-systemic perspective, comprising a participatory, democratic and empowering strategy aligned with environmental justice movements and socio-ecological context;
4. Avoid market-based approaches and monetary incentives which tend to obscure the relationship between humans and their environments, undermining the sustainability of the outcomes and a long lasting adaptation.

Initially, the trajectory would focus on those that are willing to engage with conservation and coherent practices transition by promoting and spreading three fundamental elements: awareness, knowledge and network.

The transition for sustainability requires deep awareness of the value and relevance of nature and the broader ecological realities that provide the context for human life (MILLER 2005). Awareness could move a person to act within an empowered community; however, in order to act towards a transition, we need knowledge regarding ecological and societal processes. By recognizing the relevance of ecological and human networks for sustainability, we must instil our efforts in engaging people to re-connect with nature and with each other. This is a pledge not only for an ecological network, but for a human network as well. At first, nature-based solutions come with the premise of creating linkages between people and the natural world.

Nowadays, the continuous estrangement of people from nature is one of the reasons why there is no broader motivation for conservation. This estrangement paradigm in an increasingly human-dominated landscape is further accentuated by another increasingly scarce and

commoditized 'resource': time (MILLER 2005). Therefore, would a person be willing to engage with conservation and a transition for sustainability with more time available from her/his paid day work?

The welfare argument for reversing the commodification of work and the redistribution of work proposes a reduction of working hours in the paid sector, which could be substituted by other useful work and possibly more gratifying in the unpaid sector (KALLIS 2013). Within this argument, we suggest that nature-based solutions could be encouraged through some freed time from the daily paid work, in a search for a non-commodifying strategy for biodiversity conservation and for a transition for sustainability.

The creation of a network and a platform of knowledge and practices could facilitate and inspire conservation activities through the "free time" within main strategies. For example, the ecological corridors and the agroecology are two encouraging main nature-based strategies that could be intertwined. Both strategies increase opportunities for wilderness conservation and harmonise human activities with the natural environment. The main objectives would be to:

1. Advance wild, urban and agro biodiversity conservation;
2. Foster a transition from conventional agriculture to agroecological systems;
3. Re-create interconnectedness.

The traditional path for nature conservation –keeping nature as it is– should still be the priority, considering species depend on the integrity of their habitats and their surroundings. However, we must go beyond and inspire changes in human practices and patterns to be harmonious with ecosystems integrity. Conservation is not only about the natural world, it is about bringing people back to nature (MUNIZ & CRUZ 2015).

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## 4.9 Interactive Session VII: Rural-urban linkages of nature-based solutions for climate-change mitigation and adaptation and planning perspective

### Nature-oriented infill development in growing regions– wishful thinking or reality?

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Today, smart planning concepts integrating the need for healthy living surroundings by preserving urban open spaces and the demand for fostered infill-development in growing regions are urgently needed.

The presentation aims to balance the controversy of infill development versus open space preservation presenting experiences from two research projects coming from the field of urban planning and landscape development. The presentation developed a synthesis of the two projects bringing both dimensions –the built and the natural dimension- together:

- 1) Built dimension: We presented the neighbourhood “Rheinviertel” – an inner urban neighbourhood in the city of Bonn– with potentials of additional infill development for residential purposes. Modelled scenarios being developed at the University of Bonn show varying built densities and highlight constructional potentials (de-sealing, surface materials, exposition of buildings etc.) for the adaptation of built urban structures to the impacts of climate change. Climate impacts due to densification were modelled with ENVI-Met ([www.envi-met.com](http://www.envi-met.com)). The authors also highlighted the potentials and limits of infill development in this neighbourhood focusing on planning-law requirements and climatic factors.
- 2) Natural dimension: In the field of urban open space qualification, we present first hand results of the project “Nature in grey zones” (in German: “Natur in grauen Zonen”) of the Bonn Science Shop (in German: Wissenschaftsladen Bonn) on unsealing measures and near-natural greening of company premises. The project aims to demonstrate how to integrate more green areas in the urban built structure without losing functionality of premises and open spaces.

### Findings

1. Think big and very small! The synthesis of the two projects showed that urban planners need to keep in mind both climate adaptive measures for densification projects such as de-sealing, greened roofs and keeping free of ventilation zones. But they also need to consider small-scaled improving measures for already existing urban structures such as de-sealing and re-introducing new vegetation on formerly sealed courtyards or pavements. Big measures for new housing projects and small-scale improving measures in existing built structures need to go hand in hand.
2. Need for innovative concepts: Urban planners are in need to foster concepts towards car-free or car-reduced neighborhoods in inner-urban areas. The ecological benefits of less car-bound infrastructure are evident: less sealed surfaces, increased amounts of urban green spaces and a hydrological situation allowing decentralized water management.

3. Make use of planning instruments to actively strengthen green infrastructure and reduce surface sealing: As developers need to proof parking spaces for each new apartment in Germany, the number of parking spaces (underground or in the streets) and the amount of sealed surface grows. At the same time, canals are at their limits of coping with more water during massive rain events. Therefore we advocate for a stronger use of the redemption agreement for parking spaces (in German: *Stellplatzablöse*) to enable green and ecologically valuable housing projects.

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## **Carse of Stirling – an Ecosystem Approach Demonstration Project**

NEVILLE MAKAN

### *Scottish Natural Heritage*

The Carse of Stirling Ecosystem Approach Demonstration Project stemmed from a proposal in the Scottish Land Use Strategy (2011). The goal was to demonstrate how the ecosystem approach could be used in decisions made by public bodies, to deliver wider benefits and provide practical guidance.

Scottish Natural Heritage (SNH) led the project with support from the Scottish Environmental Protection Agency. The Carse of Stirling was chosen as the project's study area because it is a well-defined landscape of low-lying flat land with a mixture of land uses and of a large enough scale to apply this approach. SNH contracted two companies (Land Use Consultants and STAR Development Group) to provide technical support and act as facilitators.



Figure 1: The Carse of Stirling from Kippen, (image: *Lorne Gill/SNH*)

### **Involving people**

The facilitators invited interest from a range of local people to form a panel of around 35 people (farmers, foresters, and people involved in recreation and conservation, local businesses and rural development etc.). The panel members volunteered their time for five evening meetings over eight months. They were asked what they valued and how they benefited from the land in the area. Later, they considered how these benefits could be sustained through integrated land use and management across the landscape, given 'drivers of change' such as climate change. Based on this vision, the panel developed an action plan at the end of the process. Having the stakeholders lead the development of the plan created a sense of 'ownership' of it, which would help in driving motivation to implement it.

### **Valuing nature's services**

The panel used the 'ecosystem services framework' to aid recognition of a wide range of nature's services (or 'benefits') that could be valued from the land in the area (e.g., provisioning, regulating and cultural). No monetary valuation was used. As individuals they ranked and prioritised the services, and then the panel as a whole agreed their 'top five' benefits.

Prioritising a list of benefits enabled a more focussed and manageable process of agreeing land use and management actions to take forward. It could be argued that wildlife was also valued for its own sake, as panel members wished their 'iconic' species back into the landscape. Having the panel agree on their collective priority benefits (as opposed to individually) enabled a better appreciation of different perspectives amongst the panel members. This was useful whilst the panel deliberated on potential 'trade-offs' and synergies necessary to agree a way forward.

### **Understanding how nature works**

Ecologists and natural scientists talked to the panel about the current state of the natural environment in the study area, and how certain 'drivers of change' across the landscape might affect the panel's prioritised list of benefits. '3D visualisations' were produced to help the panel discuss various scenarios for the future. These visualisations provided broad (not location specific) indications on 'what might happen where' within the landscape if different benefits were prioritised. For instance, if woodlands were to be planted then where might they be best placed; and if land was able to store flood waters then what types of natural features might support this. Experts were on hand to answer questions about how the land supported the different benefits.

### **The ecosystem approach**

This project aimed to demonstrate an ecosystem approach, so in some sense it is unique in that regard. Despite some challenges and many lessons learnt (full report is available via SNH's website) the project was seen as a success overall by the panel members and project team. This view is supported by the creation of a new partnership motivated to deliver their action plan.

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# Urban agriculture as a city planning adaption measure to climate change

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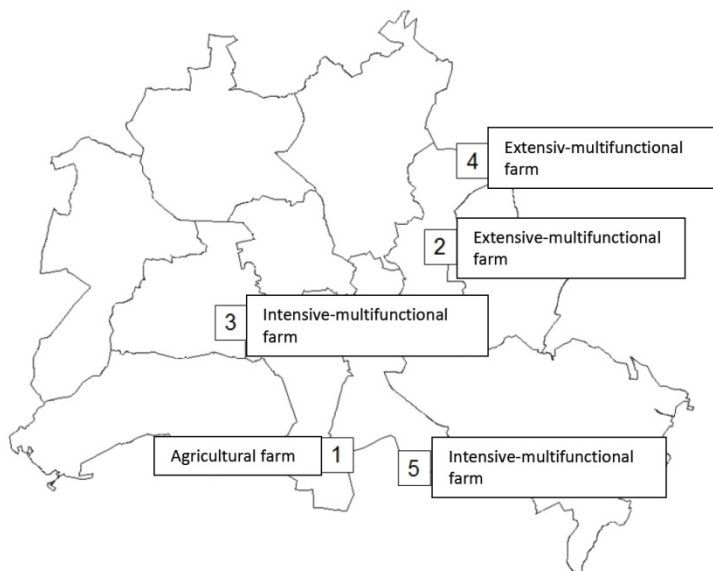
Urban agriculture is gaining importance in science and practice, in connection with actual urban challenges like climate change and increasing urbanization. Considering their manifold potentials with particular regard to climate issues, urban agriculture represents a significant city planning measure for urban areas. In a co-operation between the University of Potsdam and IASP Berlin the effect of urban farmland on city climate of Berlin was investigated (KÖHLER 2013). Aim of the study was to detect the effects of agricultural areas on the urban climate as well as the micro-climatic effects of agricultural areas compared to an asphalted area. Based on the results, recommendations for action can be deduced.

## Starting Point

Generally, agricultural areas are said to lower the temperature in urban areas but until now, only few data have been collected about this phenomenon (REUTER & KAPP 2012). Mainly intensive cold-air production is mentioned (BONGARDT 2006). After evaluation of Berlin's Environmental Atlas it can be confirmed that urban agriculture in Berlin causes high cold-air production. All agricultural areas are involved in the nocturnal cold-air production (SENATSV ERWALTUNG FÜR STADTENTWICKLUNG O.J.).

## Simulation of Berlin's agricultural areas

To understand the impact of urban agriculture on temperature and thermal comfort (PMV), compared to an asphalted area, simulations were performed with ENVI-Met. The selected



farms are located in the intra-urban and the peri-urban areas of Berlin (Figure 1). The reason are the different types of farming, which range from multifunctional agriculture in the inner city to more rural agriculture towards the outskirts. The climate impact of the agricultural areas may also be different. The simulations were performed on a day with potentially high thermal stress in mid of July. The duration of simulation was 24 hours.

Figure 1: Location of selected farms in the Berlin city area and related types of farming (KÖHLER 2013).

## Results

Compared to the temperature on the asphalted reference area, the agricultural areas were cooler at any hour of the day (Figure 2). The peak hour of temperature difference is at 14:00 hrs at the area with the highest green volume (Area 4). From 19:00 hrs, the area with the best aeration is the coldest (Area 2). Reasons for this are e.g., the grassland and the loose stock trees. Therefore the nocturnal radiation is undisrupted.

In conclusion, parameters for the cooling intensity can be found in the structure of the agricultural area and the intensity of green volume.

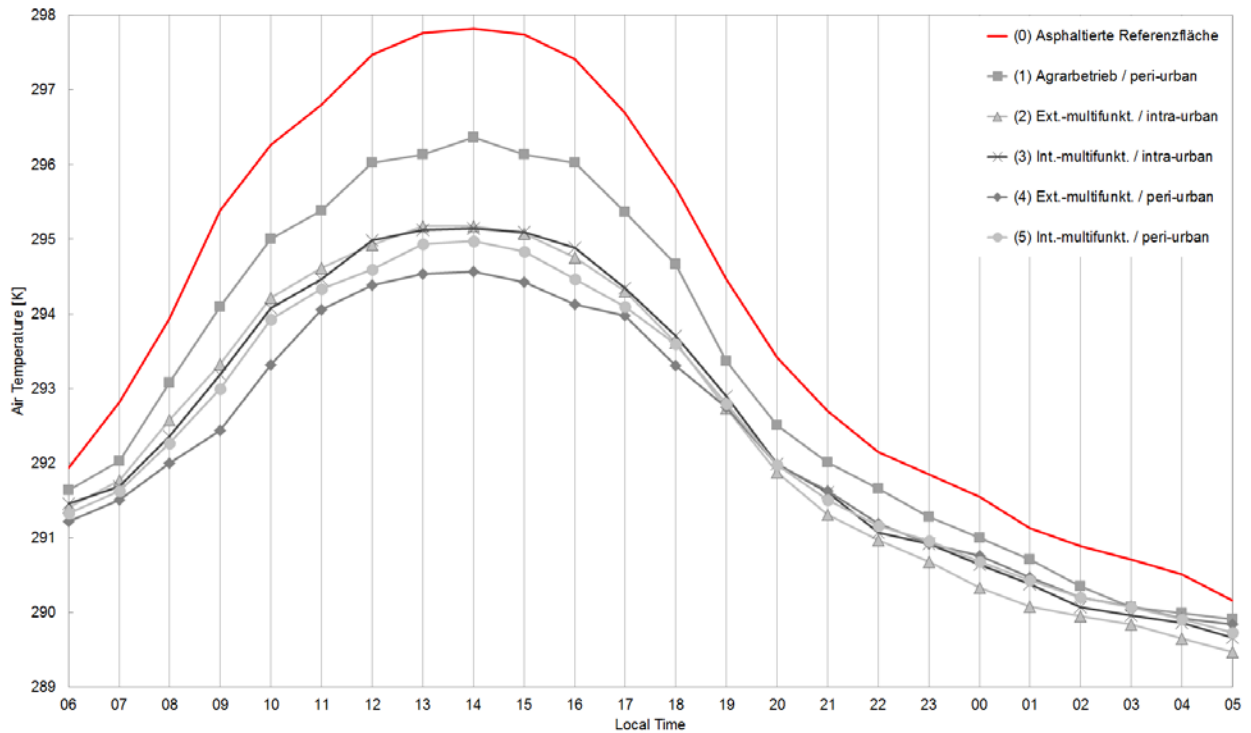


Figure 2: Modelling results - Air Temperature of asphalted reference area (0) and the study areas (1-5) at a hot summer's day (KÖHLER 2013).

At the area of Landschaftspark Herzberge (Area 2) also the thermal comfort level (PMV) at 14:00 hrs is mostly in the “comfortable” range (Figure 3 – left). Under the trees the stress is nearly equalized, the PMV is up from 0,3 to 0,6. On the asphalted area, a PMV of 2,5 to over 3 is reached (Figure 3 – right). It is hot and there is notable thermal stress for citizens.

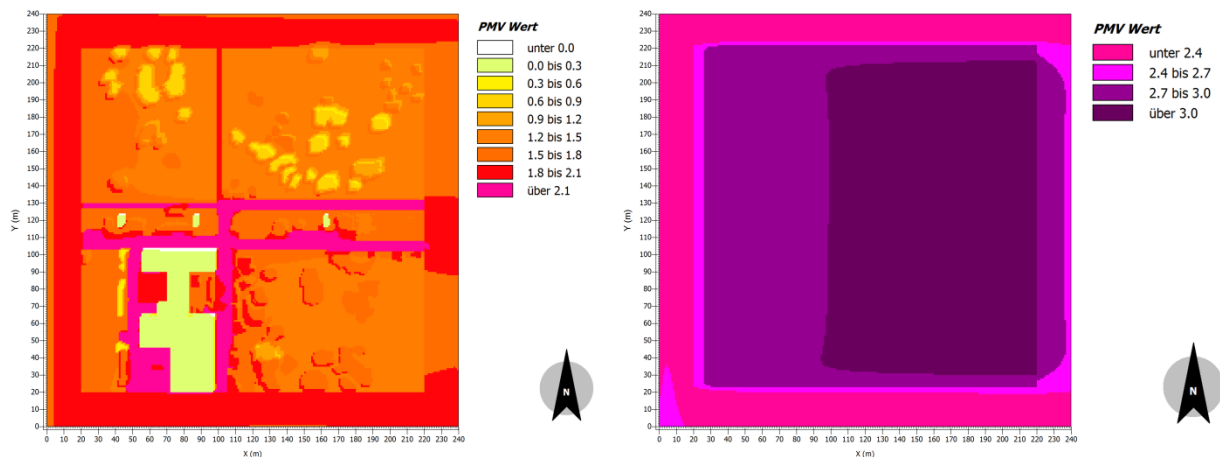


Figure 3: Modelling Result – PMV distribution of Landschaftspark Herzberge [Area 2] (left) and asphalted Area [Reference Area 0] (right) at 14:00 hrs on a hot summer's day (KÖHLER 2013).

The results confirm the importance of urban agriculture as a nature-based adaptation measure to climate change in cities. A key result is that the cooling effect is determined by occurring use (intensity of green volume) and structure (treetop cover and aeration). Therefore configuration of the agricultural area determines the climatic target effects.

Beside the climatic advantages, further positive effects are shown regarding biodiversity as well as sustainable use of urban farmland when agricultural land use is combined with secondary and tertiary sector activities.

Based on these results, recommendations are formulated to promote the integration of urban farming as adaptation and compensation measures in city planning.

### Recommendations for action

Until today, there has not been particular support for urban agriculture and unclear responsibilities in city planning departments are a contributing factor for this. One reason for the low priority of urban agriculture in today's cities are the low profit margins associated with this form of land use.

However, the challenge for the municipalities is to better integrate urban agriculture in planning and find solutions for implementation and maintenance, some of which are presented below.

In general, the barriers for urban agriculture should be reduced and the legal framework be adapted to the respective urban conditions. In planning, urban agriculture can be supported by integration in formal planning instruments (MATHEY et al. 2011). In the implementation phase, urban agriculture can be promoted by binding the lease of land to the condition of organic farming, like it is done in Hamburg or Munich. With participation of citizens and farmers, the costs for maintenance of the green and urban agricultural areas can be reduced (BOCK et al. 2013). A central organization office for urban agriculture should be established. This office should manage all aspects of urban agriculture and city food production.

Furthermore, it is important to identify good-practice examples and based on these, to develop guidelines for municipalities, urban planners and urban farmers.

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## **Nature-based spatial planning through the concept of ecosystem services in Lisbon Metropolitan Area**

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The concept of ecosystem services (ES) can help finding nature-based solutions (NBS) to the challenges that spatial planning has to address, like climate change or increasing urbanization. However, ES are still poorly integrated in spatial planning practice. Among the manifold reasons for such poor integration are insufficient knowledge, tools and data that help making explicit the ES supplied by a given territory, how they affect human well-being, how they are affected by planning decisions, as well as the trade-offs that usually spatial planning deals with.

This research presents a framework for ES integration in spatial planning, building on previous efforts to draw a profile on such integration focusing on Portugal (MASCARENHAS et al. 2014, 2015). The framework is tested in Lisbon Metropolitan Area (LMA), Portugal. Hosting over a fourth of the country's population, this region has been undergoing a suburbanization process and households have been growing at considerably higher rates than population. Highly urbanized areas co-exist with agricultural and forest areas, as well as areas designated for nature protection. Considering also that it is a southwestern European coastal region, climate change and urban-rural linkages are crucial aspects for spatial planning.

The framework for ES integration in spatial planning developed in this research covers critical issues such as the identification of priority ES, the assessment of effects of land-use and land cover (LULC) changes on ES provision under alternative scenarios, as well as stakeholder engagement. In its application in LMA, a participatory selection of priority ES and main drivers of change was done, through focus group meetings with the regional spatial planning authority, as well as a workshop with stakeholders from local authorities, the national environmental authority and academia (MASCARENHAS et al. 2016). Several priority ES identified, for example flood protection or climate regulation, can be regarded as NBS to tackle the planning challenges previously identified. The assessment of effects of main drivers of LULC change (like demographic changes) as well as of alternative spatial planning strategies (like urban sprawl vs. compact city) on ES is currently underway and can support a critical analysis of planning options, like the Metropolitan Ecological Network, a green infrastructure for the whole region. The application of the framework provides evidence on the challenges, opportunities and benefits of combining different methods and engaging stakeholders to support integration of ES in spatial planning.



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#### **4.10 Session VIII: Innovative nature-based solutions for cost-effectiveness and economic viability to enhance climate change mitigation and adaptation**

##### **Valuing the carbon sequestration and rainwater interception ecosystem services provided by Britain's urban trees**

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*University of Southampton, Forest Research*

Trees are a valuable asset to urban areas, providing numerous ecosystem services (ES) that are necessary for human well-being such as improved air and water quality, a reduction in stormwater runoff, improved thermal comfort, carbon sequestration and storage, and recreation opportunities, as well providing habitat for other species. To help decision-makers account for the benefits that urban trees provide to society, it is considered useful to quantify and potentially value these ES benefits. This can be carried out through a range of different methods, including i-Tree Eco, a software application developed by the USDA's Forest Service. i-Tree Eco provides a standardised method for surveying urban trees and quantifying various ecosystem service functions that they fulfil, which can then be valued.

i-Tree Eco surveys have been carried out in a number of British cities in recent years by Forest Research and Treeconomics, along with other partners. The purpose of this is to raise awareness of the structure and condition of Britain's urban trees, highlight their value to society and encouraging the creation or, where they already exist, refreshing of urban forest management strategies in support of the long-term health and resilience of trees in our urban environment.

Trees have been surveyed in randomly selected plots across several towns and cities in England, Wales and Scotland, including in Torbay (2010), Edinburgh (2011), Glasgow (2013), Wrexham (2013), Bridgend (2014), Swansea (2014) and London (2014). The following information was recorded within each plot: number of trees and shrubs, land use classes, percentage ground and tree cover, and plantable space. Recordings for individual trees included species, number of stems, diameter at breast height (dbh), total height, height to base of live crown, crown width, percentage crown die-back, crown light exposure and the position of the tree relative to the plot centre.

Data from the survey plots is scaled-up to the full survey area, and the provision of several ES is calculated, currently including rainfall interception, carbon storage and sequestration, and removal of air pollution. Modelling is carried out using the UFoRE (Urban Forest Effects) models available via the peer-reviewed literature. Reduction in energy usage by buildings was trialled in 2014, though its dependence on US data raises some concerns around its accuracy in the UK. From the quantified ES provision (e.g., mass of carbon stored, volume of rainfall intercepted) the value of the ES is calculated based on UK Social Damage Costs, the non-traded price of carbon, and the cost of avoided stormwater treatment. In addition, the asset value of the trees is calculated, based on the CTLA approach in i-Tree, and using the CAVAT approach of depreciated replacement cost plus amenity value.

Table 1: Ecosystem service data from the British i-Tree Eco projects

	ENGLAND		SCOTLAND		WALES		
	Torbay (2010)	London (2014)	Edinburgh (2011)	Glasgow (2013)	Wrexham (2013)	Bridgend (2014)	Swansea (2014)
Number of trees ('000s)	818	8,421	638	2,000	364	426	530
Urban tree cover (%)	12	14	17	15	17	12	16
Annual rainfall intercepted ('000 m <sup>3</sup> )	N/A	3,341	N/A	812	278	124	252
Annual avoided sewerage charges (£'000)	N/A	2,800	N/A	1,100	460	162	593
Annual carbon sequestered (tonnes, net)	3,320	77,200	4,721	8,000	1,329	2,079	3,000
Annual carbon sequestered (£'000)	173	4,790	485	2,040	24	457	660
Annual pollution removal (tonnes)	50	2,241	100	283	60	54	124
Annual pollution removal (£'000)	1,330	118,325	2,013	1,400	700	41	53
Total carbon storage ('000 tonnes)	98	2,367	146	183	66	54	102
Total carbon storage (£m)	5.1	147	14.9	20.1	7	11.8	22
Total replacement cost (£m)	280	6,120	382	4,600	900	142	234
Total asset value (£m)	N/A	43,300	N/A	4,000	1,400	686	816

The studied areas perform quite differently for certain services depending on the number, age, size, health and particular species of their trees. For example Wrexham's trees intercept proportionately more rainfall (saving almost £0.5m in sewerage charges each year) whilst carbon storage and sequestration is proportionately higher in London and Edinburgh (London's trees sequester £4.9m of carbon each year). This ongoing research clearly demonstrates the value of urban trees for mitigating and adapting to climate change and has the potential to greatly improve the economic viability of tree planting in Britain.

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## Mind the limits... to the cost-effectiveness of nature-based solutions

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Apart from working on the different dimensions of the value of urban ecosystems, I am also interested in birds, and especially their social and economic context. Looking for information on 'the value of birds', I came across a report from over 100 years ago. To my surprise, I soon discovered that this was not an isolated exception, but one of over 1000 publications that represented economic ornithology, a field that shared many similarities with our current discourse on nature-based solutions (KRONENBERG 2014).

In line with what we call today nature-based solutions, economic ornithologists suggested that "Economically considered, birds are simply natural forces, and it should be our purpose to ascertain how they may be turned to our greatest advantage" (BEAL 1900: 304). Economic ornithology was defined as "the study of birds from the standpoint of dollars and cents" (PALMER, 1900: 259), and it focused on monetary valuation of the birds' services to human society. One service was of particular emphasis – pest control – which demonstrated the usefulness of birds in agriculture. Using economic arguments to support bird conservation was seen as a political necessity when many other political discussions related to economics.

Strangely enough there has been no connection between past research on economic ornithology and our modern discussions on nature-based solutions which seem to be motivated exactly by the same reasons. Economic ornithology arose in the 19<sup>th</sup> century, its golden age was between 1870 and 1920, and it then disappeared and fell into oblivion (Figure 1).

The focus of economic ornithologists was on cost-effectiveness of the birds' pest control services and this won economic ornithology a prominent standing in many countries. Agriculture was relatively more important in economic and social terms than it is today, and economic reasoning based on the avoided damage cost method (how much damage could have been prevented had birds been in place to control pest populations) was seen as a convincing argument to support bird conservation. It paid to protect birds and to rely on them for pest control.

Today, the discourse on nature-based solutions reveals a similar overarching focus on their supposed cost-effectiveness compared to 'traditional' solutions, as reflected in a basic review of definitions used by the key players:

- "These, nature-based, solutions provide sustainable, cost-effective, multi-purpose and flexible alternatives for various objectives" (European Commission);
- "A nature-based solution is a solution that... is *cost effective relative to other solutions*" (IUCN);
- "Nature-based approaches are often more cost-effective in the long term than purely technical approaches" (Ecologic Institute);
- "... management of urban ecosystems offers sustainable and *cost-effective solutions* to climate change mitigation and adaptation" (ECBCC 2015 conference website).

In this way, the modern discourse neglects the important warning that can be drawn from the history of economic ornithology. The main reason for the decline of economic ornithology

was that an alternative solution proved much more cost-effective and reliable in eliminating pests – industrial pesticides. Economic ornithologists bet against human ingenuity and lost (KRONENBERG 2015). Ignorance of the negative external effects of using pesticides made it impossible to take them into account.

The case of economic ornithology reveals problems with how we promote nature-based solutions. The main lessons we should draw from it are that we need to:

- avoid reductionism (never emphasise individual services);
- pay more attention to a holistic view, externalities, co-benefits (and acknowledge that we may not be able to predict the externalities of new solutions that may seem much more cost-effective than the nature-based solutions we promote);
- use economic arguments to a far smaller extent and instead promote broader political

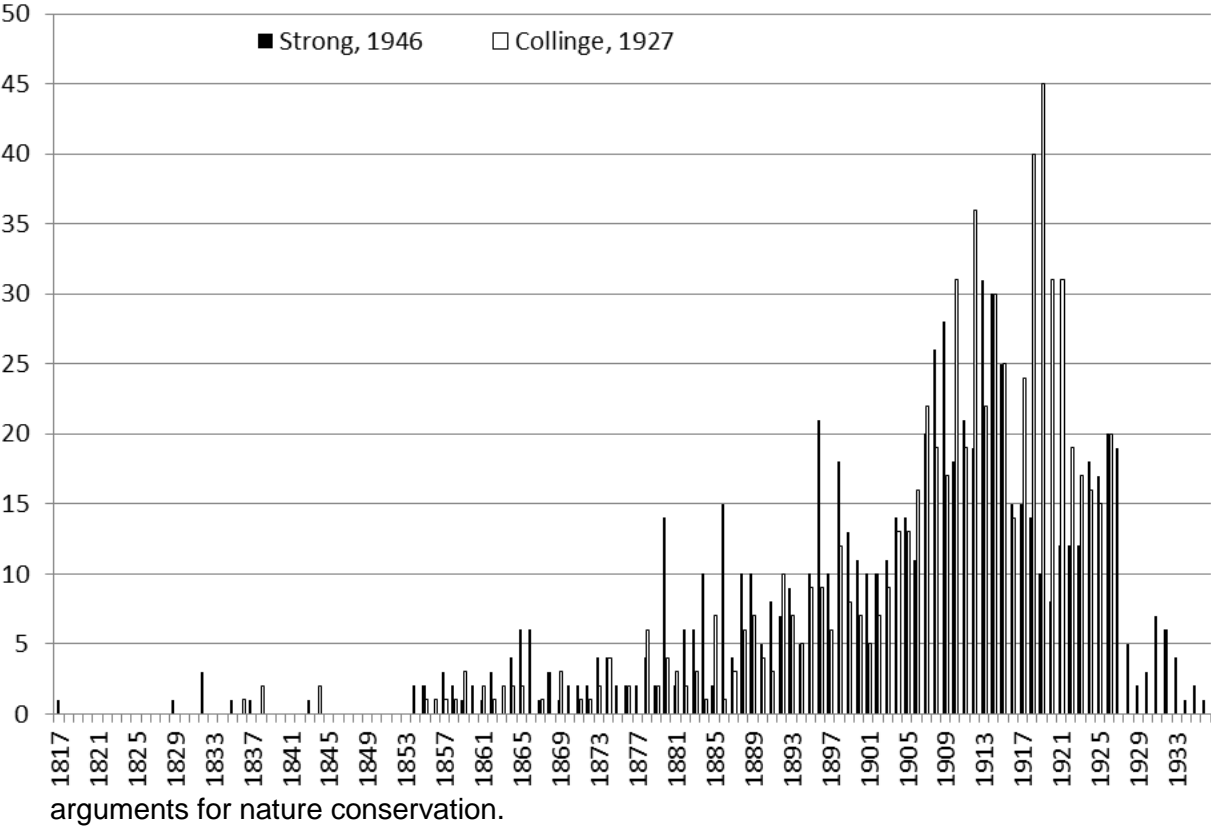


Figure 1: Number of publications on economic ornithology per year based on two most comprehensive literature lists (KRONENBERG 2014)

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## 5 Abstracts of poster presentations

### Implementing urban green infrastructure for local climate regulation: What is actually needed?

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Local actions in climate change adaptation are strongly needed for reducing the impacts of climate change on urban areas. Urban green infrastructure can contribute to adapting cities by providing regulating ecosystem services such as reducing air temperatures. In municipal planning consequently policies and activities for so-called nature-based solutions (NBS) to local climate adaption are fostered. Nevertheless, it remains unclear to what extent and with what type of measures municipalities should implement NBS as green infrastructure to reduce the adverse effects of climate change. Against this background, this study has the objective to increase knowledge on the regulating effects of different green infrastructure settings under current climate and a future climate change scenario.

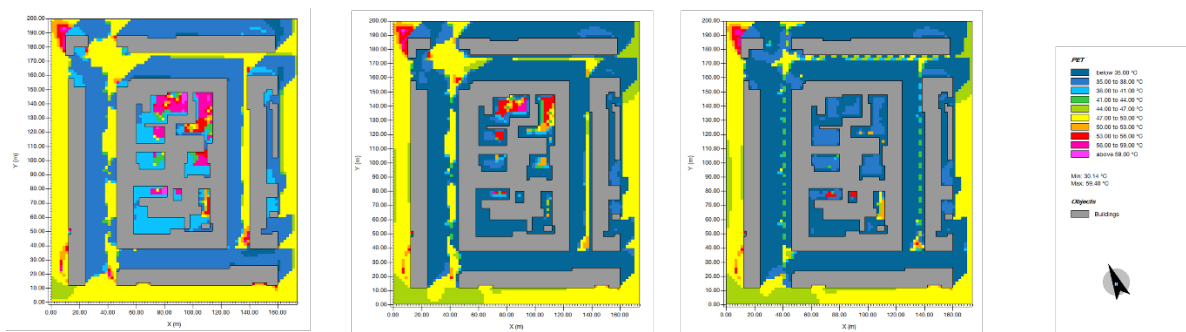


Figure 1: Maximum greening scenarios for roof greening (left), façade greening (centre) and tree plantings (right) in the case area: PET at 3 pm in 1.4 m height on a typical tropical day (Source: Teresa Zölch)

Based on a scenario modelling approach with the microclimate model ENVI-met V4, the regulating potentials of green roofs, green facades and tree plantings are assessed for varying shares of green volume as well as current and future climate conditions. The case study is located in central Munich, Germany, representing a typical urban fabric of perimeter blocks, which can be found in both German and European cities. The results show that the greening interventions have different effects on reducing outdoor thermal comfort (expressed by the PET index): tree plantings can reduce the average afternoon PET of a tropical day up to 5 K, façade greening up to 4 K. Only green roofs show almost no effect at pedestrian level (1.4 m height).

Further scenarios of varying green volume and compositions will be modelled in the next step both under current and future climate change conditions. The importance of green infrastructure location and quality will be assessed by analysing the regulating functions of vegetation (shadowing and evapotranspiration). Following from this, a guideline for urban planners is developed to choose the most effective combination of green infrastructures suitable for their respective situation.



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## A grassroots approach to climate change adaptation: The Dillingen model of stakeholder designed green spaces

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Figure 1: Xeriscaping in Wildlife gardens and Nature Experience Areas combines a low maintenance level with high biodiversity and several aspects of Adaption to Climate Change (Image U. Aufderheide).

### What is a "Wildlife Garden": Technical characteristics

Wildlife gardeners aim to create green spaces enhancing biodiversity in settled areas by using native plants and non-sealing construction techniques. A lot of projects especially at schools or kindergartens start with de-sealing the concrete ground of playground areas. Xeriscaping has been developed and is preferred because it combines a low maintenance level with high biodiversity, e.g., dry walls, flower beds on gravel or green roofs.

### Why do we do it

Designing green spaces in this way has been shown to contribute to adaptation to climate change. Surrounding temperature is decreased by increased evaporation of de-sealed areas, half-open and meadow-like vegetation. Flooding is reduced by using rainwater for design and nature experience.

### **How we do it successfully: Stakeholder participation**

The Dillingen Model has been developed based on the moderation technique „Zukunftswerkstatt“ by Robert Jungk: Stakeholders themselves change and create their living conditions in a self-determined way. The first step is non-verbal: participants build miniature garden-models in a box. Since language abilities are not important, the whole process avoids hierarchies.

The process is inclusive: participants from age 3 to 99, from different cultural backgrounds, with and without disabilities can participate. The entire process focusses on creativity, fun and doing instead of speaking, which makes the planning-process very time-efficient.

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# Willow softwood floodplain forests near deltaic cities: Adaptive response to climate change via managed woody vegetation

HEIKE MARKUS-MICHALCZYK

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## Introducing willows for sustainable use near deltaic cities

Willows have been associated with humankind since antiquity as a consequence of both preferring floodplain habitats. An interest in willow genetic resources and environmental applications (e.g., bank stabilization and phytoremediation) as well as utilization (e.g., biomass production for renewable energy) is increasing worldwide (ISEBRANDS et al. 2014). Although scientific *Salix* collections are existing, softwood floodplain forests are fragmented, assessing local willow phenotypes is requiring efforts, and conservation has to be implemented (EU Habitats Directive). In parallel, willows provide multiple benefits: bank stabilization in riverine habitats and wetland trees were found as most efficient for carbon sequestration at city fringes. Based on functional traits (e.g., flexibility, ability to establish on bare ground and self-repairing capacity), willows may contribute to coastal defense near deltaic cities.



Figure 1 Willow softwood floodplain forest near Hamburg (Image Markus-Michalczyk)

## Effects of climate change with increasing tidal flooding and salinity on willows

Characteristic mature white willow and basket willow in the tidal wetlands of the river Elbe in the Metropolitan region Hamburg (Germany) were recorded, soil water salinity at willow stands and elevation of *Salix* specimen was measured, and salinity and tidal flooding tolerance was tested experimentally on juvenile specimen. Results indicate a tolerance of willows up to oligohaline conditions (MARKUS-MICHALCZYK et al. 2014) and at least up to 60 cm tidal flooding (MARKUS-MICHALCZYK et al. 2015), predicted in moderate climate change scenarios, suggesting a general applicability of willows in tidal wetlands.

## Application of willows for shoreline protection

Autochthonous willows were used for estuarine shoreline protection at the Elbe floodplains near Hamburg and applied by the Waterways and Shipping Administration. However, after storm surge events, spatial differences in the status of the measure were observed: from vibrant growth to total loss of the plantation. Before willows should be systematically implemented, research on the interaction of currents and waves with willow applications in tidal wetlands is needed.



Figure 2 Application of willows for shoreline protection (Image Markus-Michalczyk)

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## Planning for green infrastructure in cities with the “Nature Value Explorer for Cities” Tool: Comparing scenarios

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Nature-based solutions can assist urban planners in addressing the challenges of today: health and well-being, biodiversity, climate change, air quality.... It is however not straightforward where to develop and preserve which type of green to establish solutions for several problems simultaneously. The online Nature Value Explorer tool ([www.natuurwaardeverkenner.be](http://www.natuurwaardeverkenner.be)) was originally developed to value the impact of nature development projects on ecosystem services, but is currently being extended with an urban version. Its aim is to support local authorities in providing the right green on the right place in urban environments, paying attention to the quality and the functions of the green infrastructure and the trade-offs between different ecosystem services and biodiversity. City planners can also estimate the effects of the existing and planned green infrastructure on reaching different sustainability goals. The rural version of the tool estimates the value for different provisioning, regulating and cultural services. The urban version uses a specific typology of urban green and other valuation methods specifically suitable for urban environments. Ecosystem services which can be valued include urban farming, air quality, urban heat island remediation, carbon sequestration, water retention and infiltration, and health and well-being.

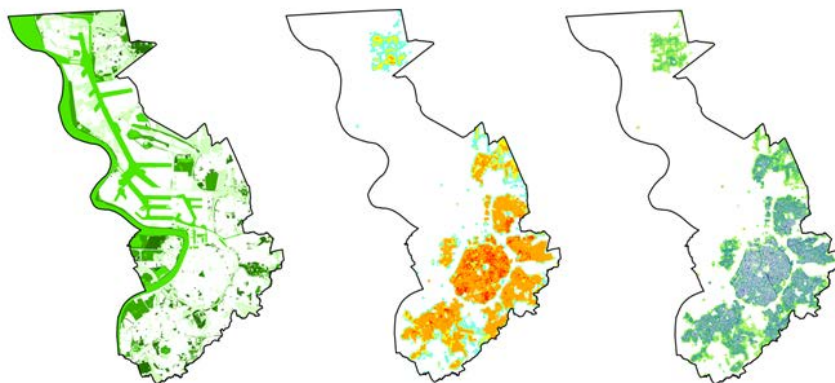


Figure 1: Example for heat stress in the city of Antwerp: mapping supply, demand and remediation potential of broad-leaved trees (© VITO).

### Functional green tool

The generic tool has been customized for the city of Antwerp. The aim is to assist the city government in planning the right type of green on the right place, by spatially analysing the existing green; the demand for green, depending on population density and local pressure points (poor air quality, noise nuisance, heat stress, lack of green space for recreation...); and the potential impact of different greening measures in reducing the pressure points.

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## **Incorporating consideration of ecosystem services into municipal planning: The case of Malmö, Sweden**

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### **Background**

In Sweden, national, regional and some municipal governments (e.g., Malmö) state that by 2018 consideration of ecosystem services (ES) shall be included in planning and decision-making. In the City of Malmö, Sweden, this has sparked an initiative by officials at the Planning office to investigate if and how consideration of ES can be integrated into the current planning process and its legal framework. Acknowledging the complexity of the ES concept and municipal planning, the project investigates the planning process from several angles: i) The legal framework surrounding local plans is studied together with seven other municipalities and The National Board of Housing, Building and Planning. ii) The link between the Green infrastructure Plan (GP) and local plans is investigated during the process of renewing the GP 2015-2016. iii) Investigation of how a GIS-based tool may be used to visualize ES-values and to bridge the gap between levels in the planning process. iv) Combining the efforts to integrate ES in the planning process with those to increase equity and public health via cooperation with the local WHO Healthy Cities network. v) Increasing the understanding of the planning and administrative system through a system analysis of factors influencing municipal planning, Figure 1.

### **Preliminary results**

In Sweden today only some biological and physical elements connected to ES can be governed within local plans, e.g. protection of trees and biotopes of conservation value, and the percentage of surface that may be sealed. Officials request tools to include (legally binding) requirements for functions in local plans, e.g., trees for shade and improved air quality, or vegetation to reduce risk of erosion. It is evident that Swedish municipalities work with ES in local plans in very different ways. National or regional mainstreaming is therefore requested, together with guidelines on which data related to ES plans should/could be based on.



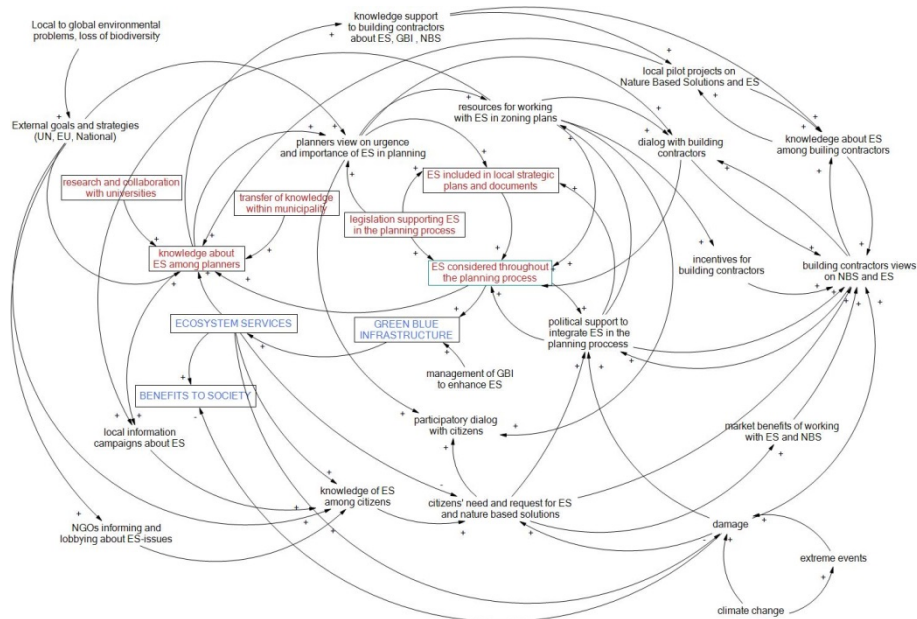


Figure1: Systems thinking and group modelling. Three workshops were carried out with 8-12 participants from across the municipal administration. The aim was to increase the understanding of the planning and administrative system and its possibilities to enhance or safeguard ES. The group modelling was led by D. Koça and S. Belyazid (CEC, Lund University). The figure shows a sketch of the resulting system. Blue text: The over-arching focus area of the project. Red text: Elements that the current project has dealt with (credit Anna Sofie Persson).

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## Urban Green – Fit For Future

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Nature-based solutions for climate change adaptation are based on various well-studied aspects, such as mitigation of the urban heat island effect by plants, improvement of infiltration by vegetation in extreme rainfall and improvement of air quality by urban green. Nevertheless, Urban Green is still low priority in urban planning and decision-making. Green spaces which do not harbour protected species fall victim to supposed economical necessities. Political focus is directed to traffic infrastructure, new housing districts and industrial estates. In spite of many projects and various private initiatives, natural buffer capacities for variation in temperature and precipitation are further reduced where it would be urgent to improve them greatly, facing climate change.

### A Toolbox Strategy for Climate Adaptation

The research project “Urban Green – Fit For Future” (funded by the German Federal Environmental Foundation), started in June 2015, aims to develop green-based climate adaptation modules for municipalities in Baden-Württemberg. Modules will be designed to overcome specifically identified inhibition thresholds. Key points are good size and structure of modules, optimizing efficacy, effort and visible benefit. Suitable protagonists must be found to implement and to maintain them, including participation of residents. Where possible existing structures should be used. Transfer and interconnection of knowledge are crucial in the implementation process. A feedback system will be designed to optimize modules and their interaction in the long run. Module descriptions will be stored in a Wiki to optimize accessibility and adaptability. Biodiversity is an essential component in our concept, as it provides natural adaptation potential. Moreover, it offers ample scope for design, enabling implementation of modules over time and space by addressing different preferences and requirements.

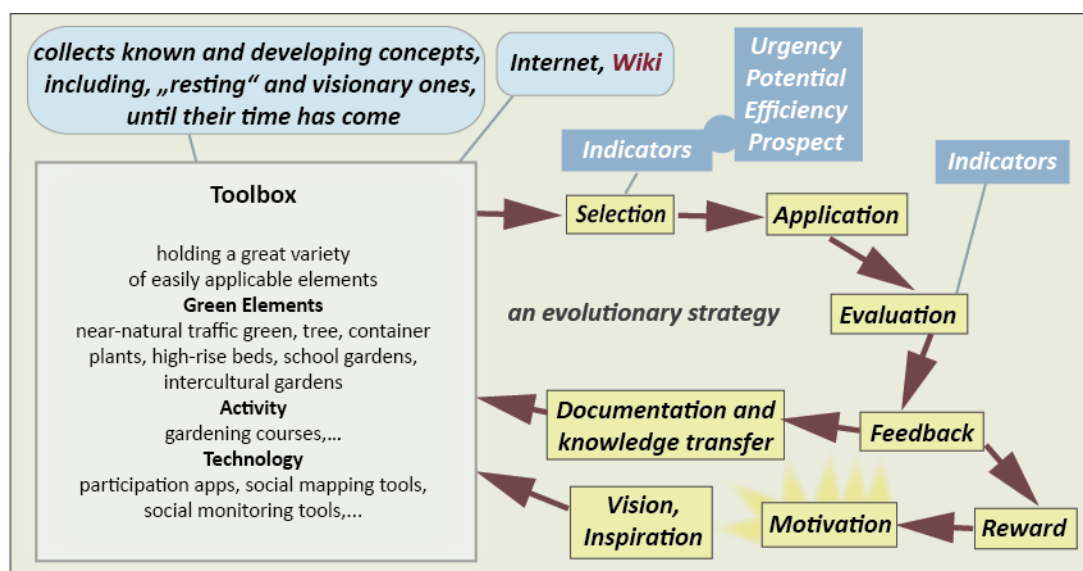


Figure 1: Toolbox strategy for green-based climate change adaptation (source Anja Kries, based on Franzeskaki et al. and J. Croft).

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# Social-ecological Perspective in Biodiversity Research – A Framework of a Transdisciplinary Research Process

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The process of urbanization is both nested in society and at the same time depending and impacting on the natural environment. Thus, urbanization can be conceived as a social-ecological process within a social-ecological system (SES) (see Fig. 1). In this context, urban biodiversity takes a special position. On the one hand, urban biodiversity is directly influenced by societal processes (e.g., politically via regulation of green spaces and culturally via recreational use). On the other hand, it also influences societal processes via contributing to the delivery of ecosystem services (e.g., food production in urban gardening), but also dis-services (e.g., spread of allergens).

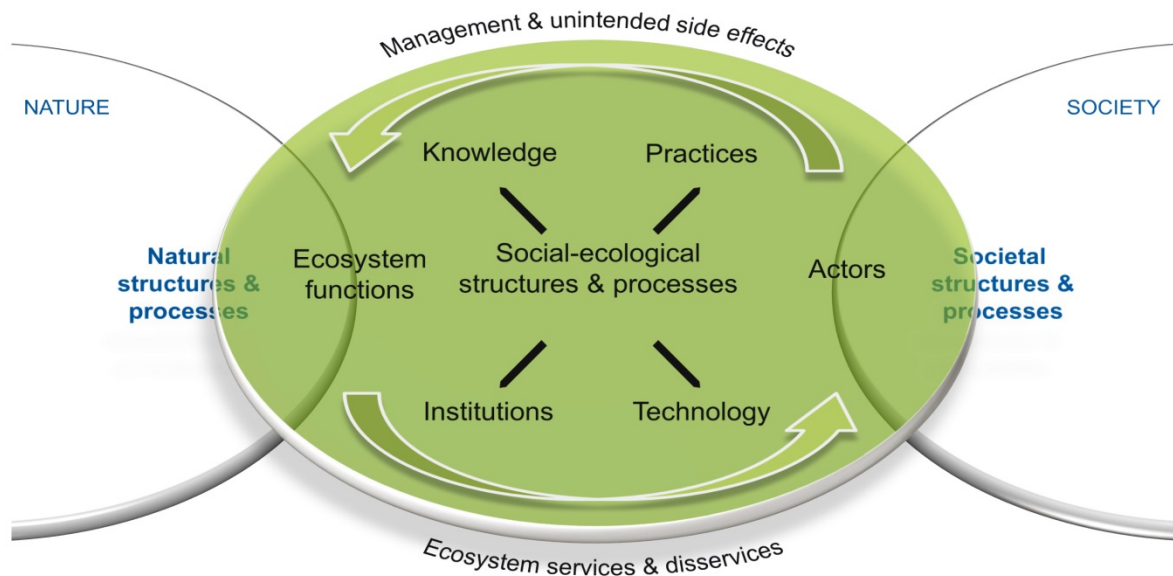


Figure 1: The concept of social-ecological systems (HUMMEL et al. 2011, modified).

## The role of trans-disciplinarity

In the field of sustainable urbanization the claim for evidence-based political decision making is high, while at the same time there is a great deal of uncertainty, ignorance and contested knowledge. Trans-disciplinarity, as a critical and self-reflexive research approach relating societal with scientific knowledge contributes to approach this aspect in terms of producing new knowledge by integrating different scientific and extra-scientific insights (JAHN et al. 2012). Trans-disciplinary research is conducted at the interface of society and science. SES represents one way to conceptualise this modus; they constitute an abstraction of the nature-society-relationships.

## Implications for biodiversity research

However, this transdisciplinary approach is hardly implemented in biodiversity research yet (MEHRING et al. 2012). Thus, a decisive turn in biodiversity research is needed that covers the hybrid notions of biodiversity between science, politics, and society. We argue that transdisciplinary research is

1. *important* to address the lack of action as acknowledged e.g., by the CBD COP 12 in Pyeongchang, Republic of Korea;
2. *critical* as there is an increasing consensus that new ways of knowledge production are necessary;
3. *obligatory* in order to bridge science, politics, and society.

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## **Agricultural cooperative “Co.R.Ag.Gio.”, an example of urban agriculture in Rome (Italy) as a resilient strategy against urban climate change**

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In urban contexts, cultivated agricultural land increases permeability, improves positive atmospheric exchanges, protects the complexity of agricultural ecosystem and helps general resilience to urban climate changes. We present an example of good practice of urban agricultural activity in Rome. It is the Italian case study of the EU-FP7 funded project “GLAMURS - Green Lifestyles, alternative models and upscaling regional sustainability” ([www.glamurs.eu](http://www.glamurs.eu)). GLAMURS investigates transitions to sustainable lifestyles and green economy, through an interdisciplinary approach in seven different regions of Europe.

The cooperative "Co.R.Ag.Gio" (“Courage”), COoperativa Romana AGRicoltura GIOvani (Roman Agricultural Cooperative of Youth) was founded in 2011, as a free association of young people (farmers, agronomists, chefs, architects, day workers, industrial workers, anthropologists, educators) with the aim to encourage citizens and institutions to conserve environmental heritages abandoned in the Roman agricultural outskirts.

### **Objectives**

CoRAgGio’s objective was to obtain the concession of the public land of Borghetto San Carlo in the northern urban area of Rome, which had been abandoned for 100 years (see Figure 1) in order to create:

- a public multifunctional farm, to produce organic food and services not present in the current Rome metropolitan context (see Figure2)
- agricultural parks on public lands (instead of shopping centres): productive, accessible to the citizenry, supporting maintenance and care of urban green, and fostering environmental education
- transparent and participatory management of public lands
- awareness of the side benefits of agriculture
- support for training and experimentation in agriculture
- entry point for citizen participation
- organisation of workshops for training young people and improving agricultural and ecological awareness
- freedom to work and earn whilst guaranteeing services to the city, to return a public good to the community, the city and the “Agro Romano” territory
- These objectives serve social, economic, and environmental purposes.



Figure 1: Borghetto San Carlo – work in progress (credit Giacomo Lepri, source: CoRAgGio: <https://www.facebook.com/CoopCoraggio>).



Figure 2: Borghetto San Carlo ready to the seeding after 100 years of abandonment (credit Giacomo Lepri, source: CoRAgGio: <https://www.facebook.com/CoopCoraggio>)

## Activities

CoRAgGio carries out concrete contributions to different sectors:

- Urban agriculture and horticulture: realization, consulting, and projects;
- Education: didactic farms, workshops on agricultural jobs;
- Food: cooking services and catering, dissemination of good practices, spread of local and organic food production (Km 0);
- Handicraft and housing: mud building techniques (raw earth).

## Strategies

In the last years CoRAgGio created a dense social network with other similar associations and social initiatives in the communities in which they operate. Such a network (Figure 3) of reciprocal support and information flow, interpersonal relationship and common social activities proves that a dense network of small groups and initiatives is the key for the transition to sustainable lifestyle goals and to drive actual social changes. As claimed in Minority Influence theory (e.g., CRANO 2012), social changes can spread from small group towards the society.

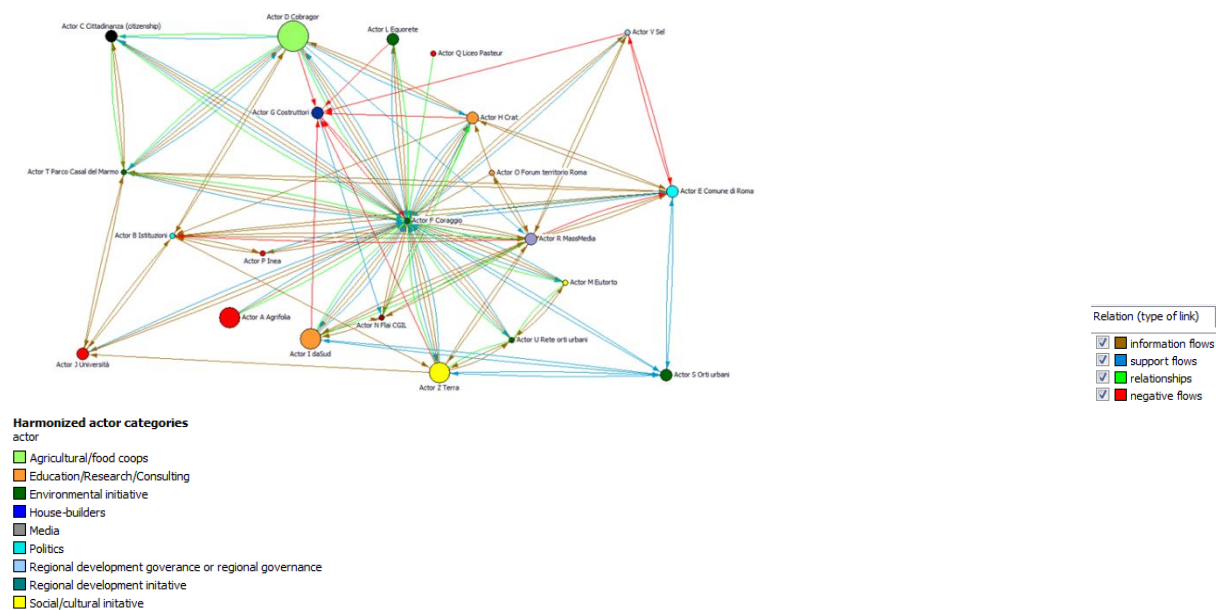


Figure 3: Netmap of actors influencing CoRAgGio (credit Fridanna Maricchiolo, source: [http://glamurs.eu/wp-content/uploads/2016/12/BS\\_Italy\\_version\\_final.pdf](http://glamurs.eu/wp-content/uploads/2016/12/BS_Italy_version_final.pdf)).

## Ecological benefits

The benefits of the project are to make public land available to all citizens, and preserve agricultural soils from the expansion of the concrete. The urban cooperative farming promotes an agricultural urban model that is healthy, organic, multi-functional, replacing the degraded concrete buildings with a proposal of a new way of living, based on ecological concerns, respecting labour dignity, and social meanings of agriculture. Promoting sustainable urban agriculture is a social and environmental benefit in terms of economic values, ecological ser-



vices and food production, improvement of the quality of life, soil protection, protection of earth resources, and biodiversity conservation.

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The research leading to these results has received funding from the European Union FP7 - SSH.2013.2.1-1 - grant agreement n° 613420

# Towards a multidisciplinary evaluation of ecosystem services for urban greens and their structural elements

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Urban green spaces have been shown to fulfil a variety of ecosystem services (ES) and functions in cities. With increasing amount of urban residents worldwide, it becomes more and more important that green spaces provide these requirements as optimally as possible. In this context, we presented a tool for the multi-disciplinary assessment of ES which are provided by a respective green space.

As a first step, we generated a structure type classification system to define structural elements in urban greens and evaluated each element from an ecological, climatological and social perspective. A multi-criterial catalogue of seventeen different ecosystem functions, such as pollination, immission reduction, CO<sub>2</sub>-fixation, cooling air or perceived beauty of the respective structural elements was identified. The ecosystem functions of each element were valued by an expert-based rating on a standardized ordinal scale. By defining ranges instead of single values for each function and structural element, we are taking into account the heterogeneity of structure types and thereby the probability that a structure type provides the respected ES to a certain extent. This enables analyses of variance and uncertainties in the evaluation of green areas ( $\hat{=}$  Analysis of sensitivity).

First results of the structure type classification and of the ES-assessment for six different urban green spaces in the city of Aachen, Germany, showed that the approach can be used to compare parks on an ES-level. Thereby, changes in the provision of ES by modifying the structural composition of a park can be detected. Results can be considered in planning strategies of green spaces.

Next, ES-distributions and correlations between ES will be implemented into a bayesian network (figure 1). As a result, trade-offs and synergies between ES can be considered. The ES-distributions, based on the heterogeneity of structural elements, will be adjusted and updated by empirical data (previously performed: Studies on the pollination potential, plant diversity, acceptance, air filter function, influence on climate conditions).

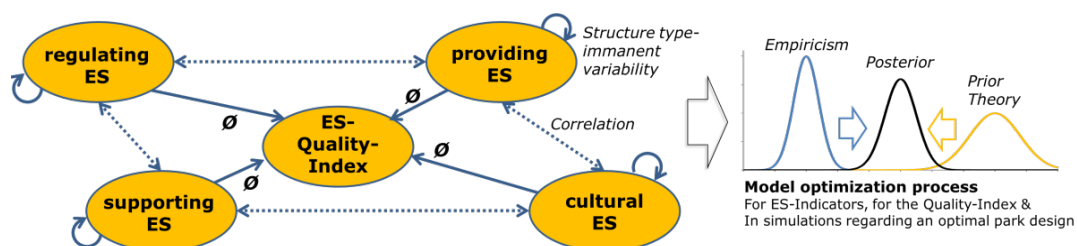


Figure 1: Bayesian network to assess the ES of urban green spaces (credit: Benjamin Daniels)

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## **Incorporating green infrastructure into urban realities – potentials of urban brownfields**

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### **Brownfields in urban development**

There is a broad evidence base regarding the manifold services of elements of urban green infrastructure to tackle current challenges of urban development, as climate change, environmental justice and biodiversity loss. Following, there is a strong political and societal call for incorporating green infrastructure into urban realities. But, obviously there are manifold barriers to implement the demands in urban development, ranging from transfer gaps from science to practice, inappropriateness of existing planning procedures and instruments to limited financial resources and conflicting needs of urban development and land use conflicts.

Within this context it is questionable, if green infrastructure can be realized only by following the common green space development models. Facing changed demands, limited public finances, and limited urban space, new and unusual types of green spaces might supplement traditional elements of urban green infrastructure, as parks, playgrounds etc. In densely built up cities, often brownfields are the only areas where new green spaces can be created. Besides, existing green urban brownfields can provide a number of ecosystem services, such as preventing the loss of biodiversity, adapting to climate change and fostering recreational and healthy urban environments (MATHEY et al. 2015).

### **Ecosystem services of green urban brownfields**

Unsealed or “green” brownfields undergo a process of ecological succession; specific stages can be distinguished. Particularly brownfields with various stages are associated with a range of habitat, regulative and socio-cultural services. **Habitat services:** In order to estimate their habitat services, different biodiversity parameters can be described, which are: structural diversity, habitat characteristics for plants and animals as well as regenerative potentials. **Recreational services:** Analysis of the use of green urban brownfields showed a wide variety of actions underpinning their recreation potential. Nevertheless, traditional notions of urban greenery (parks etc.) were most popular. Sites with spontaneous vegetation are rarely liked (BANSE & MATHEY 2013). **Microclimate regulation services:** The results of microclimate modelling indicate that both, several urban green spaces and green urban brownfields have potentials to regulate the local temperature. The average cooling effect of green brownfields of size 1 ha amounts around 1.5 K referred to an asphalt covered site and is comparable to the effects of common green sites (LEHMAN et al. 2014).

### **Implementation**

To support the preservation of green urban brownfields innovative green space types can be applied to retain and increase their ecosystem services as well as addressing land use conflicts, shifting requirements and decreasing budgets. Based on findings regarding microclimate regulation services, recreational potential and biodiversity benefits, various options had been evaluated according to their potentials to address the named challenges (Fig. 1).

Options for Green Spaces on Brownfields	Urban Agriculture 	Urban Woodland 	Gardens 	Sports/Leisure Pursuits 	Venue for Public Events 	Low Intervention Parks 	Nature Experience Areas 	Urban Wilderness 
Habitat Services	+/-	+ / ++	+/-	+/-	-	++	++	++
Micro-Climatic Regulation Services	+ / ++	++	++	+	+	++	++	+ / ++
Recreational Services	+/-	+ / ++	++	++	+	+ / ++	++	+/-

Figure 1: Options for reusing brownfields as green space and qualitative evaluation of their potentials to provide habitat services, micro-climatic regulation services and recreational services: ++ “well suited”, + “suited”, - “unsuited”, +/- “detailed investigation of individual site necessary” (Source: figure compiled by authors. Pictures: column 1: G. Arlt, columns 2-8: S. Rößler).

## Perspective

In view of the existing potential of these last remaining undeveloped sites in the urban landscape, brownfields should not be subject to excessive planning. Instead, urban planners should aim for a flexible exploitation of brownfields in order to offer room to manoeuvre in order to react to future development challenges.

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# **Vertical greening of buildings as a measure for urban climate change adaptation. A socio-geographical study on the actor network in Oststadt district in Karlsruhe/Germany**

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## **Background**

The study has been conducted in the framework of the transdisciplinary research project „Quartier Zukunft – Labor Stadt“, coordinated by the ITAS. The project aims at contributing to a sustainable transition of the Oststadt district with a bottom-up approach. In a civil forum dwellers identified the topic of façade greening as nature-based solution for sustainable urban development. But is façade greening a suitable measure for the Oststadt district?

## **Methods**

Ecological potentials as well as the perception of façade greening are discussed based on literature and own empirical data. Eight qualitative guideline interviews have been conducted to capture different perspectives on the topic. The research design was inspired by *grounded theory*. Relevant actors and networks have been identified:

- Citizen urban greening initiatives
- Municipal authorities
- Member of professional building greenery association (FBB e.V.)
- Property manager
- Dwellers

The actors' motives, objectives and strategies as well as conflicts of interest and negotiation processes have been analysed with Reuber's theoretical concept of *subjective constructions of space*.

## **Key findings and recommendations**

All interview partners pursue the common aim of increasing urban green. However, the actors' individual motivations differ among social, aesthetic or ecological aspects. Only some identified climate protection as key motivation for their engagement.

In this local context inner courtyards are of particular relevance regarding further increase of urban green. Main implementation problems of the local façade greening initiative are insufficient communication and coordination as well as a lack of practical knowledge and information. To increase urban green in order to adapt to climate change in the Oststadt district workable low-tech solutions are needed and organisational structures must be improved.

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## Integrating nature-based solutions in urban planning: examples from five case studies

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Figure 1: River restoration action in Avenida Gasteiz (Vitoria-Gasteiz). Photo by Beñat Abajo. Tecnalia Research & Innovation.

Nature-based solutions (NBS) open opportunities for a 'pro-active' approach to the planning and management of green infrastructure in urban areas, with a focus on solutions to societal needs. However, application of the framework to guide the identification of 'solutions' is still incipient. Critical questions relate to, for instance, the levels of nature-based considerations that are sufficient to achieve quality solutions, and the link of NBS to multiple benefits provided by nature and to the multi-level character of ecological systems' structure and function. In urban areas it is also important to identify those challenges or problems that NBS can address effectively.

In the five urban case studies of OpenNESS project (Operationalization of Natural Capital and Ecosystem Services), various NBS have been adopted:

- VITORIA-GAZTEIZ, Spain: managing urban surface water flows with green infrastructure.
- OSLO, Norway: removing soil pollutants using phyto-remediation.
- TRNAVA, Slovakia: material and energy efficiency through green architecture.
- SIBBESBORG, Finland: local food, green care & employment as key aspects of a new urban development plan.
- BARCELONA, Spain: combating heatwaves' health effects in a new central park design.



## **Key messages**

- NBS represent a 'pro-active' approach to the planning and management of green infrastructure in urban areas.
- In urban areas, the focus of NBS is on societal needs: urban health care; urban liveability; climate change adaptation; socio-economic benefits.
- NBS are not just about utilising nature. If nature or natural processes in the area are over-utilised to produce NBSs, it can destroy the very basis of NBS resulting in a failure of the concept.
- NBS can and should be developed in a way that is based on the multi-functionality of green infrastructure.
- Well-planned NBS can contribute to a well-connected green infrastructure and to preserving the important nature areas from the point of view of biodiversity. Thus, NBS can also improve ecosystem's health.

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More information: [www.openness-project.eu/sites/default/files/OpenNESS\\_brief\\_03.pdf](http://www.openness-project.eu/sites/default/files/OpenNESS_brief_03.pdf)

# Strengthening the climate change adaptation role of spatial planning by modelling future formation of land use

ANNAMÁRIA GÖNCZ - VILJA VASZÓCSIK - KRISZTIÁN SCHNELLER

*Lechner Nonprofit Ltd. Directorate of Geospatial Services, Department of Spatial Planning*

## Introduction

The purposeful formation of land use significantly contributes to the moderation of the adverse impacts of climate change. Since spatial planning plays a fundamental role in the formation of land use, therefore it is essential to integrate climate change adaptation goals into the planning process. Spatial plans primarily assist the achievement of adaptation purposes by the delimitation and protection (primarily against urban sprawl) of areas (as zones, such as ecological corridors) which are important in adaptation and risk prevention. In Hungary at present the spatial planning system already contributes to the above mentioned objectives, but there are lots of unexploited capacities (e.g., new zones should be introduced such as areas of non-structural flood measures or elements of green infrastructure).

## Case study area, goals of the study, tools

In this case study of Győr and its agglomeration - which is a dynamically developing industrial region and showing a significant increase in urban and industrial areas - we assessed and presented the current role of spatial planning in protection of areas important to adaptation.

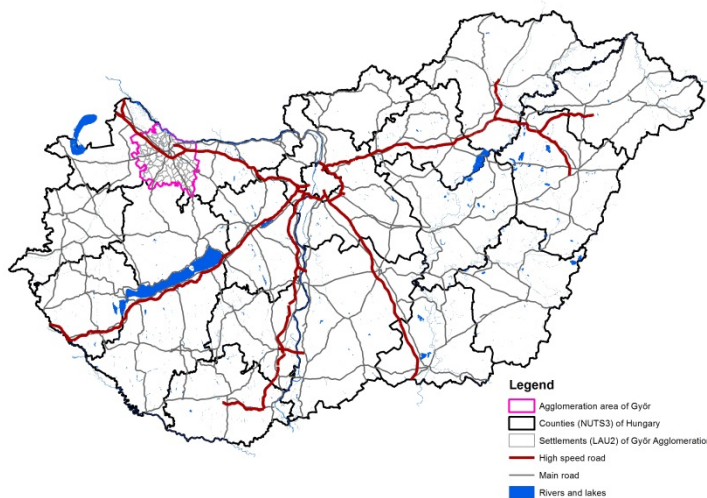


Figure 1. The location of Győr agglomeration within Hungary, created by Lechner Nonprofit Ltd. (basic data: Magyar Közút Nonprofit Ltd., GeoX Ltd.)

We also modelled the impact of the introduction of new zones. In the assessment we applied a so called Spatial Decision Support System (SDSS), which allowed us to model future land use evolution according to different scenarios. The Hungarian SDSS is a forecasting tool for planners and policy analysts working in urban and regional development. It encompasses a spatially explicit integrated simulation model that allows exploring future developments of the planning area.

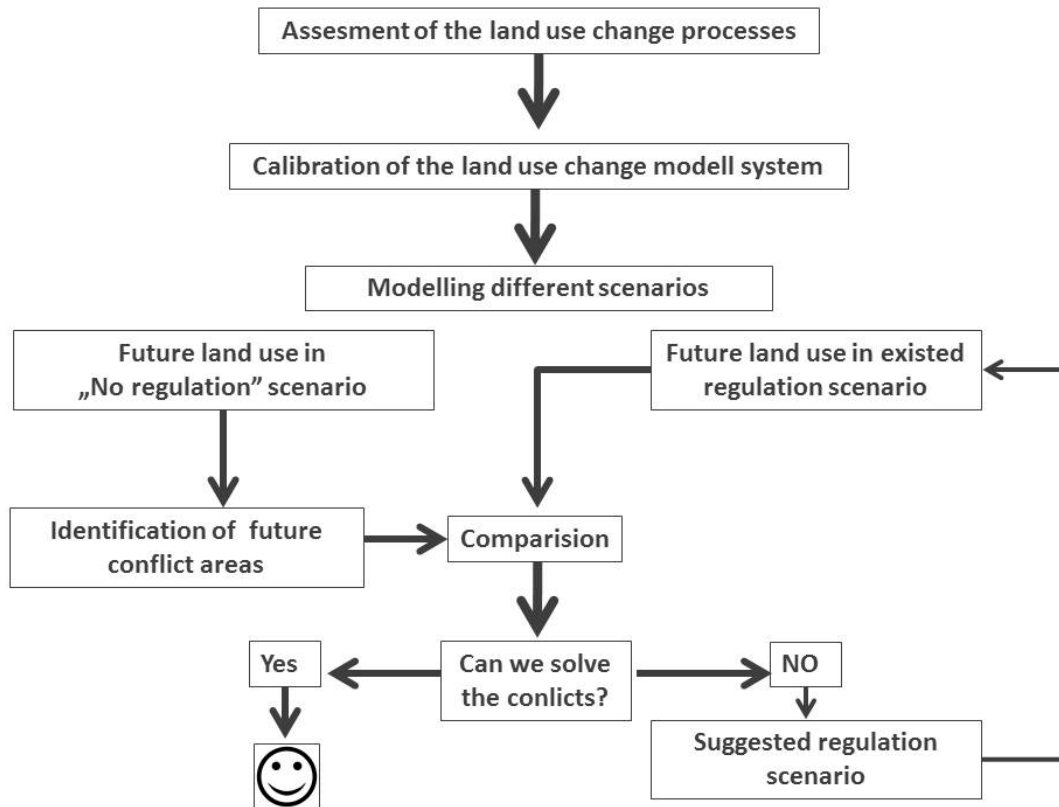


Figure 2. Process of modelling (created by Lechner Nonprofit Ltd.)

For the decision making process we have created 3 different scenarios. We have modelled the future land use with and without the regulations of the National Spatial Plan (NSP) and the third scenario based on the suggested regulation of the risk management plan’s non-structural measures. The three scenarios show three different alternative future land use patterns in the agglomeration of Győr. Comparison of the three different scenarios helped to identify the conflict areas and showed the success of the suggested measures.

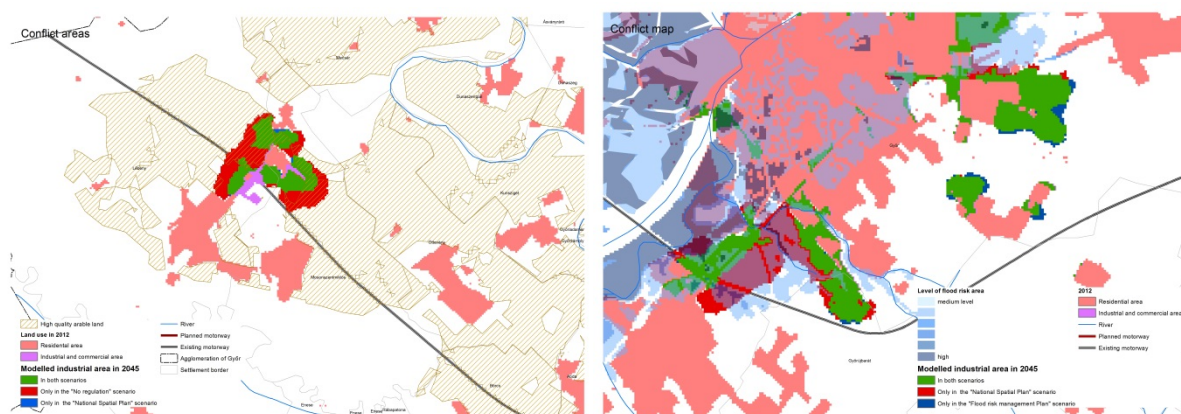


Figure 3. Conflicts areas (urban growth areas) which are handled by NSP (left) and which can be solved by the introduction of flood risk zones (right), created by Lechner Nonprofit Ltd. (basic map: EEA CORINE Land Cover).

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## **THE SPIRIT OF THE PLACE: community gardens in an enormous scale and its benefits in terms of stability**

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### **Introduction**

Justice is that value that everyone would choose if one did not know where one was going to end up in the social hierarchy. "The veil of ignorance" as put by Rawls (1971). The composition of our societies is like two sides of the same coin with "haves" and "have nots" that require some level of intervention to protect the disadvantaged. The Los Angeles Riots in 1992 left the city destructed and partially in ashes, with one billion estimated damages. In that harsh situation, some communities especially immigrants and economically deprived citizens craved for help and equal treatment. A destroyed, burned city was left from the violent protests, that dropped quality of life drastically and this was its plight. Nature at its most pure and innocent was used to bring back people's hope and pride. Doris Bloch founder of the garden in 1992 saw the potential of that empty site - a piece of land where you could find nothing but garbage and crime - as a great way to heal the community. South Central Farm feeds 350 families, which led to one of the biggest inner city community gardens in the United States.



Figure 1: View of the South Central Garden before bulldozed. ©Sakulsky S.



Figure 2: View of the South Central Garden after bulldozed. ©Carranza J.

### **Injustice process**

This study demonstrates the importance of community gardens for community stabilization, especially for impoverished citizens. The South Central Community garden helped the latter to cope with problems related to poverty and identity, thus improved their social stability.

Yet, it is not possible to perceive a successful story of justice behind a situation when private interests interfere with community activities. In 2006, the property was ultimately bulldozed. A place that had enriched biodiversity for the community and its surroundings, contributed to social stability, education and environmental sustainability was closed after a fight between the community, wishing to keep alive the community garden, and a private owner who re-bought the land and refused to sell the land to the community at any price.

**Conclusion**

Disenfranchisement and betray by the government exposed threat and the destruction of valuable community space. Opportunities for community gardens, thus, should form part of urban planning, and should get more support from decision makers.

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# Analysis of health promoting strategies, processes and instruments for adaptation to climate change in municipalities at the interface between environment, public health and urban planning [KommAKlima – Kommunale Anpassung an den Klimawandel]

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## Background

Climate change has an (in-)direct impact on human health and particularly on vulnerable groups. Therefore, appropriate adaptation strategies are required – a multifaceted challenge for decision makers in municipalities concerning environment, health and planning.

The Project entitled “KommAKlima” analysed health promoting strategies and tools for adaptation to climate change in municipalities at the Interface between environment, public health and urban planning.



Figure 1: Combined progressive qualitative approach, McCall (own diagram)

## Objectives

The project analysed the structures, instruments and processes of adaptation to impacts of climate change in municipalities in Germany with a particular view on health-related aspects. Therefore, 15 model municipalities were selected and compared regarding different approaches of health-related climate change adaptation and to identify existing municipal as well as public adaptation-potentials.

## **Methods**

Based on a combined progressive qualitatively approach, first, expert interviews were conducted in each selected community with local decision-makers from different departments (Environment, Urban Planning/Development, Public Health). Second, workshops were accomplished in each municipality for interdisciplinary collaboration, regarding climate change adaptation strategies. The results were summarised in five “hand-on guidance’s” with tangible examples (see link below contact) to support decision-makers in municipalities in formulating and communicating actions for climate change adaptation explicitly.

## **Results and discussion**

The results show that many municipalities in Germany are already dealing with adaptation-strategies to counter the (health) impacts of climate change. The communication of adaptation strategies are deficient, and there is only an implicit link to public health. Responsibilities must be regulated clearly. So far, the health resort up till now has used auxiliary tools and only handles compulsory tasks. “*KommAKlima*” is intended to further raise awareness of climate change.

This study was funded by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety.

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# New models of consumer-producer interaction in urban food supply – trends and impacts

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Emerging new flexible forms of consumer-producer relationships within the food sector are challenging the traditional models of consumption and ownership through integrating consumers into the food production and distribution process. Sharing of resources, specific land, labour, facilities and equipment, financial resources or knowledge can be regarded as social innovations and signs of economic transition. From a transition’s perspective these new models hold substantial potentials but also risks for sustainable development, welfare and quality of life.



Figure 1: Research design of the BMBF-funded project Future|Food|Commons (FuFoCo), duration 8/2015 – 7/2017, dealing with new producer-consumer relationships in urban food supply (Image: Regine Berges)

## Research questions

The research project Future|Food|Commons (FuFoCo) aims at providing answers to the following research questions:

- How can new models of consumption and ownership in the food sector be systemized?
- Which potentials and risks for sustainable development, welfare and quality of life do the different food sector consumer- producer interactions (CPI) bare?
- How are development potentials affected under different scenario perspectives?

## Approach

Future|Food|Commons (FuFoCo) applies a stakeholder-centred research approach, taking into account expert knowledge from the relevant disciplines. Systematic collection of new evidence from food cooperatives, self-harvesting gardens and community supported agriculture is carried out across Germany. Foresight studies consider future developments of new supply concepts. This allows the identification of requirements for steering and policies aiming at support for transition to a sustainable economy.

## Results

Future|Food|Commons (FuFoCo) started in 08/2015 and refers to methods for sustainability impact assessment for short food chain innovations, to results covering multiple benefits and dis-benefits, including those related to climate change, and to findings on innovation best practices gained from our previous research in the FP7 project **FOODMETRES** (Food Planning and Innovation for Sustainable Metropolitan Regions) as well as the BMBF projects **INNSULA** (Innovation and sustainability analysis of urban agriculture) and **Zfarm** (ZFarm - Innovations- und Technikanalyse Zero Acreage Farming).

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## Remote sensing – Green roof inventory and potential analysis

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Green roofs can help to adapt cities to climate change, through the provision of cooler microclimates and reduced stormwater run-off. They also enhance biodiversity in urban ecosystems. In order to evaluate these positive effects in a quantitative way, information about the already existing green roofs and potential green roof sites are needed. The German Aerospace Center (DLR), the German Roof Gardener Association (DDV) and different German cities developed a method with which existing green roofs and potential roof areas can be identified and inventoried from a "birds-eye view". The project received funding from the German Federal Environmental Foundation (DBU).



Fig. 1: The green roof detection tool combines high resolution airborne infrared imagery (false color, vegetation in red) and building outlines (purple frame). © City of Nuertingen

### Method

The remote sensing technology uses high resolution satellite or airborne optical imagery (visible and infrared), DSM (Digital Surface Model) height information and existing building outlines maps (footprints) to estimate the percentage of vegetated areas on building roofs and to identify potential green roof sites.

### Results

The results are impressive. For example the total green roof area in Munich exceeds 4 million m<sup>2</sup>. However, there are still large areas of flat roofs (13.2 million m<sup>2</sup>) in the Bavarian Capital that offer potential for the installation of green roofs. The new remote sensing technology provides municipalities with the opportunity to use this data for urban planning decisions in the field of climate modelling, drainage system calculation and biodiversity networks.

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## **Functional diversity and resilience – How biodiversity information could be re-structured to better meet needs of resilient ES provisioning**

ERIK ANDERSSON AND JULIE GOODNESS

*Stockholm Resilience Centre, Stockholm University*

Resilience as related to nature-based solutions has two aspects. A solution may be intended to provide resilience through its function, for example by preventing flooding. The second concern, and one less commonly explored, is the need to make sure that solutions providing resilience to the larger system are resilient themselves. Making sure that the functions provided are backed by species with different responses to different disturbances will make this more likely.

### **Functional traits**

Biodiversity in terms of species diversity does not immediately relate to the specific needs nature-based solutions are intended to address. Yet, in times of change, diversity is a relevant concern when designing solutions. An alternative to species diversity is to describe organisms in terms of their life history characteristics – traits – that either contribute to function and thus provide the solution, or determine how an organism may respond to environmental changes. Function and the traits contributing to it is at the core of creating nature-based solutions. This knowledge needs to be complemented with species information indicating how different species may fare under different conditions. Finally, a better understanding of the cues people respond to in terms of direct appreciation will help mainstream the solutions and the interest in investing in them.

### **Multifunctional solutions – legible and attractive diversity**

With increasing demands for multi-functionality and an often strong competition for land call for immediate use values for latent, climate insurance solutions. If we want to build in diversity, and hence resilience, into nature-based solutions we need to make them attractive to people. Here species trait profiles may be of help. Ongoing work is starting to connect perceived ecosystem services to traits, and how an extended traits framework can help inform design for ecosystem services.

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<http://www.stockholmresilience.org/21/contact/staff/8-17-2012-andersson.html>

## **MedMossRoofs: Urban green covers with no irrigation requirements under Mediterranean climate**

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Green roofs are plant-based spaces that are placed on a waterproof layer on top of houses, factories, offices and other buildings, being widely used in northern Europe. These structures increase services provided to the environment in urban areas such as urban aesthetic improvement, attenuation of flood effect, contribution to thermal regulation of buildings, and increase in carbon sequestration. Furthermore, they contribute to biodiversity conservation, improve air quality, improve the buildings' soundproofing, increase roof durability, and lag spread of potential fires.

**MedMossRoofs: The use of biological soil crusts**

However, green roofs in the Mediterranean area or similar latitudes (e.g., California, southwestern Australia, South Africa, Chile), which have a climate with hot, dry summers, requires the use of irrigation, which makes them more expensive and often unsustainable.

Biological soil crusts (biocrusts) thrive in dry areas and are composed of a complex mosaic of cyanobacteria, green algae, lichens, mosses, microfungi and other bacteria. These communities are able to photosynthesize when water is available, but in drought conditions, they cease the entire metabolism. Biocrusts can remain under these conditions for long periods of time from months to years, and return to their normal functions after rain/dew events. Particularly mosses have the ability to retain water many times their dry weight, contributing to the attenuation of flood effects in urban centres.

In the project **MedMossRoofs**, starting in 2016, we intend to develop a biological technology as green cover that does not depend on irrigation water. Therefore, green roofs based in moss-dominated biocrusts appear as an innovative solution to urban landscapes since they do not have a root system, thereby reducing the thickness of the substrate, decreasing the installation costs and the weight load on the structure on which they are applied, without using irrigation.



Figure 1: Green roof based on moss-dominated biological soil crusts (Biocrusts) (Image: Ricardo da Cruz de Carvalho).

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## Nature into grey zones

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Bringing nature into grey zones - this is the motto for the campaign for unsealing and close to nature greening of urban industrial areas. The campaign with a duration of three years started in April 2013 and is funded by the German Federal Agency for Nature Conservation (BfN) and led by the Bonn Science Shop. The objective is to raise awareness among both, corporate representatives and citizens for biodiversity conservation in urban areas and to make them actors. When greening parts of their premises, the city becomes greener, more livable and attractive - without compromising limited functional surfaces. Near-to-natural company premises are contributing valuably to the preservation of biodiversity and in addition, they have an important model function for society. The campaign takes place in three pilot cities and aims to gain 10 enterprises in each city to unseal 50 sq.m of their functional floor area before planting. Partners are the community foundations of each pilot city which act like a bridge between Bonn Science Shop and participating corporate representatives and citizens.



Figure 1: Planting on the parking lot at a dentist in Wiesloch (image: WILA Bonn)

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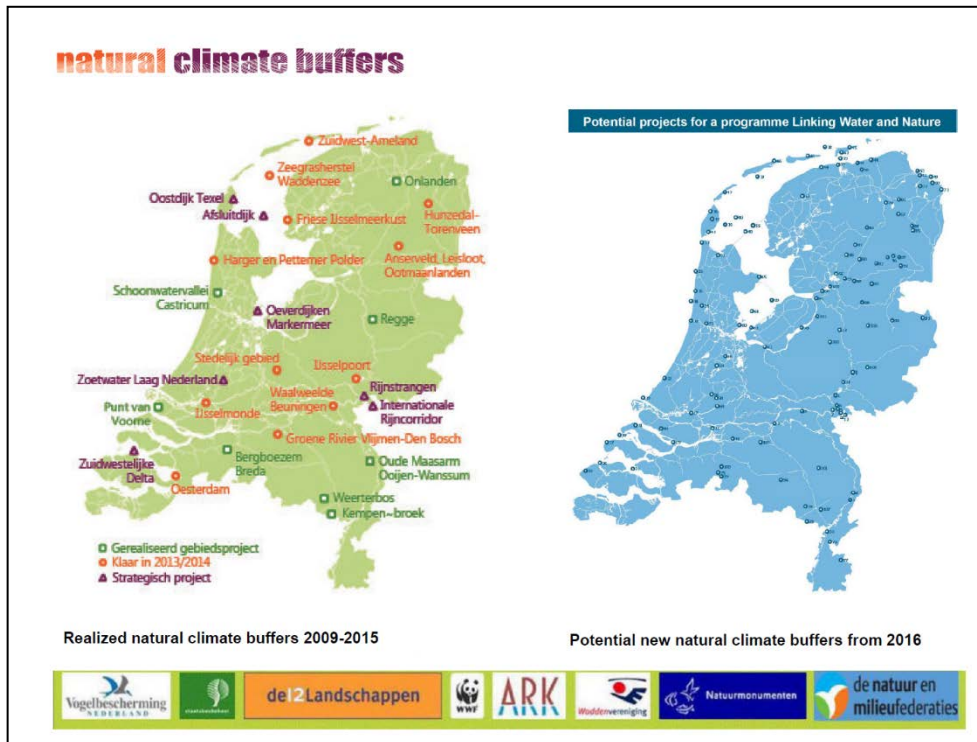
Website [www.natur-in-graue-zonen.de](http://www.natur-in-graue-zonen.de)



## Climate buffers are necessary

GEERTE DE JONG<sup>1</sup>, PAUL VERTEGAAL<sup>2</sup>

1Friese Milieufederatie, 2Vereniging Natuurmonumenten, both part of:  
Dutch Coalition Natural Climate buffers



Realized and potential new 'natural climate buffers' in The Netherlands (Illustration: Dutch Coalition Natural Climate Buffers)

## From pilots to mainstream

Eight big Dutch nature organisations united in a Coalition Natural Climate Buffers: Ark Nature, Natuurmonumenten, National Forest Service, Bird Life International The Netherlands, the Wadden Sea Society, De Landschappen, the World Wildlife Fund Netherlands and The Provincial Nature and Environment Federations. The Coalition advocates employing nature in dealing with the consequences of climate change and works on the realization of so called natural climate buffers.

## Natural climate buffers

Climate buffers are nature areas specially designed to reduce the consequences of climate change. They will not only guard us against flooding but will also store water for dry periods or secure water quality. In this way, these areas can offer 'blue' ecosystem services but also attractive natural scenery for people, habitat for plants and animals and space for economic developments.

## Realized pilot projects

To explore the concept of natural climate buffers, the Netherlands' Ministry of Infrastructure and Environment supported the Coalition's programme Natural Climate Buffers with € 19 Mio from 2008-2014. By interesting other regional stakeholders this amount could grow to € 158 Mio, by which 20 field pilots and 8 strategic studies could be executed. The smallest project consisted of a 'green facade' of several square meters, the biggest was the 2.200 ha water retention area 'Onlanden' near the city of Groningen. All projects proved that biodiversity and water management objectives can strengthen each other with synergy.



Photograph of functioning climate buffer, e.g., Onlanden near Groningen (NL) (Image: Paul Vertegaal)

## International cooperation

The main goal of the Coalition for the next years is to realize as much as possible new climate buffer projects and to inspire water authorities to make the shift "from pilots to mainstream". Co-operating in international projects, like Interreg/Efro and Horizon2020 is one of the ways we want to go.

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## **Bioindicators for land use and climate change – bats at the urban-rural interface**

NICOLE STARIK AND ULRICH ZELLER

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Ecosystem-based approaches to mitigate impacts from climate change include the conservation of biodiversity and the sustainable use of natural resources. Today, the use of bioindicators to evaluate different environmental impacts on biodiversity is increasingly becoming a key element in developing future strategies for a sustainable management of agroecosystems.

We introduce an approach to assess biodiversity changes related to human activities, using the group of Chiroptera in different agro-ecological systems in rural surroundings of Berlin (Westhavelland, Germany).

Our findings demonstrate that these mammals are promising candidates to assess the effects of land use on biodiversity, showing responses particularly with regard to overall abundances and altered community structures in differently managed forest types. These findings can mainly be attributed to the different availability of prey (insects) as a consequence of different structural vegetation characteristics. It can be expected that changes in insect populations due to climatic changes will also affect numbers and species diversity of bats. As bats are important key elements in the ecosystem, providing essential ecosystem functions to benefit human well-being (e.g., insect pest control), knowledge on their sensitivity to land use changes and their responses to altered food resources may be of great importance to predict impacts from climatic changes. It appears that there is a regular exchange of some bat communities between the rural areas and the city of Berlin (e.g., with regard to winter roosting sites), making it even more important to consider the urban-rural interface when developing land management strategies.

Building and sustaining ecosystem resilience and integrity by maintaining essential components of biodiversity is probably the most important prerequisite to safeguard against climate change impacts. To improve this required resilience, the use of bats as bio-indicators for land use and climate change may facilitate developing sustainable management strategies for landscapes in urban areas and their rural surroundings.

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## **Annex 1 - 2015 ENCA recommendations for taking forward the spatial targeting and implementation of nature-based solutions for climate change mitigation and adaptation in urban areas and their rural surroundings**

The Interest Group on Climate Change of the Network of Heads of European Nature Conservation Agencies (ENCA), and the BioClim project group funded by the German Federal Agency of Nature Conservation (BfN) developed the following recommendations based on the session outcomes and plenary discussions at the joint BfN/ENCA European Conference on “Nature-based Solutions to Climate Change in Urban Areas and their Rural Surroundings”.

The conference took place in Bonn, Germany from 17 to 19 November 2015. These recommendations further build on the discussions of an expert workshop at the International Academy for Nature Conservation, Island of Vilm, Germany in March 2015. Both events were organised by the BfN in collaboration with the Helmholtz-Center for Environmental Research – UFZ and the German Centre for integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig.

The recommendations were endorsed by the ENCA network at its 19th plenary meeting in Bern. They focus on ways forward (implementation, research and spatial targeting) to put into action nature-based solutions (NBS) for climate change mitigation and adaptation in urban areas and their rural surroundings. The recommendations highlight four key areas for action, to:

- 1. Increase the evidence base on the effectiveness of nature-based solutions (NBS) by providing examples of best practice that demonstrate the multiple benefits provided by NBS. This includes benefits related to climate change adaptation and mitigation, the conservation of biodiversity, and the provision of other ecosystem services for human well-being, including benefits to health.**

This can be achieved by

- compiling case studies that demonstrate where cross-sector policy integration has led to cost-effective and efficient delivery of ecosystem services that have provided an equitable distribution of multiple benefits.
- building a repository of good practice case studies that include evaluation methodology.
- synthesizing existing and new information and communicating this effectively to all audiences from society, policy and science.

- 2. Foster research and monitoring to determine the best assemblages of species to achieve the most efficient NBS, including the optimization of multiple economic, ecological and social benefits and exploration of trade-offs created by NBS.**

This can be achieved by

- Collection of new data in the field and the use of remote sensing to gather comprehensive data on additional benefits, to complement existing case studies and data.

- focusing on how NBS can complement and be used in conjunction with technological solutions. Conservation and construction may both offer solutions, and scientific evidence is needed to quantify their relative performance in terms of ecological functioning. This includes research that combines effects of the building sector (grey), water and storm-water management strategies (blue) as well as ecosystem services (green) and looks at them in an integrative manner.
- identifying and including all benefits in analyses of cost-effectiveness, whenever decisions about regulations and developments in urban and rural areas are made. This includes economic analyses of the costs of inaction as well as the possibility of catastrophic failure of purely technical solutions. The full range of social and economic impacts should be fully taken into account by studying the monetary and non-monetary values of NBS projects.
- focusing on health and environmental justice as central benefits (not only a co-benefit) of NBS implementation.
- analysis of case studies exploring success factors in the governance of NBS, including how the right people were reached, which kind of people, who finally took the decision to implement the action, as well as the analysis of failure e.g., why actors do not take decisions in favour of implementing nature-based solutions.

### **3. Foster wider application of NBS with partners from society and policy.**

This can be achieved by

- upscaling successful projects and transferring them to other cities.
- good communication processes among different stakeholder groups (e.g., decision makers, business, society) including a detailed description of the NBS implementation process, benefits, the solutions for certain problems, mistakes made and lessons learned to avoid them, specific context, stakeholders involved.
- Building alliances with different stakeholder groups by demonstrating alignment with their interests (e.g., health issues), in order to get non-conventional partners for NBS implementation from sectors formerly not involved in NBS. This can be supported by creating positive narratives that explain how investments in nature lead to (specific and general) gains for society.
- increased investment in new partnerships with businesses and society including community groups and people with diverse background in culture and education to find suitable settings and language. Sufficient financing and a shared understanding of objectives should be guaranteed e.g., by joint ownership of projects by decision makers and practitioners.
- When implementing NBS strategies, trade-offs and off-site effects to society and the societal context should be considered. Potential displacement of people should also be considered and avoided where possible. In particular, green space standards and political targets combined with social housing standards should be implemented in an integrative approach to planning the entire city.
- strong implementation promoted and led from the top down, including the implementation of the EU Green Infrastructure Strategy and its promotion as an instrument to

enhance development and implementation of NBS in an integrated way; but also bottom-up governance that integrates local initiatives from the urban society. Inclusive planning and maintenance strategies and citizen science can act as powerful approaches to better meet the demands of the diversity of stakeholders and develop truly multifunctional NBS.

#### **4. Enable successful ecological restoration with benefits for biodiversity through NBS.**

This can be achieved by

- connecting urban and rural green areas, which will promote NBS (such as temperature regulation) and also biodiversity by improving the connectivity of urban and rural ecological communities.
- connecting matrix (built-up areas and areas under more intensive land use) and core areas (green areas such as conservation areas or urban parks) within cities: existing green areas should be protected and complemented by green elements within the matrix (green roofs, green facades, bio retention swales, green strips along roadsides, etc.) to promote the provision of ecosystem services and biodiversity.
- While implementing the measures mentioned above, due consideration of the potential impact of invasive alien species (IAS) should be given in the design of NBS. For example potential IAS hotspots and pathways should be identified and – in cases where an invasive species is thought likely to benefit from a more connected landscape – potential advantages and disadvantages of enhancing connectivity should be considered carefully in NBS planning.
- Preferably using native species of local provenance for NBS.
- Climate change proofing NBS (e.g., species selection) to ensure that ecological function and biodiversity gain are resilient to future change. In some cases this might mean being more flexible about the provenance of species used.

#### **General remarks**

One fundamental assumption which framed the discussions during the conference was the interconnectedness between climate change, biodiversity and human health and well-being. These interlinkages occur at various levels, as illustrated in a diagram on the “determinants of health” by Barton & Grant (2006, see citation below). The recognition of the integrated manner of social, economic and environmental issues is of outstanding importance for understanding the advantages of nature-based solutions.

#### **Literature**

BARTON, H. AND GRANT, M. (2006): A health map for the local human habitat. *The Journal of the Royal Society for the Promotion of Health*, 126 (6) pp. 252-253.

ISSN 1466-4240. DOI: 10.1177/1466424006070466

Available from: <http://eprints.uwe.ac.uk/7863> or directly at [http://eprints.uwe.ac.uk/7863/2/The\\_health\\_map\\_2006\\_JRSH\\_article\\_-\\_post\\_print.pdf](http://eprints.uwe.ac.uk/7863/2/The_health_map_2006_JRSH_article_-_post_print.pdf)

## Annex 2 - Programme of Oral Presentations

	TUESDAY (17.11.2015) SCIENCE
8:00 - 18:00	Registration - Foyer
	<b>Chair:</b> Horst Korn (Head of Biodiversity Unit, Federal Agency for Nature Conservation - BfN, Germany)
9:00	<b>Introduction and Opening</b> Beate Jessel (President, Federal Agency for Nature Conservation - BfN, Germany)
9:20	<b>Welcome and update from ENCA</b> Simon Duffield (Natural England / climate change interest group European Network of Heads of Nature Conservation Agencies - ENCA, UK)
9:30	Thinking beyond grey - using nature to cope with climate change Hans Bruyninckx (Director, European Environment Agency - EEA, Denmark)
10:00	<b>Sustainability, Responsibility, and Nature-Based Solutions: the Contribution of Public and Private Research Funders</b> Wilhelm Krull ( <i>Chair H2020 expert group on nature-based solutions and re-naturing cities / Volkswagen Foundation, Germany</i> )
10:30	Coffee & Tea
	<b>Chair:</b> Aletta Bonn (Helmholtz Centre for Environmental Research-UFZ and German Centre of Integrative Biodiversity Research - iDiv, Germany)
11:00	<b>Nature-based solutions and resilience to climatic change - contribution of nature conservation to human well-being</b> Georgina Mace ( <i>University College London, Director of the UCL Centre for Biodiversity and Environment Research (CBER), UK</i> )
11:30	Mainstreaming climate change adaptation in urban governance and planning Christine Wamsler (Associate Professor, Lund University Centre for Sustainability Studies (LUCSUS), Sweden)
12:00	Discussion
12:30	Lunch / Press Conference
14:00	Opportunities for biodiversity against climate change in urban and non-urban areas. Ingo Kowarik (Technical University Berlin, Germany)
14:20	Riparian forests in urban areas as a nature-based solution for climate change mitigation and adaptation in cities and their rural surroundings Dagmar Haase (Humboldt Universität zu Berlin, Germany)

14:40	Impacts of climate change on urban biodiversity - the role of invasive and <b>non-native species</b> Franz Essl (Environment Agency Austria & University Vienna, Austria)
15:00	<b>Valuing ecosystem services for urban planning</b> Erik Gómez-Baggethun ( <i>Norwegian Institute for Nature Research - NINA, Norway</i> )
15:20	Discussion
15:30	Coffee & Tea
16:00	<b>The Power of Surface- How Cities adapt to Climate Change</b> Vera Enzi (University of Natural Resources and Life Sciences Vienna, Austria)
16:20	<b>Urban Environmental Health and Climate Change - Perspectives from WHO</b> Tanja Wolf (World Health Organisation - WHO, European Centre for Environment and Health, Germany)
16:40	Nature-based solutions as inclusive spaces: Links to people's health, well-being and quality of life Catharine Ward Thompson ( <i>Edinburgh College of Art, UK</i> )
17:00	Transformation processes in cities - opportunities for nature-based solutions Niki Frantzeskaki (Dutch Research Institute for Transitions - Drift, The Netherlands)
17:20	Nature-based solutions to climate change mitigation and adaptation in urban areas - indicators of success, barriers and opportunities Nadja Kabisch & Aletta Bonn (Helmholtz Centre for Environmental Research-UFZ and German Centre of Integrative Biodiversity Research - iDiv, Germany)
17:40	Discussion
18:00	Break
18:15	<b>Open Event / Welcome</b> Beate Jessel (President, Federal Agency for Nature Conservation - BfN, Germany)
	Public evening lecture: Urbanization and nature - conflicts and synergies Dirk Sijmons (Delft University of Technology, The Netherlands)
19:00	Conference buffet, evening reception hosted by BfN



	<b>WEDNESDAY (18.11.2015)</b> <b>PRACTICE / IMPLEMENTATION</b>
8:00 -18:00	Registration - Foyer
9:00	<b>Introduction and review of day 1</b> <b>Chair:</b> Horst Korn (Head of Biodiversity Unit, Federal Agency for Nature Conservation - BfN, Germany)
9:05	Ljubljana - European Green Capital 2016  <b>Kristina Ina Novak</b> (The City of Ljubljana, Slovenia)
9:35	Learning from cases of Nature-Based Solutions to climate change adaptation and mitigation in urban contexts  Wolfgang Teubner (ICLEI - Local Governments for Sustainability, Regional Director for Europe, Germany)
10:05	<b>Interactive session plan</b> Horst Korn (Head of Biodiversity Unit, Federal Agency for Nature Conservation - BfN, Germany)
10:10	Coffee & Tea
10:40	Interactive Parallel Sessions - SLOT 1 (for detailed programme see below) <ul style="list-style-type: none"> <li>• <b>Session 1</b> Integrating the grey, blue and green - Nature-based solutions for climate change adaptation and mitigation as complementary or alternative measures to engineering approaches <b>Chair:</b> Werner Lang (<i>Technische Universität München, Germany</i>) <b>Room:</b> Main Lecture Hall "Hörsaal"</li> <li>• <b>Session 2</b> Nature-based solutions for climate change adaptation and mitigation and the role in fostering social-environmental justice in cities <b>Chairs:</b> Dagmar Haase &amp; Nadja Kabisch (<i>Humboldt Universität zu Berlin, Helmholtz Centre for Environmental Research, German Centre of Integrative Biodiversity Research - iDiv, Germany</i>) <b>Room:</b> Seminar Room 3.01/ 3.03 (upper floor)</li> <li>• <b>Session 5**</b> The role of biodiversity conservation for nature-based solutions in climate change adaptation and mitigation <b>Chair:</b> Sonja Knapp (Helmholtz Centre for Environmental Research - UFZ, Germany) <b>Room:</b> Media Room "Medienraum" (basement)</li> <li>• <b>Session 4</b> Municipalities adapt to urban climate change - by effective use of green infrastructure for nature-based solutions and existing actor networks <b>Chair:</b> Birgit Georgi (European Environment Agency, Denmark) <b>Room:</b> Seminar Room 3.05/ 3.07 (upper floor)</li> </ul> <p>** Due to logistic reasons <b>Session 3</b> chaired by Dieter Rink was moved from SLOT 1 to SLOT 2 (14:30 – 16:30) and <b>Session 5</b> chaired by Sonja Knapp was moved from SLOT 2 to SLOT 1 (10:40 – 12:40)</p>

<b>WEDNESDAY (18.11.2015)</b> <b>PRACTICE / IMPLEMENTATION</b>	
12:40	Lunch / Market place (Poster Session)
14:30	<p>Interactive Parallel Sessions - SLOT 2 (for detailed programme see below)</p> <ul style="list-style-type: none"> <li>• <b>Session 3**</b> Urban (allotment) gardening and urban agriculture as local community based approach of small-scale climate change adaptation and mitigation in urban areas <b>Chair:</b> Dieter Rink (Helmholtz Centre for Environmental Research - UFZ, Germany) <b>Room:</b> Seminar Room 3.01/ 3.03 (upper floor)</li> <li>• <b>Session 6</b> Nature-based solutions for climate change adaptation and mitigation from a transitions' perspective <b>Chairs:</b> Ania Rok (<i>ICLEI, Germany</i>) &amp; Leen Gorissen (<i>VITO, Belgium</i>) <b>Room:</b> Media Room "Medienraum" (basement)</li> <li>• <b>Session 7</b> Rural-urban linkages of nature-based solutions for climate-change mitigation and adaptation and planning perspective <b>Chair:</b> Stephan Pauleit (<i>Technische Universität München, Germany</i>) <b>Room:</b> Main Lecture Hall "Hörsaal"</li> <li>• <b>Session 8</b> Innovative nature-based solutions for cost-effectiveness and economic viability to enhance climate change mitigation and adaptation <b>Chair:</b> Bernd Hansjürgens (Helmholtz Centre for Environmental Research - UFZ, Germany) <b>Room:</b> Seminar Room 3.05/ 3.07 (upper floor)</li> </ul> <p>** Due to logistic reasons <b>Session 3</b> chaired by Dieter Rink was moved from SLOT 1 to SLOT 2 (14:30 – 16:30) and <b>Session 5</b> chaired by Sonja Knapp was moved from SLOT 2 to SLOT 1 (10:40 – 12:40)</p>
16:30	Coffee & Tea
17:00 - 18:30	<p><b>Plenum Summary</b> Main lecture Hall <b>Chair: Horst Korn</b> (Head of Biodiversity Unit, Federal Agency for Nature Conservation - BfN, Germany)</p>
19:00	Conference dinner

	<b>THURSDAY (19.11.2015)</b> <b>NBS IN POLICY AND BUSINESS FOR CONSERVATION UNDER CLIMATE CHANGE</b>
8:00 - 18:00	Registration - Foyer
9:00	Introduction and review of day 2 <b>Chair:</b> Horst Korn (Head of Biodiversity Unit, Federal Agency for Nature Conservation - BfN, Germany)
9:10	Towards an EU Research and Innovation policy agenda for Nature-Based solutions and Re-naturing Cities Kurt Vandenberghe (European Commission, DG Research and Innovation, Director of Directorate Climate action and resource efficiency, Belgium)
9:40	<b>Spatial planning of Green infrastructure in a changing climate - Links to EU policy</b> Stefan Leiner ( <i>European Commission, DG Environment, Acting Director, Natural Capital, Belgium</i> )
10:10	IUCNs perspective on nature's solutions for urban resilience - in search of innovative models of engagement Chantal van Ham (International Union for Conservation of Nature - IUCN, EU Programme Manager Nature-based solutions, Belgium)
10:40	Coffee & Tea
11:10	Governing cities for the future using business and investment for nature-based solutions Luise Noring (Copenhagen Business School - CBS, Denmark)
11:40	<b>Economic impacts of urban green infrastructure: results from TEEB Germany</b> Bernd Hansjürgens ( <i>Helmholtz Centre for Environmental Research - UFZ, Germany</i> )
12:10	<b>Panel Discussion</b> Moderator: Horst Korn (Head of Biodiversity Unit, Federal Agency for Nature Conservation - BfN, Germany)
12:50	<b>The way forward and closing</b> Beate Jessel (President, Federal Agency for Nature Conservation - BfN, Germany)
13:00	Farewell
afternoon	Meeting of the ENCA interest group on climate change (members only)

**DETAILED PROGRAMME - Interactive Parallel Sessions SLOT 1  
WEDNESDAY (18.11.2015) Morning sessions (10:40 - 12:40)**

<p><b>Session 1</b> - Main Lecture Hall "Hörsaal"</p> <p><b>Integrating the grey, blue and green - Nature-based solutions for climate change adaptation and mitigation as complementary or alternative measures to engineering approaches</b></p> <p><b>Chair:</b> Werner Lang  (Technische Universität München, Germany)</p>	<p><b>Manfred Köhler</b>, <i>University of Applied Sciences Neubrandenburg</i>: Green roofs and living walls as tools of Green infrastructure against global warming</p> <p><b>Meinolf Kossmann</b>, <i>Deutscher Wetterdienst</i>: INKAS – a guidance tool for urban planners to assess the impact of climate adaptation measures</p> <p><b>Nektarios Chrysoulakis</b>, <i>Foundation for Research and Technology - Hellas</i>: Copernicus Sentinels observations as a tool to evaluate NBS implementation</p> <p><b>McKenna Davis</b>, <i>Ecologic Institute</i>: Sustainable Urban Drainage Systems – complementing grey with green for improved adaptation</p>
<p><b>Session 2</b> - Seminar Room 3.01/ 3.03</p> <p><b>Nature-based solutions for climate change adaptation and mitigation and the role in fostering social-environmental justice in cities</b></p> <p><b>Chairs:</b> Dagmar Haase &amp; Nadja Kabisch  (Humboldt-Universität zu Berlin, Helmholtz Centre for Environmental Research, German Centre of Integrative Biodiversity Research - iDiv, Germany)</p>	<p><b>Annegret Haase</b>, <i>Helmholtz-Centre for Environmental Research-UFZ</i>: Nature-based solutions and a socially inclusive development of cities – some reflections from a social-environmental perspective</p> <p><b>Matthias Braubach</b>, <i>WHO European Centre for Environment and Health</i>: The effects of urban green space on environmental health equity and resilience to extreme weather</p> <p><b>Lina Kusaite</b>, <i>Plant Kingdom Project</i>: Edible gardening- the tool that unites nature and community within the urban environment</p> <p><b>Renate Späth</b>, <i>Ministerium für Klimaschutz, Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes NRW</i>: Wild urban forests and wood biomass short rotation landscape laboratories on former brownfield sites as nature-based solutions in climate mitigation processes of the Ruhr Area, Nordrhein-Westfalen</p>
<p><b>Session 5**</b> -Media Room "Medienraum"-</p> <p><b>The role of biodiversity conservation for nature-based solutions in climate change adaptation and mitigation</b></p> <p><b>Chair:</b> <b>Sonja Knapp</b> (<i>Helmholtz Centre for Environmental Research - UFZ, Germany</i>)</p>	<p><b>Stephan Lingner</b>, <i>EA European Academy of Technology and Innovation Assessment GmbH</i>: Natural succession or designing nature? The case for urban climate change adaptation and mitigation</p> <p><b>Sarah Taylor</b>, <i>Natural England</i>: Nature-based solutions: delivery of biodiversity conservation and ecosystem based climate change adaptation</p> <p><b>Oilly Watts</b>, <i>Sustainable Developments Department, The RSPB</i>: A tale of two cities: developing floodplains for people and wildlife</p> <p><b>Ákos Bede-Fazekas</b>, <i>Hungarian Academy of Sciences, Vácrátót, Hungary</i>: Habitat stylization in urban environment from a climate change adaptation point of view</p>

**DETAILED PROGRAMME - Interactive Parallel Sessions SLOT 1  
WEDNESDAY (18.11.2015) Morning sessions (10:40 - 12:40)**

<p><b>Session 4</b> - Seminar Room 3.05/ 3.07</p> <p><b>Municipalities adapt to urban climate change - by effective use of green infrastructure for nature-based solutions and existing actor networks</b></p> <p><b>Chair:</b> <b>Birgit Georgi</b> (European Environment Agency, Denmark)</p>	<p><b>Eva Streberová</b>, <i>Czech Globe - Global Change Research Centre AS CR</i>: Public Participation in Developing Urban Adaptation Strategies to Climate Change with Ecosystem-Based Approaches: The Case of Three Pilot Cities in the Czech Republic</p> <p><b>Ernst Schäfer</b>, <i>Arbeitsgruppe für regionale Struktur- und Umweltforschung GmbH</i>: Nature-based climate adaptation in urban and regional planning: A review of research projects funded by German Government</p> <p><b>Dagmar Vogt-Sädler</b>, <i>Bündnis Kommunen für die biologische Vielfalt e.V. &amp; Umweltamt Neuss, Germany</i>: The concept for climate adaptation in the city of Neuss - Implementation in green space planning and maintenance</p> <p><b>Hannah Bornholdt</b>, Ministry of Urban Development and Environment Hamburg (BSU): Green roof Strategy for Hamburg</p>
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**DETAILED PROGRAMME - Interactive Parallel Sessions SLOT 2  
WEDNESDAY (18.11.2015) Afternoon sessions (14:30 - 16:30)**

<p><b>Session 3**</b> -Seminar Room 3.01/ 3.03-</p> <p><b>Urban (allotment) gardening and urban agriculture as local community based approach of small-scale climate change adaptation and mitigation in urban areas</b></p> <p><b>Chair:</b> <b>Dieter Rink</b> (Helmholtz Centre for Environmental Research - UFZ, Germany)</p>	<p><b>Eva Foos</b>, Humboldt-Universität zu Berlin: Urban Climate-Gardens in Berlin: an educational initiative</p> <p><b>Ines Cabral</b>, German Centre for Integrative Biodiversity Research (iDiv), Helmholtz-Center for Environmental Research - UFZ: Assessing the contribution of urban gardens to ecosystem services and biodiversity</p> <p><b>Francesco Orsini</b>, <i>University of Bologna</i> : Rooftop agriculture for food production, social inclusion and ecosystem service provision: a case study from Bologna</p> <p><b>Zsuzsanna Fácányi</b>, <i>University of Corvinus</i>: Sustainable Revitalization of Brownfield Lands – Possibilities of Interim Utilization in the Form of Urban Community Gardens in Budapest</p>
<p><b>Session 6</b> -Media Room</p> <p><b>Nature-based solutions for climate change adaptation and mitigation from a transitions' perspective</b></p> <p><b>Chairs:</b> <b>Leen Gorissen</b> (<i>VITO, Belgium</i>) &amp; <b>Ania Rok</b> (<i>ICLEI, Germany</i>)</p>	<p><b>Christopher Luederitz</b>, <i>Leuphana University Luneburg</i>: Local levers for change: Mainstreaming ecosystem-based adaptation into municipal planning to foster sustainability transitions</p> <p><b>Giuseppe Carrus</b>, <i>Roma Tre University, University, of Bari, Italy</i>: Use of urban green spaces and global warming</p> <p><b>Rodrigo Muniz</b>, Climate Change, Impacts, Adaptation and Modelling (CCI-AM), Centre for Ecology, Evolution and Environmental Changes (cE3c), Faculdade de Ciências, Universidade de Lisboa: Transition Practices Incentive: fostering nature-based solutions</p> <p><b>Martin Dallimer</b>, <i>University of Leeds</i>: A deliberative valuation approach to understanding the multiple facets of value of blue-green-grey solutions for flood risk reduction under climate change among urban communities</p>

**DETAILED PROGRAMME - Interactive Parallel Sessions SLOT 2  
WEDNESDAY (18.11.2015) Afternoon sessions (14:30 - 16:30)**

<p><b>Session 7</b> -Main Lecture Hall "Hörsaal"</p> <p><b>Rural-urban linkages of nature-based solutions for climate-change mitigation and adaptation and planning perspective</b></p> <p><b>Chair:</b> <b>Stephan Pauleit</b> (<i>Technische Universität München, Germany</i>)</p>	<p><b>Sophie Schetke</b>, <i>University of Bonn</i>: Nature-oriented infill development in growing regions - wishful thinking or reality?</p> <p><b>Neville Makan</b>, <i>Scottish Natural Heritage</i>: Carse of Stirling - an Ecosystems Approach Demonstration Project</p> <p><b>Jakob Köhler</b>, <i>University of Potsdam</i>: Urban agriculture as a city planning adaption measure to climate change</p> <p><b>André Mascarenhas</b>, <i>Universidade Nova de Lisboa</i>: Nature-based spatial planning through the concept of ecosystem services in Lisbon Metropolitan Area</p>
<p><b>Session 8</b> - Seminar Room 3.05/ 3.07</p> <p><b>Innovative nature-based solutions for cost-effectiveness and economic viability to enhance climate change mitigation and adaptation</b></p> <p><b>Chair:</b> <b>Bernd Hansjürgens</b> (Helmholtz Centre for Environmental Research - UFZ, Germany)</p>	<p><b>Helen Davies</b>, <i>University of Southampton</i>: Valuing the carbon sequestration and rainwater interception ecosystem services provided by Britain's urban trees</p> <p><b>Eva Streberová</b>, <i>CE SPECTRA - Centre of Excellence of Slovak University of Technology and Slovak Academy of Sciences</i>: Modelling the feasibility of different payments for urban ecosystem services: The case of a public park in Bratislava</p> <p><b>Jakub Kronenberg</b>, <i>University of Lodz</i>: Mind the limits... to the cost-effectiveness of nature-based solutions</p> <p><b>Knut Sturm</b>, <i>Community Forest Lübeck</i>: The mode of being patient – a skillful approach for urban forest use in unpredictable times</p>

## Annex 3 - Programme of Poster Presentations

No.	Titel	Author(s)	Presenter(s)	Affiliation(s)
1.	Implementing urban green infrastructure for local climate regulation: What is actually needed?	Teresa Zölch <sup>1</sup> Stephan Pauleit <sup>2</sup>	Teresa Zölch Stephan Pauleit	<sup>1</sup> TU München, Centre for Urban Ecology and Climate Adaptation (ZSK), München, Germany <sup>2</sup> TU München, Chair for Strategic Landscape Planning and Management, Freising, Germany
2.	A grassroot approach to climate change adaptation: The Dillingen model of stakeholder designed green spaces	Ulrike Aufderheide <sup>1</sup> Kerstin Lüchow <sup>2</sup> Karin Robinet <sup>3</sup>	Ulrike Aufderheide	<sup>1</sup> Planungsbüro Calluna, Bonn <sup>2</sup> Naturgarten e.V. , Heilbronn <sup>3</sup> Vebowag, Bonn
3.	Nature-based solutions for climate protection in urban areas: The example of New-Type Urbanization in China	Lile Hu	Lile Hu	Chinese Research Academy Of Environmental Sciences (CRAES), Bundesamt fuer Naturschutz (BfN)
4.	Forested Floodplains: Adaptive Response to Climate Change via managed Woody Vegetation	Heike Markus-Michalczyk	Heike Markus-Michalczyk	University of Hamburg Biocenter Klein Flottbek and Botanical Garden Applied Plant Ecology
5.	Planning for green infrastructure in cities with the "Nature Value Explorer for Cities" tool: comparing scenarios	Rik Hendrix Inge Liekens Steven Broekx Leo De Nocker Leon Brabers	Rik Hendrix	VITO
6.	Incorporating consideration of ecosystem services into municipal planning: The case of Malmö, Sweden	Anna Sofie Persson <sup>1,2</sup> Helena Hansson <sup>1,2</sup> Juliet Lidgren <sup>2</sup> Åke Hesselkrans <sup>2</sup>	Anna Persson	<sup>1</sup> Centre of environment and climate research, Lund University, Sweden <sup>2</sup> Planning office, City of Malmö, Sweden
7.	The nexus of urban biodiversity, green space and ecosystem services in growing big cities in Germany and China	Karsten Grunewald <sup>1</sup> Lennart Kümper-Schlake <sup>2</sup> Wolfgang Wende <sup>1</sup>	Lennart Kümper-Schlake	<sup>1</sup> Leibniz Institute of Ecological Urban and Regional Development <sup>2</sup> Federal Agency for Nature Conservation
8.	Urban Green - Fit for Future	Anja Kries Rainer Luick Heidi Megerle	Anja Kries	University of Applied Forest Sciences, Germany
9.	Social-ecological perspective in urban biodiversity - a framework of a transdisciplinary research process	Marion Mehring Diana Hummel Alexandra Lux	Marion Mehring	ISOE - Institute for Social-Ecological Research, Germany Senckenberg Biodiversity and Climate Research Center BiK-F, Germany

No.	Titel	Author(s)	Presenter(s)	Affiliation(s)
10.	Agricultural cooperative "Co.r.ag.gio.", an example of urban agriculture in Rome (Italy) as a resilient strategy against urban climate change	Fridanna Maricchio Giacomo Lepri Ambra Brizi Angelo Panno Giuseppe Carrus	Fridanna Maricchio	Roma Tre University, Department of Education, Italy; ° Cooperative CoRAGio
11.	A concept for a multidisciplinary evaluation of ecosystem services of urban greens and their structural elements	M.Sc. Benjamin Daniels Dr. Richard Ottermanns Dr. Martina Roß-Nickoll	Benjamin Daniels	RWTH Aachen University Institute for Environmental Research
12.	Incorporating Green Infrastructure into Urban Realities – Potentials of Urban Brownfields	Stefanie Rößler Juliane Mathey	Stefanie Rößler	Leibniz Institute of Ecological Urban and Regional Development (IOER)
13.	Vertical Greening of Buildings as Measure for Urban Climate Change Adaptation A Socio-Geographical Study on the Actor Network in Oststadt District in Karlsruhe/ Germany	Katrin Beer <sup>1</sup> Monika Heyder <sup>2</sup> Pia Laborgne <sup>2</sup>	Katrin Beer	<sup>1</sup> Albert-Ludwigs-Universität Freiburg <sup>2</sup> European Institute for Energy Research (EIFER)
14.	Future perspectives on possible ways to benefit from nature-based solutions in urban planning	Leena Kopperoinen <sup>1</sup> Francesc Baro <sup>2</sup>	Leena Kopperoinen, Francesc Baro (co-presenter)	<sup>1</sup> Finnish Environment Institute SYKE <sup>2</sup> Institute of Environmental Science and Technology (ICTA) - Autonomous University of Barcelona (UAB)
15.	Strengthening the climate change adaptation role of spatial planning by modeling future formation of land use	Annamária Göncz Vilja Vaszócsik Krisztián Schneller	Krisztián Schneller	Lechner Nonprofit Ltd.
16.	The spirit of the place: community gardens in an enormous scale and its benefits in terms of stability	Arlinda Sheqiri	Arlinda Sheqiri	Politecnico di Milano
17.	Analysis of Health Promoting Strategies, Processes and Instruments for Adaptation to Climate Change in Municipality at the Interface between Environment, Public Health and Urban Planning	Claudia Hornberg Thomas Claßen Timothy McCall	Claudia Hornberg Thomas Claßen Timothy McCall	University of Bielefeld, Faculty of Health Sciences



No.	Titel	Author(s)	Presenter(s)	Affiliation(s)
18.	Future Food Commons: New models of consumer-producer interaction in urban food supply – trends and impacts	Annette Piorr Kathrin Specht Ingo Zasada Rosemarie Siebert Ina Opitz Anita Beblek Philine Warnke Elna Schirrmeister	Annette Poirr	Leibniz-Centre for Agricultural Landscape Research (ZALF e.V.)
19.	WORLD URBAN PARKS	Anna Steidle		WORLD URBAN PARKS EUROPE REGION
20.	Investigating the multifunctional role of allotment gardens and urban farms in climate change impact reduction in the Czech cities	Frelichova Jana <sup>1</sup> Streberova Eva <sup>1,2</sup> Szkaradkiewicz Marta <sup>1,3</sup> Vackar David <sup>1</sup>	Streberova Eva, Szkaradkiewicz Marta	<sup>1</sup> Global Change Research Centre, Czech Republic <sup>2</sup> CE SPECTRA - Slovak University of Technology and Slovak Academy of Sciences, Slovakia <sup>3</sup> Wrocław University of Environmental and Life Sciences, Poland
21.	Landform diversity - basis to spatial biodiversity for mitigation of ecological problems	Siegmar Thomas	Siegmar Thomas	Dresden University of Technology
22.	Stimulating the uptake of Green Infrastructure in various sectors as a contribution to nature-based climate adaptation in urban areas	Clair Vos Joke Luttk	Clair Vos	Alterra, Wageningen University and Research Centre, The Netherlands
23.	Remote Sensing – Green Roof Inventory and Potential Analysis	Wolfgang Ansel <sup>1</sup> Julian Zeidler <sup>2</sup>	Wolfgang Ansel	<sup>1</sup> German Roof Gardener Association (DDV) <sup>2</sup> German Aerospace Center (DLR)
24.	Using urban ecological results in city planning - the example of the impact of vegetation on human bioclimate	Angela Hof <sup>1</sup> Márton Kiss <sup>2</sup> Ágnes Takács <sup>2</sup> Eszter Tanács <sup>2</sup> Ágnes Gulyás <sup>2</sup>	Angela Hof	<sup>1</sup> Department of Geography and Geology, University of Salzburg, Austria <sup>2</sup> Department of Climatology and Landscape Ecology, University of Szeged, Hungary
25.	Functional diversity and resilience - How biodiversity information could be restructured to better meet needs of resilient ES provisioning	Erik Andersson	Erik Andersson	Stockholm Resilience Centre, Stockholm University

No.	Titel	Author(s)	Presenter(s)	Affiliation(s)
26.	MedMossRoofs: Urban green covers with no irrigation requirements under Mediterranean climate	Ricardo Cruz de Carvalho <sup>1</sup> Artur Santos <sup>1</sup> Filipe Alves <sup>1</sup> Laura Concostrina <sup>1</sup> Leena Luis <sup>1</sup> Teresa Paço <sup>3</sup> Paulo Palha <sup>2</sup> Sarah Milliken <sup>4</sup>  Cristina Branquinho <sup>1</sup> Benz Kotzen <sup>4</sup>	Ricardo Cruz de Carvalho	<sup>1</sup> cE3c – Centre for Ecology, Evolution and Environmental Changes, University of Lisbon, Portugal <sup>2</sup> Neoturf – Construção e Manutenção de Espaços Verdes Lda., Portugal <sup>3</sup> LEAF, Instituto Superior de Agronomia, University of Lisbon, Portugal <sup>4</sup> Faculty of Architecture, Computing & Humanities, University of Greenwich, UK
27.	Initiating, coordinating and supporting local activities for climate change adaptation –the approach of Stuttgart Region and the example “Green Living Room Ludwigsburg”	Silvia Weidenbacher Thomas Kiwitt	Silvia Weidenbacher	Verband Region Stuttgart
28.	„Nature into grey zones“	Michaela Shields Anke Valentin Birgit Netz-Gerten	Michaela Shields	Wissenschaftsladen Bonn e.V., Germany
29.	European Research project TURAS and the Urban Green Infrastructure Approach	Stuart Connop <sup>1</sup> Silvia Weidenbacher <sup>2</sup>	Silvia Weidenbacher	<sup>1</sup> Fellow University of East London <sup>2</sup> Verband Region Stuttgart
30.	Adaption to Climate Change - the TURAS demonstration site “Green Living Room Ludwigsburg”	Silvia Weidenbacher	Silvia Weidenbacher	Verband Region Stuttgart
31.	Climate buffers are necessary	Geerte de Jong	Paul Vertegaal	Friese Milieu Federatie
32.	Bioindicators for land use and climate change – bats at the urban-rural interface	Nicole Starik Ulrich Zeller	Nicole Starik	Humboldt-Universität zu Berlin, Faculty of Life Sciences, Albrecht Daniel Thaer-Institute of Agricultural and Horticultural Sciences

## Annex 4 - List of Participants

Gender	Last name	First name	Institution	Country
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Mr	Ansel	Wolfgang	Deutscher Dachgärtner Verband	Germany
Ms	Aufderheide	Ulrike	Planungsbüro CALLUNA	Germany
Mr	Baró	Francesc	Institute of Environmental Science and Technology (ICTA) - Autonomous University of Barcelona (UAB)	Spain
Mr	Bede-Fazekas	Ákos	Centre for Ecological Research, Hungarian Academy of Sciences	Hungary
Ms	Beer	Katrin	European Institute for Energy Research	Germany
Mr	Beninde	Joscha	Trier University	Germany
Ms	Birnbeck	Sabine	Landesbund für Vogelschutz	Germany
Ms	Bockmühl	Kathrin	German Federal Agency for Nature Conservation	Germany
Ms	Bonn	Aletta	iDiv / UFZ	Germany
Ms	Bornholdt	Hanna	Ministry of Environment and Energy, Directorate General of Nature Conservation, Landscape Architecture and Energy	Germany
Ms	Brack	Franziska	Landesbetrieb Wald und Holz NRW - Fachbereich Holzwirtschaft, Forschung, Klimaschutz	Germany
Mr	Braubach	Matthias	WHO European Centre for Environment and Health	Germany
Ms	Brenck	Miriam	Helmholtz Centre for Environmental Research	Germany
Ms	Bruggisser	Odile	Departement Bau, Verkehr und Umwelt, Abteilung Landschaft und Gewässer	Switzerland
Mr	Bruyninckx	Hans	European Environment Agency	Denmark
Ms	Cabral	Maria Ines	iDiv	Germany
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Ms	Chen	Hung-Yu	TU-WIEN	Austria

<b>Gender</b>	<b>Last name</b>	<b>First name</b>	<b>Institution</b>	<b>Country</b>
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Mr	Craps	Marc	KU Leuven	Belgium
Mr	Cruz de Carvalho	Ricardo	cE3C - Faculty of Sciences - University of Lisbon	Portugal
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Ms	Davis	McKenna	Ecologic Institute	Germany
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Mr	De Vreese	Rik	BOS+ ngo	Belgium
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Mr	Dury	Stephen	Somerset County Council	UK
Mr	Edelmann	Hans Georg	University of Cologne	Germany
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Ms	Engel	Sophia	Landesbund für Vogelschutz	Germany

<b>Gender</b>	<b>Last name</b>	<b>First name</b>	<b>Institution</b>	<b>Country</b>
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Ms	Georgi	Birgit	European Environment Agency	Denmark
Ms	Godin	Marie-Céline	Brussels Environment	Belgium
Mr	Gomez-Baggethun	Erik	Norwegian Institute for Nature Research	Norway
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<b>Gender</b>	<b>Last name</b>	<b>First name</b>	<b>Institution</b>	<b>Country</b>
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Ms	Jessel	Beate	German Federal Agency for Nature Conservation	Germany
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Mr	Köhler	Manfred	Hochschule Neubrandenburg	Germany
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<b>Gender</b>	<b>Last name</b>	<b>First name</b>	<b>Institution</b>	<b>Country</b>
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Mr	Kronenberg	Jakub	University of Lodz	Poland
Mr	Krull	Wilhelm	VolkswagenStiftung	Germany
Mr	Kümper-Schlake	Lennart	BfN - German Federal Agency for Nature Conservation	Germany
Ms	Kunze	Kerstin	Hanseatische Naturentwicklung GmbH	Germany
Ms	Kusaite	Lina	Freelanc	Belgium
Mr	Lang	Werner	TU München	Germany
Mr	Lanza	Francesco	Thetis S.p.A.	Italy
Mr	Leiner	Stefan	European Commission, DG Environment	Belgium
Mr	Lemaitre	Frederic	FRB (BiodivERSA3)	France
Ms	Leuterer	Julia	ARTS Project Europe	Germany
Ms	Lijzenga	Susan	Waterschap Vechtstromen	The Netherlands
Mr	Lingner	Stephan	EA European Academy	Germany
Mr	Lipp	Torsten	University of Potsdam	Germany
Ms	Llobet	Victoria	European Liaison Office of the German Research Organisations	Belgium
Ms	Lohner	Herbert	BUND Berlin	Germany
Ms	Lorentz	Neomi	GIZ	Germany

<b>Gender</b>	<b>Last name</b>	<b>First name</b>	<b>Institution</b>	<b>Country</b>
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Ms	Mace	Georgina	University College London	UK
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Mr	Makan	Neville	Scottish Natural Heritage	Scotland
Ms	Malmnäs	Katarina	European Investment Bank	Luxembourg
Ms	María Teresa	Escamilla Bran	GIZ	Guatemala
Ms	Markus-Michalczyk	Heike	University of Hamburg	Germany
Mr	Mascarenhas	André	CENSE (Universidade NOVA de Lisboa) & Humboldt Universitaet zu Berlin	Germany
Mr	Mata	Duarte	Câmara Municipal Lisboa - Lisbon Municipality	Portugal
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Ms	Mayer	Katharina	Universität Konstanz	Germany
Mr	McCall	Timothy	University of Bielefeld	Germany
Ms	Mehring	Marion	ISOE - Institute for Social-Ecological Research	Germany
Ms	Mertens	Julia	Gartennetzwerk Dresden (über IÖR Dresden)	Germany
Mr	Moret	Nicholas	ZEF Center for Development Research	Germany
Mr	Mueller	Christian	Bochum University of Applied Sciences	Germany
Mr	Muniz	Rodrigo	Climate Change Impacts, Adaptation and Modelling (CCIAM), Centre for Ecology, Evolution and Environmental Changes (cE3c), Faculty of Science, University of Lisbon	Portugal
Ms	Naumann	Sandra	Ecologic Institute	Germany
Mr	Nero	Bertrand	Center for Development Research, ZEF	Germany
Ms	Noring	Luise	Copenhagen Business School	Denmark
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Ms	Nyenhuis	Ulrike	German Federal Ministry for the Environment	Germany



<b>Gender</b>	<b>Last name</b>	<b>First name</b>	<b>Institution</b>	<b>Country</b>
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Mr	Pauleit	Stephan	Technical University of Munich	Germany
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Ms	Reuter	Katrin	Museum für Naturkunde Berlin	Germany
Mr	Rink	Dieter	Helmholtz-Centre for Environmental Research-UFZ	Germany
Mr	Ries	Felix	GIZ	Germany
Ms	Rok	Ania	ICLEI Local Governments for Sustainability	Germany
Ms	Roß-Nickoll	Martina	RWTH Aachen University, Insitute for Environmental Research	Germany
Mr	Ruecker	Gerd	DLR	Germany
Mr	Rusche	Karsten	ILS - Research Institute for Regional and Urban Development	Germany
Ms	Lindenberg	Stefanie	European Investment Bank	Luxembourg
Mr	Sasko	Tomas	Uni Bayreuth	Germany
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Mr	Scheele	Ulrich	Arbeitsgruppe für regionale Struktur- und Umweltforschung GmbH (ARSU)	Germany
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<b>Gender</b>	<b>Last name</b>	<b>First name</b>	<b>Institution</b>	<b>Country</b>
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