

Workshop report

**European Expert Workshop on Urban Biodiversity and Health in the Face of Climate Change:
Opportunities, challenges and evidence gaps – Towards management and policy
recommendations**

Isle of Vilm, 05. – 06. October 2016



Organised by the German Federal Agency for Nature Conservation (BfN) and ENCA Climate Change Interest Group (European Network of Heads of Nature Conservation Agencies)

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1 Introduction

Climate change and increasing urbanization poses significant challenges to both human health and biodiversity. Extreme weather events such as flooding and heat waves, exacerbated by the urban heat island effect, can cause illnesses and premature death (IPCC, 2014). Urban living is associated with environmental stressors – like noise and air pollution, heat, crowding, crime – which can negatively affect human health and wellbeing (Evans, 1982). Urban development transforms open landscapes into enclosed landscapes (Seto et al., 2011), which may lead to biodiversity loss (Millennium Ecosystem Assessment, 2005), an increase in soil sealing, and decreases in the quantity and access to urban green and blue spaces (Kabisch, Stadler, Korn, & Bonn, 2017). New approaches are needed in order to mitigate and adapt to negative effects of climate change and urbanization and to maximize opportunity for improving the health of urban residents.

For centuries, people have used the natural environment as a place for positive health and wellbeing (Ward Thompson, 2011). A large body of empirical research has shown that contact with nature can improve human health and wellbeing (Bowler et al., 2010; Hartig et al., 2014). Natural environments have been shown to reduce physiological and psychological stress, depression, and negative emotions and improve positive emotions, cognitive abilities and mental wellbeing – compared to urban environments. Natural environments may also contribute to social equality. For example, living near to a natural environment has also been found to reduce social inequalities in health (Mitchell & Popham, 2008).

The majority of the studies of the health benefits of nature consider nature as homogeneous, without consideration of its ecological quality. At present, there is a growing recognition of the importance of biodiversity to human physical, psychological and social health and wellbeing (Lovell et al., 2014; Marselle et al., 2015; Marselle et al., 2016). The level of objective biodiversity in the environment has been found to be positively associated with health (Hough, 2014; Jorgensen & Gobster, 2010; Lovell et al., 2014; Wheeler et al., 2015), psychological well-being (Carrus et al., 2015; Fuller et al., 2007) and positive emotions (Cracknell, et al., 2016; Johansson et al., 2014). Similarly, subjective biodiversity of birds, butterflies and plants/trees has been positively correlated with psychological wellbeing (Dallimer et al., 2012). This developing research, highlighting the importance of biodiversity to human health and wellbeing in the face of climate change, argues that conservation of biodiversity and urban green spaces is a social imperative.

There is great potential for synergies between public health, nature conservation and climate change adaptation. Natural environments can play an important role as a natural health clinic to promote human health and wellbeing (Maller et al., 2005; Nilsson et al., 2011). Nature can be a cost-effective measure to support public health. Positive experiences in nature contribute to feelings of connection to nature (Mayer et al., 2009), which could result in greater acceptance of nature conservation activities and pro-environmental behaviours (Zelenski et al., 2015).

Nature-based solutions for climate change mitigation and adaptation provide an opportunity to benefit both biodiversity conservation as well as health promotion. Solutions for mitigating climate change can include carbon capture through photosynthesis in plants or carbon storage in soils. Adaptation to climate change can include making space for flood plains to reduce flood risk or using green infrastructure for local microclimate regulation. These nature-based solutions can have “multiple co-benefits for health, the economy, society and the environment, and thus they can represent more efficient and cost-effective solutions than more traditional approaches” (European Commission DG Research and Innovation, 2015; Kabisch et al., 2017). Thus, governments and planners applying nature-based solutions for climate change mitigation and adaptation should also consider the added value of the project for biodiversity conservation and positive human health and wellbeing.

Biodiversity and human health is at the heart of high-level strategic decisions being taken at a national and international scale to deal with climate change, i.e. the WHO and the Convention of Biological Diversity (CBD; Conference of the Parties 12 Decision XII/21 on biodiversity and health); and the EU Council Sustainable Development Goal 11 encouraging nature-based solutions. High profile international evidence reviews on natural environments and health were recently published by the World Health Organisation (WHO) and the CBD (WHO & CBD, 2015), and the Institute for European Environmental Policy (IEEP)(IEEP, 2016) further highlight the international policy interest in this topic.

For these reasons, the German Federal Agency for Nature Conservation (BfN) and the European Network of Heads of Nature Conservation Agencies (ENCA) Climate Change Interest Group in collaboration with the Helmholtz-Centre for Environmental Research (UFZ) and the German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig organized a European Expert Workshop on “Urban Biodiversity and Health in the Face of Climate Change: Opportunities, challenges and evidence gaps – towards management and policy recommendations” from 05. – 06. October 2016 at the International Academy for Nature Conservation Isle of Vilm, Germany.

Definitions of common words used in this workshop – such as urban green space, biodiversity, health – are listed in Table 1.

Table 1: Definitions of commonly used terms.

Definitions of commonly used terms	
Biodiversity	“The diversity of life on Earth – the variability among living organisms and the ecological complexes of which they are part. Three levels of biodiversity are distinguished: first, the diversity of ecosystems, ecological communities, habitats and landscapes, second, the diversity among species, and third, the genetic variety within species” (German Federal Agency for Nature Conservation (BfN), 2016, following the Convention of Biological Diversity (CBD), 1992).
Green infrastructure	“A strategically planned network of high quality natural and semi-natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings” (European Commission, 2013).
Health	“A state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity” (World Health Organisation, 1948).
Nature-based climate change adaptation and mitigation	“In nature-based climate change mitigation, ecosystem services are used to reduce greenhouse gas emissions and to conserve and expand carbon sinks. In nature-based climate adaptation, the goal is to preserve ecosystem services that are necessary for human life in the face of climate change and to reduce the impact of anticipated negative effects of climate change (e.g. more intense rainfall, more frequent floods as well as heat waves and droughts)” (Naumann et al., 2014).

Definitions of commonly used terms	
Nature-based solutions	“...actions which are inspired by, supported by or copied from nature. They have tremendous potential to be energy and resource-efficient and resilient to change, but to be successful they must be adapted to local conditions. Many nature-based solutions result in multiple co-benefits for health, the economy, society and the environment, and thus they can represent more efficient and cost-effective solutions than more traditional approaches.” (European Commission DG Research and Innovation, 2015).
Urban green space	“The most common definition of urban green space that has been used in studies in Europe is based on the defined from the European Urban Atlas...code 14100 includes public green areas used predominantly for recreation such as gardens, zoos, parks, and suburban natural areas and forests, or green areas bordered by urban areas that are managed or used for recreational purposes” (World Health Organisation, 2016c).
Wellbeing	“A positive state of mind and body, feeling safe and able to cope with a sense of connection with people, communities and the wider environment” (sometimes referred to as mental wellbeing or emotional wellbeing) (UK Government, 2011).

2 Objectives

The aim of this European Expert Workshop was to showcase and to explore existing evidence and case studies on the health effects of urban green space and biodiversity. The workshop had four objectives:

1. Assess the positive contribution nature-based solutions for climate change mitigation and adaption may have to human health and biodiversity.
2. Assess how green space and biodiversity could positively influence human health, and to provide guidance to planning and implementation initiatives with experts from science, policy and society.
3. Identify opportunities, challenges and barriers of green space intervention strategies.

This workshop also served as a think-tank to steer the content of the international BfN/ENCA conference on “Biodiversity and Health in the Face of Climate Change” on 27—29 June 2017 in Bonn, Germany.

3 Methodology

The workshop was organized in two full days with different sessions of framing keynote presentations, panel discussions and group activities and discussions. The workshop started with a short ice-breaker at the evening of the 4th October in order to present the objectives of the workshop, introduce the participants and discuss main expectations from the participants.

The first full day started with keynote presentations that provided an overview of the scientific evidence for the effects of urban biodiversity and health in a changing climate. Keynote presentations were followed by a brainstorming session on current demonstration projects and intervention studies.

The afternoon session focused on the 2015 BfN nature awareness study (Küchler-Krischun, et al., 2016) and followed by a keynote presentation on the WHO's "Regions for Health Network". The first day ended with an outlook on the forthcoming European BfN/ENCA Conference 'Biodiversity and Health in the Face of Climate Change' in Bonn (27-29 June 2017) and identification of the main questions to be addressed in the planned parallel working sessions of the conference.

The morning session of the second day continued with the policy context presented through plenum presentations. The subsequent group exercise took place in form of a world café, dividing the participants into two groups – Science and Policy/Practice. Participants were asked to discuss and brainstorm on four different issues. Pin boards were used to collecting information and facilitating discussions. Results were presented in a plenary discussion in the afternoon session. The final evening session was used for final plenum presentations focusing on selected case studies related to nature-based solutions promoting health and social integration.

4 Results

4.1 Keynote presentations – Wednesday morning session

Rebecca Lovell (University of Exeter Medical School, UK) gave a general overview of the evidence on urban nature, health and climate change. Although premature death rates have been significantly reduced over the past 50 years, non-communicable diseases like chronic respiratory diseases, cardiovascular diseases, diabetes, cancer and mental disorders are on the rise (WHO, 2016b). The World Health Organization (WHO) states that “whether people are healthy or not, is determined by their circumstances and environment [...] factors such as where we live, the state of our environment [...] have considerable impacts on health [...] the more commonly considered factors such as access and use of health care services often have less of an impact” (WHO, 2016a).

Green spaces are very important to health, especially for people living in urban areas. Research shows reduced rates of all-cause mortality within greener urban environments – especially in the most deprived neighbourhoods (Mitchell and Popham 2008). It can be concluded that there are positive relationships between “natural” environments and health in the urban setting. However, in the majority of studies on health impacts of green space, the green space is typically examined as a uniform concept, without examining the specific features, characteristics, composition or structure of the green space. Furthermore, there aren't the same effects across different population groups, health outcomes and places. These vary according to the type and features of the place, the person experiencing natural environments and their (and their community's and culture's) prior expectations and experiences. For example, cardiovascular disease and respiratory disease mortality rates decrease with increasing green space for men but not for women, showing noticeable gender differences in relationships between urban green space and health in the United Kingdom (Richardson and Mitchell 2010). How to assess the relationship might play an important role, too. Rebecca pointed out that the evidence of the relationship between biodiversity and good human health and well-being varies depending on scale. On the national level, the biodiversity and health relationship mainly shows an inverse relationship. At a much more local level – reflecting how people experience urban nature on a day-to-day basis - more biodiverse areas are more appreciated and relate to better health outcomes. Looking at urban green interventions and their effects, a small amount of mixed evidence was found. However, Rebecca highlighted that not all green is beneficial; sometimes “urban green space strategies may be paradoxical: while the creation of new green space to address environmental justice problems can make neighbourhoods healthier and more aesthetically attractive, it also can increase housing costs and property values” (Wolch et al. 2014). Nevertheless, promoting the use of urban natural spaces as a long-term and multi-component intervention seems to be the most effective way — although there is still no full understanding of what works, for whom or in what circumstances.

The state of the environment (e.g. presence of litter) influences how people feel about it and thereby impacts health (Ellaway et al., 2009). A synthesis of the results of 14 studies showed that there is some evidence to suggest that exposure to biodiverse environments may relate to better health and well-being in humans (Lovell et al., 2014). But people perceive biodiversity differently. One study found participant's perception of species richness (birds, butterflies and plants) was positively associated with self-reported well-being (Dallimer et al., 2012). However, they found no association between perceived and actual species richness, in general people are not very good at assessing biodiversity (Dallimer et al., 2012). Furthermore, Rebecca emphasized the aspect of social inequalities – stressing that certain groups are less likely to use urban green due to disabilities, illnesses, historical and socio-cultural legacies (Hollenbeck 2016). Even the type and frequency of childhood experiences relates to the comfort in natural spaces (Ward Thompson et al., 2007). As health related impacts of climate change are likely to be particularly acute in urban areas, “greening our communities with trees and

green infrastructure is one of the most important things we can do to reduce the risks of heat illness and flooding” (Public Health Institute/Center for Climate Change and Health, 2016). In conclusion, more robust longitudinal intervention evidence to inform future activities, in particular on climate change adaptation and health promotion, is needed.

Following this, **Dörte Martens** (Eberswalde University for Sustainable Development, Germany) introduced the psychological effects of urban nature and biodiversity. According to Evolutionary Theory of Stress Reduction (Ulrich, 1983) and Attention Restoration Theory (Kaplan and Kaplan, 1989) evidence exists that exposure to nature has positive effects on physical (Schneider-Ulmann et al., 2010), social (Milligan, Gatrell & Bingley, 2004; Sempik, Aldridge & Becker, 2005) and psychological (see Lee & Maheswaran, 2011; Hartig et al., 2003) well-being. Nevertheless the effects of different natural environments (forests, agricultural land, gardens and natural experience areas) have to be differentiated. Dörte gave an overview on a variety of empirical studies and demonstrated the potential of natural areas for health. The aim should be the accessibility and availability of urban green space for all population groups and providing a multifunctional use.

Stefan Heiland (TU Berlin, Germany) referred to the project “Green, natural, healthy” (2012 – 2014; Rittel et al., 2016) on health potentials of multifunctional urban greenspaces. The majority of current planning practices do not consider the topic of human health in terms of health promotion. To answer the question “How can health promotion be integrated in urban nature conservation and urban planning?” Stefan Heiland suggested that situational prevention – i.e. establishing a healthy urban environment through the use of urban green space – may be an appropriate approach.

In cooperation with health scientists and four participating German municipalities, guidelines for integrating health into urban nature conservation and planning were developed. The aim of the guidelines is to support the enhancement of urban green for the benefit of human health as well as for biodiversity. Consequently, the guidelines include material for municipalities regarding:

a) science based arguments for municipal practice regarding health effects of urban green, b) a criteria checklist for identifying health-promoting potentials of urban green spaces and c) general requirements of different user groups.

Finally, Stefan Heiland presented a case study of health considerations in landscape planning from the “Bewegungsstadtplan Leipziger Osten” project.

The first keynote session was closed by a presentation from **Regina Treudler** (University Leipzig, Germany) about “Allergenic plants and their relevance to human health in a changing climate – Ambrosia as a case study”. Ambrosia or ragweed is a neophyte in Europe, originating from the United States of America that is now spreading aided by a changing climate. The Ambrosia pollen is a highly inhalative allergen, producing symptoms of hay fever. Because of the very small pollen, that are inhaled deep into the lower airways and the very low concentration (about 10 pollen/m³) needed to evoke allergic symptoms, Ambrosia often leads to asthma. The consequences of Ambrosia and its concomitant hay fever symptoms can include reduced quality of life for the individual and economic burden for society. Considering the time lag between Ambrosia sensitization and Ambrosia allergy (Tosi et al. 2011), and the Ambrosia sensitization rate of 8.2 % in Germany (Haftenberger et al. 2013), understanding Ambrosia distribution and colonization of urban habitats and actions (e.g. detecting and eliminating Ambrosia plants) is important for the prevention of ill health.

4.2 Main discussion points from the keynote presentations

Several issues and questions were raised during the discussions of the presentations, such as:

- Can urban green/ urban nature be equated with urban biodiversity?
- How is urban biodiversity defined? How can it be measured?
- What are the causal relationships between urban green spaces – presence and use – and health outcomes? What results can be expected from changes in urban green space availability and use?
- What qualities of urban green spaces should be promoted to increase citizens' health and well-being?
- Are self-reported or objective recorded health measures better for assessing health outcomes? Is it more difficult to identify any relationship between health and green spaces when physical health is measured quantitatively?
- Are there assessment tools or a criteria checklist to see which indicators/factors should be considered for potential health impacts?
- How can urban green spaces be planned to avoid major conflicts between different user groups (biking, walking, running, dog walking)?
- What do municipalities and city planners want to know? What data do they need for implementing nature-based health promoting activities in city planning?
- The issue of social-environmental equity in biodiversity and health research needs to be addressed. For example, poor people live in less green areas with less access, whilst people with high incomes can choose to live close to urban green spaces. What are the effects on well-being?
- Are there scenarios about the allergenic reactions of people correlated to climate change?
- Are there any plans for international cooperation on eradication programs of ambrosia/ragweed? How can we sensitize politicians to think beyond their election period?
- Can the increasing number of allergies especially for young people be seen as indicator of fundamentally bad living conditions? Why are more and more people getting allergic? Should we fight ambrosia/ragweed or against the whole complexity of allergies? Nevertheless, it was confirmed by the audience that having a look on both sides is essential – getting rid of the plants as well as looking at resilient patients to understand the underlying mechanisms of the allergies (e.g. correlations with preservatives in food, epigenetic effects, contact with nature in childhood).
- Is there a correlation/evidence between rural/urban places and pollen release?

4.3 Brainstorming and first group discussion

4.3.1 Mapping exercise of current projects and activities

In the first group discussions participants were asked to map projects that work with nature and green infrastructure (GI) to realize health and social benefits in cities at different spatial scales. The four spatial scales, from local to international, are detailed in Figure 1. Responses were clustered according to three pillars of science, policy and practice (Figure 1).

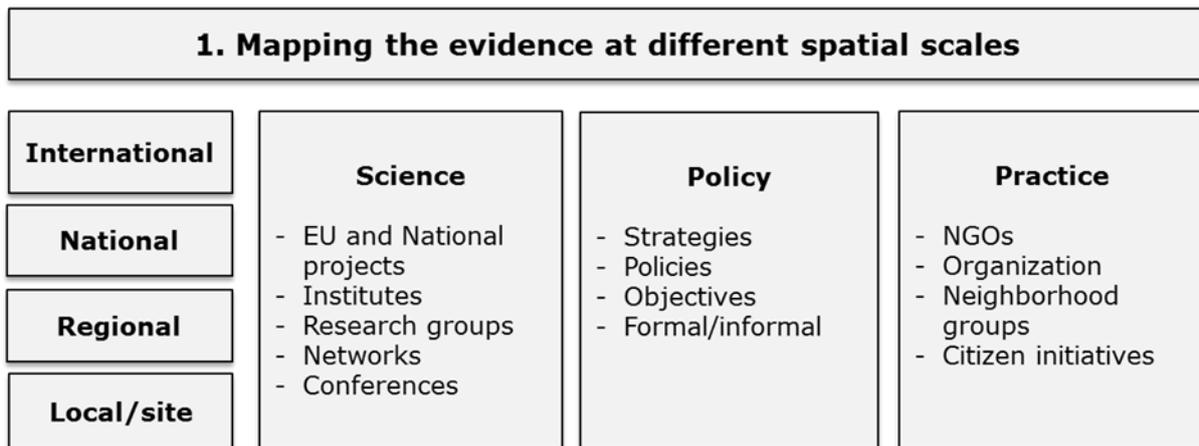


Figure 1: Structure of the mapping exercise.

As a second task participants were asked to identify health, policy and practice indicators that address health effects from biodiversity.

4.3.2 Projects that work with nature and GI for health and wellbeing in cities

The following summarizes the results of the discussion from the first task.

At the scientific, international level, there are many research projects, initiatives and programmes working with nature and GI to realise health and social benefits. Large consortium projects include:

- IAPS (International Association People-Environment Studies, <http://www.iaps-association.org>);
- GREEN SURGE (Green Infrastructure and Urban Biodiversity for Sustainable Urban Development and the Green Economy, <http://www.greensurge.eu>);
- PHENOTYPE (Positive health effects on the natural outdoor environment in typical populations of different regions in Europe, <http://www.phenotype.eu>);
- The Breath Project (<http://www.thebreathproject.org>);
- EcoHealth (International Association for Ecology & Health, <http://www.ecohealth.net/en>);
- One Health (One Health Organisation, www.onehealthorganisation.org);
- MAES Urban Pilot (Mapping and Assessment of Ecosystems and their Services, <http://www.biodiversity.europa.eu/maes>),
- EKLIPSE ‘knowledge and learning mechanism on biodiversity and ecosystem services (http://www.eclipse-mechanism.eu/about_eclipse), and
- future Horizon 2020 EU projects that will be funded in the current call “Demonstrating innovative nature-based solutions in cities”

(<http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/scc-02-2016-2017.html>).

The following international scientific programmes and institutions work with nature and GI to realise health and social benefits: UNEP (United Nations Environment Programme) and EEA (European Environment Agency). Reviews of the evidence of greenspace on health have been published by the WHO (WHO, 2016c; WHO, 2017) and the Institute for European Environmental Policy (IEEP) (IEEP, 2016).

There are also clear scientific activities on the national level. For example, in Germany, several activities were listed, such as: Natural Capital Germany (Naturkapital Deutschland – TEEB DE)(see Kowarik et al., 2016); NatGesIS DE (Nature Conservation and Health)(see Erdmann et al., 2008); Resilient Cities (Leitinitiative Zukunftsstadt, Ministry of Research and Education BMBF funding programme for national and regional cohort studies). For the UK, the government department DEFRA (Department for Environment Food & Rural Affairs) funds many projects on this topic, as well as the Natural Environment Research Council's (NERC) Valuing Nature Programme. The government advisor on the natural environment in England, Natural England, hosts an annual survey on the ways in which people engage with the natural environment – “Monitor of Engagement with the Natural Environment”.

In general, scientific studies at the regional and local level were considered to be very limited.

In the international policy arena, the collaboration between the WHO and the Convention on Biological Diversity (CBD) was highlighted with special reference to CBD Conference of the Parties (COP) 12 Decision XII/21 on Biodiversity and human health (2014) (www.cbd.int/decision/cop/default.shtml?id=13384). Also highlighted were the conclusions from the EU Council on Habitat III, giving important impetus especially to the Sustainable Development Goal (SDG) 11 by encouraging Nature-based Solutions¹. Regarding policy at the national level in Germany, the Health Ministry, the Ministry of Education, and the research programme “Social Cities” were quoted. The German “Healthy Cities Project” is an example of regional level policy on nature and health. Policy, however, is often confronted with challenges of various responsibilities on national and regional levels with differences across countries in law, regulations and processes that could hinder cooperation.

In the practice arena, there was a clear focus on projects and stakeholders working at the local level, but few activities at the international and national level. At international level, practice-based nature-health projects generally focused on dealing with global change (e.g. climate change and increased urbanization) and/or decreasing public knowledge on ecosystems (e.g. lack of knowledge due to less contact to nature during childhood). Importantly, the World Health Organisation (WHO, <http://www.who.int/sustainable-development/cities/health-risks/urban-green-space/en/>) and the International Union for Conservation of Nature (IUCN) (<https://www.iucn.org/theme/protected-areas/wcpa/what-we-do/health-and-wellbeing>), are both leading organisations promoting natural environment as an important factor for health and wellbeing. Both organisations publish case studies on urban green space intervention for health (e.g. WHO 2017).

On the national level, practice-based national projects included: “Social City” of the German Federal Ministry for the Environment (BMUB) (Soziale Stadt, <http://www.bmub.bund.de/themen/stadt-wohnen/staedtebau-foerderung/soziale-stadt-biwaq/soziale-stadt/>), “Urban Biodiversity” of the BfN (http://www.bfn.de/0321_veroe.html) or “Outdoors for All” by Natural England (<http://www.gov.uk/government/publications/outdoors-for-all-fair-access-to-a-good-quality-natural-environment>), as well as grass-roots networks like (intercultural) urban-gardening

¹ For the new urban agenda, global level, see <https://habitat3.org/the-new-urban-agenda>. For discussion on a new urban agenda, for the EU, see <http://urbanagendaforthe.eu/pactofamsterdam/>

(<http://anstiftung.de/urbane-gaerten/gaerten-im-ueberblick>; <http://anstiftung.de/die-stiftung/stiftung-interkultur>). Medical associations, unions, and foundations working on health-related ecosystem “dis-services” (like allergens) were also mentioned.

At the local level, governance and processes of practice-based nature and health projects can be complex as these projects often involve many different local government departments (e.g. environment, urban planning, and health departments). Additional issues for practice-based projects were highlighted, such as lack of knowledge-transfer and coordination between projects at national and international scales. Practice-based actions or measures posted for the local level were: the introduction of green infrastructure (e.g. green houses, roofs, walls), use of nature for physical activity (e.g. local health walks); urban gardening projects; and the introduction of environmental education programs to children. This was represented by examples of local practice like: the landscape-plan “Landschaftsplan” of the municipality of Hohen Neuendorf near Berlin (<http://www.hohenneuendorf.de/de/bauen-wirtschaft/stadtplanung/landschaftsplan/landschaftsplan>); the programme “fit in the park” in Munich (<http://www.muenchen.de/freizeit/sport/gymnastik-im-park.html>); free outdoor gym equipment in UK parks; local and national group walking programmes (e.g. www.walkingforhealth.org.uk; www.pathsforall.org.uk/); urban gardening projects supporting mental health programs (www.gib-bremen.info/urban_gardening_farming_gemuesewerft.php, <http://www.toentje.nl>); ‘eatable city’ projects (e.g. <http://incredibleediblenetwork.org.uk/>; www.andernach.de/de/leben_in_andernach/essbare_stadt.html); or a local tree-planting initiative “Baumstark” in Bielefeld, Germany (<http://www.uni-bielefeld.de/bi2000plus/projekte/baumstark.html>). Critical points addressed were: the need to address the different preferences and needs certain population groups have for urban green spaces; and the cross-departmental character of environmental health projects causing difficulties in the planning and implementation processes. With regard to a better implementation of projects, a higher level of knowledge exchange was considered important. This would help inform decision makers that nature-based solutions and green infrastructure can be more efficient and cheaper than grey infrastructure in achieving both conservation, climate change adaptation and health outcomes. Examples mentioned were knowledge bases like the BfN Urban Biodiversity Project (<https://www.bfn.de/22641.html>), case studies like the Environmental Justice for Social Cities Report (Umweltgerechtigkeit für die Soziale Stadt; http://www.bmub.bund.de/fileadmin/Daten_BMU/Pool/Broschueren/umweltgerechtigkeit_soziale_stadt_broschuere_bf.pdf) or city-networks like the Healthy Cities Network (<http://www.gesunde-staedte-netzwerk.de/>).

4.3.3 Indicators for assessing health effects from biodiversity

As a second task participants were asked to identify health, policy and practice indicators that address health effects from biodiversity. The following three subsections describe the outcomes of this task.

Indicators for assessing the health effects from biodiversity can be divided into objective and subjective (self-reported) measures to evaluate a) health and wellbeing outcomes, b) environmental exposure and c) measures of environmental exposure (see Figure 2). Health and wellbeing outcomes may include objective measures (e.g. sensitization rates on allergens, cortisol stress level and birth weight) or subjective measures (e.g. perceived health/well-being or feelings of safety). Whatever measures are used, it is important that validated measures are used for assessing the impact of urban green spaces on health and well-being. Furthermore, the influence of confounders should be considered.

Indicators of environmental exposure often focus on negative health impacts (see Figure 2). As such, environmental indicators of the positive health impacts of biodiversity – such as aesthetic value perceived by users of green spaces – need to be found. It was discussed how specific health effects from biodiversity relate to health, and how this can be measured. Another aspect discussed in the group was the confusion with terminologies (urban nature vs. urban biodiversity) and their contextual rele-

vance in research and practice. Understanding the underlying causes or mechanisms of the relationship between health and green infrastructure was mentioned as one of the main questions to be answered. A potential way of doing so would be to use citizen science for long-term studies; there are already a lot of data available from different sources (e.g. Big Data, Citizen Science), which could be analyzed reasonably. Furthermore, it was highlighted that air temperature and occurrence of extreme events can be seen as indicators in the face of climate change whereas e.g. air pollution due to dust is rather a matter of industrialization.

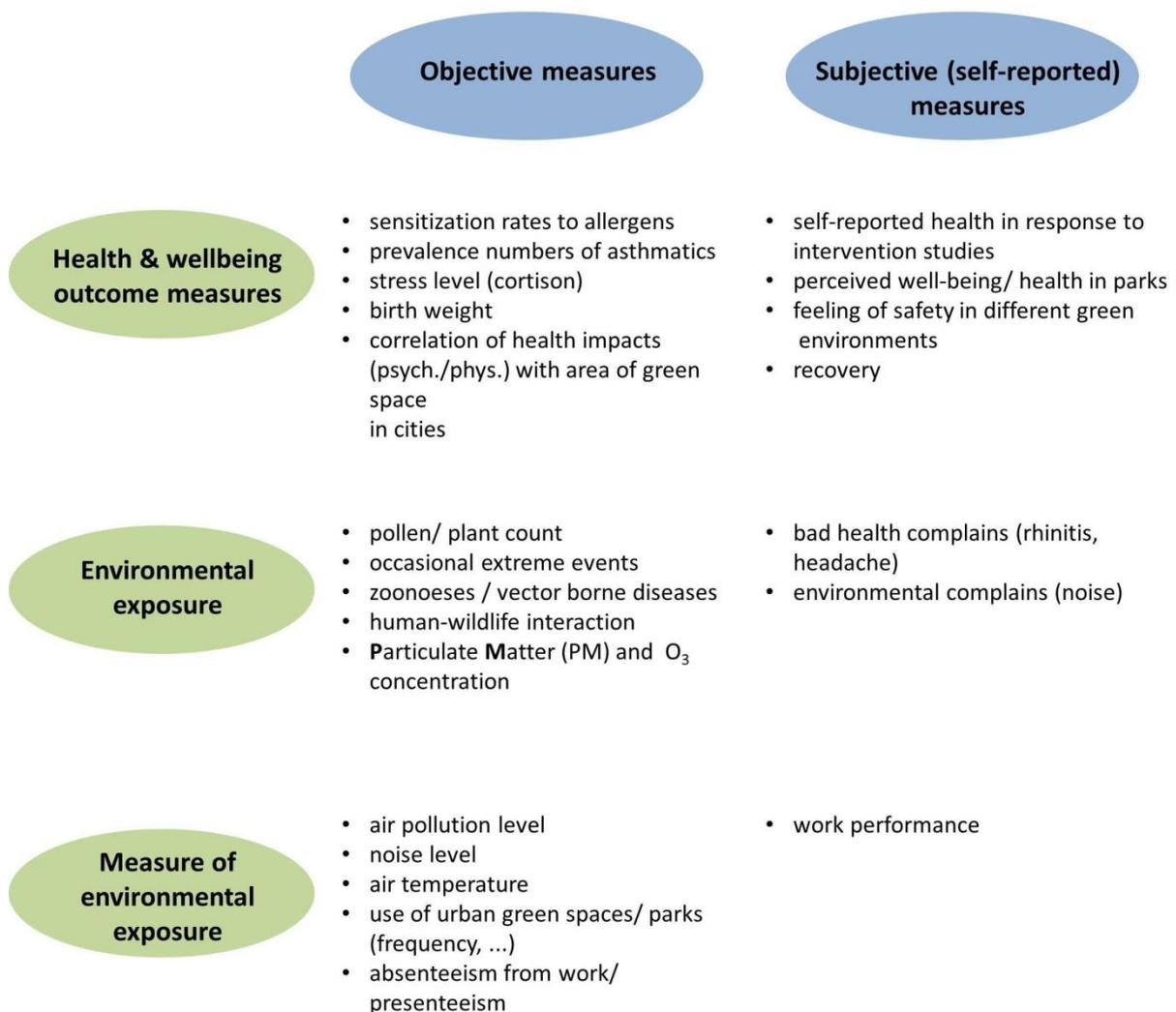


Figure 2: Potential indicators to address health effects from biodiversity.

4.3.4 Policy indicators which address health effects from biodiversity

The following describes the policy indicators which address health effects from biodiversity. Indicators relating to collaboration of sectors, the integration of health and biodiversity across various political sectors and government departments (e.g. urban planning), the co-production of policies with communities, and the relationship between health protection and health promotion were mentioned. The workshop participants discussed what exactly was meant with indicators, and whether if it is about indicators which enable politics to pursue a policy (like as requirement) or if it is about indicators which evaluate policies. On national and local level the money provided for clinical trials (e.g. from the Ger-

man ministry of education and research, BMBF), and the availability or access to urban green spaces can be taken as indicators, respectively. Furthermore there was the question on feasibility; can these indicators align with Health 2020, Sustainable Development Goals or other existing national indicators?

Workshop participants identified the concrete relationships between green space, biodiversity and human health, and the knowledge gaps of this relationship (Figure 3). Firstly, there is evidence that green space can have positive or negative impacts on health. Secondly, it is known that green spaces can be designed to foster biodiversity. The knowledge gap is the relationship between biodiversity and human health and wellbeing. Evidence in this relationship is lacking, and should be subject to future investigations.

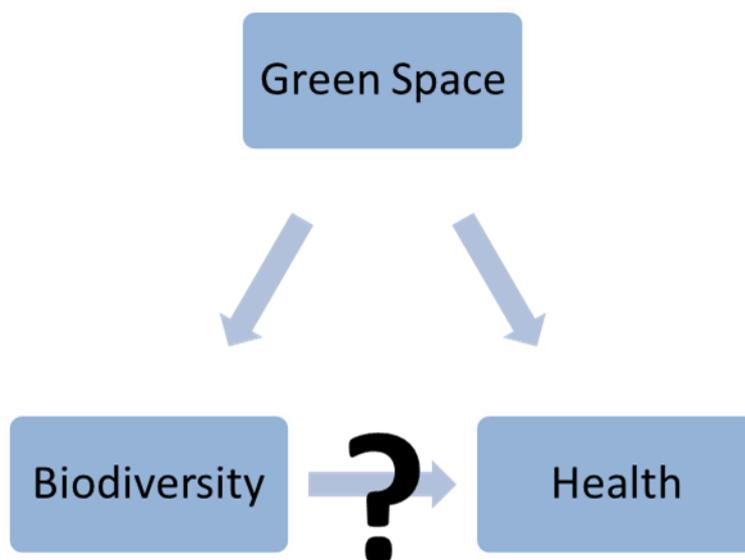


Figure 3: Flowchart on the relationship between green spaces, biodiversity and human health.

4.3.5 Indicators in practice which address health effects from biodiversity

The central question was to develop suitable indicators to assess urban green space projects relating to health. The group clustered their discussion points into four major themes: general issues, green space indicators, indicators for social equity and indicators of success.

In the cluster related to 'general issues', the group pointed out that it is difficult to measure biodiversity indicators on health directly, because of the difficulty in measuring biodiversity and the other socio-environmental influences on health. Proxies are therefore needed to assess positive health outcomes, and successful management of a project. In this context, a sound validation of the chosen indicators is essential. The selection of proxies has a very strong influence on the outcome of a study. Therefore, it was recommended that the selection of indicators should be done in a participatory manner, including stakeholder groups like researchers, experts, administrative personal, local populations and green space users (Cvitanovic et al., 2015; Cvitanovic, McDonald & Hobday, 2016). Furthermore, longitudinal evaluations of the health and wellbeing outcomes of urban green space projects are important to gain evidence on best practice for future planning.

Indicators of green space are often used instead of biodiversity indicators. Commonly used green space indicators used in research publications are: the availability of green space around a particular area (e.g. the quantity of green space per capita); green space quality (e.g. facilities, aesthetics); the accessibility to green space (e.g. ratio of public vs. privately owned green space); and the level of

participation of different user groups. The acceptance of certain green space types (e.g. deadwood) should be considered in this context.

With regard to social equity indicators, the group recommended to apply a milieu perspective based on the work by the SINUS Institute (<http://www.sinus-institut.de/sinus-loesungen/sinus-milieus-deutschland/>). The analysis of the health outcomes of urban green space by gender, age or socioeconomic status of green space user groups may provide a proxy for social justice.

The proposed indices for success of green space projects ranged from simple measures (e.g. the harvested yield of urban agriculture or the share of population taking part in projects) to rather complex themes (e.g. measuring the sustainability of a project and identifying the factors influencing the “survival” of good practices). For this purpose, a long-term evaluation of finished projects is essential. Finally, future evaluations should rather focus on potentials of green space projects than on deficits of the current situation (e.g. analyse health promotion effects instead of actual health problems).

4.4 Keynote presentations – Wednesday afternoon session

Carsten Hagenau (Projektkommunikation Hagenau GmbH, Germany) reported on the project “Gartenstadt Drewitz“ in Potsdam, Germany. In 2009, in the context of a federal competition, the project plan won the silver medal with recommendation to be implemented. However, the local residents were against the implementation of the project. The whole masterplan had to be redesigned according to the demands and wishes of the residents, discussed in 64 public events with all social groups. Comprehensive changes with regard to innovative urban redevelopment through the reorganization of traffic and green spaces, as well as socially acceptable restoration of the housing stock and the strengthening of the social infrastructure led to an enhancement in living quality of the district.

Carsten Hagenau underlined four observations in the process of implementation, which should be taken into account for future work:

1. The knowledge of architects or administration is one-dimensional. There is the need for a complete rethinking across sections and disciplines.
2. Networking and having mediators between disciplines is essential.
3. There were prejudices and reservations experienced among planners; many have denied to work for the project and socially deprived communities.
4. The maintenance of the green spaces should be considered in the long term.

Conclusion: Urban green space itself is not a goal for people. Increasing their residential quality is convincing people to change their environment. Green spaces can be used as a medium for that purpose.

Andreas Mues (BfN, Germany) reported on the “2015 Nature Awareness Study - Attitudes towards urban nature” (Küchler-Krischun, et al., 2016). Referring to the questionnaire developed for the study, general attitudes towards nature conservation were categorized into five attitudinal types/groups – ranging from “nature conservation oriented” (valuing nature of high personal importance, and nature conservation as an important social duty) to “faraway from nature” (nature is not only alien but is actually connected with negative feelings). Results show that for the majority of 2000 German representatives, urban nature is primarily a space for recreation and health. The results emphasize the variation of personal importance of urban nature due to socio-demographic differences. For example, there were especially strong appreciation differences by age and gender. Andreas argued that the attitude towards nature conservation might be influenced by education, knowledge and where you grew up. In particular, he argued, young people and city dwellers are important target groups for future nature communication.

Christoph Hamelmann (WHO, Italy) reported on the WHO Regions for Health Network. He introduced the two agendas for health in Europe as basic stepping-stones. The Health 2020 document, where the integration of health in all policies is called for, is very closely linked to the Agenda 2030, where “Health and well-being are an outcome, a determinant and an enabler of the 17 Sustainable Development Goals (SDGs)”. Looking at health, it’s not just about preventing diseases, it is also about promoting health and this can be reached with a cross-sectoral approach. The WHO European Regions for Health Network, established in 1993, is acting as a mediator between regional and national goals by implementing actions that promote health and organizing the distribution of data from and to the regional level.

The Wednesday session ended with a presentation of the conference on “Biodiversity and Health in the Face of Climate Change” which will take place in Bonn, Germany from 27 to 29 June 2017. **Aletta Bonn** (UFZ and iDiv) introduced the aim and general structure of the conference: first day – science with keynote input; second day – practice and parallel interactive workshop sessions, third day – policy with keynote input.

4.5 Main discussion points from the keynote presentations

After the keynote presentation of Carsten Hagenau, the following question was asked:

- Did you see changes in social behavior because of the “Gartenstadt Drewitz” Project? Did the community get closer? How has the quality of life changed? Carsten Hagenau argued that due to the changes it has high symbolic power for kids.

After the keynote presentation of Andreas Mues there was an intensive discussion on the study design of the “2015 Nature awareness study”:

- To what extent were respondents’ answers influenced by social desirability of nature conservation issues? How can you control the impact of social desirability response bias in questionnaires? Are some people more inclined to answer socially desirable?
- How have the answers been designed to get independent results?
- Would a monetarization approach better suit assessing the attitude towards nature?
- “Faraway from nature” people grew up more often in cities. Concerning health – what are the implications? By improving the health of city dwellers, do they even need nature? Or are they already adapted to a less natural environment? Have people living in cities already adapted to tolerate extreme weather events? Does nature have the same health outcomes/effect on them, or do they get health benefits elsewhere?

The controversial discussion made clear that there is an attitude – behaviour gap. The “nature awareness study” reports on the general attitude towards nature conservation by German people, which can be used to advise politicians. However, as the study did not address the actual behaviour of people, the results should be taken with caution; how do people act in their daily life in relation to nature conservation issues is a totally different matter. In the end it was concluded that matching the “2015 Nature awareness study” with an assessment of actual behaviour would be necessary for a future study. Experimental studies could analyse the underlying causalities of what motivates people to give a particular response.

After the presentation from Christoph Hamelmann the following question was asked:

- How can the SDGs be integrated within nature-based strategies?

4.6 Keynote presentations – Thursday morning session

The first talk of the day was given by **Matthias Braubach** (WHO) on urban green space interventions and their impacts. Describing the long-standing engagement of the WHO in connecting environment and health (on the basis of the WHO Ministerial Conferences on Environment and Health, Health 2020 policy and the SDGs), Matthias made clear that there is an increasing interest in the health determinants of urban settings. The aim of the presented project on green space interventions was to explore which green space intervention components work and deliver the best results from a health and an equity perspective. The interventions were defined as changes by: a) creating, b) modifying or c) removing/replacing green spaces, in publicly accessible green spaces. These interventions may include social/promotion activities based on the physical changes to the green space – but not as the exclusive intervention. The results of an evidence review indicated that park-based interventions combined with social promotion programs provided the most consistent benefits for health and equity. For other green space interventions there were mixed results. In conclusion, interventions don't have to be cost-intensive and that the applications of social promotion activities – in parallel to the physical intervention – are helpful to give meaning to the green space and make it a resource for the residents.

Switching to a second project that explored 48 European intervention studies on urban green space, Matthias reported that the intervention focus was mostly on environmental and active lifestyle outcomes. Fewer studies were looking into equity or health impacts as the main objective – even though many case studies acknowledged them as a co-benefit. Moreover, the targeting of the interventions was mostly done through the selection of the location, not by target group. Reason for that is that many interventions studies took brown field or area regeneration projects as their starting point. Based on the compiled evidence and conclusions, the WHO (2016c, 2017) has published a report reviewing the evidence of urban green space for health. This report will inform local practitioners and provide practical guidance on urban green space interventions and how to maximize their health and equity outcomes.

On behalf of Prof. Dr. Claudia Hornberg (University Bielefeld, Germany), **Sinja Gattig** (University Bielefeld, Germany) presented the chapter on “Urban nature promoting human health” of the recently published report “Ecosystem services in the city – Protecting health & improving quality of life” (Naturkapital Deutschland – TEEB DE, 2016). The main content of this report is the relationship between the performances of nature, economical creation of values and human well-being. Sinja gave an overview of the research knowledge of psychological and physical effects of urban nature on human health. Showing that urban green areas have positive impacts on human health, the question poses itself how to make the health relevance of urban nature measurable, and how it can be assessed economically. It follows as conclusion that, urban green areas are an increasingly important topic in urban development and are in particular in the responsibility of the communities.

4.7 Main discussion points from the keynote presentations

In the group discussion on the keynote presentation of Matthias Braubach it was concluded that:

- There is great need for process (Moore et al., 2014) and outcome evaluation for intervention studies.
- One problem is that most calls for papers/case studies are in English, but local projects don't have information available in English. How can local studies be better reached/collected? How can you get information on studies in other languages?
- There are projects out there, but there is no overview of who is doing what. Therefore, there is a need for networks to effectively support groups in research efforts and to get advice from other projects, not starting again and again with similar projects.
- Main objective for interventions is to improve the general attractiveness of an area and secondly focusing on disadvantaged target groups. How can equity be stronger integrated into health issues?
- Funders may not be interested in a more holistic approach that combines different aspects (biodiversity, environmental, etc.), they are driven away because there is too much stuff that we are interested in and they don't have the mandate to fund it. There should be shift in funding organizations to support broader research approaches.
- Need to consider equity issues on health.
- Money is there for infrastructural changes, but it is very difficult to get funding for social/promoting activities. How can we promote a dual approach better?

It was pointed out that there is a need for cross-sectional collaboration in planning activities, which led to a plenary discussion on the following questions:

- To what extent this is working in practice (at the moment)?
- Can urban planning procedures fully involve local health authorities in being part of the planning process and meetings? Do they have the time? Does the staff have the capacity, experience, knowledge? Are they equipped for that?
- Regarding the interdisciplinary and transdisciplinary collaboration: It's hard to work together because planners and health scientists have different language, different understanding of issues.
- How can the communication within health departments be improved so that planners know whom to ask for certain issues? And how is information and knowledge spread?
- How can health issues be smoothly integrated into landscape planning?
- The new German prevention law (The Preventive Health Care Act) is forcing the integration of health promoting intervention into the health insurance system.

4.8 Break out groups

The group exercise on the second day of the workshop was split up in two break out groups: one on Science; and the other on Policy/Practice. The following questions were raised for each group:

Science:

- What are the challenges and limitations for research to quantify and assess effects of biodiversity on health?
- What are the potential measures, methods and tools for assessment?
- What are knowledge gaps to future climate and socio-ecological changes?
- What are knowledge gaps on the effectiveness of concrete biodiversity implementation projects/interventions?

Policy and Practice:

- What are the opportunities to facilitate application and management action in practice?
- What are challenges or limitations for policy and planning to aligning biodiversity and health goals in the face of climate change?
- What are potential actors/sectors for accelerating implementation/participation?
- What is good practice for assessing/monitoring health and/or social effects?

4.8.1 Science

4.8.1.1 Biodiversity and health framework

The group built upon the nature and health framework developed by Hartig, Mitchell, de Vries and Frumkin (2014). This framework is important because it describes the pathways through which the natural environment influences human health and wellbeing. Figure 4 demonstrates Hartig et al's (2014) framework with modifications from the Workshop group.

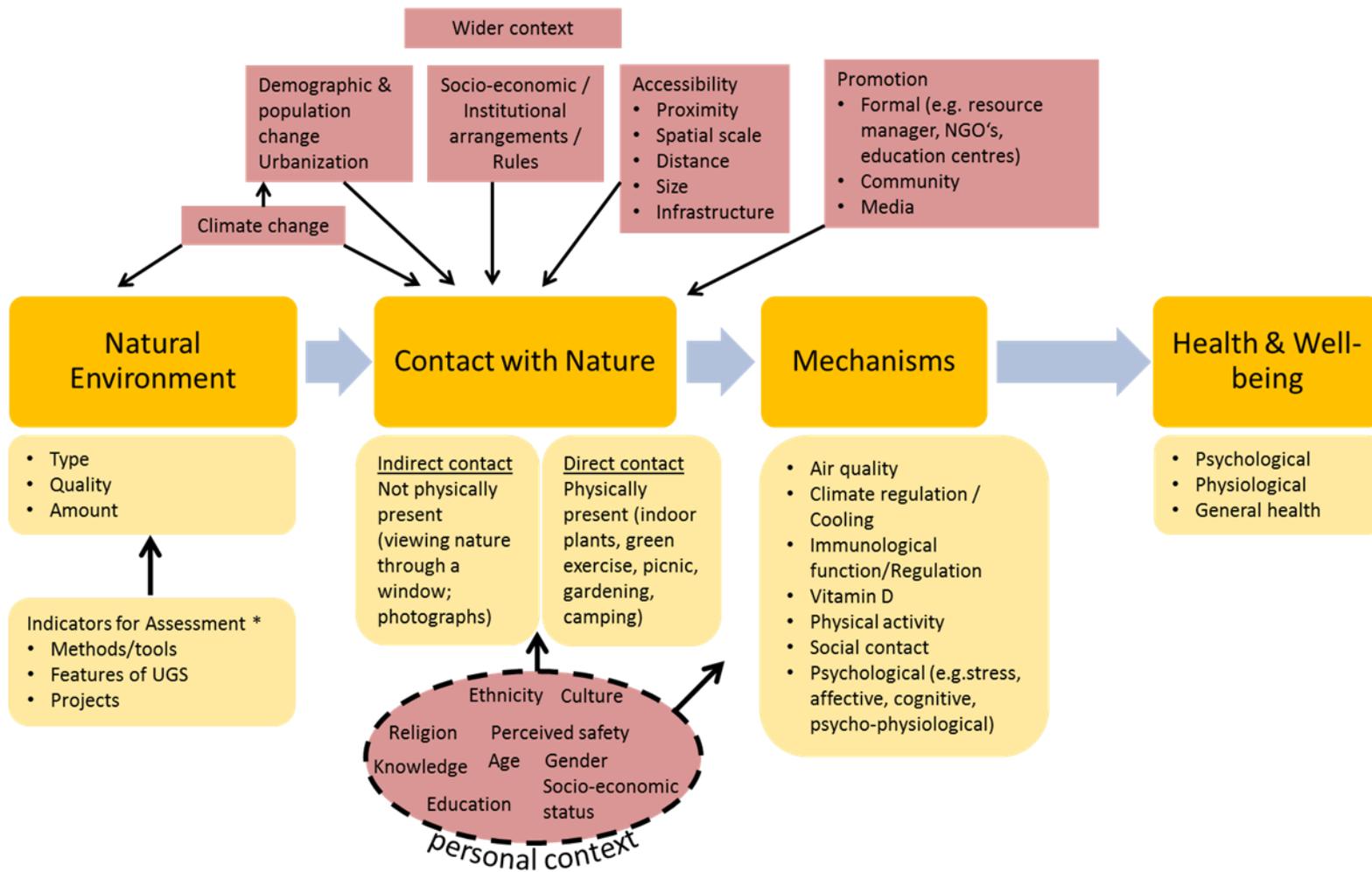


Figure 4: Nature and health framework depicting the pathways in which natural environments influence human health and wellbeing. The framework highlights a sequential pathway from natural environment to health and wellbeing via contact with nature and several mechanisms. The natural environment and contact with nature are influenced by personal and/or the wider context. The mechanisms are also influenced by the personal context of the user(s). Adapted from Hartig, et al. (2014). * = Indicators of Assessment are further detailed in Figure 5.

The Hartig et al (2014) framework states that the natural environment, and contact with nature, indirectly influences human health and wellbeing through 4 mechanisms: air quality, physical activity, social contacts and stress. The first stage of the Hartig et al (2014) nature and health framework is 'Natural Environments' (see Figure 4); the authors stated that natural environments could be defined as: "type (e.g. urban park); quality (e.g. species diversity); and amount (e.g. tree canopy near home)" (Hartig et al., 2014, p. 213). In the Workshop, the group expanded this further by considering the indicators for assessing the type, quality and amount of natural environments: methods or tools; specific features of urban green spaces (i.e. standalone features and citizen- or agent-based features); and current research projects (see Figure 5). These indicators can be used to help define a natural environment's type, quality or amount.

Indicators for assessment

- Methods/Tools
 - Field surveys, sensors
 - Land cover data (e.g. CORINE)
 - Land use data (e.g. Generalised Land Use Database)
 - Remote sensing data (e.g. Vegetation indices like the NDVI, 3D mapping; Landmap UK)
 - Participatory methods (e.g. citizen science, crowdsourcing, public participation geographical information systems (PPGIS))
- Features of Urban Green Space (UGS)
 1. Stand alone features:
 - Geometry (size, shape)
 - Topology
 - Quality (e.g. species richness, vegetation structure, protection status)
 2. Citizen or agent-based features:
 - Distance from residence, work, school, etc.
 - Function/ use (By whom? When? How?)
 - % area of green space per capita
 - Perceived environmental quality (e.g. Scania Green Score)
- Projects
 - US Forest Service Urban Tree Canopy Assessment
 - German Municipality's for Biological Diversity Alliance
 - EU COST-Action Urban Agriculture
 - EU COST-Action Urban Allotment Gardens

Figure 5: Indicators for assessing characteristics of natural environments that link to the expanded nature-health model in Figure 4. Indicators for assessing natural environments' type, quality and amount include: methods or tools; features of urban green spaces; and current projects.

The second stage of the nature and health framework by Hartig et al (2014) is 'Contact with Nature' (see Figure 4). The placement posits that contact with nature is required for the natural environment to influence human health and wellbeing². The authors state that contact with nature can be measured as: "frequency of contact; duration of contact; [and] activity affordance (e.g. for viewing, for walking)" (Hartig et al., 2014, p.213). The original model, however, did not mention the different types of contact with nature. The workshop identified two different types of contact with nature: indirect and direct (Keniger et al., 2013; Pretty, Hine & Peacock, 2006) (see Figure 4). Indirect contact with nature "does not require a person to be physically present in nature" (Keniger et al., 2013, p.916) and can include viewing nature through a window, and looking at photographs, paintings or motion pictures of nature. Direct contact with nature stipulates that nature, or natural elements, are physically present in the same space as the individual (Keniger et al., 2013). Examples of direct contact with nature include: indoor plants; using urban green spaces for education purposes; reading or picnics in the park; doing sports or exercise in a natural setting (also known as green exercise; Pretty, Hine & Peacock, 2006); gardening; and camping. Both types of contact with nature contribute to positive health and well-being outcomes through one of the identified mechanisms.

The third stage of the Hartig et al (2014) nature and health framework are the 'mechanisms' through which contact with natural environments affects health and well-being (see Figure 4). Hartig et al (2014) originally identified four mechanisms: air quality; physical activity; social contacts; and stress. The Workshop group expanded on these mechanisms in two different ways. First, the group altered the descriptive label of the 'stress' mechanism. As originally labeled by Hartig et al (2014), the descriptor 'stress' is misleading, as it fails to convey "affective, cognitive, physiological restoration" following contact with nature (Hartig et al., 2014, p.213). Thus, to improve understanding, the group decided to modify the label from 'stress' mechanism to 'psychological' mechanism in order to better communicate the various psychological mechanisms involved between contact with nature and health: stress; affective; cognitive; and psycho-physiological responses. Second, the group added three additional mechanisms that influence how contact with nature influences health. These three additional mechanisms are: climate regulation/cooling; immunological function/regulation, and Vitamin D. These new three mediating variables are related to the 'air quality' mechanism in that they all relate to regulating mechanisms of nature. Regulating mechanisms mediate the effect of natural environments on human health by reducing air pollution, mitigating against the 'urban heat island' effect, supporting health immune function, and opportunities for exposure to direct sunlight. Importantly, these regulating mechanisms can be experienced with indirect contact with green spaces. In other words, one may be able to experience the health impacts of regulating mechanisms air quality, temperature, immune function and Vitamin D without having direct physical contact with nature or an urban green space (Hartig et al., 2014).

The final stage of the Hartig et al (2014) nature and health framework is 'Health and Wellbeing' (see Figure 4). The authors of the framework describe health and wellbeing outcomes as being either psychological (e.g. cognitive performance, subjective wellbeing, depression), or physiological (e.g. cortisol levels, coronary heart disease, cardiovascular disease, longevity, subjective general health) (p. 213 & 219). The workshop did not expand on this final stage of the Hartig et al (2014) model.

The nature-health relationship is influenced by personal context of the user(s) and the wider context (Hartig et al., 2014). These moderating variables influence the strength or direction of the effect of

² Hartig et al (2014, Figure 1) is a multiple mediation model in which the natural environment influences human health and wellbeing via contact with nature and 4 mechanisms. However, the authors state that the natural environment may influence health and wellbeing without contact with nature, by influencing the mechanisms air quality and stress. In this instance, the Hartig et al (2014) model is a simple mediation model in which the natural environment influences health and wellbeing via air quality or stress. Our modification of 'indirect contact with nature' takes this pathway into account.

natural environments on human health. The workshop expanded these modifiers (indicated by the red boxes in Figure 4). Personal contextual factors – such as age, gender, ethnicity, socio-economic status, religion, and feelings of perceived safety – determine whether people have contact with nature or not. Contact with nature can also be strongly influenced by wider contextual factors (see Figure 4). Climate change has an influence on both the natural environment and contact with nature; this is indicated with arrows pointing to both the ‘natural environment’ and ‘contact with nature’ boxes in Figure 4. For example, people use green spaces as escapes during hot summer days due to cooler air temperatures, but climate change could cause rising temperatures and drier green spaces in urban environments – due to the urban heat island effect – making the green spaces not as attractive to visit. Demographic and population changes in a local area could result in greater urbanization, which would result in less green space available per person in the future. The socio-economic or institutional arrangements and rules determine contact with nature. For example, some green spaces may not be open to the public, meaning the health benefits from direct contact with nature are not equally available for everyone. The accessibility of green spaces can be determined by the physical characteristics of the environment – such as size, distance, or proximity. Furthermore, missing infrastructure (e.g. benches, toilets, public transport) or a great distance to the park, may hinder older people’s (and others) use of the natural environment. Finally, direct contact with nature can be determined through promotion activities to inform the public about their local greenspaces, and encourage them to visit by providing activities.

Feedback loops also exist in the nature and health framework. Hartig et al (2014) identified feedback loops between natural environment and contact with nature, as well as between the four mechanisms highlighting “their reciprocal relatedness” (p. 213). The Workshop Group also identified feedback loops between moderating variables (e.g. climate change can affect migration and demographic change of an area (IPCC, 2014)) and between contact with nature and the mechanisms (e.g. contact with nature results in psychological restoration which may influence greater frequency or duration of contact in the future). However, due to complexity, these feedback loops were not included in Figure 4.

4.8.1.2 Knowledge gaps

Figure 6 identifies the knowledge gaps relating to biodiversity and health research. These knowledge gaps are grouped into six clusters: assessment methodology of urban green spaces; urbanization; biodiversity; health; climate change and its relationship on both biodiversity and health; and the negative impacts of climate change (e.g. invasive alien species or allergies). Workshop participants identified key research questions to help address these knowledge gaps in future biodiversity-health research studies (these research questions are listed in Figure 6).

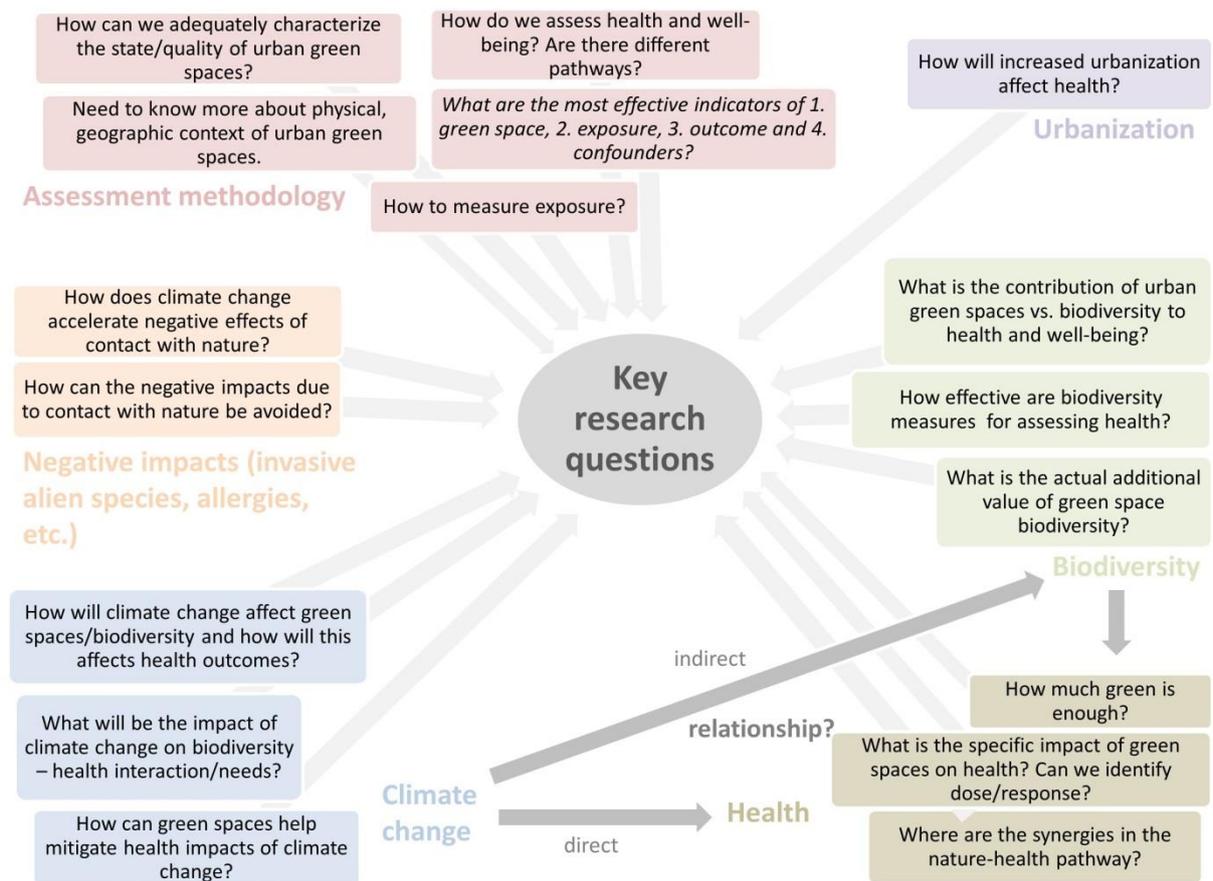


Figure 6: Knowledge gaps, and key research questions relating to biodiversity and health studies: assessment methodology; urbanization; biodiversity; health; climate change; and the negative impacts of climate change.

Figure 7 identifies the knowledge gaps on the effectiveness of biodiversity interventions. Workshop participants agreed that biodiversity implementation projects or intervention studies often fail to address 6 key research questions (see Figure 7). Future evaluations of implementation or intervention projects should seek to address these questions.

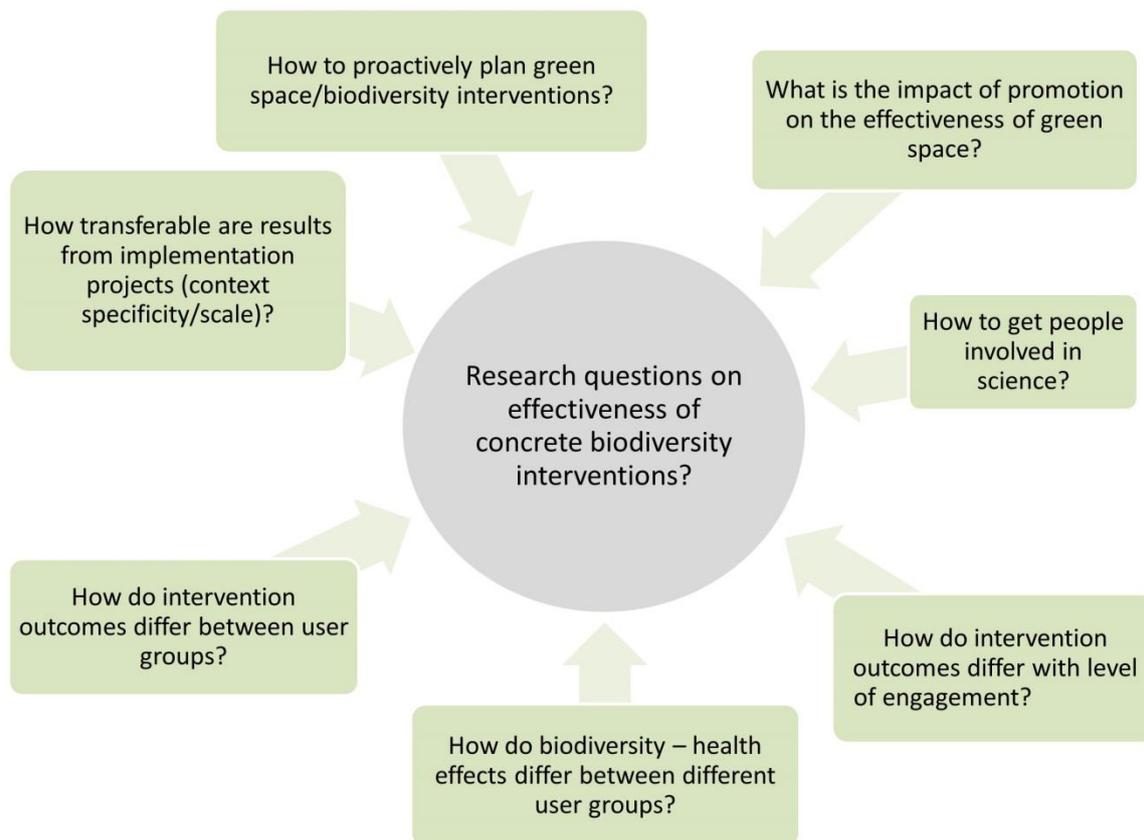


Figure 7: Knowledge gaps on the effectiveness of concrete biodiversity interventions.

4.8.2 Policy and Practice

Issues relating to policy and practice were split into five major themes: “Opportunities”, “Challenges/ Gaps”, “Actors/ Sectors”, “Assessing/ Monitoring” and a “Wish list”.

4.8.2.1 Opportunities

The group identified existing opportunities facilitating the application and management of urban green space projects related to health. These include: frameworks and funding; planning instruments and processes; and existing settings.

Frameworks and Funding:

In this field existing financial and legislative frameworks supporting green space projects were collected. The focus is on two major fields:

- **Political action plans.**

Examples include the German white paper on urban green space (“Weißbuch Stadtgrün”, http://www.bmub.bund.de/fileadmin/Daten_BMU/Pools/Broschueren/gruenbuch_stadtgruen_broschuere_bf.pdf), the initiative for future cities (“Leitinitiative Zukunftsstadt“, <https://www.fona.de/de/zukunftsstadt>) and urban renewal programs like “social city” program of the BMUB (“Soziale Stadt”, <http://www.bmub.bund.de/themen/stadt-wohnen/staedtebaufoerderung/soziale-stadt-biwaq/soziale-stadt/>). These plans mostly relate to the improvement of green infrastructure.

- **Legislation.**

Examples include the German Preventive Health Care Act, frameworks like the social welfare system. This legislation focuses on the beneficial effects urban green spaces of specific user groups, and considers dimensions like equality and accessibility. The potential that urban green space projects offer for the social labour market – rehabilitation, activation, and participation that people perceive through contact with nature – were also discussed.

Instruments and processes:

The instruments and processes for the implementation of urban green space projects belong, in general, to the field of landscape planning. Realization can be facilitated by integrated planning processes within city and region networks or by the combination with other urban development goals (e.g. adaptation strategies). Furthermore, the integration of urban gardening initiatives in urban planning offers an opportunity for the sustainable management of green spaces.

Existing settings:

Some settings in which urban green space programs could be successfully applied were: area regeneration projects; the improvement of residential areas (organized by housing agencies); and the school playgrounds.

4.8.2.2 Challenges/ Gaps

How to avoid pitfalls in the realization of urban green space projects? Key issues discussed were the dissemination of knowledge among projects and among stakeholders, organisational obstacles in local administrations and conflicting interests of different user groups.

Knowledge dissemination:

Knowledge dissemination is a central element for the successful realisation of urban green space projects. The main task (and at the same time the main challenge) is to inform the general public and local stakeholders about the interactions between urban green space, health, biodiversity and climate change adaptation. For this reason, knowledge must be made accessible and comprehensible to local stakeholders. Optional formats include easily accessible and ‘easy to read’ project reports, best practice reports (e.g. the “Report on Urban Health” by the WHO) or new communication forms like social media, web-maps, internet platforms or games. Knowledge exchange is also important to inform green space planners about best practice solutions.

Local administration:

The main obstacle for health related green space projects is their interdisciplinary character, which is not suitable for prevailing administrative structures. In this context, the willingness or interest of administrative staff to implement green space projects is often lacking (due to frustration or missing knowledge). Moreover, interdisciplinary projects are often hindered by legal restrictions in public fund-

ing. To overcome such obstacles municipal collaboration incentives to foster knowledge exchange are needed.

Conflicts:

Private use (e.g. community gardening, or maintenance) of public spaces may cause conflicts between different user-groups, and may also be restricted by administrative regulations or limited temporary use (in case of urban gardening projects). Another type of conflict is when a planned green space development does not match the needs of the local populations in the neighbouring areas.

4.8.2.3 Actors/ Sectors

Concrete actors or institutions most relevant for urban green space projects were listed by Workshop participants: use of given structures; key people; sectors; and knowledge transfer.

Use of given structures:

Prevailing administrations or organizations that could foster the realization of green space projects were listed by Workshop participants.

- Infrastructure or maintenance organisations:
 - (social) enterprises/ companies
 - supply and waste-management services
 - quarter management
- Community engagement organisations:
 - NGOs
 - communities, associations initiatives with different background
 - sport clubs
 - education: schools / Kindergartens

Key People:

Key people mentioned were the mayors of towns, who have power to set guidelines mandatory for the local administrations. Furthermore, role models like 'local heroes' (e.g. in sport/ celebrities) could help to foster the acceptance or popularity of green space projects.

Sectors:

Sectors listed were the administration and its departments related to spatial planning:

- urban planning departments
- landscape planning departments
- nature conservation departments
- transport & mobility departments, and
- Housing agencies – as possible partners or supporters.

In regard to the benefits green spaces provide to people, administrative departments related to the wellbeing of citizens were mentioned:

- health departments

- social departments
- social welfare system
- health insurance companies and
- health professionals.

Finally, communication and public relations as well as the IT sector play a very important role with regard to informing citizens about the beneficial health effects of green space, about plans or initiatives or about already existing projects.

Knowledge transfer:

Universities – as well as university spin-offs related to science communication (e.g. WiLa Bonn, <http://www.wilabonn.de>; KUBUS TU Berlin, https://www.zewk.tu-berlin.de/v_menuue/nachhaltigkeit_umwelt_kubus) – can be useful partners in the dissemination of academic outcomes on the health effects of green spaces, as well as in organizational issues like capacity building or evaluation of projects.

4.8.2.4 Assessing/ Monitoring

A sound evaluation of urban green space projects plays a very important role for gaining evidence about the effectiveness of green space measures, as well as for identifying best practice for implementation. Evaluation was seen as a crucial point in project development, as it may indicate, in early stages, if projects turn out as planned or are going in the wrong direction. Thus it was the aim of the Workshop to look for good practice in evaluation. The discussion points were listed in three clusters: approaches for indicator development, possible indicators and examples.

Approaches:

In this cluster, the Workshop participants defined the requirements for suitable indicators and monitoring schemes as well as methods for the development of indicators. An important aspect was the integration of transformative research approaches like participative science (with local stakeholders) in the definition and elaboration of success-measures. Another important aspect mentioned was the sustainability of the projects. For this reason, it is necessary to consider the evaluation both at very early stages of project development and well after the realization of the projects (e.g. evaluations with 6 month or 1 year follow-ups). It is also important to compare the project outcome to baseline developments (e.g. pre- post evaluations) and to consider unintended side effects of the project. Reported data should be collected on site or in the direct neighbourhood of the project. As the development of reporting schemes needs a lot of expertise, guidance and standard monitoring tools should be provided e.g. by network-platforms.

Possible indicators:

Possible indicators include:

- Biophysical indicators:
 - climate data or reports
 - (ecological) condition of the green spaces
- Acceptance measures:
 - visitor rates
 - duration of stay

- socioeconomic structure of user groups (as well as of non-user groups)
- analysis of use patterns
- user group behavior
- public/ media response
- analysis of social conflicts
- Health effects:
 - mental health measures (e.g. attention, persistence, reduction of psychiatric episodes, reduction in caretaking use or hospitalization etc.)
- Economic effects
 - rents or ground prices.

Examples:

Examples mentioned were the effects on nature and environment, as well as effects on human behaviour. Good practice mentioned was the “Waldscout”-Project at the “Kellerwald” National Park.

4.8.2.5 Wish list

Workshop participants listed four further action points that could be very helpful in the implementation of green space projects:

Mentoring and supervision of (grass-root) projects:

- change agents
- guidance from networks
- monitoring tools and indicators
- “supervision” or “moderation” between the science and the practice field and funding opportunities (network)

Changes in administrative processes:

- local authority coordinator (high level) for cross-cutting areas (“Strategiestelle”)
- focus on consolidation by standard (“every day”) practice instead of (often not sustainable) short-term projects
- communal funding of basic investments (water/ electricity/ sewer)
- use of public ground at no charge

Evaluation of projects:

- Evaluation as a requirement for funding

Project communication:

- Use of new technologies (e.g. augmented/ virtual reality, apps, etc.)

4.9 Keynote presentations – Thursday afternoon session

Chiara Cortinovia (University of Trento, Italy) introduced the case of urban planning in Trento, a city in Italy with approximately 120,000 inhabitants. Due to the location in a narrow valley floor, the city experiences great heat waves during summer time and the increasing number of hot days in the city is a concern for human health. The interest on climate change is proven by ongoing research, such as the CLIMAWARE Project (CLIMatic change impacts on future Availability of WAtER REsources and hydro-geological risks), an interdepartmental project at the University of Trento involving land use planning and social sciences. Chiara and her working group generate spatially-explicit models to maps and quantify ecosystem services and their beneficiaries at the urban scale. A model to assess the micro-climate regulation produced by urban green spaces – the cooling effect on the surrounding environment by different categories of “green” – has been developed (Geneletti, 2016) and the results set against the demand of different demographic groups (children, older people and immigrants) with vulnerability to heat stress (Kabisch and Haase, 2014; Kazmierczak, 2012). In the case study, two scenarios obtained through the transformation of existing brownfield sites into green spaces with different cooling performances were presented. The comparison with the baseline condition enhanced the understanding of how the availability of green spaces promotes health, and how improving the existing green infrastructure and the plans for their implementation can support these benefits. This scenario analysis can be used to figure out which types of intervention and which planning actions produce the highest benefits for citizens, and where it is more cost-effective to intervene (Geneletti et al., 2016). Further steps of the study will be to complete the assessment for key urban ecosystem services and to mainstream this information into the new Urban Plan (revision process started in 2016).

Björn Brodner (Umweltamt Bielefeld, Germany) reported on Climate Change Adaptation Strategies in Bielefeld, Germany. To protect the global climate, and to adapt to unavoidable consequences of local climatic changes, the Bielefeld city administration worked on various climate change issues. For example, a 2011 population survey asked for awareness and perception of climate change and related health aspects. Furthermore, the 2014 project ‘KommAKlima - Municipal structures, processes and instruments for adaptation to climate change’ used Bielefeld as a model (with financial support from the BMUB). Particularly noteworthy are the practical examples in Bielefeld: “Healthy & Climate-Friendly School Kitchen”; “KlimaNetze”; and the participation in a BfN project “Biodiversity & Urban Green - Integrated Strategies & Measures to Protect and Promote Urban Biodiversity” with the sub-project on “Schlosshofbach greenway”. The overall project aims of the “Biodiversity & Urban Green” project were the practical testing of concrete measures for the implementation of the National Biodiversity Strategy at the level of urban landscapes and the development of generally applicable recommendations for municipalities. Björn also highlighted the initiative “Bielefeld 2000plus”, whose aim is to intensify the networking of science, city authorities and the region and to promote the inter-institutional exchange of expert knowledge.

Michael Scheer (Gesellschaft für integrative Beschäftigung mbH) introduced the project “Urban agriculture ‘Gemüsewerft’”, which started in 2014. It aims to generate mental health, local food and added values by planting crops within the city limits. Sponsored by “Aktion Mensch” currently about 10 benefit recipients (being non-employable according to the Twelfth Volume of the Code of Social Law (SGB XII)) with psychiatric diseases and mental disorders are working in the garden. The work ranges from growing vegetables, fruits, hops, or cultivating oyster mushrooms in a Second World War bunker to deliver two local restaurants in Bremen. A part of the harvest is processed by the company-owned gastronomy (café brand).

Through the project, agricultural competence is brought back into cities. The ‘Gemüsewerft’ offers a multifunctional room for events, like brewery seminars, artistic performances, garden dinners, etc. These events bring people in contact with the urban gardening movement. The project assesses health effects of clients as a result of regular occupation. Outcome measures are: the degree of ab-

sence from work caused by illness (and its change over time); the in- or decrease of working quantity (hours per week); and the reduction of further social services (e.g. supported living) as an indirect result of psychological stabilization (see Scheer et al. 2011; Scheer & Bartling 2013). During the two-year project 'Social Farmers' (2015-2017) the Gesellschaft für integrative Beschäftigung further promotes and consults fusions between social service providers and urban agricultures. The aims are to intensify cross-sectoral cooperation and to strengthen economic sustainability of urban agriculture as successful green space interventions and socially inclusive environments.

Urban agriculture promotes health through different pathways:

- They enable access to green space and provide hospitality (often within walking distance).
- They provide opportunities for active (therapeutic) gardening providing positive physical and psychological health effects.
- Environmental justice (access to green space for minorities and people with low income).
- Within the welfare system, urban agriculture provides inclusive working, leisure and participation possibilities for disabled people.
- They are productive places for healthy and local food (ecological planting, regionality, traditional and rare seeds). Thus they improve food supply and decrease negative effects of global food streams.
- They promote and increase biological diversity as they transfer sealed allotments into planted micro-habitats and prevent from using toxic pesticides or inappropriate fertilizers.
- As social labs, they promote 'ecological behaviour' among citizens.
- Reduce negative effects of densification (soil sealing, CO₂-reduction, micro-climate).
- They promote health and strengthen identification with nature as participants can actively manipulate their natural environment.
- They provide cultural, political and social added values (participation/leisure: cultural and political events; science: future labs/urban planning).

Finally, **Henning Nahm** (Schreberjugend, Berlin) reported on the project "Schule im Wald" ("School in the forest") which is an approach in the city of Berlin to get kids from socially deprived communities or with migration backgrounds into nature. With the project they want to counteract the growing separation of children from nature – described as the "nature deficit disorder" (Louv 2008) – and let them gain experiences in the forest using all senses. It can be demonstrated that children develop themselves in physical, emotional and social terms during their stay in nature (Renz-Polster & Hüther 2016). A strong connectedness to people and to nature is therefore one of the main targets.

4.10 Main discussion points from the keynote presentations

- Will such research projects, like the one in Trento, be implemented into practice? Data and results could be interesting for other projects. Bringing partners together and interacting with Regional Health Network, Esmeralda Project, etc.
- How can the public be efficiently involved in health promoting decisions?
- How can urban agriculture reach economic sustainability?
- How can urban planning better include and promote participatory approaches in urban green space use?
- How can the community contribute to and finance participatory green space use? What can be legal backbones or how can we change laws to strengthen participatory approaches?
- What kind of gardening system is best used in urban gardens regarding CO₂-emission and productivity (comparing soilless and soil systems)? What are future research questions in the field of urban horticulture?
- How can plantings be stronger and additionally included/introduced into horizontal and vertical architecture (rooftops, fronts, balconies) and blue space environments?
- What is the role of environmental protection (urban biospheres)?
- Who is financing nature-based approaches to promote health and social inclusion in Germany?
- What are the impacts of nature experience in childhood on health?
- How should nature experiences for kids be designed to ensure they instil nature connectedness and positive impacts on their attitude (sense of responsibility) towards nature when they are grown up? How to promote appreciation of nature?

5 Conclusions

The expert workshop on urban biodiversity and health, and the use of nature-based solutions for climate change adaptation and mitigation to this relationship, brought together experts from various disciplines including experts from natural and social sciences as well as representatives from city administrations and the World Health Organization. A number of issues were discussed intensively in two days based on input from keynote presentations and group activities.

A summary of future tasks includes the following issues and further remarks:

- It was determined that urban green spaces and urban biodiversity can't be treated as equivalent. What is the relation between them? And how can urban biodiversity be measured in the context of urban green spaces?
- It was determined that biodiversity and urban green spaces have distinct effects on health. How can these be evaluated?
- There is the need for more scientific evidence on health impacts from urban green spaces.
- How to enable a stronger cooperation between the health sector and urban nature conservation/ green space planning?
- How can health issues be integrated into landscape planning?
- Consideration of all population groups in cities when designing urban green spaces to guarantee equal access to health benefits.
- Identification and communication of the best practice examples to city officials, stakeholders and regional authorities, spreading the already existing knowledge and experiences.
- Integrating social or promotion actions into the process of green interventions was pointed out to be important (dual approach).

Based on the knowledge produced in this workshop, important questions and research topics will be discussed further at the conference on the relationship between biodiversity and health in the face of climate change in Bonn taking place in June 2017.

6 References

- Bowler, D. E., Buyung-Ali, L., Knight, T. & Pullin, A. S. (2010). A systematic review of evidence for the added benefits to health of exposure to natural environments. *BMC Public Health*, 10, 456. <http://dx.doi.org/10.1186/1471-2458-10-456>.
- Carrus, G., Scopelliti, M., Laforteza, R., Colangelo, G., Ferrini, F., Salbitano, F., Agrimi, M., Portoghesi, L., Semenzato, P. & Sanesi, G. (2015). Go greener, feel better? The positive effects of biodiversity on the well-being of individuals visiting urban and peri-urban green areas. *Landscape and Urban Planning*, 134, 221-228. <http://dx.doi.org/10.1016/j.landurbplan.2014.10.022>.
- Cracknell, D., White, M. P., Pahl, S., Nichols, W. J. & Depledge, M. H. (2016). Marine biota and psychological well-being: A preliminary examination of dose response effects in an aquarium setting. *Environment and Behavior*, 48(10), 1242-1269. <http://dx.doi.org/10.1177/0013916515597512>.
- Cvitanovic, C., Hobday, A. J., van Kerkhoff, L., Wilson, S. K., Dobbs, K. & Marshall, N. A. (2015). Improving knowledge exchange among scientists and decision-makers to facilitate the adaptive governance of marine resources: A review of knowledge and research needs. *Ocean & Coastal Management*, 112, 25-35. <https://doi.org/10.1016/j.ocecoaman.2015.05.002>.
- Cvitanovic, C., McDonald, J. & Hobday, A. J. (2016). From science to action: Principles for undertaking environmental research that enables knowledge exchange and evidence-based decision-making. *Journal of Environmental Management*, 183, 864-874. <https://doi.org/10.1016/j.jenvman.2016.09.038>
- Dallimer, M., Irvine, K. N., Skinner, A. M. J., Davies, Z. G., Rouquette, J. R., Maltby, L. L., Warren, P. H., Armsworth, P. R. & Gaston, K. J. (2012). Biodiversity and the feel-good factor: Understanding associations between self-reports human well-being and species richness. *Bioscience*, 62(1), 47-55. <https://doi.org/10.1525/bio.2012.62.1.9>.
- European Commission (2013). Building a green infrastructure for Europe. Luxembourg. <https://doi.org/10.2779/54125>.
- European Commission DG Research and Innovation (2015). Towards an EU research and innovation policy agenda for nature-based solutions and re-naturing cities - Final report of the Horizon 2020 expert group on "Nature-based solutions and re-naturing cities". Luxembourg. <https://doi.org/10.2777/765301>.
- Ellaway, A., Robertson, C., Allardice, G. & Robertson, R. (2009). Associations between health and different types of environmental incivility: a Scotland-wide study. *Public Health*, 123(11), 708-713. <https://doi.org/10.1016/j.puhe.2009.09.019>.
- Erdmann, K. H., Eilers, S., Job-Hoben, B., Wiersbinski, N. & Deickert, S. (2008). Naturschutz und Gesundheit: Eine Partnerschaft für mehr Lebensqualität. *Naturschutz und Biologische Vielfalt*, 65. Bonn, Germany, Federal Agency for Nature Conservation (BfN). ISBN 978-3-7843-3965-8.
- Evans G. W. (Ed.) (1982). Environmental stress. New York, Cambridge University Press.
- Federal Agency for Nature Conservation (BfN) (2016). Biodiversity. https://www.bfn.de/0304_biodiv+M52087573ab0.html.
- Fuller, R. A., Irvine, K. N., Devine-Wright, P., Warren, P. H., & Gaston, K. J. (2007). Psychological benefits of green space increase with biodiversity. *Biology Letters*, 3, 390e394.
- Geneletti, D. (2016). Handbook on biodiversity and ecosystem services in impact assessment. Cheltenham, UK, Edward Elgar Publishing. ISBN 978-1-78347-898-9.

- Geneletti D., Zardo L. & Cortinovis C. (2016). Promoting nature-based solutions for climate adaptation in cities through impact assessment. In: Geneletti, D. (2016). Handbook on biodiversity and ecosystem services in impact assessment. Cheltenham, UK, Edward Elgar Publishing, 428-452.
- Haftenberger, M., Laußman, D., Ellert, U., Kalcklösch, M., Langen, U., Schlaud, M., Schmitz, R. & Thamm, M. (2013). Prävalenz von Sensibilisierungen gegen Inhalations- und Nahrungsmittelallergene. *Bundesgesundheitsblatt*, 56(5/6), 687-697. <https://doi.org/10.1007/s00103-012-1658-1>.
- Hartig, T., Evans, G. W., Jamner, L. D., Davis, D. S. & Garling, T. (2003). Tracking restoration in natural and urban field settings. *Journal of Environmental Psychology*, 23(2), 109-123.
- Hartig, T., Mitchell, R., de Vries, S., & Frumkin, H. (2014). Nature and health. *Annual Review of Public Health*, 35, 207-228. <https://doi.org/10.1146/annurev-publhealth-032013-182443>.
- Hollenbeck, J. (2016). Understanding factors influencing marine access. <http://www.ecehh.org/research-projects/sea-to-me/>.
- Hough, R. L. (2014). Biodiversity and human health: Evidence for causality? *Biodiversity and Conservation*, 23, 267-288. <https://doi:10.1007/s10531-013-0614-1>.
- IEEP (2016). The health and social benefits of nature and biodiversity protection. <http://ec.europa.eu/environment/nature/biodiversity/intro/docs/Health%20and%20Social%20Benefits%20of%20Nature%20-%20Final%20Report%20Main%20sent.pdf>.
- IPCC (2014). Climate change 2014: Impacts, adaptation, and vulnerability. IPCC WGII AR5 Technical Summary. <https://www.ipcc.ch/report/ar5/wg2/>.
- Johansson, M., Gyllin, M., Witzell, J. & Küller, M. (2014). Does biological quality matter? Direct and reflected appraisal of biodiversity in temperate deciduous broad-leaf forest. *Urban Forestry & Urban Greening*, 13, 28-37.
- Jorgensen, A. & Gobster, P. H. (2010). Shades of green: measuring the ecology of urban green space in the context of human health and well-being. *Nature and Culture*, 5(3), 338-363. <http://dx.doi.org/10.3167/nc.2010.050307>.
- Kabisch, N. & Haase, D. (2014). Green justice or just green? Provision of urban green spaces in Berlin, Germany. *Landscape and Urban Planning*, 122, 129–139. <http://doi.org/10.1016/j.landurbplan.2013.11.016>.
- Kabisch, N., Stadler, J., Korn, H. & Bonn, A. (2017). Nature-based solutions to climate change in urban areas - Linkages between science, policy and practice. Theory and Practice of Urban Sustainability Transitions. Springer International Publishing. ISBN 978-3-319-53750-4. <https://www.springer.com/de/book/9783319537504>.
- Kaplan, R. & S. Kaplan (1989). The experience of nature: A psychological perspective. Cambridge University Press (Archive).
- Kazmierczak, A. (2012). Heat and social vulnerability in Greater Manchester: A risk-response case study. EcoCities project, University of Manchester, Manchester, UK.
- Keniger, L. E., Gaston, K. J., Irvine, K. N. & Fuller, R. A. (2013). What are the benefits of interacting with nature? *International Journal of Environmental Research and Public Health*, 10, 913-935.
- Küchler-Krischun, J., Nürnberg, M., Schell, C., Erdmann, K-H. & Mues, A. (2016). 2015 Nature Awareness Study. Population survey on nature and biological diversity. Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) & Federal Agency for Nature Conservation (BfN). <http://www.bfn.de/fileadmin/BfN/gesellschaft/Dokumente/nature-awareness-study-2015.pdf>.
- Kowarik, I., Bartz, R. & Brenck, M. (2016). Ökosystemleistungen in der Stadt. Gesundheit schützen und Lebensqualität erhöhen. Naturkapital Deutschland – TEEB DE. ISBN 978-3-944280-35-6. <http://www.naturkapital->

teeb.de/fileadmin/Downloads/Projekteigene_Publikationen/TEEB_Broschueren/TEEB_DE_Stad
tbericht_Langfassung.pdf.

- Lee, A. C. K. & Maheswaran, R. (2011). The health benefits of urban green spaces: A review of the evidence. *Journal of Public Health, 33*(2), 212-222.
- Louv, R. (2008). Last child in the woods: Saving our children from nature-deficit disorder. Algonquin Books.
- Lovell, R., Wheeler, B. W., Higgins, S. L., Irvine, K. N. & Depledge, M. H. (2014). A systematic review of the health and well-being benefits of biodiverse environments. *Journal of Toxicology and Environmental Health, Part B, 17*(1), 1-20. <http://dx.doi.org/10.1080/10937404.2013.856361>.
- Maller, C., Townsend, M., Pryor, A., Brown, P. & St Leger, L. (2005). Healthy nature healthy people: 'Contact with nature' as an upstream health promotion intervention for populations. *Health Promotion International, 21*(1), 45-54. doi:10.1093/heapro/dai032.
- Marselle, M. R., Irvine, K. N., Lorenzo-Arribas, A. & Warber, S. L. (2015). Moving beyond green: Exploring the relationship of environment type and indicators of perceived environmental quality on emotional well-being following group walks. *International Journal of Environmental Research and Public Health, 12*, 106-130.
- Marselle, M. R., Irvine, K. N., Lorenzo-Arribas, A. & Warber, S. L. (2016). Does perceived restorativeness mediate the effects of perceived biodiversity and perceived naturalness on emotional well-being following group walks in nature? *Journal of Environmental Psychology, 46*, 217-232.
- Mayer, F. S., McPherson Frantz, C., Bruehlman-Senecal, E. & Dolliver, K. (2009). Why is nature beneficial? The role of connectedness to nature. *Environment and Behavior, 41*(5), 607-643. <https://doi.org/10.1177/0013916508319745>.
- Millennium Ecosystem Assessment (2005). Ecosystems and human well-being: Biodiversity synthesis. World Resources Institute, Washington, DC.
- Milligan, C., Gatrell, A. & Bingley, A. (2004). 'Cultivating health': Therapeutic landscapes and older people in northern England. *Social Science & Medicine 58*(9), 1781-1793. [http://dx.doi.org/10.1016/S0277-9536\(03\)00397-6](http://dx.doi.org/10.1016/S0277-9536(03)00397-6).
- Mitchell, R. & Popham (2008). Effect of exposure to natural environment on health inequalities: An observational population study. *The Lancet 372*(9650), 1655-1660.
- Moore, G., Audrey, S., Barker, M., Bond, L., Bonell, C., Hardeman, W., Moore, L., O'Cathain, A., Tinati, T., Wight, D. & Baird, J. (2014). Process evaluation of complex interventions: Medical Research Council guidance. MRC Population Health Science Research Network, London.
- Naturkapital Deutschland – TEEB DE (2016). Ökosystemleistungen in der Stadt – Gesundheit schützen und Lebensqualität erhöhen. (Ecosystem services in the city – Protecting health & improving quality of life). Hrsg. von Ingo Kowarik, Robert Bartz und Miriam Brenck. Technische Universität Berlin, Helmholtz-Zentrum für Umweltforschung – UFZ. Berlin, Leipzig. <http://www.naturkapital-teeb.de/publikationen/projekteigene-publikationen/bericht-3.html>
- Naumann, S., Kaphengst, T., McFarland, K. & Stadler, J. (2014). Nature-based approaches for climate change mitigation and adaptation. Bonn, Germany, Federal Agency for Nature Conservation (BfN).
- Nilsson, K., Sangster, M., Gallis, C., Hartig, T., de Vries, S., Seeland, K. & Schipperijn, J. (2011). Forest, trees and human health. Springer. ISBN 978-90-481-9806-1.
- Pretty, J., Hine, R. & Peacock, J. (2006). Green exercise: The benefits of activities in green places. *Biologist, 53*, 143-148.

- Public Health Institute & Center for Climate Change and Health (2016). Climate action for healthy people, healthy places, healthy planet: Urban greening & green infrastructure, climate change and health. <http://climatehealthconnect.org/wp-content/uploads/2016/09/UrbanGreening.pdf>.
- Renz-Polster, H. & Hüther, G. (2016). Wie Kinder heute wachsen: Natur als Entwicklungsraum. Ein neuer Blick auf das kindliche Lernen, Denken und Fühlen. Beltz. ISBN 978-3-407-85953-2.
- Richardson, E. A. and R. Mitchell (2010). Gender differences in relationships between urban green space and health in the United Kingdom. *Social Science & Medicine* 71(3), 568-575.
- Rittel, K., Bredow, L., Wanka, E., Hokema, D., Schuppe, G., Wilke, T., Nowak, D. & Heiland, S. (2016). Green, natural, healthy: The potential of multifunctional urban spaces. *BfN-Skripten* 371. Bonn. https://www.bfn.de/fileadmin/BfN/service/Dokumente/skripten/Skript371_EN_barrierefrei.pdf.
- Scheer, M., Bennecke, R., Oetjen, H., v. Schwarzkopf, J., Schwarz, B., Lorenz, E., Höppner, B., Hagen, A. & Rösner, J. (2011). Beschäftigung jenseits der Erwerbsarbeit: Zuverdienst schafft Teilhabe. Bremer Beschäftigungsmodellprojekt nach §11(3) SGB XII für psychisch und suchtkranke Menschen zeigt erste Erfolge. *Sozialpsychiatrische Informationen* 4, 32-36.
- Scheer, M. & Bartling, A. (2013). Eingliederungshilfe - Ziele und Kennwerte evaluieren. *Sozialwirtschaft - Zeitschrift für Führungskräfte in sozialen Unternehmen* 5, 18-20.
- Schneiter-Ulmann, R., Beck, T., Föhn, M., Georg, J., Höchli, K., Hoffmann, R., Karn, S., Vef-Georg, G. & Verra, M. (2010). Lehrbuch Gartentherapie. Hogrefe (formerly Hans Huber).
- Sempik, J., Aldridge, J. & Becker, S. (2005). Health, well-being, and social inclusion: Therapeutic horticulture in the UK. Bristol, UK, The Policy Press.
- Seto, K. C., Fragkias, M., Güneralp, B. & Reilly, M. K. (2011). A meta-analysis of global urban land expansion. *PLoS One*, 6, 1–9. <http://dx.doi.org/10.1371/Citation>.
- Tosi, A., Wüthrich, B., Bonini M. & Pietragalla-Köhler B. (2011). Time lag between Ambrosia sensitisation and Ambrosia allergy : A 20-year study (1989-2008) in Legnano, northern Italy. *Swiss Medical Weekly*, 141, 132-153. <http://dx.doi.org/10.4414/smw.2011.13253>.
- UK Government (2011). No health without mental health: A cross-government mental health outcomes strategy for people of all ages. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/213761/dh_124058.pdf.
- Ulrich, R. S. (1983). Aesthetic and affective response to natural environment. In: Altman I., Wohlwill J. F. (1983). Behavior and the natural environment. Human Behavior and Environment (Advances in Theory and Research), Vol 6, Boston (MA), USA, Springer.
- Ward Thompson, C., Aspinall, P. & Montarzino, A. (2007). The childhood factor: Adult visits to green places and the significance of childhood experience. *Environment and Behavior*, 40, 111-143.
- Ward Thompson, C. (2011). Linking landscape and health: The recurring theme. *Landscape and Urban Planning*, 99, 187-195.
- Wheeler, B. W., Lovell, R., Higgins, S. L., White, M. P., Alcock, I., Osborne, N. J., Husk, K., Sabel, C. E. & Depledge, M. H. (2015). Beyond greenspace: An ecological study of population general health and indicators of natural environment type and quality. *International Journal of Health Geographics*, 14(1), 17. <http://dx.doi.org/10.1186/s12942-015-0009-5>.
- Wolch, J. R., Byrne, J. & Newell, J. P. (2014). Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough'. *Landscape and Urban Planning*, 125, 234-244.
- World Health Organization (1948). Constitution of WHO: Principles. <http://www.who.int/about/mission/en/>.

- World Health Organization and Secretariat of the Convention on Biological Diversity (2015). Connecting global priorities: Biodiversity and health: A state of knowledge review. <http://www.who.int/globalchange/publications/biodiversity-human-health/en/>
- World Health Organization (2016a). The determinants of health. <http://www.who.int/hia/evidence/doh/en/>.
- World Health Organization (2016b). Noncommunicable diseases. <http://www.euro.who.int/en/health-topics/noncommunicable-diseases>.
- World Health Organization (2016c). Urban green spaces and health. Copenhagen, WHO Regional Office for Europe. http://www.euro.who.int/__data/assets/pdf_file/0005/321971/Urban-green-spaces-and-health-review-evidence.pdf?ua=1.
- World Health Organization (2017). Urban green space intervention and health: Review of impacts and effectiveness. Copenhagen, WHO Regional Office for Europe. http://www.euro.who.int/__data/assets/pdf_file/0010/337690/FULL-REPORT-for-LLP.pdf?ua=1.
- Zelenski, J. M., Dopko, R. L. & Capaldi, C. A. (2015). Cooperation is in our nature: Nature exposure may promote cooperative and environmentally sustainable behavior. *Journal of Environmental Psychology*, 42, 24-31.

Annex

Final programme

Tuesday, 04. October 2016

Arrival	Ferry times from Lauterbach harbour: 16.10 / 17.10 / 18.10 / 20.10 (dinner will still be available)
18:30	Dinner
20:00	Welcome and retrospect on past BfN/ENCA conferences HORST KORN, BfN AND SIMON DUFFIELD, ENCA INTEREST GROUP ON CLIMATE CHANGE
20:10	Introduction to the workshop and introductory round of participants ALETTA BONN AND NADJA KABISCH, GERMAN CENTRE FOR INTEGRATIVE BIODIVERSITY RESEARCH (IDIV) HELMHOLTZ- CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

Wednesday, 05. October 2016

08:00	Breakfast
I	Urban biodiversity and health in the face of climate change – Overview of European developments
09:00	Urban nature, health and climate change – An overview of the evidence REBECCA LOVELL, UNIVERSITY OF EXETER, UK
09:30	Psychological effects of urban nature and biodiversity DÖRTE MARTENS, EBERSWALDE UNIVERSITY FOR SUSTAINABLE DEVELOPMENT, GERMANY
10:00	Green, natural, healthy: the potential of multifunctional urban spaces STEFAN HEILAND, TU BERLIN, GERMANY
10:30	Coffee/tea break
11:00	Allergenic plants and their relevance to human health in a changing climate – <i>Ambrosia</i> as a case study REGINA TREUDLER, UNI LEIPZIG, GERMANY
11:30	Brainstorming session Demonstration projects – What is the practical experience of projects that work with nature and green infrastructure to realize health and social benefits? What are indicators that address health effects from biodiversity?
12:30	Lunch
13:30	Guided tour and walk through the nature reserve of the Island of Vilm JUTTA STADLER, BFN

- 15:00 Coffee/tea & cake
- 15:30 Presentation of results of group discussion
- 16:00 Nature-based approaches to promote health and social integration in Germany,
Case study: "Gartenstadt Drewitz", Potsdam
CARSTEN HAGENAU, PIA VON ZADOW, PROJEKTKOMMUNIKATION
HAGENAU GMBH, GERMANY
- 16:30 Coffee/tea

II Climate change, biodiversity and health awareness

- 17:00 German nature awareness study 2015 – Results from the fourth representative
survey on knowledge, attitudes and willingness of the population to act in mat-
ters of nature, conservation and biological diversity
ANDREAS MUES, BFN

**III Policy framework – Moving towards recommendations for policy, practice,
education and science**

- 17:30 Regions for health network – Prioritizing equity, developing strategic delivery
alliances and fostering good governance
CHRISTOPH HAMELMANN, WHO, ITALY
- 18:30 Dinner
- 19:30 **Group discussion/plenary**
Presentation and invitation to the European BfN/ENCA conference, June 2017,
in Bonn; Identification of main questions to be addressed in the parallel sessions
planned
- 20:30 Informal get-together

Thursday, 06. October 2016

- 08:00 Breakfast
- III Policy framework – Moving towards recommendations for policy, practice,
education and science**
- 09:00 Green space and health: intervention impacts and effectiveness from a WHO
perspective
MATTHIAS BRAUBACH, WHO
- 09:30 Ecosystem services in cities – Urban nature for health promotion (TEEB-DE)
SINJA GATTING, UNIVERSITY OF BIELEFELD, GERMANY
- 10:00 Coffee/tea break
- 10:30 World cafe / break out groups

Science:

- What are challenges and limitations for research to quantify and assess effects of biodiversity on health?
- What are potential measures, methods and tools for assessment?
- What are knowledge gaps to future climate and socio-ecological changes?
- What are knowledge gaps on the effectiveness of concrete biodiversity implementation projects/interventions?

Policy and practice:

- What are opportunities to facilitate application and management action in practice?
- What are challenges or limitations for policy and planning to aligning biodiversity and health goals in the face of climate change?
- What are potential actors/ sectors for accelerating implementation/participation?
- What is good practice for assessing/monitoring health and/or social effects?

12:30

Lunch

14:00

World cafe / break out groups (cont.)

14:30

Plenary

Presentation of world cafe results

IV

Nature-based approaches to promote health and social integration in Germany – selected case studies

15:00

Health benefits of urban green infrastructures from science to policy: the case of urban planning in Trento, Italy

CHIARA CORTINOVIS, UNIVERSITY OF TRENTO, ITALY

15:30

Bielefeld 2000plus – Climate change adaptation strategies in Bielefeld

BJÖRN BRODNER, UMWELTAMT BIELEFELD, GERMANY

16:00

Coffee/tea & cake

16:30

Urban agriculture 'Gemüsewerft': generating mental health, local food and added values by planting crops within the city limits

MICHAEL SCHEER, GESELLSCHAFT FÜR INTEGRATIVE BESCHÄFTIGUNG MBH

17:00

Project "Schule im Wald" ("school in the forest")

HENNING NAHM, SCHREBERJUGEND, BERLIN

Discussion

18:30

Evening reception, hosted by the German Federal Agency for Nature Conservation (BfN)

19:30

Opportunity for ENCA interest group on climate change meeting

20:00

Informal get-together

Friday, 07. October 2016

07:25	Departure (train from Lauterbach/Mole leaving at 8.00 am)
08:00	Breakfast
08:25	Departure (bus from Lauterbach/Harbour leaving at 09.01 am)
09:20	Departure (train from Lauterbach/Mole leaving at 10.00 am)

List of participants

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