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No time to lose – Green the cities now

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1. Introduction

1.1. Urban health

Contemporary health issues are increasingly determined by social and environmental context. In a rapidly urbanising world this calls for urban planners and public health workers to collaborate for creating healthy city environments.

Although cities are centres of prosperity, education, and culture, strained environmental conditions and urban lifestyles have adverse health impacts, resulting in for example risk factors like physical inactivity, chronic stress, and a high prevalence of non-communicable diseases (NCDs) (McMichael, 2000; Peen et al., 2010; Vos et al., 2015). The urban environment is also characterised by high levels of air pollution and other physicochemical hazards, noise, density, crowding, and a relative lack of green and open spaces (Nieuwenhuijsen, 2016; Mueller et al., 2016). The issues are of particular severity in rapidly urbanising developing parts of the world (McMichael, 2000).

Climate change has a specific impact on the urban environment and health, for example through exacerbation of the urban heat island (UHI) and related morbidity and mortality (Hajat and Kosatky, 2010). Depending on climate zone and topographic location, various climate change impacts will strike differently across cities. For instance, in colder climates cold spells may be more harmful than heat waves (Gasparrini et al., 2015). However, on a global level the negative effects of heat stress are likely to outweigh cold related morbidity, due to the disproportionally larger populations in hot climates with a large proportion of poor and outdoor workers (Kjellstrom et al., 2009). Other climate and geographically dependent effects are flood related events, due to rising sea-levels and extreme rainfalls, with a particular impact for cities in flood hazard zones. Many cities, particularly in low-income countries, are established and grow around coastal areas, which increasingly concentrate people in areas liable to flooding and related health risks (Haines et al., n.d.; Korah and Cobbinah, 2016). The situation is compounded by rapid land use changes, more impervious surfaces and less vegetated areas, and sometimes haphazard housing and infrastructure expansion in developing cities (Few and Matthies, 2006). Many other effects of climate change, such as extreme events, storms, and droughts, will have severe impact on life in cities, where population density is high. Due to high levels of unpredictability, both in terms of immediate and long-term health effects, it is hard to evaluate which climate change related health risk will impose the dominating threat in the future (McMichael et al., 2006).

The harmful aspects of climate change and urbanisation are particularly pronounced in vulnerable populations, such as children or socio-economically deprived, and in developing parts of the world (McMichael, 2000). Children are, for example, disproportionally affected by toxic environmental exposures, due to harmful effects on developing organ systems (Vanos, 2015), and deprived areas are often located close to traffic or industrial zones with high levels of pollution and poor quality of green and recreational spaces (Martuzzi et al., 2010; Richardson et al., 2013). The quick shift from rural to urban in developing countries imposes a risk for unplanned or insufficient strategic policies for development of healthy and resilient urban infrastructure (Glaeser, 2013).

Many of the environmental risk factors and diseases are beyond health care systems' and services' capacity to control for or cure (Wagner et al., 2001). This calls for system approaches and transdisciplinary strategies to maintain and improve health, relying on disciplines and sectors also outside medicine and health sciences and practice, such as environmental, conservation and socio-ecological sciences and urban and transport planning (Nieuwenhuijsen, 2016; Annerstedt, 2010; McMichael, 2013a; McMichael, 2013b). An emerging topic, with a transdisciplinary appeal, includes the recognition of urban natural (green and blue) spaces as health promoting environments with potential to protect health through a multitude of pathways and effects, including climate change mitigation and adaptation (WHO, 2016).

In this paper we review and evaluate existing knowledge on health impacts of urban natural spaces and make a case for increased investments in such, concluding a high probability for benefits outweighing any harmful consequences. We also discuss potential explanations for poor transfer of science to policy and practice, including cognitive bias, lack of and uncertainty in evidence, incommensurability between disciplines and sectors, vested interests and economic constraints. Based on the existing literature, we suggest that the escalating urbanisation, especially in developing countries, and the epidemic of NCDs and contemporary environmental threats justify urgent inclusion of natural space considerations in public health policies and actions, also in the absence of gold standard evidence, as long as the risk for harmful effects is evaluated as low and the cost-efficiency likely to be high.

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2. Nature in cities

2.1. Health benefits of urban nature

An increasing amount of studies suggests various health benefits by exposure to urban natural spaces (WHO, 2016). Exposure is often defined as neighbourhood accessibility, or frequency of or duration of visits to parks and other natural spaces. Naturalness can be monitored by satellite images, classification in Geographic information Systems (GIS), field studies, or self-assessments (WHO, 2016).

Much research focuses on natural spaces' influence on risk or health factors, such as stress or physical activity. These mediators are considered as explanations for defined diagnoses and health outcomes which have been associated with natural spaces. It is possible to consider the mediators or pathways as urban ecosystem services (ESS) – cultural and regulating (Hernández-Morcillo et al., 2013; MA, 2005). Ecosystem services, in general, refer to services and goods provided by ecosystems that are of importance for human society and well-being (Daily, 1997; MA, 2005).

2.1.1. Cultural ecosystem services

While biodiversity and supporting ESS, like nutrition cycles and soil formation, are fundaments for any health benefits from nature, cultural ESS particularly include recreational and spiritual values (Hernández-Morcillo et al., 2013). In this article, we define effects on stress, mood, and health behaviours as cultural ESS. Existing systematic reviews on cultural ESS, indicate evidence for effects on stress recovery (Bowler et al., 2010a), positive affect and emotions (McMahan and Estes, 2015; Bowler et al., 2010a), physical activity (McGrath et al., 2015; Lovell et al., 2014; Lee and Maheswaran, 2011), and overweight (Lachowycz and Jones, 2011). There is consistent, strong evidence for improvement of affect and emotions (McMahan and Estes, 2015; Bowler et al., 2010a). For the other mediators, the tendency is equally positive, although the evidence is less strong. Other mediating cultural pathways that have been suggested in the literature, but not systematically reviewed, are prosocial and pro-environmental behaviour (Zhang et al., 2014; Zelenski et al., 2015; Annerstedt van den Bosch and Depledge, 2015), improved social cohesion (de Vries et al., 2013), and buffered health inequalities in communities (Mitchell and Popham, 2008; Mitchell et al., 2015). Recent biological theories and pathways, with some empirical support, such as improved immunoregulation (Lewis et al., 2012; Rook, 2013) and brain functionality (Hunter et al., 2010; Bratman et al., 2015), require further investigation before evidence can be established. Importantly, all studied pathways are significant determinants of dominating diseases globally, such as NCDs and mental disorders. Physical inactivity and stress are well-known risk factors (Ding et al., 2016; McEwen, 1998) and, for example, positive affect is strongly related to mortality (Mroczek et al., 2015; Shirom et al., 2010), recovery from physical illness (Lamers et al., 2012), and mental health (Hu et al., 2014). While the singular effect size of nature's impact on each respective factor might be relatively small, this means that the overall public health effect may be large. Although not scientifically proven, it is likely that many factors work in synergy, including the regulating services, adding up the effects to each other.

2.1.2. Regulating ecosystem services

Regulating ESS from urban trees and natural spaces can potentially mitigate climate change related events, such as increased heat, and contribute to urban adaptation and preventing diseases following strenuous environmental conditions. Systematic reviews on regulating ESS related to urban natural spaces and health, provide strong evidence for a cooling effect of urban green spaces (Bowler et al., 2010b) and moderate evidence for reduced noise perception (Dzhambov and Dimitrova, 2015). Indirectly, these services may protect health from heat related morbidity and mortality (Voskamp and Van de Ven, 2015; Chen et al., 2014) and noise related disorders (Dzhambov and Dimitrova, 2015). Some studies suggest that urban natural spaces may provide also other regulating ESS, such as air pollution dispersion (Janhäll, 2015; Nowak et al., 2014), which would reduce the risk for e.g. respiratory diseases, and reduction of storm water run-off by canopy interception and water quality improvement through nutrient uptake, which could reduce drowning or infectious diseases from unsafe drinking water (Lindgren et al., 2010; Livesley et al., 2016). While the direct effect on air pollution by absorption, deposition and dispersion, may be small, it is possible that the replacement effect (nature instead of traffic) and the reduced heat effect (reduced air pollution concentration following decreased heat (Cheng and Berry, 2013; Bowler et al., 2010b)) can indirectly improve air quality. Most studies suggest a protective effect on air quality and storm water management, but mechanisms are somewhat unclear and the evidence is inconsistent. However, similarly to the potential impact on NCDs, the burden of disease related to air pollution and unsafe water is substantial, why also small improvements may have a relatively large public health impact (Dadvand et al., 2015b).

2.1.3. Disease prevention

Studies on defined health outcomes, which may be related to the outlined pathways, include systematic reviews of all-cause and CVD-related mortality (Gascon et al., 2016; Wendel-Vos et al., 2015) and mental health and wellbeing (Wendel-Vos et al., 2015; Gascon et al., 2015), showing moderate to strong evidence for these outcomes. Other defined health outcomes systematically reviewed are lung cancer related mortality (no evidence) (Gascon et al., 2016) and birth weight (weak evidence) (Dzhambov et al., 2014). Empirical studies, though not systematic reviews, also indicate an association to cognitive and behavioural outcomes among children (Dadvand et al., 2015a; Amoly et al., 2014), general physical and mental health (Alcock et al., 2014; Triguero-Mas et al., 2015), depression (Reklaitiene et al., 2014), and asthma (Sbihi et al., 2015).

Health effects of exposure to natural spaces depend on a multitude of or interactions between different factors and vary between populations and regions. Likely, direct impact, cultural and regulating ecosystem services provided by natural spaces interact to determine the various health effects. This implies a very high level of complexity, obscuring evidence and making it intricate to evaluate and attribute specific effects to s defined natural space features. Embedded in the complexity of the variables as such, are the dynamics of the pathways as well as variation in spatial, demographic, and individual factors. Scientific attempts to quantifying impacts and attributing specific mechanisms are eluded by the ever-changing conditions, resulting in inconsistency in the findings, large variations in effect sizes, and contradictive results. In addition, there is no agreed methodology for well-being impact assessments of urban interventions (Braubach et al., 2015). Thus, evidence-based recommendations on how to use and apply urban natural spaces for public health have been difficult to provide and urban densification continues at the cost of natural environments and urban ecosystems, especially among the urban poor and socially deprived (Pauleit et al., 2005). In developing parts of the world, the rapid speed of urbanisation may also hamper investments in urban nature (Schäffler and Swilling, 2013), as the benefits may not even be considered, especially if immediate effects are difficult to detect, and the long-term wins are therefore neglected, especially in case of competing economic interests.

3. Co-benefits of nature in cities

When evaluating the balance between cost-efficiency, risks, and potential benefits of natural spaces, the health of both humans and environmental should be considered. This means that environmental impact assessments of urban densification and replacing natural spaces with built environment, ought to be complemented by health impact assessments, considering potential human health risks and associated

costs. Win-win-options can be gained by for instance establishing high-quality natural spaces for improved wellbeing in residential areas, simultaneously creating benefits to the environment, like maintaining urban biodiversity, preventing spread of invasive species, and providing habitat for urban wildlife (Busse-Nielsen et al., 2013; Haase et al., 2014). In addition, urban greenery and tree canopies can sequester and store carbon, with reduced atmospheric carbon dioxide as a consequence (Nowak and Crane, 2002). Also financial co-benefits may appear. A recent study concluded that investing in green infrastructure in cities, might not only be ecologically and socially desirable, but also economically advantageous (Elmqvist et al., 2015). Investments in urban natural spaces can enhance a city's economic competitiveness, where aesthetic and beautiful places and quality of life are important for attracting and retaining a skilled workforce (KPMG, 2012b; KPMG, 2012a). Such investments may also create green jobs and potentially increase tourism (Cianga and Popescu, 2013). Urban natural spaces seem to benefit economically deprived urban communities more than others, contributing to mitigation of socio-economic inequalities (CABE, 2010).

While several alternatives to conventional medical treatment and health promotion exist, such as cultural activities (Clift, 2012) or mindfulness practice (Sharma and Rush, 2014), only nature-based solutions such as natural space investments seem to hold the potential for co-benefits to the environment. Equally, technological solutions to reduce heat, like air condition or cool roofs (Dabaieh et al., 2015), may be costly in terms of energy-consumption and lack the co-benefit potential for health.

4. Obstructions to implementation and good-practice

In spite of a substantial research body and evidence, a recent review demonstrates that evidence on co-benefits to health and environment of urban natural spaces unfortunately eludes policy impact and decisions (Posner et al., 2016). This may imply a "lose-lose" situation for urban health and environment.

Urban tree canopy is currently decreasing in most cities across the world due to densification, expansion, and increasing populations (Mincey et al., 2013). A few European cities have established greening campaigns (Nieuwenhuijsen and Khreis, 2016), but the case is different in most developing countries, where the challenges of urbanisation are multiple, including loss of natural spaces(Qureshi et al., 2010, Fanan Ujoh et al., 2011). In order to avoid similar mistakes as in the Western world during industrialisation and technological revolution, it should be a responsibility of scientists to engage and communicate the importance of natural spaces for urban development in those regions. This is of particular importance considering the disproportionally fast urbanisation and the inheritance of Western lifestyles, with NCDs becoming major obstacles to public health also in these parts of the world (Vos et al., 2015).

We lack full knowledge to explain why human health and co-benefits are not sufficiently considered in contemporary urban policies, but in the following a few theories are discussed. While not always directly related to the case of natural spaces and health, nor totally exhaustive, those theories may serve as some of the plausible explanations to be further explored in practice and research.

4.1. Cognitive bias

One complicating factor for applying knowledge in public health policy and practice in general, is the so called cognitive bias – even if solutions exist they may not work if they contradict people's or politicians' preferences, positions, or worldviews (Kataria, 2012; Klotz, 2011). Solutions that are perceived as rewarding only in a longer-perspective, are often less accepted for implementation although long-term approaches tend to be what is required to act on complex issues (Nyhan, 2010). Thus, if the knowledge around benefits and co-benefits of urban natural spaces is not part of the normative agenda, they may be perceived as containing merely aesthetical value, which can be hard to defend against more hard-core values like economic incentives or housing needs. This represents a cognitive bias in the sense that a common position has been shaped by a long-term neoliberalistic tradition and future generations' health and ecological thresholds are poorly integrated in people's and politicians' worldviews (Kahneman et al., 1991). Heuristic thinking, like "business as usual" and "rules of thumb" easily becomes the choice and natural spaces are put at risk (Kahneman, 2011; Kahneman et al., 1991).

The last century has been characterised by a support of "quick-fix" technological solutions, which may be less efficient, or at least not enough, for complex problems relating to environment, climate change and health. For example, studies have shown that "green" building techniques can be both systematically irrational and cost-inefficient (Turner and Frankel, 2008). Rather than relying merely on technological solutions most outlooks and foresight reports now stress the need for system approaches, including nature-based solutions and other intersectoral actions (WHO, 2010; UNEP, 2012). The systems view must urgently become part of the normative mind-set and researchers hold a responsibility for communicating this knowledge to the public and to decision makers.

4.2. The science-policy-practice gap in health and environment topics

Several environmental risk factors have been scrutinised and nailed to the chain of causality, as is for example the case with air pollution, causing around 7 million deaths worldwide annually (Brauer et al., 2016). Cause-effect relations are proven epidemiologically and biological mechanisms are clarified. Obviously, risk varies between countries, populations, and individuals, but the link of causality is indisputable and dose-response assessments are available.

However, even if evidence exist efficient translation into policies and actions do not always occur, referred to as the science-policy gap (Bradshaw and Borchers, 2000). For example, while regulations of air pollution do exist (e.g. the European Air Quality Directive2008/50/EC), most of those are primarily based on monitored or modelled data and do not incorporate health impact assessments (Costa et al., 2014). This prevents efficient policies to improve health situation in polluted cities. Furthermore vested interest may delay or distort the implementation of efficient solutions, not considering side-effects of trade-offs, like was for example the case around narrowly framed introduction and support of diesel technology (Amoly et al., 2014). Other examples of poor awareness of scientific evidence are related to the early warnings of climate change and its detrimental impacts on environment and health (EEA, 2013). While evidence was available several decades ago, the uncertainty of scenarios and of size of outcomes hindered efficient policies (Barrett and Dannenberg, 2012).

Equally, in a case study Grant and Manuel (Grant and Manuel, 2011) found that despite strong evidence linking obesity rates to land-use policy, planners showed limited knowledge of connections between their decision-making and public health outcomes, which were consequently ignored in the process.

There is also a policy-practice gap, which may create a disjuncture in both directions. While many practitioners and urban planners can see the incentives for greening the city on a local scale, this is not always supported by adequate resource allocation from policies and programmes. Barriers like lack of time, excess of information, and poor dissemination of research results, complicate implementation (Mulley and Reedy, 2013).

4.3. Falsification and the cautiousness of academic language

The prevailing scientific method of hypothesis testing and falsification provides a logical and ethical approach to exploring tentative solutions to identified research problems (Popper, 1963). However, in a real world situation, where policies and decisions depend on scientific evidence based on gold-standard methods, the tradition may become counterproductive, as researchers tend to use a language of a more

cautious nature than policy messages, and thus the scientific consensus is at risk of getting lost. Especially in research on health promotion or disease prevention, although practically little is to lose, this may serve as a reason for politicians not to act when science suggests complex solutions, potentially challenging the cognitive bias and sometimes being costly in a short-term perspective. For example, while research seems to conclude that the health benefits of urban natural spaces are several, including both cultural and regulating ESS, the scientific "warning flag", stressing that effect sizes or dose-response relations are yet not established (Ekkel and de Vries, 2017), tends to disrupt the holistic view of public health and decisive rules on urban tree canopy cover or park protection may elude us. Therefore it might be important for scientists to communicate that the risks of urban green spaces are small, not merely that the outcomes are uncertain. Equally, researchers, policymakers, and practitioners might sometimes need to re-define and adapt to a more dynamic definition of what constitutes gold-standard methods and evidence based policies or practice (Davoudi, 2006; Angelstam et al., 2013; Annerstedt, 2010).

Policies around natural spaces and health is challenged by defining how to measure, objectify and standardise natural spaces, what indicators are appropriate for what outcomes, what distances and sizes of green spaces are optimal, and what features should be included to provide the best possible and most cost-efficient solutions. No scientific consensus around optimal "health distance" or "health size" of an urban natural space exist. Various recommendations are given (Natural_England, 2010; Annerstedt van den Bosch et al., 2016), but such are usually based on common praxis rather than scientific evidence. Environmental qualities and features are difficult to measure on a larger scale (Annerstedt et al., 2012; Björk et al., 2008). These issues refer to scientific uncertainty and a need for proper communication, so as to not miss the overall picture.

In the case of urban natural spaces, this means that the available evidence on positive health effects, found to be moderate to strong for mood improvement and heat reduction, could be used for setting long-term policy-goals, in spite of some uncertainties. These policies should support urban planners and practitioners in creating and designing cities where natural spaces are incorporated in new developments and already established trees and natural areas are protected to highest possible extent. This would also provide examples of best-practice and successful plans and design tools should be exported to developing countries and implied in rapidly urbanising regions across the world, where urban green spaces are at great risk (Jim, 2013).

Scientific cautiousness and evidence-based decisions aim to prevent harmful consequences and optimise prioritisations. Ethically speaking, the potential risk must be weighed against costs and the potential gain of health improvement (Brock and Wikler, 2006). This means that in case of incomplete evidence for a public health intervention, it may still be justified if the potential health gains are evaluated as likely to be significant and cost-efficient (Rychetnik et al., 2002). This could for example refer to urban natural spaces, displaying multiple benefits for both health and environment and are likely to reduce health care costs for many chronic diseases, with few negative side-effects. A somewhat corresponding situation is when epidemics or health threats are considered so acute and serious that medical interventions are implied, in spite of insufficient data. Such decisions were for example taken during the most acute Ebola crisis, when WHO declared that interventions with potential benefits, but unknown efficacy and side-effects, should be offered also in the absence of sufficient data and randomised controlled trials (Adebamowo et al., 2014). This could be put in relation to figures demonstrating that the number of deaths associated with high levels of air pollution in affected countries by far outweigh the number of deaths after Ebola infection (GAHP, 2014). This would suggest that poor air quality may be an even more severe emergency, but interventions to protect people from pollution are still not sufficiently implemented. Similarly to the arguments during the Ebola crisis (Adebamowo et al., 2014), it could be discussed whether more studies and evidence are needed before we urgently replace streets with health promoting natural spaces, for the sake of improving air quality and preventing NCDs (Nieuwenhuijsen and Khreis, 2016).

4.4. New scientific methods may require new ways of communicating

Engaging in interdisciplinary research concepts and methods, might require that we develop a new way of translating science that can support decision-making also without significance values and dose-response curves (Metzger and Zare, 1999). While we must accept that uncertainties in projections and future scenarios based on modelling techniques will be large (Lloyd et al., 2011), we may need to rely on and communicate likely tendencies and directions of associations, using those as basis for best possible policies and actions (Bradshaw and Borchers, 2000). The need for researchers to change ways of communication is demonstrated by the fact that it is suggested that academic research has a "low status" in urban planning practice and that lack of time tend to direct planners and decision makers, including those employed in local and state government, to rely on "business-as-usual" and information from popular media and industry reports, rather than research outputs (Taylor and Hurley, 2016). Researchers might also need stronger incentives to engage in participatory studies and use new communication tools, such as research-to-practice websites, pod-casts, mass-media, and practice networks (Taylor and Hurley, 2016). This would, however, require higher academic merits and recognition of such activities.

Poor translation of science to policy is a shared responsibility – policy- and decision-makers must incorporate scientific uncertainty in international goals and frameworks for future societal development and scientists must acknowledge that uncertainty does not necessarily mean that results are not adequate for decision-making (Bradshaw and Borchers, 2000).

4.5. Economic circumstances

Even though the science may point to great benefits of green space, economic circumstances may not always allow the creation or good maintenance of green infrastructure, partly because of competing priorities for funding of other issues high on the agenda (Abbott, 2012). Over the years, the governmental budgets for green space management have decreased significantly in many cities because of land use competition combined with economic crisis (Buizer et al., 2015). In addition, the organisations that fund the creation and maintenance of green space, say local councils, do not necessarily gain economic benefits in the end, due to separated budgets where for example reduced health care costs rather renders profit to national governments. There are exceptions though, for example in private building developments where building companies create green spaces because the value of property becomes higher when green spaces are included in the project (Konijnendijk et al., 2013). A more direct link between costs and benefits through a systems approach may lead to more favourable conditions for developing and maintaining green spaces.

5. "Disservices" from urban natural spaces and risk perception

If urban natural spaces should be considered for health promotion, also risks and side-effects must be assessed. The concept of ecosystem disservices has gained some attention in this context (Lyytimäki et al., 2008). Ecosystem disservices are harmful effects and nuisances perceived and experienced from ecosystems and natural spaces, such as vector-borne pathogens in parks, allergies from airborne pollen, trapping of air pollution under dense street tree canopies and emissions of volatile organic compounds, hazards due to windthrows and falling branches from trees, or fear of crime in green areas (Dunn, 2010).

One aspect of this is why urban populations, to an increasing extent, perceive nature as risky. It is possible that as people become more

urbanised, motorised and computerised, the connection to natural environments diminishes and those are instead perceived as unfamiliar and associated with fear and riskiness (Valentine and McKendrck, 1997). This implies that public preferences for places shift away from nature and the perception of risk may be overestimated as compared to the actual benefits that can be gained (Slovic, 2000; Slovic, 2010). In recent years there has been a major push by advocates of injury prevention, accidental and intentional, to reduce injuries, and this has resulted in the implementation of numerous safety measures, some including restrictions on people's, and particularly children's, engagement with nature (Ball and Ball-King, 2011; Ball and Ball-King., 2013). For example, in UK the outdoor area in which children may roam without supervision has decreased by almost 90% since the 1970s (Moss, 2016).

Risks and negative health effects of urban nature are reality and evidence is definitely at hand (Pataki et al., 2011). However, while this evidence shall not be ignored, most harmful effects are possible to prevent, for example by selecting tree species and genotype without allergenic potential (Ogren, 2004), accident awareness, proper clothing and protection measures, and by maintaining high quality natural spaces (Vogt et al., 2015). Considering that many disservices are often caused by anthropogenic ecosystem interference at the first place and that proper management and education could decrease risks and perceived risks substantially it is very unlikely that the disservices would outweigh the many various health benefits from urban ecosystem services (Villa et al., 2014; McPherson et al., 2005). And to put it bluntly – without functional ecosystems and their services to humankind our mere survival is undermined (Chivian and Bernstein, 2009; MA, 2005). This means that, given a disservice or two, we, as professionals and citizens, still have a responsibility to maintain urban natural spaces and healthy ecosystems for the sake of future generations. From this overarching perspective, size, distance, risks, and particular features or amenities may be of less importance.

6. What are we waiting for?

While the evidence may not yet be consistent for some potential outcomes or the optimal design strategy, most research of today points in the direction that public health, in general, can be improved by exposure to natural spaces, in general, and systematic reviews have confirmed evidence for positive impact on mood and affective state as well as on heat reduction (McMahan and Estes, 2015; Bowler et al., 2010b). A couple of recent studies have also attempted to make dose-response assessments, indicating that longer duration of visits (>30 min) is related to enhanced stress reduction (up to almost 10% reduction of blood pressure) (Shanahan et al., 2016). A dose-response relation between tree cover density and self-reported stress is also suggested (Jiang et al., 2014). Recent studies also conclude that properly planned and managed urban natural spaces can improve urban ecosystem function in all climates, sociocultural circumstances, and biogeographical locations (Livesley et al., 2016), with consequential net-gains for public health although those gains may vary by time, place, and people.

Therefore, it may be considered if reports on nuisances from natural spaces or the lack of precise recommendations, should provide a more balanced picture and complemented by evidence about the overarching benefits of nature. There is a risk that such reports may otherwise serve as arguments for decision-makers to restrict investments in green infrastructure, which will most likely have a negative long-term effect on human health and urban environments. Particularly important is to increase and improve collaborations between disciplines and agencies of public health, epidemiology, climatology, forestry, ecology, plant biology, urban planning and design. Through a transdisciplinary approach health impact assessments can be combined with evaluations of disease-resistant, appropriate plant selection with low allergenic potential, resilient and hardy trees with large leaf surface area and leaf area index for optimised pollution dispersion, shade and evapotranspiration, plans for avoiding pollution trapping beneath tree canopies, and increased amount and quality of natural spaces in deprived areas (Sanusi et al., 2016; Sæbø et al., 2012; Jaganmohan et al., 2016). Primarily, the development of an ecologically sustainable urban environment could be promoted, recreating and maintaining healthy ecosystems recognising their public health value as prerequisites for healthy lives for everyone.

By considering urban nature as a public health measure, people may be re-connected, already from childhood, to natural environments, creating a better understanding of how our behaviour influences the environment and how we best interact for optimised health and ecosystem function (Moss, 2016). While definite cost-benefit analyses and estimates are difficult to provide, the evidence is sufficient for concluding that the probability of cost-efficiency is high and with an increasing number of studies and with support for further research we are getting closer to conducting appropriate and comparatively precise assessments. Already, a few such assessment reports exist, concluding that small per capita investments can improve and produce significant savings in both human lives and monetary costs. Green infrastructure is, for instance, suggested to be the most efficient tool to reduce heat (APWA, 2007; McDonald et al., 2016) reduce heat. Branas et al. (2016) evaluated the impacts and economic returns on investment of urban blight remediation programmes involving 5112 abandoned buildings and vacant lots on the occurrence of firearm and non-firearm violence in Philadelphia and found that taxpayer and societal returns on investment for the prevention of firearm violence were $5 and $79 for every dollar spent on abandoned building remediation and $26 and $333 for every dollar spent on vacant lot remediation. Kardan et al. (2015) found that planting 10 more trees per city block in Toronto is equivalent to increasing the income of every household in that city block by more than $10,000 annually which suggests a favourable cost benefit ratio as planting and maintenance of 10 urban trees cost between $300 to $5000 annually. These kind of initiatives must be followed and implemented in various regions, climates, neighbourhoods, and populations to determine where investments are most needed and most cost-efficient.

Naturally, the scale of health impact varies between different actions or lack of actions or policies. Adequate air pollution regulation would particularly affect urban populations in highly polluted cities, often in developing parts of the world. Proper planning for heat reduction would have a negligible impact in northern climates, but the larger among outdoor workers in hot climates. Establishing parks for recreation, stress recovery, and physical activity may currently have the largest impact in developed parts of the world, where for example social stress and overweight are major risk factors for NCDs, though similar issues are increasing also in developing regions (Vos et al., 2015). While health impact of natural spaces can appear small, the establishment and preservation of natural spaces may be considered a contribution, smaller or larger, to several of the issues and by providing both cultural and regulating ESS the impact can be important now and in the future.

We suggest that urban natural spaces are considered as part of the urgent interventions required to control and revert the epidemic of NCDs and climate change related diseases across the globe. Not the least, it is imperative to communicate the indisputable evidence that natural areas are not only of soft, aesthetical value, but are the fundaments for our existence (van den Bosch et al., 2016) and loss of biodiversity and environmental degradation have a detrimental impact on human health (Wang and Horton, 2015). This basic message sometimes seems to get lost in discussions around why and where and how to invest in urban nature. While waiting for the evidence to be cemented, we suggest to rely on already existing knowledge about both benefits and co-benefits and to prioritise natural spaces in urban development plans, increase the amount of street trees in cities, and/or replace (part of) streets and roads with trees or other green space, and manage and establish high quality natural spaces with public accessibility particularly in deprived urban areas and in urbanising, developing countries. For improving cost-efficiency and prioritisations, investments in natural spaces should be accompanied by increased efforts to study and

evaluate effect sizes and efficacy, define properties and features optimal for health benefits, and what populations would benefit the most in various regions of the world.

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