Appendix 2.8: Contributions to physical, mental and social dimensions of health section

Introduction

This appendix provides more detail about the assessment approach for the "Contributions to physical, mental and social dimensions of health" section. This includes results from the literature review on Contributions to Physical, Mental and Social Dimensions of Health and the expert elicitation that reviewed the collated information which was presented in the Second Order Draft of the assessment, with in addition some focused elicitation questions regarding evidence and key recommendations.

For the specific literature review on contributions to physical, mental and social dimensions of health, we built on the recent state of knowledge (SoK) review coordinated by WHO and CBD ((World Health Organization & Secretariat of the Convention on Biological Diversity, 2015)). We only searched the period 2014 – February 2017 in order to update the SoK. We looked for reviews only, adding some non-review papers if relevant. Further we added two regional categories: General region (e.g. Europe, Balkan, Mediterranean region) and Marine.

Why an expert elicitation? The linkages between nature and health are of increasing research and policy interest. Whilst research efforts are increasingly interdisciplinary, there is still a need for greater integration of different fields of expertise and recognition of the importance of accounting for different forms of knowledge, as with other aspects of biodiversity policy ((Pullin, Frampton, & Jongman, 2016)). With this perspective in mind, in addition to following the literature methodology of this chapter we also engaged in a process of IPBES-approved expert elicitation to strengthen the quality of the assessment and literature review. This also supports a key aim of IPBES, which is to build capacity in this rapidly growing field.

First, we present here the text on Contributions to Physical, Mental and Social Dimensions of Health as it was presented to the experts taking part in the expert elicitation. We incorporated some key suggestions from reviewers in order to as to not leave the valuable review comments without use and to the extent practically feasible at this stage: we consider more structural changes not very useful at this stage, as we had to drastically downsize the assessment text on Contributions to Physical, Mental and Social Dimensions of Health and we want readers to keep a good understanding of the information basis of the expert elicitation.

Second, we present the questions posed to the experts and the outcomes of the expert elicitation.

Literature review results put forward in the expert elicitation

The recent state of knowledge (SoK) review coordinated by WHO and CBD (2015) provides a detailed global assessment of the interlinkages between biodiversity and human health, exploring the evidence base across the three broad areas of human health outcomes – non-communicable diseases, communicable (i.e. infectious) diseases, and injury – and looking at the value of biodiversity to medical science (World Health Organization & Secretariat of the Convention on Biological Diversity, 2015). The SoK highlights the role of biodiversity and ecosystem services in supporting good health status, and the health risks posed as a result of loss of biodiversity and ecosystem degradation.

Health benefits may be experienced passively, e.g. where ecosystem structures and processes supports the provision of NCPs that regulate sources of potential health risks, or otherwise provide a protective function. This includes regulation of pest and disease organisms, support for biodiversity that is required for pollination of important food resources, and buffering against risks associated with natural hazards. Health benefits may also be acquired actively, e.g. through appropriation or manipulation of NCPs such as in agriculture and green engineering, or through harvesting of foods and materials (including genetic resources) for medicines, shelter, fuel wood, clothing etc. which support good health. Other benefits can occur where biodiversity or specific NCPs are integrated into cultural motifs or practices which are linked to concepts of sense of place, sense of identity, or sense of community, and are thereby part of the fabric of social health and well-being (Horwitz & Kretsch C., 2015).

In recent years, the importance of human interactions with the natural environment as a determinant of health outcomes has become of increased interest in Europe, with particular focus on key issues in urban health, reflecting the increased urbanization of European populations and growing concerns over related health issues, including disease associated with dietary choices sedentary lifestyles and the stresses of modern living. In Central Asia, although there has been comparatively less research on health–biodiversity linkages there has been some focus on issues relating to agriculture, food security and traditional and local knowledge, including traditional medicine.

Whilst some of these connections between health and nature are well established – such as the value of wild species as sources of food and as resources for pharmaceutical development – others are less well understood, and may be locally or regionally specific – such as the linkages between biodiversity and infectious disease risk in humans (Karesh & Formenty, 2015). The ways in which health status is affected by biodiversity and NCPs is therefore determined by the nature of specific social-ecological systems, including the degree and types of interactions between people or their communities and the natural environment. This points to the importance of **social, economic and cultural factors** in mediating the strength and direction of linkages between health and biodiversity (Clark et al., 2014). This means that differentials in the ways in which some communities (including indigenous and local communities) or groups within wider society (e.g. women, people suffering from poverty) experience and interact with biodiversity and ecosystems may also result in differences in the influence of biodiversity and ecosystems on their health status, with the potential for group- or community-specific dependencies and risks.

Changing global and regional demographics are placing an increasing burden on health care systems, which must also contend with increased challenges associated with economic and environmental changes, including economic inequalities and the impacts of climate change. Key issues include ageing populations, increased migration resulting in increased cultural diversities at national and sub-national scales, and rapid urbanisation.

Culturally competent **health care systems** that can meet these challenges will need to account for the many different ways in which different social groups view, experience or interact with the natural environment and how they recognise and utilise NCPs which can influence their health. Understanding and addressing these challenges requires an understanding of the combined social economic and environmental drivers of health status, and how health inequalities arise and affect different communities and groups within society. This raises issues of **social justice**, including issues of distributive, procedural and inter-generational justice.

The SoK also highlights the negative impacts which certain health sector activities can have on biodiversity, including through the release of active pharmaceutical ingredients into the environment (Boxall & Kretsch, 2015). The report emphasises that the health sector is a key partner in

mainstreaming biodiversity and NCPs into national decision-making, and calls for closer co-operation between the sectors, particularly in areas of immediate cross-cutting concern such as climate change, pollution prevention and disaster risk reduction. The report advocates further development and uptake of ecosystem approaches to health, such as the One Health approach which focuses on interlinkages between the health of humans, ecosystems and biota, and other approaches which promote **integrated approaches** and sharing of new knowledge to support development and implementation of policies to concurrently support biodiversity conservation and human health.

The following sections provide an overview of some of the key issues linking health, building on and updating the SoK report for the ECA region.

Non-communicable disease

Non-communicable diseases (NCDs) are those illnesses which are not caused by an infectious agent. The term is often associated with chronic conditions, though some NCDs may be of short duration. NCDs are a major cause of disability, morbidity and mortality and surpass infectious diseases as the major public health issue worldwide, with the exception of sub-Saharan Africa. NCDs may be associated with genetic disorders which are heritable (e.g. cystic fibrosis, haemophilia), or be environmental in nature, associated with lifestyle (e.g. related to smoking or lack of exercise) or exposures to specific environmental risks (e.g. air pollution, or contaminated food or water). Global Burden of Disease studies indicate that the prevalence of NCDs has been increasing at least since the 1990s; cardiovascular diseases are the major NCDs worldwide, with the highest per-capita cardiovascular disease burden falling on Eastern Europe and Central Asia (Benziger, Roth, & Moran, 2016). Major causes of cardiovascular disease in these regions include tobacco and alcohol consumption and dietary factors, stress, and increasingly sedentary lifestyles. As such, NCDs frequently demonstrate the interaction of social and environmental determinants of health outcomes, and the role of biodiversity and NCPs in contributing to risks or remedies for NCDs is mediated by the complex interactions of social, personal, economic and cultural factors. The following sections provide a snapshot of these linkages in the ECA region.

Nutrition

The role of biodiversity in underpinning modern agriculture and food security is well documented (Hillel & Rosenzweig, 2008). Of increasing interest is the role which biodiversity can play in nutrition security, supporting dietary health by providing a wide food resource base, diversifying sources of macro- and micro-nutrients, providing opportunities for development of nutraceuticals, and helping to meet nutritional needs in times of social or economic instability.

From a policy perspective, the CBD's cross-cutting initiative on Biodiversity for Food and Nutrition (www.b4n.org) has encouraged research and practical measures for conservation of crop and livestock diversity. The importance of conserving crop wild relatives (CWR) *in situ* and *ex situ* to ensure future food and nutrition security has been recognised at the pan-European level by the European Strategy for Plant Conservation (Planta Europa, 2008) and the EU Biodiversity Strategy to 2020 (European Commission, 2011), and all countries in the ECA region have committed to conserving genetic diversity of food crops and animals through the Aichi Biodiversity Targets. The IUCN European Red List of Vascular Plants (Bilz, Kell, Maxted, & Lansdown, 2011) states that, of 572 European CWR species at least 11.5% are threatened, with 3.3% being Critically Endangered, 4.4% Endangered, 3.8% Vulnerable, and 4.5% Near Threatened. Globally, concerns have been raised about the lack of coverage of CWR within protected area networks (Stolton et al., 2008)(Hunter, Maxted, Heywood, Kell, & Borelli, 2012). This is being addressed in the ECA region through detailed inventories, identifying national or regional CWR hotspots, gap analysis, and national strategies (e.g. (Fielder et al., 2015; Fielder, Smith, Ford-Lloyd, & Maxted, 2016; Kell, Knupfeer, Jury, Ford-Lloyd, & Maxted, 2008). Cataloguing effforts indicate

that the diversity and species richness per unit area is particularly high in parts of the Mediterranean, Eastern Europe and Central Asia, with many species endemic to oceanic islands (Kell et al., 2008).

The dietary importance of wild food species and traditional diets have been widely assessed (Grivetti & Ogle, 2000). However, information on nutritional composition of many species, and therefore their health significance, is scant. In a recent review (Schulp, Thuiller, & Verburg, 2014) examined patterns in the consumption and marketing of terrestrial wild foods in Europe. They identified 38 species of game, 27 species of mushrooms, and 81 species of vascular plants that are regularly hunted / collected and consumed in the EU, with over 100 million EU citizens consuming wild food each year, and argue for greater attention to be given to wild foods in ecosystem service assessments. Despite the prevalence of culinary uses of wild foods, the move away from traditional diets in the ECA region has seen many food species become increasingly underutilised, though they are receiving renewed attention in recent years for their potential contributions to healthy diets, and as a potential resource for development of nutraceuticals (Sánchez-Mata et al., 2012). Wild food plants are still at least seasonally important for many local ECA communities; for example, nutritional analysis of wild vegetables which are commonly consumed in Turkey (Kibar & Kibar, 2017), Mediterranean (García-Herrera et al., 2014), and Italy (Ranfa A., Orlandi F., & Maurizi A. Bodesmo M., 2015) illustrates that at several species hold significant potential as a healthy and cheap food resource. There has been comparatively little research into the contribution of wild foods to diet and nutrition in Central Asia, and no regionally specific research or data was found for the present assessment.

Ecotoxicology

In addition to potential positive inputs, concerns have been raised about wild foods as a route of exposure to environmental contaminants. Several assessments have considered wild game meat as a potential source of exposure to heavy metals; e.g. in animals hunted in parts of Spain (Taggart, Reglero, Camarero, & Mateo, 2011), Poland (Jarzyńska & Falandysz, 2011), and Italy (Danieli et al., 2012). These have highlighted potential risks to human health associated with use of lead ammunition by hunters and in game animals which live near mining sites. In contrast, some other studies e.g. in Poland (Warenik-Bany, Strucinski, & Piskorska-Pliszczynska, 2016) and Austria (Ertl, Kitzer, & Goessler, 2016) suggest that wild game may not present a significant toxic risk from other heavy metals or certain industrial contaminants such as PCBs and dioxins.

Recent review studies on ecotoxicology relevant to health issues for the ECA-region IPBES assessment (N=14) focus mainly on environmental pressure on the ecosystem related to health care & safety (N=11) and some on the use of animals or plants as bioindicators for monitoring environmental pollution and its effects (N=3). Below more detail on these reviews.

Environmental pressure on the ecosystem related to health care & safety

Several environmental pollutants related to products relevant for human health care or safety with potential health impacts for humans and wildlife investigated in recent reviews are relevant for the ECA-region. Partly focusing on well and less well-known pollutants, some of them banned from use, but due to their persistence still present in the environment, some still used. They focus on Bisphenol A which is used in many products ((Corrales et al., 2015); inconclusive on health effects), flame retardants ((Abou-Elwafa Abdallah, 2016; Coelho, Sousa, Isobe, Tanabe, & Nogueira, 2014; Linares, Bell??s, & Domingo, 2015); moderately conclusive on health effects), pharmaceuticals (Ahmed et al., 2015; Gaw, Thomas, & Hutchinson, 2014; Kulik-Kupka et al., 2016; Ribeiro, Nunes, Pereira, & Silva, 2015), endocrine disrupting chemicals in pharmaceuticals (Scsukova, Rollerova, & Bujnakova Mlynarcikova, 2016) and in medical equipment (Beronius & Vandenberg, 2016).

Interestingly (Brown et al., 2017) discuss the relevance of an ecosystem services approach to Environmental Risk Assessment of Chemicals, as a holistic and transparent approach. The authors suggest that better protection of the environment as a whole could be facilitated by developing and, where appropriate, adapting the EFSA Ecosystem Services approach for use with chemicals other than those that fall under the remit of EFSA.

Animals or plants as bioindicators for monitoring environmental pollution

Recent review studies regarding the use of the animals or plants used as indicators of environmental pollution relevant to the ECA-region focus on the use of fish (Lenhardt et al., 2015), bats (Zukal, Pikula, & Bandouchova, 2015) or plants (Rai, 2016). The studies are partly or fully related to Europe, but not to Central Asia. The combined relevance to both ecological and human health is not always clearly stated, but the studies illustrate potential.

Exposure to nature

Scientific review literature shows that there are many pathways between exposure to nature or natural spaces and health (Hartig, Mitchell, de Vries, & Frumkin, 2014; Jackson, Daniel, McCorkle, Sears, & Bush, 2013; Myers & Patz, 2009; Oosterbroek, de Kraker, Huynen, & Martens, 2016; Sandifer, Sutton-Grier, & Ward, 2015; World Health Organization & Secretariat of the Convention on Biological Diversity, 2015). Review literature also shows that more research is needed: *"We found strong evidence linking biodiversity with production of ecosystem services and between nature exposure and human health, but many of these studies were limited in rigor and often only correlative. Much less information is available to link biodiversity and health. Overall, much more research is needed on mechanisms of causation."* (Sandifer et al., 2015).

The EU recently funded two projects on nature – health linkages. The *'The health benefits of nature and biodiversity protection'* project explored the potential health and social benefits associated with the protection and enhancement of biodiversity in the EU – and in particular with the Natura 2000 network ((ten Brink et al., 2016)). It covers the pathways of improved air quality, reduced heat stress through improved climatic conditions, health benefits of noise reduction, health benefits in people's living & working environments, outdoor recreation & physical activity and reduced social tension. The project concludes that "there is robust scientific and practice-based evidence that nature can contribute to addressing health and social challenges that EU citizens are facing". The PHENOTYPE project explored mechanisms underlying stress reduction, physical activity, social interaction and exposure to environmental hazards (Nieuwenhuijsen et al., 2014). The PHENOTYPE project produced a range of research outcomes and publications, sometimes with differing conclusions between different locations.

Additional to these large projects, several review articles address the human health effects of green space, evaluating studies that were to a large extent performed in European countries. In **Table 2.8.1**, we show the results of recent articles that explicitly indicate to review literature covering a set of specific nature-health linkages. Based on several cross-sectional and longitudinal studies performed in the UK, the Netherlands, Belgium, Sweden, Lithuania, Germany, Spain, France and Denmark (as well as other countries outside Europe), these reviews report evidence for a positive relation between the quantity of green space around residential areas and certain health outcomes.

Table 2.8.1: Often reviewed greenspace-related health outcomes and their state of evidence as reported in reviews

Outcome category	Specific health outcome (or precursor)	Strength of evidence*	Source

Reduced all-cause mortality	""	'fairly consistent' (II of III)	(James, Banay, Hart, & Laden, 2015)
	""	'strong' (III of III)	(Van Den Berg, Wendel-Vos, Van Poppel, et al., 2015)
	""	'more limited'	(Gascon et al., 2016)
Improved overall physical health	""	'weak'	(Lee & Maheswaran, 2011)
Improved overall mental health	""	'weak'	(Lee & Maheswaran, 2011)
Improved perceived general health	""	'moderate' (II of III)	(Van Den Berg, Wendel-Vos, Van Poppel, et al., 2015)
Improved perceived mental health	""	'strong' (III of III)	(Van Den Berg, Wendel-Vos, Van Poppel, et al., 2015)
	Self-reported mental health	'suggestive' (II)	(James et al., 2015)
	Self-reported measures of emotions	'some indication'	(Bowler, D.E., Buyung-Ali, L., Knight, T.M., & Pullin, 2010)
Reduced psychiatric morbidity	Attention (precursor)	'some support'	(Bowler, D.E., Buyung-Ali, L., Knight, T.M., & Pullin, 2010)
	Blood pressure and cortisol concentrations (precursor)	(relatively) 'less evidence'	(Bowler, D.E., Buyung-Ali, L., Knight, T.M., & Pullin, 2010)
Reduced overweight and obesity	""	'positive or weak'	(Lachowycz & Jones, 2011)
	""	'some' (II)	(James et al., 2015)
	Physical activity (precursor)	'consistent' (I/II of III)	(James et al., 2015)
Reduced cardiovascular disease	""	'consistent' (II/III)	(James et al., 2015)
	""	'evidence shown'	(Gascon et al., 2016)
	Blood pressure, heart rate, and rate variability	13 studies mixed, 8 significant positive, 5 insignificant	(Haluza, Schönbauer, & Cervinka, 2014)
Improved birth outcomes	Birth weight	'consistent'	(James et al., 2015)
	Other birth outcomes	'less conclusive'	(James et al., 2015)
Endocrine system	Various	5 studies mixed, 12 significant positive, 2 insignificant	(Haluza et al., 2014)
Immune function	Various	5 studies significant positive, 2 insignificant	(Haluza et al., 2014)

** Strenth of evidence levels between parenthesis are explained further in the text*

Within the selection of review studies of **Table 2.8.1**, uncontested and moderate to strong evidence was found for a relation of green space with reduced all-cause mortality, improved perceived mental health, reduced cardiovascular disease and increased birth weight. Studies documenting adverse effects of green space on the listed health outcomes were rarely found in the reviews (exceptions are (Gascon et al., 2016; Van Den Berg, Wendel-Vos, Van Poppel, et al., 2015)). The reviews appear to not have major disagreements on any of the strengths of evidence between them. A final important observation from **Table 2.8.1** is that on the state of evidence for overall reduced psychiatric morbidity,

or actual (non-perceived) mental health, 'week' or 'less' evidence is reported in 2011 and 2010 reviews respectively. However, more recent studies conclude that there are positive correlations with these health outcomes or their proxies (e.g. Honold, Lakes, Beyer, & Meer, 2015; MacKerron & Mourato, 2013; Nutsford, Pearson, & Kingham, 2013; (De Vries et al., 2016).

Part of the explanation of (minor – moderate) differences in reported strengths of evidence between studies for the same outcome, is that both study selection criteria and strength grading criteria vary widely per review study. Also, some reported evidence strengths are only formulated in a relative way: they are related to other health outcomes within the same review study. Even though selected sets of health outcomes vary widely between the review studies that we included in **Table 2.8.1**, all reviews do apply one and the same set of selection and grading criteria. **Table 2.8.2** provides an idea of the evidence criteria used per review study. It clearly shows the wide variation in selection and grading criteria.

Increasing green space may also have adverse effects, such as to citizens allergic to pollen, or gentrification effects. However, increased awareness of the potential hazards of green infrastructure should not necessarily be a reason to reduce greening projects. Instead, incorporating public health awareness and interventions into urban planning can help insure that green spaces achieve full potential for improving general citizen health (Lõhmus & Balbus, 2015).

Table 2.8.2: Often reviewed green space related health outcomes and their state of evidence. Remarks in Italic

Source and types of green space included	Study inclusion criteria*	Study exclusion criteria*	Evidence grading criteria*
Bowler, D.E., Buyung-Ali, L., Knight, T.M., & Pullin, 2010. 'Natural environment' included any environment that appeared to be reasonably 'green', ranging from gardens and parks through to woodland and forests.	Data availability on both direct exposure to the natural environment and to the synthetic environment	Studies investigating effects of environmental hazards	Comparison with the effect on the same benefit type, but then in a synthetic environment
Gascon et al., 2016. Search engine keywords related to natural outdoor environments (greenspace, green space, natural environment, urban design, built environment, blue space, park, forest).	Study contains keywords related to natural outdoor environments combined with keywords related to mortality	No original research article, or no report of mortality in relation to green or blue space exposure	Score (%) assigned based on quality of the individual studies, assessed by criteria focusing on e.g. study design, study population, sample size, exposure assessment, outcome assessment and confounding factors
Haluza et al., 2014. combinations of "Physiologic *", "natur *", "green", "outdoor", "restorati *", and "stress".	Publication date between 1991 and 2012, peer-reviewed journal, research conducted internationally, study subjects adults, at least one physiological parameter	Research articles on effects of simulated/indoor nature, animal contact, and wood as building material.	Study results labelled "significant positive" if all study comparisons showed positive effects of nature (significant at 5% level), "mixed results" if only some comparisons showed significant positive effects of Nature and "insignificant" for comparisons with statistically insignificant effects.
James et al., 2015. Results from a survey of greenness – health literature.	*This review is not meant to be comprehensive, but*	-	Evidence grade from I-III based on consistent, plausible and precisely

	results from a survey of recent public health literature.		quantified evidence and low probability of bias
Lachowycz & Jones, 2011. A greenspace access measure, generated using either a Geographic Information System or an assessment by trained auditors using a consistent tool.	Empirical data, objective greenspace measure, greenspace access included as variable, outcome related to obesity.	-	Each study was assigned label 'Positive', 'Equivocal (weak/ mixed)', 'No relationship' or 'Negative'.
A. C. K. Lee & Maheswaran, 2011. Keywords 'green space', 'public open space', 'open space' and 'park'.	Studies and review articles refer to green spaces with a health perspective.	Not 'relevant' articles	Evidence grade from I-III based on if the effect is plausible, precisely quantified and not vulnerable to bias
M. Van Den Berg et al., 2015. Keywords 'natural environment', 'natural space', 'natural infrastructure', 'greenspace' and 'greenery' and additionally combinations of 'green', 'greener', 'greening' and 'greenness' with 'environment', 'space', infrastructure', 'city/cities', 'area', and 'neigbo(u)rhood'.	Study has to be observational with either a cross-sectional or longitudinal design.	*Studies are screened for relevance by independent reviewers*	Evidence grade from I-III based on number and quality of studies and consistency of findings

** Only the first or dominant criteria per review study have been included in this overview*

There are several knowledge gaps regarding the evidence of green space – health linkages. Age, gender and especially socio-economic status (SES) may modify the association between greenness and health behaviors and outcomes. For example lower SES groups have less green space access but perhaps benefit more from greenness exposure ((James et al., 2015); (Gascon et al., 2016)). Challenges for future research are therefore to follow subjects prospectively, differentiate between greenness quantity and quality, and identify the above mediators ((James et al., 2015); (Gascon et al., 2016)). Longitudinal observational designs, (quasi-) experiments or even well-controlled interventions are needed to provide better evidence for a causal relationship ((Hartig et al., 2014); (Van Den Berg, Wendel-Vos, van Poppel, et al., 2015)). It has to be acknowledged here that manipulating environments or people is often more difficult and expensive than applying a more pure observational design.

Another important natural landscape element next to greenspace is water. However, the relationship between water and health in current literature is almost only investigated in the field of environmental toxicology and microbiology and not explicitly in the research field of blue space and human well-being. Therefore, there also is a lack of a systematic reviews of the health effects of blue space, despite results that blue space has many types of influences on health (Völker & Kistemann, 2011). Associations with mental health might even be stronger for blue space than for green space (De Vries et al., 2016). Further studies are therefore needed evaluating the benefits of blue spaces (Gascon et al., 2016). An EU research project on blue infrastructure and health (BlueHealth) started in 2016 and is currently ongoing.

Communicable disease

There are many factors involved in the transmission of infectious disease, including social, ecological, and economic factors, as well as personal factors such as individual behaviours and innate immunity,

and use of / access to health services. Biodiversity and ecosystems can act as reservoirs of pathogens (infectious agents i.e. bacteria, viruses, fungi, or parasites), and it has long been known that changes in the ecology of pathogens arising from environmental change can increase the risks of spread to humans, with loss of biodiversity being put forward as an important factor (e.g. (Myers et al., 2013; Patz et al., 2005; Pongsiri et al., 2009)).

Routes of pathogen exposure for humans include through contaminated foods or water, or activities that lead to interaction with host wildlife, domestic animals or disease vectors (e.g. biting invertebrates). Whilst ecosystem change is recognised as a risk factor for disease emergence and spread, a specific role for biodiversity is not always clear. One mechanism by which biodiversity may reduce disease rise is the “dilution effect”, whereby, in ecosystems where hosts of an infectious agent vary in their ability to transmit an infection, increased diversity of potential hosts reduces the risk of disease outbreak. This concept remains controversial, and any such effect is likely highly specific to pathogen and location (e.g. (RANDOLPH & DOBSON, 2012)). However, some evidence for the dilution effect in at least some local contexts has been presented from several European studies (e.g. (RUYTS et al., 2016); (Khalil, 2016); (Kedem et al., 2014); (Bolzoni, Rosà, Cagnacci, & Rizzoli, 2012)).

Diseases passed from animals to humans (zoonoses) have been of particular interest from a public health perspective in recent years with several zoonotic diseases posing major public health threats in the ECA region. Diseases shared between wildlife, livestock and humans are increasingly important medically and economically and from a nature conservation perspective. In a recent assessment of these shared diseases in Europe, (GortÃ¡zar, Ruiz-Fons, & HÃ¶fle, 2016) highlight growing risks caused by greater interaction between wildlife and agricultural animals, by increased human population density and urbanisation, and environmental changes including habitat conversion and climate change. Ranking 46 shared pathogens of human health, agricultural and conservation significance in Europe, the authors make the case for greater integration of wildlife disease and wildlife population monitoring, and greater co-ordination of these fields with human and livestock disease surveillance. Greater harmonisation of methods is also required both between disciplines and countries. The European Wildlife Disease Network (Kuiken, Ryser-Degiorgis, Gavier-Widén, & Gortázar, 2011)k has taken steps towards this, though Gortázar et al. (GortÃ¡zar et al., 2016) suggest that greater standardisation is required for assessments over large geographic scales.

This integrated “One Health” approach - linking human, veterinary and wildlife health in research and practice – has gained widespread attention in the ECA region, and several initiatives are reported in the literature, including the GeoHealth Hub for Eastern Europe and West Central Asia (Coman et al., 2015), the Israel wildlife Disease Surveillance Programme (Lapid, King, Yakobson, Shalom, & Moran-Gilad, 2016), and the MEREEB network in the Middle east and Central Asia (Aikimbayev et al., 2014). Other related efforts included the EU-funded APHAEA (www.aphaea.eu) and ANTIGONE (www.antigonefp7.eu) projects. However, while the One Health concept is receiving more recognition and interest across disciplines, (Sikkema & Koopmans, 2016) find that in some parts of the region education, training and investment in developing One Health approaches is often lacking.

Natural and man-made disaster risk

Natural and man-made disasters present significant challenges to human health and health care systems, including significant physical and mental trauma and loss of life as a direct result of the event, and longer term risks of psychological stress and depression, and impacts on food and water resources including increased risk of infectious disease outbreaks. The health burden of disasters is likely to increase as a result of climate change ((World Health Organization & Secretariat of the Convention on Biological Diversity, 2015)).

The use of natural and managed habitats to reduce the risk or impacts of natural disasters has gained increased interest as increased climate variability and extreme weather events have a greater impact upon communities in the ECA region and worldwide. Well-known examples of disaster risk reduction as a NCP is the use of forestry as a means of reducing risks of erosion, snow avalanche, rockfalls and landslides in mountainous regions, such as the Alps ((Dorren, 2004)(Brang et al., 2006)), and the use of wetlands as protection against coastal flooding and storm surges ((Smolders, Plancke, Ides, Meire, & Temmerman, 2015) (Stark, 2016)). Recently, major flooding events in Europe have promoted assessment of Ecosystem–based Adaptation (EbA) as an option to reduce future flood risk associated with climate change (e.g. (Huq, 2016; Loos & Rogers, 2016)). In rural parts of Central Asia, where water scarcity, rather than flooding, is a major climate risk, integrated approaches which link sustainable agriculture with ecosystem restoration and water-use efficiency have been suggested as a means of enhancing community resilience (Aleksandrova, Lamers, Martius, & Tischbein, 2014).

There has been little quantitative research into the degree to which EbA or other ecosystem approaches may actually reduce the risk of physical harm or psychological stresses from disasters and extreme weather events in the ECA region. Some limited work has been carried out to assess the potential of green infrastructure or access to open green space for reducing risks of climate-related heat stress (Lafortezza, Carrus, Sanesi, & Davies, 2009; Wang, de Groot, Bakker, Wörtche, & Leemans, 2017; Zölch, Maderspacher, Wamsler, & Pauleit, 2016). However, mainstreaming of EbA into urban planning and climate preparedness strategies is still slow (Wamsler, 2015).

Medicines and biomedical research

We found five recent review studies on biomedical research relevant regarding health issues for the ECA-region IPBES assessment. Two focus on legal and ethical issues regarding bioprospecting and natural resource use. (Appleby, Kinsey, Wheeler, & Cunningham, 2015) focus on marine law pointing out that commercial biomedical research on its own will not be able to meet all the opportunities which marine research can give human health, and that therefore needs public funding. (Efferth et al., 2016) focus their review on biopiracy: the use of biological resources and/or knowledge of indigenous tribes or communities without allowing them to share the revenues generated out of economic exploitation or other non-monetary incentives associated with the resource/knowledge. They argue that the patenting of herbs or natural products by pharmaceutical corporations disregards the ownership of the knowledge possessed by the indigenous communities on how these substances worked, and this is not sufficiently prevented by current treaties and court decisions. They call upon scientists to take responsibility in publishing relevant data, preferably with indigenous communities, thus avoiding patenting by pharmaceutical companies.

Three papers focus on the potential for new drug development for human ailments. Two of these focus on the marine: (Montalvão et al., 2016) reviewed the antimicrobial, antifouling, anti-inflammatory and anticancer potential of in total 98 specimens collected from the Aegean Sea. The study demonstrates that the Aegean Sea is a rich source of species that possess interesting potential for developing industrial applications, e.g. in relation to antimicrobial activity, antiproliferative activity against cancer and anti-inflammatory activity. They conclude that despite this potential, biological activities of marine fauna and flora of the Aegean Sea have remained poorly studied when in comparison to other areas of the Mediterranean Sea. (Purves et al., 2016) reiterate that the oceans represent an understudied resource for the isolation of bacteria with the potential to produce novel secondary metabolites useful for biomedical application. In that respect they reviewed the potential for bacteria from among other Scottish sediments, illustrating among other potential for bioactivity against epithelial colon adenocarcinoma cells. (Nisa et al., 2015) sketch potential for endophytic fungi (in general, but including European studies) for among other medicinal applications, potentially in relation to cancer, malaria and tuberculosis. The feasibility of industrial production of bioactive compounds by endophytic fungal sources has still to be proven.

Integrating approaches to research, policy and practice

Improving our knowledge on how nature affects human health can be achieved by first identifying which specific types of nature are relatively effective for particular health outcomes as well as research on the mechanisms of causation (Hartig et al., 2014). For example, if adverse health effects of green space, such as sources of infectious diseases and allergens, are integrated in assessments, a much better estimation could be made of the net impact on human health (Oosterbroek et al., 2016). Also needed are new coalitions of ecologists, health scientists, social scientists and planners that conduct research, develop policies and perform land-use planning together (Sandifer et al., 2015).

Importance of nature – human health linkages: ECA-CBD country perspective

For the preparation of the ECA assessment an analysis was undertaken to explore how national institutions (referred to as parties below) in ECA-countries consider nature–human health linkages (see below: *Boxes related to Integrating approaches to research, policy and practice*). Across ECA, almost all CBD parties involved in our analysis (covering 93% of all ECA-CBD countries) explicitly recognize the importance of nature – human health linkages. Few (8%) parties only mention these linkages in general terms, most consider key details such as the diversity of linkages, local specificities, challenges, opportunities and actions. Some parties also mention local practice examples regarding application of health relevant insights. Most parties (63%) mention both human health benefits and risks, a few only mention risks (6%) and some mention only benefits (27.5%). When we single out the risks mentioned in relation to human actions/drivers, the picture changes: then 49% of the parties only refer to nature benefits. The human actions/drivers inducing human health risks mentioned by most parties are: environmental pollution (55% of ECA), invasive alien species (data only for CWE: 35%), genetically modified organisms (GMO) (25.5% of ECA) and disturbances of ecosystems and biodiversity loss (12% of ECA). Risk of infectious diseases is mentioned across the ECA-region by 27.5% of the parties; most (17.5%) link this with human actions/drivers such as disturbances of ecosystems and biodiversity loss (8%), IAS (8%) and climate change (4%). Allergy is mentioned by 15.5%, only in WCE; mostly mentioned in relation to IAS: 12%. Toxicological health risks are mentioned by 8%, mainly in relation to IAS (8%), partly in relation to ecosystem disturbance (4%). Several other human health risks related categories are mentioned to a lesser extent: flooding (8%), high summer temperatures (4%).

As main examples of human health benefits, the importance of biodiversity for (the production of) medicine and medicinal plants is mentioned across ECA (respectively 57 and 57%). Regarding medicinal plants overharvesting/uncontrolled collection is mentioned as a threat by 21.5% and ecosystem disturbance by 10%. Regarding medicinal plants the importance of local knowledge/traditional medicine/local use is mentioned by 27.5%. Some countries (33%) moreover present specific data on medicinal plants in their country. Healthy nutrition is mentioned across ECA by 31.5%, water and/or air purification by 15.5% and climate change regulation by 10%. Biological control of pests and infectious diseases is only mentioned by 6% with specific reference to human health. Further, quite a diversity of other benefits is mentioned by some countries. One promising example is mentioned only by Finland: “sensitisation to non-pathogenic microbes in the environment may inhibit the development of allergies”. Finally, not only physical health benefits are mentioned; mental health benefits are also mentioned explicitly by 19.5% of countries.

Of key challenges mentioned across ECA, active involvement of the healthcare sector is prominent (45%), as is the need for investment in education and training (27.5%). In Belgium a community of practice for Biodiversity and Health is active (H Keune et al., 2013) and in Finland (Jäppinen & Heliölä, 2015) a two year expert platform with workshops resulted in proposals for a National Nature for Health and Well-Being -program (2015–2025). Austria mentions similar plans. Some countries (17.5%) mention the need to improve our understanding of the complexity of the human health and

biodiversity linkages. Integrated approaches are propagated by only 6%, integrating nature– health benefits and risks, animal and human health. This does not mean that in general countries feel confident about the evidence base: only 8% (only date for WCE) explicitly expresses confidence in the evidence base, and mainly in relation to health benefits of green space for mental and physical health and wellbeing. 21.5% (only data for WCE) express the need for green infrastructure initiatives for improved human health conditions in urbanized areas and healthier lifestyle, 10% underline the importance of blue infrastructure. Lithuania mentions a health risk in relation to urban green space: potential increase of animals carrying infectious diseases such as tick encephalitis and Lyme disease in urban parks. Nature-based tourism and recreation in natural areas are promoted for health benefits by 23.5% (only WCE).

Across ECA, several **win-win opportunities** are mentioned in support of nature–health benefits: improved health conditions will result in lower healthcare costs (8%), and raising public awareness on the health benefits will support both public health and nature conservation (16%). Other win-win examples are mentioned: e.g. "as well as health benefits, increased outdoor activities bring economic benefits" and the value of houses in green and healthy areas will increase. In relation to opportunities for nature based health, several parties (13.5%) mention the importance of equity: nature benefits should also be accessible for lower social strata to avoid health inequalities.

Regarding knowledge gaps, we emphasizes several issues:

1. *The need for an IPBES health assessment* in order more completely outline and define the scope and complexity of biodiversity-health relationships, and more appropriately assess their relevance to human well-being in ECA and other regions. Currently in IPBES it is only dealt with in a fragmented manner with very limited space for in-depth understanding and communication. Further this would help bring to the fore the key importance of related opportunities and challenges for society and the crucial bridge between science, policy and practice. Also, ongoing and rapid environmental and demographic changes affecting biodiversity – health linkages and related scientific developments and challenges warrant a policy oriented update of earlier reviews such as the CBD – WHO State of Knowledge review.
2. *The need for integrated approaches to research, policy and practice.* We need more integrated approaches to nature & health both in and between science, policy and practice, such as called upon earlier by CBD, WHO, FAO, OIE. The importance of human health interlinkages with nature and the environment in general has gained attention in science, policy and society at large. The recent (2015) State of Knowledge review of the Convention on Biological Diversity (CBD) and the World Health Organization (WHO) addresses the diversity and complexity of the interlinkage between biodiversity and human health and the opportunities and challenges that go with it. In order to better address all (or subsets of) interrelated aspects in an integrated/holistic manner, several integrative frameworks were developed over time. The CDB-WHO State of Knowledge review refers to several of these, such as One Health (as was earlier also done jointly by WHO, FAO and OIE), EcoHealth, the ecosystem approach and One Medicine. One of the key messages from the review to the scientific and policy community and society at large is promotion of the OneHealth concept as a common framework under which all these (other) relevant integrative frameworks can be connected.
3. *The need for improved monitoring of nature – health linkages.* As health is such an important and encompassing angle on nature - human linkages, we advise to invest in data collection & processing work relevant for nature – health linkages. Regarding trends information both for nature – health linkages in general and for medicinal plants in particular it is hard to find information relevant across the ECA region, or a significant part of the ECA region, and easily accessible and usable for the RA ECA. When relevant data were found, there was a lot of processing work needed for it to be useful for the RA ECA, for which we do not have the capacity

and it would result in new knowledge which is beyond the ambition of IPBES assessments. For specific topical foci we refer to the health section in CH2. Recently CBD parties adopted the CBD-WHO recommendation on the need for integrated One Health approaches was adopted. This means that CBD parties, among which quite some ECA countries, support the One Health concept for the mentioned integration ambitions, and in the near future will have to report to the CBD on state of the art and progress.

4. *The need for research on urban NCPs to health.* Research setups employing longitudinal prospective methods are necessary to provide more sound evidence for the strengths of causal relationships with specific urban ecosystem aspects. Depression reduction is one of the health benefits most strongly associated with urban ecosystems. The influence of biodiversity, differences in green space composition and water on this association, however, has not been systematically assessed. Though it has to be acknowledged that manipulating environments or people is often more difficult and expensive than applying a more pure observational design, research setups employing longitudinal prospective methods are necessary to provide more sound evidence for the strengths of causal relationships with specific urban ecosystem aspects.
5. *The need for research on the human immune system - natural environment linkage.* Recently emerging studies suggest that the enforcement of the human immune system through exposure to a natural environment could be a core pathway in which nature affects human health. Quantitative research regarding this relation is almost limited and would be informative for human health measures.
6. *The need for research on individual mediators in nature – health linkages.* Age, gender and socio-economic status may mediate the association between ecosystem and health behaviours and outcomes. For example lower socio-economic status groups have less green space access, but studies indicate that this group might perhaps benefit most from greenness exposure. Challenges for future research are therefore to ex-ante identify these mediators, select suitable cohorts and follow subjects prospectively in order to learn more about their strength and perhaps alter the design of urban green infrastructure based on this knowledge.

Information related to Integrating approaches to research, policy and practice

Overview of ECA countries in CBD reports. Documents included in the analysis are in **bold**, except for those marked **yellow**; these were not included because of analysis of another document from more or less the same period, or because these documents were considered outdated (from before 2000); the documents in *red font* were not included because not available in English. NEAs were not included as there is not enough comparative material in English across ECA.

ECA-region countries	CBD parties	Acronym	CBD NBSAP	CBD NREP
1. Albania	1. Albania	ALB	**1999-11-30**	**2014-06-02**
2. Andorra	*2. Andorra*	-	-	***2016-03-10***
3. Armenia	3. Armenia	ARM	**2016-02-11**	**2014-09-04**
4. Austria	4. Austria	AUS	**2015-07-13**	**2014-09-26**
5. Azerbaijan	5. Azerbaijan	AZB	**2008-06-28**	**2014-04-29**
6. Belarus	6. Belarus	BELA	**2015-09-03**	**2014-04-07**
7. Belgium	7. Belgium	BE	**2014-02-07**	**2014-03-25**
8. Bosnia and Herzegovina	8. Bosnia and Herzegovina	BIH	**2008**	**2014-05-29**
9. Bulgaria	9. Bulgaria	BUL	**2005**	**2014-06-13**
10. Croatia	10. Croatia	CRO	**2009-06-16**	**2014-06-11**
11. Cyprus	11. Cyprus	CYP	**-**	**2014-08-06**
12. Czech Republic	12. Czech Republic	CZE	**2006-04-26**	**2014-06-11**
13. the Kingdom of Denmark	13. Denmark	DEN	**2015-05-19**	**2014-03-31**
14. Estonia	14. Estonia	EST	**2014-05-26**	**2014-05-22**
15. -	15. European Union	EU	**2011-05-03**	**2014-06-19**
16. Finland	16. Finland	FIN	**2013-03-08**	**2014-05-05**
17. France	17. France	FRA	**2011-05-20**	**2014-07-04**
18. Georgia	18. Georgia	GEO	**2014-09-26**	**2015-06-10**
19. Germany	19. Germany	GER	**2016-03-09**	**2014-04-01**
20. Greece	20. Greece	GRE	**2014-12-22**	**2016-03-18**
21. Hungary,	21. Hungary	HUN	**2015-06-23**	**2014-05-05**
22. Iceland	22. Iceland	ICE	**-**	**2014-06-18**
23. Ireland	23. Ireland	IRL	**2012-01-17**	**2014-09-29**
24. Israel	24. Israel	ISR	**2010-03-31**	**2016-03-31**
25. Italy	25. Italy	ITA	**2010-12-22**	**2014-04-18**
26. Kazakhstan	26. Kazakhstan	KAZ	**1999**	**2014-05-21**
27. Kyrgyzstan	27. Kyrgyzstan	KYR	**2016-01-18**	**2016-01-18**
28. Latvia	28. Latvia	LAT	***2015-07-15***	**2014-08-13**
29. Liechtenstein	29. Liechtenstein	LIECH	**2014-09-03**	**2014-09-03**
30. Lithuania	30. Lithuania	LIT	**1998-12-31**	**2009-10-23**
31. Luxembourg	*31. Luxembourg*	-	***2007***	***2015-03-18***
32. Malta	32. Malta	MALT	**2012-12-27**	**2015-04-23**
33. Monaco	*33. Monaco*	-	**-**	***2014-11-13***
34. Montenegro	34. Montenegro	MONT	**2010-07-30**	**2014-04-02**
35. Netherlands	35. Netherlands	NL	**2014-09-16**	**2014-04-15**
36. Norway	36. Norway	NOR	***2016-01-27***	**2014-07-04**
37. Poland	37. Poland	POL	**2015-12-31**	**2014-03-28**
38. Portugal	38. Portugal	PORT	***2001-11-16***	**2010-09-29**
39. Republic of Moldova	39. Republic of Moldova	MOLD	**2015-08-18**	**2014-04-01**

40. Romania	40. Romania	ROM	**2009-06-01**	**2014-10-20**
41. Russian Federation	41. Russian Federation	RUS	**2002-04-19**	**2014-07-25**
42. San Marino	42. San Marino	SANM	**-**	**2016-02-15**
43. Serbia	43. Serbia	SERB	**2011-03-16**	**2014-08-15**
44. Slovakia	44. Slovakia	SLOVA	**2015-08-27**	**2015-01-16**
45. Slovenia	45. Slovenia	SLOVE	**2002-05-30**	**2015-07-03**
46. Spain	*46. Spain*	-	***2012-01-30***	***2014-03-31***
47. Sweden	47. Sweden	SWE	**2007-01-11**	**2014-04-15**
48. Switzerland	48. Switzerland	SWI	**2012-05-02**	**2014-04-30**
49. Tajikistan	49. Tajikistan	TAJ	**2004-02-27**	**2014-04-25**
50. the former Yugoslav Republic of Macedonia	50. the former Yugoslav Republic of Macedonia	MAC	**2004**	**2015-01-29**
51. Turkey	51. Turkey	TURKE	**2009-03-26**	**2015-06-29**
52. Turkmenistan	52. Turkmenistan	TURKM	**2003-01-16**	***2015-09-28***
53. Ukraine	53. Ukraine	UKR	**1998-05-15**	**2015-04-07**
54. United Kingdom of Great Britain and Northern Ireland	54. United Kingdom of Great Britain and Northern Ireland	UK	**2011-08-19**	**2014-05-02**
55. Uzbekistan	55. Uzbekistan	UZB	**-**	**2015-08-17**

Overview of main nature – health linkage issues in national CBD reports

Issues	CBD NBSAP + NREP
Health is important?	
Not explicitly mentioned	BELA, LIECH
Explicitly mentioned (*only in general terms*)	*ALB*, ARM, AUS, AZB, BE, BIH, BUL, CRO, *CYP*, CZE, DEN, EST, EU, FIN, FRA, GEO, GER, GRE, HUN, ICE, IRL, ISR, ITA, KAZ, KYR, *LAT*, LIT, MAC, MALT, MOLD, MONT, NL, NOR, POL, PORT, ROM, RUS, SANM, SERB, SLOVA, SLOVE, SWE, SWI, TAJ, TURKE, *TURKM*, UK, UKR, UZB (49 = 96%)
Benefits & risks?	
Benefits and risks	ARM, AUS, AZB, BE, BIH, BUL, CZE, FIN, FRA, GEO, GRE, HUN, IRL, ISR, ITA, KAZ, LIT, MAC, MALT, MOLD, NL, ROM, SANM, SERB, SLOVE, SWE, SWI, TAJ, TURKE, UK, UKR, UZB (32 = 63%)
Only benefits	DEN, EU, GER, FRA, ICE, KYR, MALT, MONT, POL, PORT, RUS, SLOVA, TURKE, UK (14 = 27,5%)
Only risks	CRO, EST, NOR (3 = 6%)
Only benefits when excluding risks related to human actions/drivers	ARM, AUS, AZB, BE, BIH, BUL, CZE, FIN, FRA, GEO, GRE, HUN, IRL, KAZ, MALT, MOLD, NL, ROM, SANM, SERB, SLOVE, SWI, TURKE, UK, UKR (25 = 49%)
Which risks?	
Environmental pollution	ARM, AUS, AZB, BE, BIH, BUL, CZE, EST, FRA, GEO, GRE, HUN, IRL, ISR, ITA, KAZ, MAC, MALT, NL, NOR, ROM, SLOVE, SWE, SWI, TAJ, UK, UKR, UZB (28 = 55%)
Invasive alien species	AUS, BE, BIH, BUL, CRO, CZE, EST, FIN, GRE, HUN, ISR, ITA, LIT, MAC, SANM, SWE, SWI, UK (18 = 35%)
Genetically modified organisms	AUS, BE, EST, FIN, HUN, ITA, MAC, MALT, MOLD, RUS, SERB, TAJ, TURKE (13 = 25.5%)

Disturbances of ecosystems and biodiversity loss	ARM, BE, ISR, ITA, KAZ, UK (6= 12%)	
Infectious diseases	ARM, BE, EST, FIN, ISR, ITA, LIT, MAC, MALT, SWE, SWI, TAJ, UK, UZB (14 = 27.5%)	
Due to disturbances of ecosystems	ARM, BE, ITA, UK (4= 8 %)	ARM, BE, FIN, ISR, ITA, MALT, SWE, SWI, UK, (9= 17.5%)
Due to invasive alien species	BE, FIN, SWE, SWI (4= 8%)	
Due to climate change	ISR, MALT (2= 4%)	
Allergy	ITA, MALT (2= 4%)	BE, BUL, CRO, HUN, ITA, MAC, MALT, SWI (8 = 15.5%)
Due to invasive alien species	BE, BUL, CRO, HUN, MAC, SWI (6 = 12%)	
Toxicological health risks		
Due to disturbances of ecosystems	ITA, SWE (2= 4%)	BE, ITA, SWE, SWI (4= 8%)
Due to invasive alien species	BE, ITA, SWE, SWI (4= 8%)	
Flooding	ARM, FIN, SERB, UK (4=8%)	
High summer temperatures	ITA, UK (2 = 4%)	
Which benefits?		
medicine	ARM, BE, BIH, BUL, CZE, DEN, EU, FIN, FRA, GRE, HUN, ICE, IRL, ISR, ITA, LIT, MAC, MALT, MOLD, MONT, ROM, RUS, SLOVE, SWE, SWI, TAJ, TURKE, TURKM, UK (29= 57%)	
medicinal plants	ARM, AZB, BE, BIH, BUL, FIN, GEO, GRE, HUN, ISR, KAZ, KYR, LIT, MAC, MALT, MOLD, MONT, NL, PORT, ROM, RUS, SERB, SWE, SWI, TAJ, TURKE, TURKM UKR, UZB (29=57%)	
Threat of overharvesting	ARM, CZE, GEO, KAZ, LIT, MAC, RUS, SERB, SLOVE, TAJ, UZB (11= 21.5%)	
Ecosystem/biodiv disturbance threat	BIH, ITA, SLOVE, TAJ, UK (5= 10%)	
Importance of local knowledge/traditional medicine/local use	ARM, AZB, BIH, ITA, KAZ, LIT, MAC, MONT, PORT, SERB, TAJ, TURKM, UKR, UZB (14= 27.5%)	
Specific data for countries	ARM, AZB, BIH, BUL, GEO, GRE, KAZ, KYRG, LIT, MAC, MOLD, RUS, SERB, SWI, TAJ, TURKE, UZB (17= 33%)	
Healthy nutrition	ARM, BE, BIH, BUL, CZE, DEN, HUN, IRL, ISR, ITA, LIT, MALT, NL, RUS, SERB, TAJ (16=31.5%)	
Water and/or air purification	ARM, BE, BIH, FIN, IRL, ISR, MALT, SWI (8 = 15.5%)	
Climate change regulation	ARM, BE, BIH, ITA, UK (5= 10%)	
Control of pests and diseases	BE, BIH, UK (3= 6%)	
Mental health benefits	ARM, BE, BIH, DEN, FIN, IRL, ISR, MALT, SWI, UK (10=19.5%)	
Key challenges?		
Active involvement of the health care sector	ALB, ARM, AUS, AZB, BE, BIH, BUL, CRO, FIN, FRA,GEO, IRL, ISR,KYR, MOLD, NL, RUS, SANM, SLOVE, TAJ, TURKM, UK, UZB (23= 45%)	
Need for investment in education, training	BE, BIH, BUL, CRO, FIN, FRA, IRL, ISR, ITA, MAC, PORT, SERB, TAJ, UK (14= 27.5%)	
Need to improve our understanding of the complexity of the human health and biodiversity linkages	AUS, BE, FIN, GEO, ITA, MAC, NL, SWI, UK (9= 17.5%)	
Integrated approaches	BE, FRA, ITA (3= 6%)	

Mounting evidence demonstrating the contribution green spaces have to mental and physical health and wellbeing	FIN, IRL, NL, UK (4= 8%)
Green infrastructure/space	BE, FIN, GER, HUN, MALT, NL, NOR, POL, SWE, SWI, UK (11= 21.5%)
Blue infrastructure	BE, FIN, ISR, MALT, UK (5= 10%)
Nature-based tourism and recreation in natural areas	BE, BIH, CZE, DEN, FIN, IRL, LIT, MALT, NL, SLOVE, SWI, UK (12= 23.5%)
Win-win opportunities?	
Improved health conditions will result in lower health care costs	MOLD, NL, SERB, SLOVE (4= 8%)
Raising public awareness on the health benefits -support both public health and nature conservation	BIH, ISR, ITA, POL, SERB, SLOVE, SWI, UK (8= 16%)
Equity	DEN, GER, ITA, MAC, SWE, UK, TAJ (7= 13.5%)

Questions of the expert elicitation on Contributions to Physical, Mental and Social Dimensions of Health

Original questions on characterization of evidence posed to the experts					
Key findings from the literature review	*Well established*	*Unresolved*	*Established but incomplete*	*Inconclusive*	*I do not know*
1) The importance of biodiversity and ecosystem services to human health is well-established in some areas of health research, including the contribution of biodiversity to food security, to contemporary and traditional medicine, and linkages to infectious disease risk.	☐	☐	☐	☐	☐
2) The precise nature of relationships between biodiversity / ecosystems and human health is highly variable for other aspects of health research, such as whether biodiversity loss increases the risk of infectious disease emergence, and the impact which exposure to nature can have on mental well-being. In these cases, social, economic and cultural factors are equally important.	☐	☐	☐	☐	☐
3) Increased urbanisation in Europe poses significant challenges for human health – including a rise in non-communicable diseases associated with modern lifestyles, such as obesity, cardiovascular diseases, depression and anxiety disorders, diabetes, etc. Efforts to increase access of urban dwellers to green space and open countryside can help address these health issues.	☐	☐	☐	☐	☐
4) Differentials in the ways in which some communities (including indigenous and local communities) or groups within wider society (e.g. women, people suffering from poverty) experience and interact with biodiversity and ecosystems may result in differences in the influence of biodiversity and ecosystems on their health status, with the potential for group-specific or community-specific dependencies and risks.	☐	☐	☐	☐	☐
5) Biodiversity can play a role in nutrition security, supporting dietary health by providing a wide food resource base, diversifying sources of macro- and micro-nutrients, providing opportunities for development of nutraceuticals, and helping to meet nutritional needs in times of social or economic instability.	☐	☐	☐	☐	☐
6) The phenomenon known as the “dilution effect”, whereby increased biodiversity within a particular setting can reduce the likelihood of transmission of a pathogen to competent hosts and therefore potentially reduce the risk of disease outbreak in human populations, has been confirmed in some parts of Europe.	☐	☐	☐	☐	☐
7) A healthy functioning immune system is supported by exposure to biodiversity. For example, exposure to environmental microbiota reduces risks of allergy, chronic inflammation and certain other autoimmune diseases.	☐	☐	☐	☐	☐

8) By reducing threats of biodiversity loss and increasing opportunities for exposure to nature and natural environments, the designation, enforcement and increasing connectivity of protected areas can help to support public health policy goals.	☐	☐	☐	☐	☐

Original key messages posed to the experts for ranking

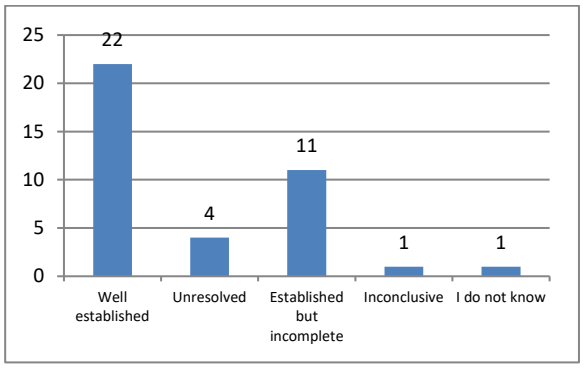
Key message	Ranking *(1 to 6)*
1) Dedicated IPBES assessments should be considered to look at nature – human health linkages in ECA and other regions, in order to better assess the quality and scope of the evidence base, to more completely illuminate the scope and complexity of biodiversity-health relationships and their importance to health outcomes, and to better target guidance to decision makers across he various relevant disciplines.	
2) Development of more and better integrated approaches to addressing nature – human health linkages are required across research, policy and practice. Knowledge exchange across a wide range of socioeconomic sectors and research disciplines, and engaging directly with local and indigenous communities, is essential to addressing evidence gaps and devising appropriate responses. Key themes which can facilitate integration include the intersections between health, biodiversity and climate change, and economic implications.	
3) The development of cross-cutting indicators and of multi-disciplinary data collection programmes relevant to nature – health linkages should be encouraged. This can include multi-sector partnerships for monitoring and reporting changes in biodiversity and nature contributions to people of specific relevance to health outcomes, health policy and health care systems, and of health issues (e.g. disease outbreaks) which may alert to unrecognised impacts of ecosystem change.	
4) There is an urgent need for research into the specific relevance of individual ecosystems to health. Recent demographic changes and increasing urbanisation suggests in particular highlight the importance of considering the impact of biodiversity and nature contributions on the health of urban communities, and opportunities for improving health by encouraging access to biodiversity. Other key ecosystems include High Nature Value farmland, marine and coastal ecosystems, forests, and wetlands.	
5) Further detailed research on the human immune system - natural environment linkage should be supported. Recent studies indicate that human immune function is supported by exposure to a natural environment; further epidemiological studies should explore the importance of such exposures for different communities (e.g. urban vs. rural), and the interaction with other factors such as nutritional status, and whether there is a "critical period" for such exposures.	
6) More focus must be given to understanding the degree to which social, cultural and economic factors influence the relationship between biodiversity / nature contributions to people and human health outcomes. This should include research into the ways in which socio-economic status, age, gender and ethnicity (*inter alia*) can mediate health risks and benefits of nature. Such research can help to illuminate how health-biodiversity relationships are framed or understood by different communities or vulnerable groups.	

Outcomes of the expert elicitation on Contributions to Physical, Mental and Social Dimensions of Health

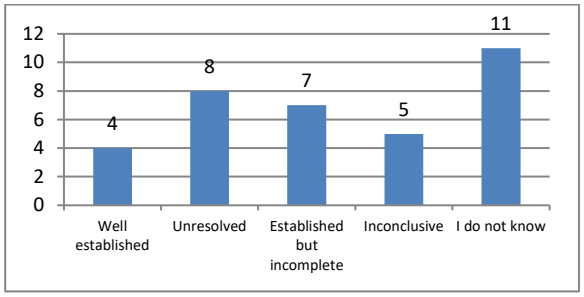
Key findings

An initial set of eight draft key findings was prepared and submitted to an expert panel for consideration. The key messages as presented here are slightly adapted for improvement of precision and clarity, and they were re-ordered to have a better flow of content. The original key messages are provided above.

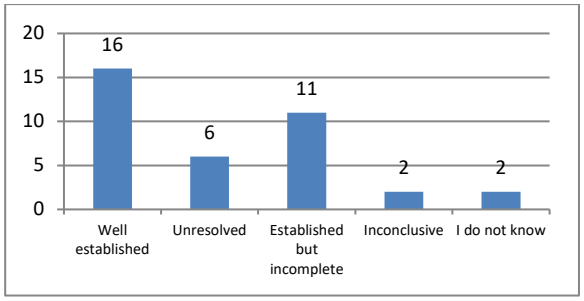
1) **The importance of biodiversity and ecosystem services to human health is well-established in some areas of health research, for example with regards to the contribution of biodiversity to food and nutrition security, to contemporary and traditional medicine, and linkages to infectious disease risk.** *("Well-established" - "established but incomplete")*



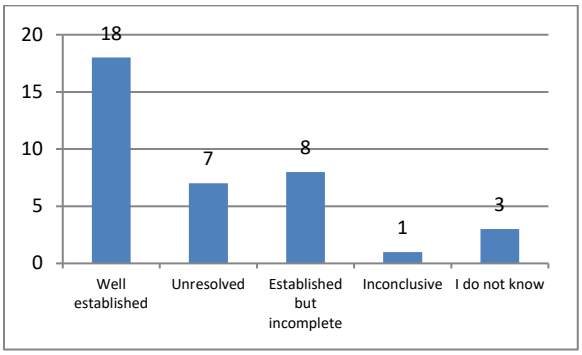
2) **The phenomenon known as the "dilution effect", whereby increased biodiversity within a particular setting can reduce the likelihood of transmission of a pathogen to competent hosts and therefore potentially reduce the risk of disease outbreak in human populations, has been confirmed in some parts of Europe.** *("Unresolved" - "inconclusive")*



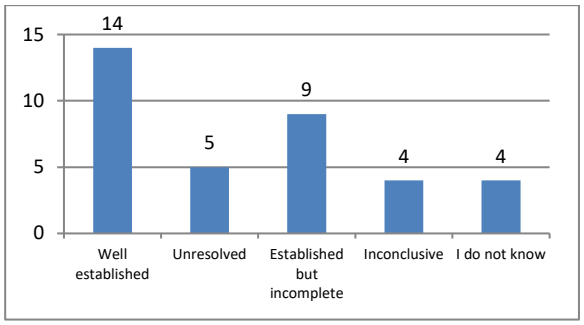
3) **The precise nature of relationships between biodiversity / ecosystems and human health can be highly variable for some other aspects of health research, such as whether or to what extent biodiversity loss may increase the risk of infectious disease emergence, and the impact which exposure to nature can have on mental and physical well-being. In these cases, social, economic and cultural factors may be at least equally important.** *("Unresolved")*



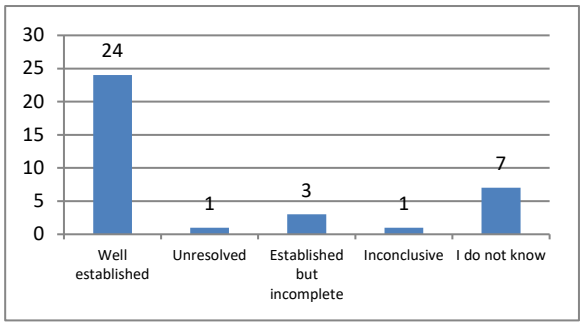
4) **Increased urbanisation in Europe poses significant challenges for human health – including a rise in non-communicable diseases associated with modern lifestyles, such as obesity, cardiovascular diseases, depression and anxiety disorders, diabetes, etc. Efforts to increase access of urban dwellers to green space and open countryside may help to address some these health issues.** *("Unresolved")*



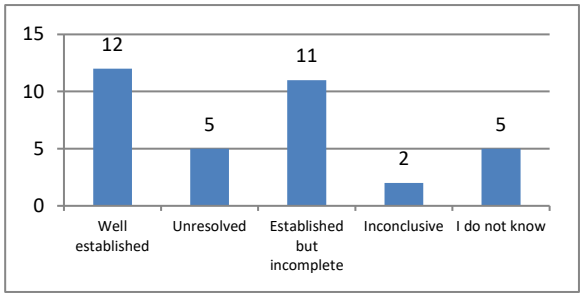
5) **Differentials in the ways in which some communities (including indigenous and local communities) or groups within wider society (e.g. women, people suffering from poverty) experience and interact with biodiversity and ecosystems may result in differences in the influence of biodiversity and ecosystems on their health status, with the potential for group-specific or community-specific dependencies and risks.** *("Unresolved")*



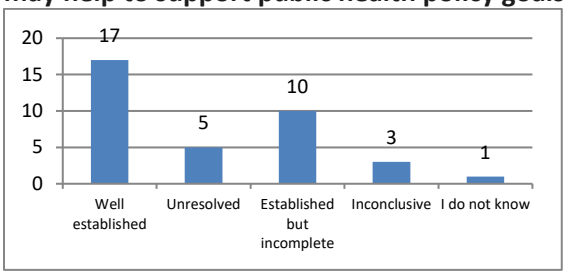
6) **Biodiversity can play a role in nutrition security, supporting dietary health by providing a wide food resource base, diversifying sources of macro- and micro-nutrients, and helping to meet nutritional needs in times of social or economic instability, including during natural or man-made disasters.** *("Well-established")*



7) There is compelling evidence from multiple studies that **a healthy functioning immune system is supported by exposure to biodiversity. For example, exposure to environmental microbiota has been associated with reduced risks of allergy, chronic inflammation and certain other autoimmune diseases.** *("Unresolved")*



8) **By reducing threats of biodiversity loss and increasing opportunities for exposure to nature and natural environments, the designation, enforcement and increasing connectivity of protected areas may help to support public health policy goals.** *("Unresolved")*



Key recommendations

An initial set of six draft key recommendations was prepared and submitted to an expert panel for consideration. Below you find the consensus ranking derived from the individual expert rankings. We should note that experts sometimes disagreed substantially, so this consensus ranking should not be considered as an outcome of negotiation among experts. It was derived from processing by means of a ranking program (Hans Keune, Springael, & Keyser, 2013).

Expert ranking	*Key message*
1	*Development of more and better integrated approaches to addressing nature – human health linkages are required across research, policy and practice.* Knowledge exchange across a wide range of socioeconomic sectors and research disciplines, and engaging directly with local and indigenous communities, is essential to addressing evidence gaps and devising appropriate responses. Key themes which can facilitate integration include the intersections between health, biodiversity and climate change, and economic implications.
2	*Dedicated IPBES assessments should be considered to look at nature – human health linkages in ECA and other regions*, in order to better assess the quality and scope of the evidence base, to more completely illuminate the scope and complexity of biodiversity-health relationships and their importance to health outcomes, and to better target guidance to decision makers across he various relevant disciplines.
	More focus must be given to understanding the degree to which social, cultural and economic factors influence the relationship between biodiversity / nature contributions to people and human health outcomes. This should include research into the ways in which socio-economic status, age, gender and ethnicity (*inter alia*) can mediate health risks and benefits of nature. Such research can help to illuminate how health-biodiversity relationships are framed or understood by different communities or vulnerable groups.
3	*The development of cross-cutting indicators and of multi-disciplinary data collection programmes relevant to nature – health linkages should be encouraged.* This can include multi-sector partnerships for monitoring and reporting changes in biodiversity and nature contributions to people of specific relevance to health outcomes, health policy and health care systems, and of health issues (e.g. disease outbreaks) which may alert to unrecognised impacts of ecosystem change.
	There is an urgent need for research into the specific relevance of individual ecosystems to health. Recent demographic changes and increasing urbanisation suggests in particular highlight the importance of considering the impact of

	biodiversity and nature contributions on the health of urban communities, and opportunities for improving health by encouraging access to biodiversity. Other key ecosystems include High Nature Value farmland, marine and coastal ecosystems, forests, and wetlands.
4	*Further detailed research on the human immune system - natural environment linkage should be supported.* Recent studies indicate that human immune function is supported by exposure to a natural environment; further epidemiological studies should explore the importance of such exposures for different communities (e.g. urban vs. rural), and the interaction with other factors such as nutritional status, and whether there is a "critical period" for such exposures.

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