World Health Organization
REGIONAL OFFICE FOR Europe

Nature, Biodiversity and Health:

AN OVERVIEW OF INTERCONNECTIONS

UNIVERSITY OF EXETER

European Centre for Environment & Human Health

WHO Collaborating Centre on Natural Environments and Health

Abstract

Urbanization, land use, global trade and industrialization have led to profound and negative impacts on nature, biodiversity and ecosystems across the world. The ongoing depletion of natural resources not only affects environmental conditions but also has an enormous impact on the well-being and security of societies.

This report provides an overview of the impacts of the natural environment on human health. It presents the ways nature and ecosystems can support and protect health and well-being, and describes how nature degradation and loss of biodiversity can threaten human health. It is targeted at readers who do not have extensive experience with the links between nature and health. While the overview report aims primarily to inform professionals and decision-makers in the health and environment sectors, it will also be of relevance for other sectors involved with the protection, management and use of nature and biodiversity.

Keywords

NATURE, BIODIVERSITY, PREVENTION, ENVIRONMENT AND HEALTH, ONE HEALTH, ECOSYSTEM SERVICES

ISBN 978-92-890-5558-1

Suggested citation. Nature, biodiversity and health: an overview of interconnections. Copenhagen: WHO Regional Office for Europe; 2021. Licence: CC BY-NC-SA 3.0 IGO.

Cataloguing-in-Publication (CIP) data. CIP data are available at http://apps.who.int/iris.

Cover photos: Becca Lovell
Design by Pellegrini

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Contents

Acknowledgments

This report was produced with the financial assistance of the German Federal Ministry of Health.

It was prepared by:

- Benedict W Wheeler, Becca Lovell, Lora E Fleming and Emma Bland (WHO Collaborating Centre on Natural Environments and Health, European Centre for Environment and Human Health, University of Exeter, Truro, United Kingdom);
- Matthias Braubach and Sinaia Netanyahu (WHO European Centre for Environment and Health, Bonn, Germany).

WHO would like to acknowledge the technical support of the following contributors:

- Deborah Cracknell, Siân de Bell, Lewis R Elliott, Jo Garrett, Ruth Garside, Cornelia Guell, Emily Haynes, Anne FC Leonard, Karyn Morrissey, Tim Taylor, Nigel C Unwin and Maria C van Hove (European Centre for Environment and Human Health, University of Exeter, Truro, United Kingdom);
- James Grellier (European Centre for Environment and Human Health, University of Exeter, Truro, United Kingdom and Institute of Psychology, Jagiellonian University, Krakow, Poland);
- Rebecca E Short (European Centre for Environment and Human Health, University of Exeter, Truro, United Kingdom and Stockholm Resilience Centre, Stockholm University, Sweden);
- Mathew P White (European Centre for Environment and Human Health, University of Exeter, Truro, United Kingdom and Cognitive Science HUB, University of Vienna, Austria).

WHO also thanks all the reviewers for their input and helpful comments on earlier versions of this publication:

- Hans Keune (Chair Care and the Natural Living Environment, University of Antwerp, Belgium);
- Laura Mancini (National Institute of Health, Rome, Italy);
- Uriel Safriel (Chair of Israel National Man and Biosphere Committee, Jerusalem, Israel);
- Hélène Soubelet (French Foundation for Biodiversity Research, Paris, France);
- Jutta Stadler (Federal Agency for Nature Conservation, Bonn, Germany);
- Brigit Staatsen (National Institute for Public Health and the Environment, Bilthoven, Netherlands);
- Dorota Jarosinska, Vladimir Kendrovski, Pierpaolo Mudu, Francesca Racioppi and Oliver Schmoll (WHO European Centre for Environment and Health, Bonn, Germany);
- Peter Hoejskov and Danilo Lo Fo Wong (WHO Regional Office for Europe, Copenhagen, Denmark).

Executive summary

The global environment is changing, and these changes have profound and negative impacts on nature – from a worldwide reduction in biodiversity and loss of pollinators to humans' use of about half of the planet's liveable surface to feed and provide resources for themselves. This depletion of natural resources has, and will increasingly have, an enormous impact on human health.

The ongoing degradation of biodiversity and ecosystems will undermine progress towards the vast majority of the assessed targets of the Sustainable Development Goals (SDGs). Loss of biodiversity is therefore not only an environmental concern but also a developmental, economic, security, social and moral challenge that must be tackled.

This report provides an overview of the impacts of the natural environment on human health. Specifically, it focuses on the myriad ways that nature, biodiversity and ecosystems can support and protect health and well-being. It also explores how environmental change and loss of biodiversity – from plant and animal species to microbiomes within the human gut – can threaten human health.

The overview report is written with a focus on the WHO European Region. Its aim is to inform policy- and decision-makers in the health and environment sectors, as well as other sectors involved with the protection, management and use of nature and biodiversity. It is also intended to be of use for planners and decision-makers seeking ways to benefit from natural and biodiverse environments locally.

The key messages of the report are as follows.

- **Nature provides the basic conditions for human health.** For example, nature can be essential to purify water or regulate air quality, and it enables soil formation and food production on land and in seas. It is a resource for traditional medicines and provides opportunities for new pharmaceutical discoveries. The natural environment provides inspiration and settings for healthy lifestyles and social contact.
- **The environment protects human health.** While nature itself can also present health risks, intact, functioning and resilient nature can help to mitigate extreme events and effects of natural disasters, and to limit human exposure to pathogens.
- **Pressure on natural environments threatens human health.** Processes such as climate change, resource depletion and loss of biodiversity contribute to the increasing frequency of extreme events, threaten ecological collapse and affect food systems. Environmental change is also resulting in conflict and displacement of people, with consequent health impacts.

Nature provides health benefits through a number of pathways in both terrestrial and aquatic environments. This overview introduces topics relating to freshwater systems; air quality; coasts, seas and oceans; soil, agriculture, nutrition and food security; infectious diseases emerging from human–wildlife interaction; microbial diversity; medicine and health care; and green and blue spaces.

Nature and biodiversity have an intrinsic value (related to general benefits of nature availability), and an immense economic value to societies. The value of nature is poorly reflected in typical economic figures, however. It has significant non-market and non-monetary benefits – for example, opportunities for recreation, energy supply, water purification and carbon storage – that are not fully valued.

Building a deeper understanding of the vital role that nature plays in human health presents two main challenges:

- the need to acknowledge and mitigate environmental damage caused; and
- the necessity of finding effective and equitable ways to adapt human behaviour for the future benefit of all life on the planet.

This report represents a call to arms for local and national governments to promote, support and enhance both nature and ecosystems worldwide, considering the implications of all related policy-making on the health of societies and the conditions of the natural world in which they exist.

Taking crucial steps to protect nature and thereby to protect human health is essential. Avoidable environmental damage and biodiversity loss threaten the health of people both now and in the future. Building environmental resilience and ensuring diverse and functional ecosystems will help mitigate health impacts in the longer term. These require all policy sectors and both national and local governments to:

- consider and communicate internally and externally the links between nature, biodiversity and health;
- prepare long-term strategies (at a minimum 25–50 years) for sustainable management of the natural environment, with explicit consideration of health impacts;
- incorporate nature, environment and health considerations into all policies at both national and local levels as standard (for example, applying One Health or Planetary Health approaches);
- seek no-regret and nature-based solutions to societal, economic, environmental and climate challenges; and
- compile and utilize environmental data and share insights on good practice.

Introduction

Dependence of human health on nature

Humans are fundamentally dependent on nature *(1)*. All systems and goods that support health and well-being can ultimately be traced back to the natural world *(2)*. Environmental change threatens human health in a variety of ways, however: from the disruption of essential natural mechanisms (such as pollination) and the loss of potential (such as new nature-inspired pharmaceuticals) to direct health threats of extreme events, the spread of vector-borne diseases or water scarcity *(3)*. Growing understanding of how the natural environment supports, protects and threatens health underlines the importance of recognizing the links in policy and practice *(4)*.

The ongoing degradation of biodiversity and ecosystems will undermine progress towards the vast majority of the assessed targets of the Sustainable Development Goals (SDGs) – especially those related to poverty, hunger, health, water, cities, climate, oceans and land (SDGs 1, 2, 3, 6, 11, 13, 14 and 15). Loss of biodiversity is therefore not only an environmental concern but also a developmental, economic, security, social and moral challenge that must be tackled *(3)*.

The rapid spread of COVID-19 and its associated costs to health, societies and economies around the globe have given rise to a growing understanding of the need to redefine human interactions with ecosystems and natural habitats, including in some cases the protection of vulnerable natural settings from human interference. In the face of resource depletion, a changing climate, changes in biodiversity and new and emerging diseases, the need to act is becoming increasingly acute and urgent. It is now also clear, however, that better protecting the environment and its biodiversity can simultaneously achieve significant short- and long-term gains and co-benefits for humans *(5)*.

Objective and target audience

This report provides an overview of the interconnections between natural environments, biodiversity and human health. Specifically, it focuses on the myriad ways that nature, biodiversity and ecosystems can support and protect health and well-being. It also explores how environmental change, degradation of nature and ecosystems and loss of biodiversity – from plant and animal species to microbiomes within the human gut – can threaten human health, and describes the economic value of nature and biodiversity for human health and well-being.

The report builds on the 2015 review by WHO/Convention on Biological Diversity *(2)* and is written with a focus on the WHO European Region, considering current evidence[1]. Citations of specific sources are kept to a minimum to aid readability and in line with the nature of this report as an overview. Key references for further reading are identified at the end of the report, and an extended bibliography of the compiled evidence underlying this overview is provided separately for interested readers.

As an overview, it is targeted at readers who do not have extensive experience of considering the links between nature and health. It aims primarily to inform professionals and policy- and decision-makers in the health and environment sectors, but it will also be of relevance for other sectors involved with the protection, management and use of nature and biodiversity, and for interested individuals. It is further intended to be a resource for planners and decision-makers seeking ways to benefit from natural and biodiverse environments locally.

Many key terms on nature, biodiversity and health have multiple conceptualizations and definitions within different sectors and for different stakeholders, indicating the challenge of unifying such terminology across disciplines. Definitions of how these terms are applied in this overview report are therefore set out below (Box 1). The aim of this overview report is to enable readers to recognize the interconnections and goals that are common to these various definitions and approaches on nature, biodiversity and health, and to understand more about these critical issues for the environment and human health in the 21st century.

1 Although much of the evidence presented on nature and health is applicable globally, this overview report aims to focus on the conditions in the 53 Member States in the WHO European Region. As data are not always available for the Region, the report may sometimes refer to national examples, to data for the European Union or other country groupings, or to global data.

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Box 1. Definitions of key terms as applied in this report

Human health is a state of physical, mental and social well-being, and not merely the absence of disease or infirmity. Health can be considered a dynamic state: it is not fixed or absolute but constantly responding to environmental, social, biological, emotional and cognitive conditions.

Nature can be thought of as the entirety of the physical and biological world not made by humans (although it may be influenced by humans).

Biodiversity is the variability of – and among – living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part. It includes diversity within species, between species and of ecosystems.

Ecosystems are the dynamic complexes of plant, animal and microorganism communities and their non-living environment interacting as a functional unit.

Ecosystem services are the natural services provided by ecosystems that benefit human well-being, including health. They are typically categorized into provisioning (e.g. supply of water, food, materials), regulating (e.g. climate regulation, water purification) and cultural (e.g. aesthetics, recreation) services, all underpinned by supporting services (e.g. nutrient cycling, soil formation).

One Health is an approach to designing and implementing programmes, policies, legislation and research in which multiple sectors communicate and work together to achieve better public health outcomes. The One Health approach is critical to addressing health threats in the animal, human and environment interface.

Planetary Health is the ambition to promote human health through the protection of the natural systems on which humans depend. It investigates the effects of environmental change on human health and well-being, as well as the political, economic and social systems that govern those effects., as well as the political, economic and social systems that govern those effects.

A changing world: a risk to nature and a risk to health

Interrelated processes of social, demographic and climate change; habitat loss; overexploitation; and pollution pose a substantial threat to the natural environment, with potential catastrophic consequences for human health and well-being. Some of the main drivers for change, and the resulting pressures on the environment, are presented below.

A changing environment

The increased concentration of greenhouse gases in the earth's atmosphere has led to increases in global temperatures. Raised temperatures are resulting in, for example, higher frequencies and intensity of heatwaves, droughts, flooding and wildfires, and an associated change of terrestrial habitats and species distribution. Rising sea levels and ocean acidification cause changes in marine species. Water scarcity and droughts, affecting habitats and food production, are also of increasing concern.

Globally, approximately 75% of the terrestrial environment and 66% of the marine environment have been "significantly altered" through human actions. Important habitats and ecosystems have been lost; for example, more than 85% of the wetlands present in the year 1700 had been lost by 2000. These environmental changes threaten biodiversity. Around 1 million animal and plant species are threatened with extinction over the coming decades; this may mean the loss of around 10% of insect and 40% of amphibian species *(3)*. In addition, pollution of land, air and aquatic bodies continues. Each year approximately 300–400 million tonnes of heavy metals, toxic sludge, solvents and other forms of mostly untreated waste from industrial facilities are discharged into the world's waters, providing further pressure on nature and ecosystems *(3)*.

Changing societies

Population growth and an increasing environmental footprint of modern societies cause widespread environmental concerns and damage to nature. Rising demands for energy, mobility, water and food production, unsustainable production and consumption patterns, and a still largely untackled increase in waste generation put stress on local and national nature resources. They also affect environmental conditions in other countries through increasing trade interdependencies. Furthermore, international tourism can damage local ecosystems and increase dangerous exposure to wildlife.

At the same time, many countries in the WHO European Region have ageing populations, and older people are more vulnerable to some environmental change-related health risks (such as weather extremes or infectious diseases). There is also hope for the future, however, as younger generations are pushing for more sustainable lifestyles, potentially leading to beneficial impacts on both natural environments and health.

Changing land use

Humans have always modified and altered land use and land cover, and it is estimated that more than half of the global habitable land surface is already occupied by human use, such as agriculture or human

settlements *(6)*. The intensification of agriculture with increasing use of industrial fertilizers, pesticides and herbicides, homogenization of landscapes and soil degradation is a significant driver of biodiversity loss. Transformation of natural and biodiverse ecosystems to agricultural production systems led to an increase in food provision, but came at the expense of pollination of agricultural crops, flood regulation, regulation of pests and human infectious diseases, and other important ecosystem services.

By 2050, almost 85% of Europe's population are expected to be living in urban areas *(7)*.[2] Progression of urbanization – both urban sprawl and infill within existing urban areas – consumes natural areas and leads to soil sealing, which describes covering the ground with an impermeable material (such as asphalt in road-building). Soil sealing is a risk for biodiversity, contributes to global warming, increases the risk of urban flooding and limits groundwater recharge, with ensuing consequences for human health and well-being. Urban land use and soil sealing also contribute to the destruction and fragmentation of natural habitats. Habitat fragmentation can further add pressure to stressed ecosystems, disconnecting plant and animal populations and risking the long-term survival of species as a result of reduced genetic diversity.

An unequal world: uneven distribution of access to nature and ecosystem services

Depending on their social status and residential location, many individuals and communities have different access to nature and are exposed to different levels of environmental risk. There are multiple interconnections between social, health and environmental inequalities. Exposure to environmental health risks is typically disproportionately high among low-income, minority and marginalized communities, while opportunities for environmental health benefit (such as access to natural areas) are often also unfairly distributed.

At the local level, for example, green spaces and trees in cities can mitigate risks associated with excess urban heat, but such green spaces are often less prevalent in poorer neighbourhoods. Higher-quality, health-promoting natural environments are usually more likely to be found in wealthier areas. Access to natural environments for recreation may be substantially constrained by distance and availability of resources and time to visit them. In addition, safety concerns and other individual, societal and structural constraints tend to be unequally experienced within and between populations, affecting access to nature and limiting the benefits of nature interaction for some population groups.

Nature-related inequalities are also situated within wider, global environmental injustices. For example, neither carbon emissions nor the impacts on ecosystems of the climate emergency or deforestation are equally distributed across the globe: the greatest adverse impacts emerge among the populations and within regions least responsible for them. Industrialized agriculture for international markets and the global tourism industry result in inequities in terms of the economic benefits versus associated negative health and environmental impacts.

These inequalities may affect the distribution and impacts of all the challenges discussed in the following sections. Policies, programmes and interventions aiming to mitigate risks and increase benefits to health associated with nature and biodiversity should consequently aim to ensure that they reduce, and do not exacerbate, inequalities.

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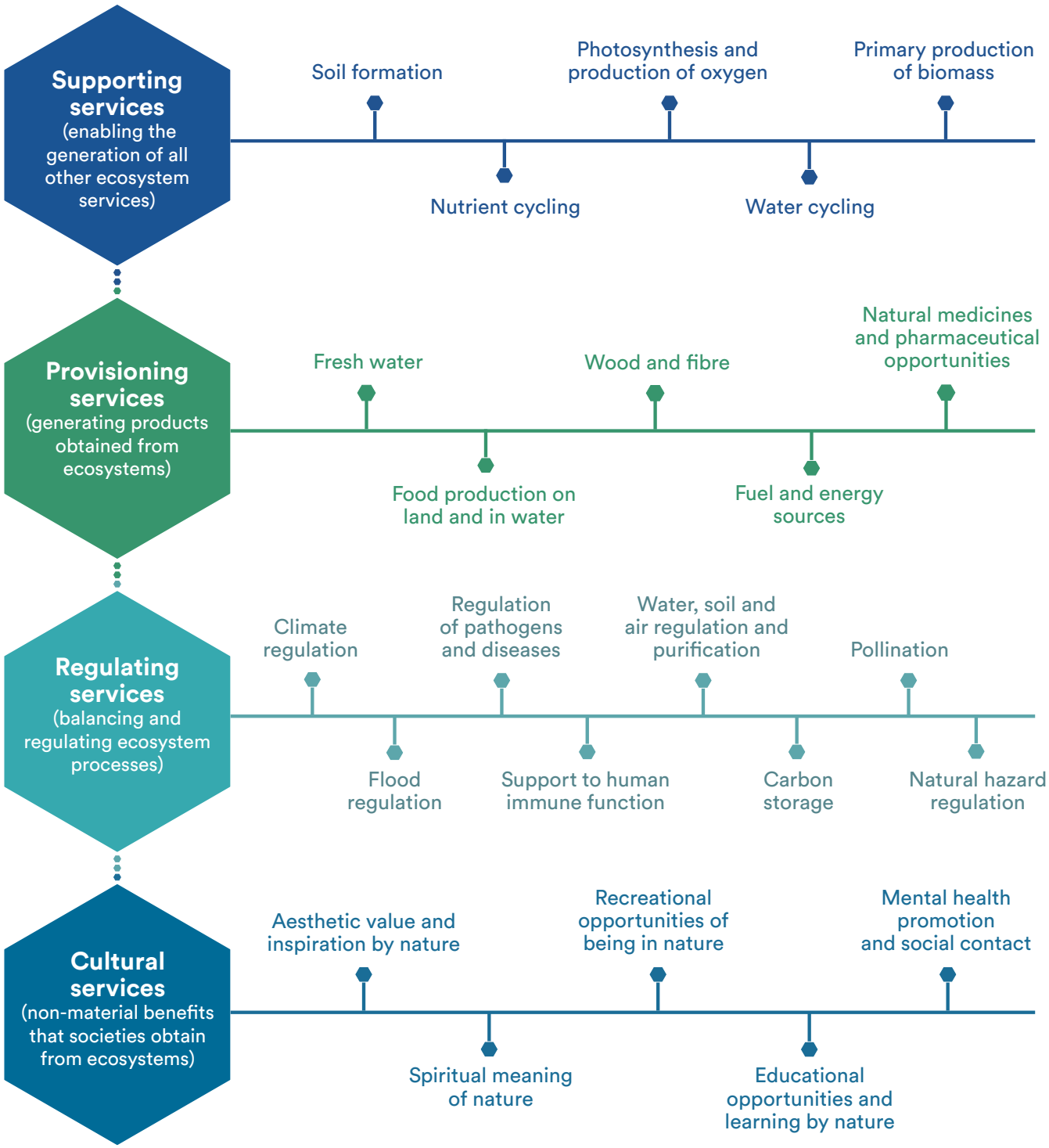
2 Data exclude countries in central Asia as well as Armenia, Azerbaijan, Cyprus, Georgia, Israel and Turkey.

The benefits of nature for health and well-being

Benefits of nature for health, to be secured and maintained, include many important ecosystem services (Fig. 1).

Fig. 1. Nature: health's vital support system



These characteristics, framing nature as a vital support system for human health and well-being, are based on concepts of ecosystem services. This approach is consistent with the 2015 review by WHO/Convention on Biological Diversity *(2)* and the 2005 United Nations Millennium Ecosystem Assessment *(8)*, which described in great detail ecosystems' delivery of provisioning, regulating, cultural and supporting services. The approach also covers the four suggested pathways (reducing harm, restoring capacities, building capacities and causing harm) through which nature and biodiversity can affect health *(9)*.

Damaging nature may create direct and indirect risks for human health, and may contribute to:

- threats to biodiversity and the balance of ecosystems and habitats;
- increasing frequency of extreme events;
- ecological collapse (drastic reduction in carrying capacity, often associated with mass extinction);
- expansion of vector-borne diseases and invasive species;
- failure of food systems;
- water scarcity;
- conflict and displacement of people; and
- loss of health-promoting opportunities.

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There are an estimated 8 million animal and plant species on Earth *(3)*.

Up to 1 million species are threatened with extinction – many within decades *(3)*.

Around 4 billion people worldwide rely primarily on natural medicines *(3)*.

More than 80% of global wastewater is discharged untreated into the environment *(3)*.

Plastic pollution has increased tenfold since 1980 *(3)*.

Around 70% of cancer drugs are natural or synthetic products inspired by nature *(3)*.

Global per capita consumption of natural materials has increased by 15% since 1980 *(3)*.

A summary of links between nature, biodiversity and health

The following sections provide an overview of the interconnections (Fig. 2) between nature and health through consideration of key issues discussed in the 2015 review by WHO/Convention on Biological Diversity *(2)*.

Fig. 2. Overview of interconnections between nature and health

Freshwater systems

Freshwater systems relate to human health and well-being through myriad processes, interacting with and underpinning the majority of ecosystem services. Availability of fresh water is one of the most fundamental requirements for human health and well-being, while agriculture, industry and many basic infrastructures also depend on water provision. While natural water systems can themselves be sources of naturally occurring health risks, this report focuses on how they underpin health.

Biodiversity, through its role in water purification and the atmospheric cycle, as well as erosion and sedimentation control, is one of the key factors for functioning freshwater systems. In turn, availability of good water quality supports biodiversity, which supports all other ecosystem services.

Relevance to human health

- **Microbiological and chemical contamination of water is an issue throughout the WHO European Region, threatening ecosystems and human health.**
- **Significant inequalities in access to clean water exist across the Region: 16 million people lack access to basic drinking-water services, and more than 3 million use surface water as a primary source for drinking, cooking and washing *(10)*.**
- **Almost 20% of outbreaks of infectious diseases investigated in the WHO European Region are attributable to inadequate water supply and sanitation *(10)*.**

Role of biodiversity and functioning ecosystems in supporting and protecting clean water

Biodiversity supports freshwater systems. The biodiversity of upland landscapes, especially in forest ecosystems, plays a crucial role in the systems that maintain and regulate surface water flow. Biodiversity probably contributes to soil stability, helping to reduce erosion and sedimentation of water courses. Functioning ecosystems also contribute to water security – healthy wetlands, for instance, provide water sources for many millions of people.

Functioning ecosystems reduce exposure to water-related health risks. Biologically diverse ecosystems, such as wetlands, contribute to water quality, helping protect people from waterborne chemical and biological risks through processes of filtration and sedimentation to remove pollutants and excess nutrients. Functioning water ecosystems also protect human health by reducing and mitigating the consequences of extreme weather events such as flooding.

Pressures

- **Europe's water systems, and the biodiversity they support and are supported by, are highly threatened, with a loss of about two thirds of the wetlands in the European Union in the last century *(11)*.**
- **Groundwater and surface water bodies are affected by point source pollution (such as wastewater treatment, urban and industrial discharge or agricultural facilities) and by diffuse pollution (such as run-off from agriculture).**
- **Water security is one of the most significant natural resource challenges. In southern Europe, more than half of the population lives incessantly under water scarcity conditions *(12)*.**
- **Agriculture represents the greatest use of water resources, taking on average 59% of the total water used in Europe *(11),* and significantly more in some southern European river basins.**

How biodiversity loss and ecosystem disruption affect water quality and provision

Loss of water systems threatens biodiversity. Around a third of global biodiversity loss has been attributed to the degradation of freshwater ecosystems. Disruption to the water cycle affects the functioning and provision of all other ecosystem services.

The degradation or loss of certain functioning ecosystems – such as upland forests and biodiverse wetlands – leads to the loss of significant water sources. This exacerbates water security concerns and increases dependence on water purification and management.

Impaired water purification processes through loss of biodiversity within ecosystems can increase the risks of exposure to pathogens and other pollutants for those who depend directly on surface water, and increases costs for communities with water treatment services. Loss of nutrient-removal processes can affect livelihoods and food sources such as fisheries. All these factors may affect human health and well-being, if not well managed.

Air quality

Poor air quality is the number one cause of premature death from environmental factors in Europe and has considerable economic impacts. It increases medical costs and reduces economic productivity owing to ill health of workers. Good air quality is also important for biodiversity. Poor air quality harms soil, crops, forests, lakes and rivers, while air pollutants also damage built infrastructure.

Nature, ecosystems and their level of biodiversity play a fundamental role in the regulation of local and global air quality. Biological mass such as trees and forests produces oxygen and stores carbon dioxide, and has the ability to clean the atmospheric environment at both the local level and a larger, regional scale. By cooling and cleansing the air, plants and trees contribute to safer air for breathing by all living beings, and provide co-benefits for nature habitats.

Relevance to human health

- **Poor air quality has been shown to contribute to human morbidity and mortality by affecting the cardiovascular, respiratory and metabolic systems.**
- **Across the WHO European Region, exposure to particulate matter decreases the life expectancy of every person by an average of almost one year, mostly owing to increased risk of cardiovascular and respiratory diseases and lung cancer.**
- **Fine particulate matter is the air pollutant driving the most significant health problems and premature mortality in the Region.**

Role of biodiversity and functioning ecosystems in supporting and protecting air quality

Plant biodiversity is involved in the important ecosystem service of air quality regulation: trees can remove gaseous air pollution such as ozone and sulfur dioxide through their leaves. Tree canopies prevent upper atmosphere pollution reaching ground level and cool the air – particularly in urban areas – through evaporation and shade, while healthy trees in cities may support the removal and storage of air pollutants. There are indications that higher diversity of trees in urban areas can result in greater protection of air quality *(13)*.

Functioning ecosystems reduce exposure to air quality-related health risks. Through filtration and evaporation, biologically diverse ecosystems can directly contribute to maintaining good air quality. Although this effect should not be overestimated, these processes may contribute to the protection of people from airborne pollutants via filtration and pollutant removal, potentially reducing mortality and morbidity associated with poor air quality.

Biodiversity also supports natural infrastructure. Plant biodiversity interacts with air quality to help prevent soil depletion through excessive nitrogen, thus maintaining healthy soil for food and water provision. Equally, poor air quality affects vegetation, affecting the natural filtering of water systems.

Pressures

- **While air pollution has improved significantly across the WHO European Region, many pollutants (such as particles, ozone and nitrogen dioxide) remain of concern and affect nature and the status of ecosystems throughout the Region.**
- **Transportation, fossil fuel combustion for heating and agriculture represent the greatest pressures on air quality. Transportation alone accounts for more than one quarter of the European Union's total greenhouse gas and other pollutant emissions.**
- **While a good third of the cities in high-income countries in the Region have annual particulate matter values below the WHO air quality guidelines, this is only the case for around 8% of the cities in low- and middle-income countries in the Region *(14)*.**
- **Climate change affects air quality, and air quality can also affect climate change: ozone in the atmosphere warms the climate, while different components of particulate matter can have either warming or cooling effects on the climate.**

How biodiversity loss and ecosystem disruption affect air quality

Plants and trees can contribute to clean air, filtering out gases that are not only harmful to humans but also harmful to the earth's ecosystems as a whole. The degradation or loss of functioning ecosystems can therefore result in poorer local and regional air quality, as well as reduced carbon storage and increased greenhouse gas emissions.

The impacts of vegetation on air quality depend in part on the species mix and other aspects of plant biodiversity of these ecosystems, however. Trees are often planted in urban areas to improve aesthetics and/or the physical or social environment. The diversity of the tree species can affect human health in terms of their ability to remove or add to air pollutants: some are able to tolerate pollution better and help improve air quality, while others may produce pollen, adding to air pollution and its impacts.

Ensuring good air quality means ensuring rich plant biodiversity. Poor air quality may threaten the functions of the plant biodiversity component of the air quality regulating service. In general, poor air quality affects plants, with pollutants such as ozone, nitrogen dioxide and sulfur dioxide damaging their leaves. In addition, increased ground-level ozone also causes damage to plant cell membranes and key pollinators, inhibiting key processes required for plant growth and development. This may have impacts not only on nature and ecosystems – and their ability to clean air – but also on agricultural productivity.

Coasts, seas and oceans

Oceans cover 71% of the planet's surface and make up 95% of all the space available to life *(15)*. Oceans, seas and coastal environments support many ecosystem services that provide benefits for human health and well-being. Biodiversity underpins the productivity, stability and resilience of these services.

Health benefits of coasts, seas and oceans include the production of food for human consumption, opportunities for interactions with high-quality blue spaces (such as unpolluted beaches), marine biotechnology and pharmaceutical opportunities. On a global scale, these aquatic ecosystems have a significant influence on climate mechanisms and store 16 times as much carbon as the terrestrial biosphere *(16)*.

Relevance to human health

- **Ocean and coastal ecosystems sequester carbon, regulate nutrients and release oxygen through photosynthesis.**
- **Globally, fisheries and aquaculture are crucial sources of employment, recreation and cultural benefits.**
- **Consumption of seafood provides essential nutrients that help to prevent chronic health conditions.**
- **Access to blue spaces has been demonstrated to improve physical health and mental well-being, particularly for people with lower socioeconomic status.**

Role of coastal and ocean biodiversity and functioning ecosystems in protecting human health and well-being

Coastal and ocean biodiversity provide nutrition and income from seafood. Coastal environments are important nurseries, feeding and spawning grounds for wild fish species and, increasingly, for aquaculture production. Seafood provides not only livelihoods but also protein and omega-3 fatty acids, which can reduce the risk of chronic diseases such as diabetes and are essential for neurological development. Care must be taken, however, to ensure that seafood removals do not exceed their regenerative capacity.

Physical and mental well-being can be derived from contact with blue spaces. Growing evidence across many countries demonstrates that direct interactions with seas and oceans can lead to a number of public health benefits, including increased physical activity and improved mental well-being.

Coastal and ocean functioning ecosystems are a source of biotechnology and future medicines. With many marine species still to be discovered, the seas and ocean are a unique source of largely unexplored natural products, including medicines, food supplements, enzymes and biomaterials. Pharmaceutical products include drugs for cancer and antiviral compounds, with several marine-derived pharmaceutical substances now in use.

Pressures

- **Overfishing, climate change, urban development, loss of coastal habitats, pollution run-off, eutrophication and invasive species all threaten the functioning of marine ecosystems and thus the benefits to human health.**
- **Chemical and other pollution are rampant in seas and oceans globally, through terrestrial and atmospheric contamination and direct ocean dumping. A newly emerging pressure is the problem of microplastics in marine ecosystems.**
- **As seas and oceans deteriorate, marine biodiversity continues to decrease. Further, seafood quality is falling due to contamination with chemicals and pathogens.**

How coastal and ocean biodiversity loss and ecosystem disruption affect health and well-being

The oceans have stored most of the excess heat generated by climate change. As a result, rising ocean temperatures and acidification affect numerous ocean ecosystems and associated services such as marine food production. Declining fisheries through overexploitation may endanger human health. Additionally, aquaculture production can both cause and suffer from ecosystem damage without appropriate mitigation.

Coastal ecosystems have significant potential for reducing flood risk, reducing wave heights and protecting coastal populations, but characteristics of the vegetation and habitat form (such as coral reefs) influence the effectiveness of the protection. Degradation of coastal ecosystems can therefore lead to increased risk of coastal floods in the future, with rising sea levels and increased severity and frequency of storms. In addition to physical impacts, flooding can affect medium- and long-term mental health.

Marine ecosystems are affected by chemical and microbial pollutants from human activities on land and air, as well as by microplastics and direct ocean dumping. As well as threatening marine species directly, the pollution also enters the marine food-chain. This not only affects productivity of marine organisms but also leads to acute and chronic illness in humans consuming contaminated seafood. Increased nutrient run-off and environmental pollution, paired with climate change, affect aquatic ecosystems and may lead to harmful algal blooms. These produce powerful natural toxins, which can cause sickness and death in humans and other animals.

Oceans provide the most important carbon storage and regulate the global climate, affecting temperature and determining rainfall, droughts and floods. Pollution, acidification and warming of the oceans are likely to affect all these functions and may – alongside a loss of marine biodiversity – accelerate climate change effects such as more extreme weather events, melting of ice sheets and rising sea levels. This will have a significant impact on population health.

Soil, agriculture, nutrition and food security

Fertile soil is a precondition for vegetation growth, and thereby a requirement for both natural environments and global food production. Concentration of human population and activities in restricted areas and changes in climate and land use have led to irreversible losses, however, through soil sealing and erosion, contamination, acidification, salinization and compaction. Soil degradation affects soil quality and leads to increased surface water run-off, affecting aquatic ecosystems.

To support healthy diets for all, nutritious food needs to be accessible and affordable, and interest in understanding the role of the food system in health is increasing. Poor nutrition is currently identified as one of the main risk factors for noncommunicable diseases, such as heart attack, stroke, diabetes and many cancers.

Within the European Union, 41% of the land surface was used for farming in 2015 *(17)*. Globally, agriculture accounts for over a quarter of greenhouse gas emissions and over three quarters of fresh and seawater eutrophication (pollution due to nutrient run-off), contributing to extensive biodiversity loss. Of the 28 000 species threatened with extinction on the International Union for Conservation of Nature red list, 24 000 are under threat from agriculture and aquaculture, primarily through habitat loss and pollution *(18)*.

Relevance to human health

- **Poor diets with excessive fat and refined carbohydrate intake and low fruit and vegetable intake cause obesity and contribute to a large proportion of noncommunicable diseases in the WHO European Region.**
- **Globally, around 45% of deaths in children under 5 years of age are linked to undernutrition *(19)*.**
- **Accelerating declines in soil quality and biodiversity will affect access to food and its dietary diversity and nutritional value.**
- **Evidence also suggests that dietary diversity plays an important role in the gut microbiome, which influences metabolism and other health indices.**

Role of biodiversity and functioning ecosystems for soil quality and agriculture

Soil is the most biologically diverse material on earth and contributes to many nutrient cycles, such as for carbon or nitrogen. The biological diversity of soil organisms is critical to all ecosystems, contributing to soil formation and breakdown of biomass; water storage and retention of nutrients for plants; and the suppression of pests and parasites.

Biodiversity within agricultural systems (crop and livestock production, forestry, fisheries and aquaculture) contributes to food security and the provision of diverse healthy diets. Biodiverse agriculture is more

resilient to external shocks and stresses, including the effects of climate change. Agricultural biodiversity directly affects nutrition, in that a loss of diversity in what is produced leads to fewer options for consumption. It includes the diversity of what is produced for food as well as non-edible "agroecosystem services" (such as pollination).

Agricultural production that can preserve enough features of the wild habitat to maintain biodiversity is essential – for example, using sustainable agricultural practices that include intercropping species, crop rotations and the preservation of diversity within crops and animal breeds and contributing to diverse diets beneficial for human health.

Pressures

- **Increasing demand to feed a growing global population and rising meat consumption require extensive land resources and water provision.**
- **The amount of arable land globally is decreasing due to falling biodiversity of plants, pollinators and soil; overuse of chemicals; monoculture; desertification; and overexploitation of resources.**
- **Current farming practices and use of fertilizers and pesticides are associated with reduced soil biodiversity, and climate change affects plant growth and the nutritional value of food.**
- **Conversion of land use from food to energy production puts further pressure on arable land resources.**

How disruption to and loss of soil and agricultural related biodiversity and ecosystems affect health and well-being

Soil degradation and reduced biodiversity affect important nutrient cycles: they have an impact on nature and ecosystems on a large scale, and restrict soil formation and decomposition of organic matter locally. This may enhance soil erosion, reduce nutrient and water storage capacities, and restrict plant growth, resulting in less productive and fertile soils and stronger vulnerability of soil-based ecosystems.

In parallel, biodiversity of food and agriculture is in severe decline. Further, owing to the growing human population and changing dietary habits as populations become wealthier, pressure to expand agricultural land use and thus risk encroaching on wilderness is huge.

Modern farming systems are typically based on a small number of species and varieties of plants and animals, often grown as single crops in large fields ("monocropping"), with soil fertility and pest and weed control reliant on chemical inputs. This decline in biodiversity for food and agriculture not only includes the plants and animals that become human food but also has detrimental effects on the other organisms on which food production depends, such as insect pollinators and the invertebrates and microorganisms within soils.

Infectious diseases

Infectious diseases can be caused by direct exposure to certain organisms (pathogens): bacteria, viruses, fungi and parasites. Zoonotic diseases (zoonoses) are diseases or infections that are transmitted from vertebrate animals to humans. Infectious zoonoses comprise a significant share of new and existing diseases in humans, and fall into three main categories *(20)*:

- directly transmitted diseases, where the host animal transmits a pathogen directly to humans (including Ebola, HIV, SARS and COVID-19), which may then be transmitted further between humans;
- vector-borne disease, where a vector (such as a mosquito or tick) transmits a pathogen from a reservoir species (such as sheep, deer or other animals) to humans (as with Lyme disease);
- diseases caused by parasites that infest humans (including Cryptosporidium and hookworm).

Relevance to human health

- **Zoonoses represent a major public health problem around the world owing to humans' close relationship with animals in agriculture, as companions and in the natural environment.**
- **The emergence of COVID-19 highlights the potential risks of novel infectious diseases emerging from human–wildlife interactions. Zoonoses account for around 75% of emerging infectious diseases *(21)*.**
- **Evidence of local transmission of mosquito-borne diseases such as malaria, dengue, West Nile fever and Chikungunya in European countries has been increasing.**
- **Tick-borne diseases such as Lyme disease are also spreading throughout Europe.**

Role of biodiversity and functioning ecosystems in preventing infectious diseases

The links between biodiversity and infectious disease are complex. High levels of biodiversity may be linked to increased risk of disease spread; for example, by supporting greater environmental reservoirs of pathogens that can be transmitted to humans by vector species.

Biodiversity losses, however, can also lead to increased risk of infectious disease, as a lower level of biodiversity may increase risk of zoonotic pathogen spillover by reducing the prevalence of pathogens among a diversity of host species. This risk could be enhanced further by disruption of local ecosystems and reduction of local biodiversity – for example, when human activities encroach into biodiverse ecosystems – leading to increased human–pathogen interactions and affecting internal species interactions and ecosystem balance.

While these interactions between humans, wildlife, vectors and pathogens are complicated, it is suggested that sensitive environmental management strategies should be applied to promote biodiversity conservation and simultaneously mitigate infectious disease risks *(22)*.

Pressures

- **The risk of vector-borne disease outbreaks is likely to increase as the vectors become more established and their habitat extends as a result of climate change and other factors.**
- **Land use change and increased interaction of humans and domestic animals with wild animals and their habitats, caused by transformation of natural ecosystems into urban land for human settlement, will lead to increased risk of zoonoses.**
- **International travel and trade increase the risk of zoonoses and other infectious diseases and their global spread.**

How disruption to biodiversity and ecosystems affects health and well-being via infectious diseases and pandemics

Pathogens are primarily naturally occurring components of ecosystems, to which humans have always been exposed. Thus, disruption of ecosystems and changes to biodiversity change the risks of human disease by changing the geographical and temporal distribution of exposure to known pathogens. This leads to risks of the emergence of new infectious diseases in humans. Damaged ecosystems may also enable certain species to become more dominant, or invasive species to establish themselves.

The emergence of COVID-19 highlights the pandemic potential of novel infectious diseases emerging from human–wildlife interaction, causing enormous costs to societies and health care systems in terms of morbidity and mortality and the economic impact associated with combating the disease (including vaccine development). COVID-19 is unlikely to be the last virus that spreads from natural ecosystems to human populations, and intense global efforts will be needed to prevent future pandemics and slow their spread *(21)*.

Microbes in the environment and human body

Microorganisms (or microbes) include bacteria, viruses, fungi, archaea and protists (such as algae and protozoa). In humans and natural environments, microbes form complex communities composed of thousands of individuals from multiple species.

Microorganisms are found in every type of environment on this planet: from the polar ice caps to deep-sea hydrothermal vents, and even in the sky. Although invisible to the naked eye, microbes – a significant component of global biodiversity – play a key role in the functioning of all ecosystems, including those within the human body. Disruptions to microbial populations can have long-lasting impacts on ecosystem services and human health.

Relevance to human health

- **In natural environments, microbes perform essential ecosystem services, including nitrogen and carbon fixation, oxygen production, decomposition and nutrient cycling, bioremediation, biocontrol, biotechnology and pharmaceutical production (such as antimicrobials).**
- **The microbes that live within humans (making up the "human microbiome") perform and support important processes such breaking down food, enabling uptake of essential nutrients and regulating the immune system.**
- **Human health and well-being depend on a healthy and biodiverse microbiome, catalysing processes in natural environments as well as within human bodies.**

Role of microbial diversity in human health

Natural environments host microbial populations that play critical roles in provision of a wide range of ecosystem services *(23)*. Ecosystems that support and promote human health therefore need to include well functioning and diverse microbial communities.

The human body is also home to a plethora of microbial life. The human microbiome's symbiotic communities inhabit the gastrointestinal, urinogenital and respiratory tracts, as well as the skin, and are a hugely important determinant of various aspects of human physical and mental health. High biodiversity in the gut microbiome helps to achieve and maintain various functions.

Environmental and human microbiomes interact, and it is suggested that macro-scale biodiversity supports microbial diversity, which in turn supports a healthy, diverse human microbiome *(24)*.

Further, a variety of environmental exposures (such as food, water and medication) can introduce factors that promote or suppress the growth of certain microbes. Loss of diversity in the human microbiome has been linked to various noncommunicable diseases such as obesity, diabetes, asthma and autoimmune diseases. Interest in the interaction between the microbiome and psychiatric disorders is also increasing.

Pressures

- **A large proportion of antibiotics in humans and animals are included in excreta, which enter the environment. These compounds can affect non-targeted microbes and create antimicrobial resistance in microbes and pathogens, threatening effective prevention and treatment of infectious diseases.**
- **Antibiotic treatment may affect non-targeted microorganisms in the human microbiome, removing species and making space for colonization by harmful pathogens.**
- **Loss of diversity in plant and animal species can have adverse implications for environmental microbial diversity and affect ecosystem functions.**
- **Urbanization can reduce human contact with all-natural environment components, including microbes, potentially leading to changes in the human microbiome.**

How disruption to biodiversity and ecosystems affects microbial diversity

Microbial communities in the environment are well adapted to the niches they occupy, and are responsible for a wide variety of processes necessary for sustaining human life and health. Large and sudden changes to their environments can alter the composition and structure of these communities, and microbial communities can be slow to recover from these changes. Significant disruptions (such as pollution, climate change and overuse of antibiotics) can diminish microbes' ability to perform vital ecosystem services.

The human microbiome is similarly sensitive, and is inherently connected to the environmental microbiome. Disruption to microbial communities in the environment and changes to how humans are exposed to them (such as through reduced contact with nature among urban populations) can therefore lead to changes in the human microbiome, with the potential for consequent health impacts.

Medicine and health care

Biodiversity is essential in the provision of pharmaceuticals and health care. Plants, animals and entire ecosystems form components of traditional medicine, which is still important in supporting people's health worldwide, particularly in developing countries and remote, isolated areas. Around one third of modern pharmaceuticals have been directly derived from compounds found in the natural world, and many other drugs are designed to mimic natural products *(25)*. Globally known examples include penicillin, aspirin and quinine. As a result of these drugs derived from nature, many diseases that killed most people a century ago are treatable or even curable today. The discovery of new compounds from natural ecosystem biodiversity also has a significant role to play in future health care.

Relevance to human health

- **A significant proportion of pharmaceuticals have been derived from nature: between 1981 and 2019, 185 small molecule drugs were approved to treat cancer, of which 65% were derived from or inspired by natural products *(25)*.**
- **Around 60 000 species – plants, animals, fungi and microbes – are used for their medicinal, nutritional and aromatic properties *(2)*.**
- **Further exploration of the natural world could identify new pharmaceuticals (for instance, very few drugs have yet been derived from marine ecosystems).**

Role of biodiversity and functioning ecosystems for medicine and health care

In traditional medicine, plant and animal products are used as medical treatments through consumption or application, as well as in cultural and spiritual practices. For many millions of people globally, traditional medicine is the main source of health care; for many others it plays a complementary role to conventional medicine. Further, traditional medicine can support health by building knowledge, skills and capabilities within communities and through its contributions to the local economy.

Modern medicines derived from naturally occurring compounds include antibiotics, antivirals and anti-parasitics, as well as anaesthetics and drugs that offer pain relief, reduce blood pressure and treat various cancers. These compounds are found in plants, animals, fungi and microbes, and are the result of evolutionary processes to produce defences against invasion or parasites.

Higher levels of biodiversity in natural ecosystems increases the chance of finding new natural compounds that could have medicinal uses. Plants have been the greatest source of these to date, but other groups of organisms remain comparatively unexplored. Marine and microbial biodiversity are likely to have particular potential as sources of new pharmaceuticals.

Pressures

- **Habitat loss and species extinction through climate change, urbanization, changing land use, environmental damage and overharvesting is estimated to result in the loss of one important drug every two years.**
- **The International Union for Conservation of Nature red list warns that of over 5000 currently known medicinal plants assessed, 13% are under threat *(26)*.**
- **Many modern health care activities have an impact on the natural world, with high energy and water demands as well as waste production.**
- **Misuse and overuse of pharmaceuticals can lead to evolution of resistant organisms (such as antibiotic-resistant bacteria), for which current pharmaceuticals are not effective and no defensive compounds occur naturally.**
- **International trade is a significant pressure on the sustainable exploitation of natural substances with medicinal properties, with a global trade value for medicinal plants over US$ 2.5 billion *(2)*.**

How biodiversity loss affects health and health care

Biodiversity loss affects plants, animals and places used in traditional medicine. People who are reliant on local biodiversity for their health care or income often belong to the poorest social groups. Further, the resulting loss of traditional knowledge affects biomedical discovery for pharmaceuticals: utilizing traditional knowledge greatly increases the chance of chemists finding the compounds with medicinal properties.

Extinctions compromise humans' ability to search for and develop new pharmaceutical products. Of an estimated 10 million species on the planet, only 2 million have scientific names: very little is known about many of these species. It is vital to conserve not only the species that are known to be valuable but all species and habitats. Conservation also has further benefits for health care, facilitating the study of the relationships between species within diverse natural habitats to aid understanding of epidemic diseases.

Biodiversity is a source of traditional medicine, has provided many existing pharmaceuticals, and is a potential source of many more. It is important that biomedical discovery should consider the interests of indigenous people who hold important knowledge regarding their local environments and are often reliant on these areas for their livelihoods. The search for new compounds needs to be carried out in compliance with the Nagoya Protocol and associated Access and Benefit Sharing legislation *(27)*, considering equity and the sharing of information between the public, academics, medical professionals, policy-makers and commercial bodies.

Access to nature

Being out in nature and interacting with high-quality green and blue spaces is good for physical health and mental well-being. Increased exposure to green space has been associated with indicators of good health (such as lower cortisol and blood pressure) and better self-reported health. Spending time in nature has also been associated with a lower risk of specific health conditions (including pre-term birth, low birthweight and type 2 diabetes) and reduced risk of death from all causes *(28)*.

These health benefits are thought to arise through a range of pathways, including providing opportunities and safe spaces for physical activity, for restoration and relaxation, and for socializing with friends and family. Especially in dense and artificial urban environments, access to natural areas and the distribution of blue and green space are relevant features for quality of life, health and well-being.

Relevance to human health

- **Increased exposure to high-quality green and blue space is associated with various indicators of good physical and mental health.**
- **Visiting green and blue spaces can promote and support a physically active lifestyle.**
- **Higher levels of greenness around a person's home are associated with reductions in the risk of death.**
- **Exposure to green and blue space is associated with higher levels of life satisfaction.**

Role of natural and diverse spaces for mental health

Nature and well-being are linked. One area of critical importance for global public health is poor mental health. Current WHO estimates indicate that by 2030 depression will be the leading cause of disease burden globally. Living near and spending time in green and blue spaces have been demonstrated to have particularly beneficial impacts on population mental health and well-being, especially in dense urban settings where natural areas are rare *(29)*. These benefits arise through providing opportunities for stress reduction and getting sufficient physical activity, both of which can help people to cope with daily hassles and pressures. Access to natural elements in urban settings has been found to play a role in reducing the need for antidepressant medication, particularly among poorer people *(30)*.

More frequent leisure visits to natural environments have also been shown to relate to increased well-being in terms of life satisfaction and happiness ratings. These aspects of subjective well-being are strongly associated with physical and mental health outcomes.

Not only the presence or absence of green and blue spaces but also their qualities and characteristics are important for health. For example, natural environments that are accessible to all, are aesthetically

attractive and feel safe are more likely to enable and support mental health and health-promoting behaviours. High-quality, attractive and diverse nature areas are also more likely to be visited. Further, those green and blue spaces with higher biodiversity may be more supportive of good mental health and well-being, although these relationships are complex. For example, the presence of a diversity of songbirds may enhance well-being benefits, but the presence of other birds (such as gulls or pigeons) may be perceived as more of an annoyance.

Pressures

- **Increased urbanization, growing populations and changes in land use are leading to reduced availability of high-quality green and blue spaces.**
- **Adequate and equitable access to high-quality green and blue environments is a major issue, particularly in urban areas where disadvantaged neighbourhoods often have fewer natural areas.**
- **Insufficient provision of urban parks and other nature areas can result in overuse of existing nature areas, leading to environmental damage and reduced benefit generation.**

How loss of locally accessible nature endangers health and well-being

Loss of accessible natural environments, such as through urban sprawl and its associated infrastructure development, can result in the loss of opportunities for promotion of good health and well-being and lead to adverse impacts on population health. This is particularly pertinent in urban areas, given the considerable development pressures in many regions for housing, business premises and built infrastructure such as roads. Similar pressures on nature areas exist in periurban and rural areas (such as intensive agriculture) and may also result in lost opportunities for health-promoting visits to nature. In many countries, however, the COVID-19 pandemic has re-emphasized the value for physical and mental health of recreational access to green and blue spaces *(31)*.

Urban green and blue spaces can form valuable components of functioning ecosystems even in densely populated areas, while also supporting public health. There are trade-offs between use (and overuse) and gaining human health benefit without causing ecosystem damage, however, even for highly managed ecosystems.

The economic value of nature and biodiversity

Nature provides a wide range of services and benefits that are often taken for granted. How to value the natural environment and, more specifically, biodiversity's contributions to human health and well-being has been an issue of much debate in recent years. The difficulties inherent in this analysis – the valuing of an asset that is essential to the survival of the human race – have presented challenges to economists and others seeking to highlight the monetary benefits of ecosystems in terms of the goods and services they produce.

The 2021 Dasgupta Review (the United Kingdom Government's review of the economics of biodiversity) highlights these issues, including the difficulties of placing "shadow prices" on nature *(32)*. While this will continue to be an area of debate, it is clear that biodiversity provides significant benefits in terms of both marketed and unmarketed goods and services; in providing livelihoods; in reducing burdens on the health care system; and in the wider, intangible benefits of biodiversity and nature to humanity.

Value to economic systems

Biodiversity has immense value to economies. From the crops grown to the meat and fish humans consume; from the timber used for building new houses to the pharmaceuticals or the fibres extracted from plants, all have significant market values that are reflected in national accounts and measures of gross domestic product. The difficulties with the use of gross domestic product as a measure of economic progress – and particularly in facilitating sustainable economic growth – include the fact that it does not include how the value of an asset or resource can decrease over time.

Not all the value of biodiversity is reflected in gross domestic product: there are significant non-market benefits, including recreation, water purification and carbon storage. Biodiversity also helps to provide resilience to the system in terms of response to diseases and pests. Some attempts have been made to place monetary values on a number of these wider benefits and their associated implications for health and well-being. These "natural capital" accounts are in their infancy, but they offer a potentially useful way of considering some of the non-market impacts of biodiversity and nature.

Value to livelihoods

Biodiversity is an important source of livelihoods, particularly in developing countries. Fisheries, agriculture and animal husbandry provide income for many – as does nature-based tourism. This has implications for health and well-being in societies, but also calls for a sustainable and balanced

exploitation of the resource "nature" to ensure that its capacities remain. New ways to replace nature exploitation for income generation by financially rewarding environmental stewardship and improvement, such as through "payments for ecosystem services", offer the potential to safeguard natural resources while providing alternative incomes and compensations for individuals, communities and even nations.

Value to health care systems

Biodiversity, and its appropriate management or protection, can support health and help reduce the burden on health care systems. Yet all too often the impacts of failure to protect ecosystems and the impacts of humans on natural biodiversity – and the consequential impacts on health – are clear. Examples include the degradation of marine ecosystems and overfishing, which may have provided a space for invasive jellyfish to flourish (leading to increased health impacts on swimmers and other recreational users), and the impact of soil sealing and erosion and loss of natural retention areas on flood risk by an increase of surface water run-off and reduced water storage (leading to injuries, hygiene risks and interruption of service delivery).

Further, biodiversity offers opportunities to discover new pharmaceuticals, including the potential for new antibiotics and other treatments, some of which may come from traditional medicines. Species loss may therefore have a direct impact on the capacities of health care systems to treat and cure disease.

Wider value of biodiversity and nature

Biodiversity and the functioning ecosystems it supports are valuable in terms of what they provide as goods and services to humanity. Nature represents more than economic value, however. Witnessing the beauty of nature can be profoundly spiritual for many people; rivers, mountains and wild spaces are often culturally important; and for many nature may simply be a preferred place to go to for a needed break. It is difficult to place monetary values on the benefits of biodiversity in stimulating artistic expression, architecture and advances in engineering and innovation.

Nature and biodiversity are therefore valued beyond simply the services and goods they provide. Accordingly, the Dasgupta Report *(32)*, p. 310 suggests that:

Biodiversity does not only have instrumental value, it also has existence value – even an intrinsic worth. These senses are enriched when we recognise that we are embedded in Nature. To detach Nature from economics is to imply that we consider ourselves to be external to Her. The fault is not in economics; it lies in the way we have chosen to practise it.

Conclusions

The need to protect nature

Nature is a vital support system for human health: it provides energy, food, water and air. Nature contributes to quality of life: it provides inspiration, places to exercise and socialize, and an antidote to the pressures of modern life. Nature protects: it provides dynamic systems that mitigate climate change and defend humans against extreme events. When humans fail to protect nature, however, and fail to recognize the damage already done and still being done to the environment, it also threatens health and well-being.

Bold steps are needed to protect the natural environment and thereby to protect human health. Avoidable environmental damage and biodiversity loss threaten the health of people and societies – now and in the future, in the WHO European Region and beyond.

Considering the more distant impacts in space and time on biodiversity and health from human actions is essential in terms of the Planetary Health or One Health approaches. One example for such a wider perspective could be the need to consider accountability and global responsibility in relation to current agricultural production standards and trade mechanisms, which may enable low prices through unsustainable production patterns (creating environmental damage as well as social, economic and health implications in the producing countries).

The need for action

National governments, local decision-makers, businesses and private citizens make choices every day. Most of these choices have direct or indirect impacts on how finite natural resources are used. This report brings together the current state of knowledge on the importance of nature for health, making it available to the many sectors that may benefit from this knowledge and can play an active role in protecting and promoting health while and by preserving nature. Considering dimensions of nature in decision-making in all sectors and at all levels is therefore paramount to protect natural environments as the foundations of human existence – a global challenge that requires multisectoral action and coordinated efforts across sectoral and disciplinary boundaries *(1, 2)*.

Based on this report, the following points emerge as areas for which concerted action across government policies and at different levels of government would be particularly promising and beneficial to support environmentally responsible decision-making.

- Natural ecosystems and their biodiversity should be protected. Ensuring the functionality of natural ecosystems helps to stabilize and maximize the benefits of the services they provide to societies at the local and international scales.

- International commitments should be respected and implemented. The Sustainable Development Agenda and existing biodiversity-related multilateral environmental agreements need to be promoted and duly enforced, reflecting the commitments made by national governments (33).

- Nature-based approaches should be embedded in policy development. Health in All Policy and Environment in All Policy approaches should be adopted and integrated, and the environment and health incorporated across all departments, sectors and spheres of decision-making as standard. Consideration should be given to how shared outcomes and accountability can be used to ensure meaningful action.

- Nature-based approaches should be made the norm. Green infrastructure and sustainable agriculture, land use and production schemes with less impact on nature and ecosystems should be incorporated as standard.

- Horizon-scanning and preparation of long-term strategies (at a minimum 25–50 years) should be undertaken to assess how natural resources can be sustainably managed and preserved in the context of environmental and social change.

- Action across sectors should be incorporated into the mainstream: One Health, Planetary Health and similar transdisciplinary approaches that balance risks while promoting benefits for both human health and the natural environment should be adopted (34).

- Capacity should be built at all levels – international, national and local – to deliver integrated health and environment strategies that protect and preserve natural environments and biodiversity. Local and national action to improve and protect natural settings is required to meet global biodiversity goals, and should be complemented by support for and participation in coordinated global action to meet international biodiversity targets.

- No-regret solutions and co-benefits should be sought for societal and environmental challenges. These include nature-based solutions, such as protecting and sustainably managing natural ecosystems and restoring modified and transformed ecosystems, addressing societal challenges effectively and adaptively, and simultaneously providing human well-being and biodiversity benefits.

- Commitment should be made to sustainable financial interventions. Investment in and policy support for environmentally damaging industries, activities and processes should be avoided, and harmful subsidies removed. Instead, the focus should be on investment in sustainable production and consumption mechanisms that protect the environment, and public support should be provided for activities that have positive impacts on nature and health.

- The consequences of inaction should be acknowledged. The health impacts and opportunities lost from environmental damage and biodiversity loss associated with lack of action should be recognized and debated.

- Investment should be made in collation of adequate social, health and environmental data to monitor and inform longer-term strategies with sufficient detail to enable short-term, local action.

- Insights should be shared by evaluating, learning from and sharing good practice on how ecosystems can be sustainably managed and protected, enabling them to generate human health outcomes.

- Education of people of all ages on the links between nature and health should be supported, and sustainable behaviours that benefit nature and health promoted.

- Environmental and nutritional labelling should be strengthened to inform consumers about the environmental footprint of various goods and their impacts on biodiversity and health.

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An extended bibliography on nature, biodiversity and health compiled during the production of this overview report is available on the website of the WHO Collaborating Centre on Natural Environments and Health at https://www.ecehh.org/about-us/who-cc/.


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ISBN 978-92-890-5558-1

WHO European Centre for Environment and Health
Platz der Vereinten Nationen 1
D-53113 Bonn, Germany

Tel.: +49 228 815 0400
Fax: +49 228 815 0440
E-mail: euroeceh@who.int
Website: www.euro.who.int