Why is nature vital to us?

Jian-Sheng Sun,
Director of the Living Organism Adaptation Department,
Muséum national d'Histoire naturelle,
Jean Gaudart,
Public health doctor,
Planetary Health Officer,
Environmental and Occupational Health Department,
Santé publique France.

KEY POINTS

Nature is a vital environment for human societies. Water, air, food production and therapeutic resources are key to population survival and human well-being largely depends on the quality of natural environments.
Yet the depletion of biodiversity jeopardises this balance, directly threatening the health of humans and other living beings.

Scientists today are making two incompatible observations: firstly, that nature – with its geological, biological and ecological components – is essential for the survival and evolution of all living beings on Earth, including humans; secondly, that humans, through technological innovations and social organisation, are disrupting the functioning of natural systems to an alarming extent. It is therefore important to recognise the close links and interdependencies between human health and the health of domestic and wild animals, plants and the environment in general (including ecosystems), which is the rationale behind the "One Health" concept [1]. This vast subject demands that multiple sectors, scientific disciplines and communities work together to overcome the threats to health and to ecosystems[1]. While non-exhaustive, this article aims to shed light on the interconnections between nature, biodiversity and health. Understanding these interconnections is something of a prerequisite for committing to the One Health approach (*see article* The diversity of concepts that lie behind the word "nature" *in this issue*).

The ways in which nature and biodiversity contribute to human health are best understood through the anthropocentric prism[2] of "ecosystem services". These fall into four categories:

- Provision of resources (e.g. food, materials)
- Regulation of ecosystems, to ensure they function properly (e.g. climate, pollination)
- Social and cultural services, which are the non-material benefits of biodiversity in the relationship between humans and nature (e.g. recreation, inspiration)
- Support for all the other services (e.g. soil formation, water cycle)

Ecosystem services are based on the structures, processes and functions of the biosphere[3], which can be represented using a cascade model (*see figure 1*) to conceptualise the causal pathways by which nature, biodiversity and ecosystems provide services and benefits to human societies, including health and well-being [2].

The notion of ecosystem services reflects a utilitarian view of nature: an ecosystem service is not a fundamental property of the ecosystem itself, but something useful to human beings. However, beyond this instrumental value given to nature and biodiversity, there is also intrinsic value.

A web of interconnections

It is clear that nature is essential for all of our planet's ecosystems to flourish. High biodiversity increases the stability of the biosphere and its ability to adapt to changes in environmental conditions. The biosphere supports the livelihood and well-being of the human race. However, the degradation of nature and the loss of biodiversity can threaten biosphere health, both directly (zoonoses[4], pollution) and indirectly (effects of climate change). The main links between nature, biodiversity, ecosystems and human subsistence, health and well-being [3] (*see figure 2*) are presented below.

Fresh water

Freshwater systems are the source of all life on earth. Biodiversity contributes to freshwater systems

© Ville de Ris-Orangis

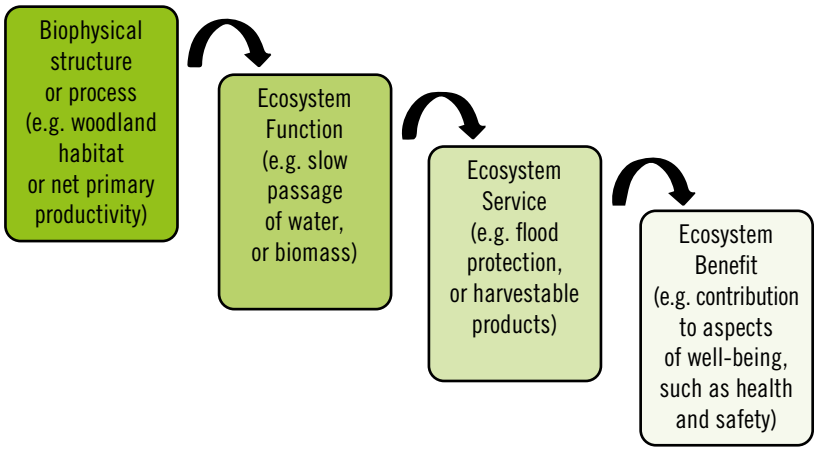

Figure 1 – Simplified diagram of the cascade model of ecosystem structures, functions and services that benefit human societies (adapted from M. B. Potschin, R. H. Haines-Young [2]).

functioning smoothly by maintaining and regulating the flow of surface water, helping to purify water and contributing to the atmospheric cycle of water, reducing extreme weather phenomena and soil erosion through the sedimentation of waterways. Inversely, the availability of good quality fresh water supports biodiversity, which in turn supports other ecosystem services.

Healthy ecosystems reduce exposure to water-related health risks. Biologically diverse ecosystems such as wetlands contribute to water quality. They also protect people from chemical and biological hazards as filtration and sedimentation processes remove pollutants and excess nutrients [4].

Air quality

Nature, ecosystems and their level of biodiversity play a key role in regulating air quality for all living beings. Through biosynthesis[5], trees and forests produce oxygen and store carbon dioxide, cleaning up the atmospheric environment both locally and more widely. In urban environments, vegetation can capture some of the particulate and gaseous pollutants

(e.g. fine particles and nitrogen oxide (NOx) emitted by combustion engine vehicles), improving air quality in certain configurations and proportions [5].

Reducing sources of air pollution must be a priority [6]. This is because poor air quality due to environmental factors is a cause of premature death around the world [7], with considerable economic repercussions (increased medical costs, lower productivity due to poor health of workers). It damages crops, forests, soils, lakes and rivers [8], threatening biodiversity.

Coasts, seas and oceans

The oceans cover 71% of the planet's surface and make up 95% of the space available for life. Seas and coastal environments provide many ecosystem services, the productivity, stability and resilience of which depend on biodiversity [9]. On a global scale, aquatic ecosystems have an impact on climate mechanisms, with the circulation of ocean currents helping to regulate extreme events. They also store 16 times more carbon than the terrestrial biosphere. Yet the acidification and warming of oceans are affecting this balance.

The services provided to humans by these ecosystems include first and foremost food production: in 2022, 20.7 kg of fish were consumed on average per person worldwide, 51% of which came from aquaculture. In terms of marine stocks fished, 62.3% (2.3% less than in 2019) were fished within biologically sustainable levels [10]. In addition, access to high quality blue spaces (such as unpolluted beaches), marine biotechnologies[6] and the pharmaceutical potential of the seas [11] provide other physical and mental health benefits.

Soil, agriculture, nutrition and food security

Fertile soil is a prerequisite for vegetation to grow, and this is imperative for natural environments and for food production. With populations and human activities being concentrated in small areas, combined with changes in climate and land use, there have been irreversible losses of biodiversity through deforestation, surface sealing in urban areas, soil erosion, contamination, acidification, salinisation, etc. Soil degradation, caused by loss of land to urban construction and intensive agriculture, means lower quality soils and fewer nutrients available to plants [12], which in turn leads to higher use of chemical *inputs*[7]. Another consequence is that the increase in surface water run-off affects aquatic ecosystems, in particular by dispersing pollutants as far as the ocean – the final spillway. The decline in genetic biodiversity resulting from intensive farming also poses a risk for food and the economy (e.g. the depletion of *Penicilium camemberti*, a microorganism used in the manufacture of Camembert cheese).

Healthy food must be accessible and affordable for all in order to maintain good health. This is because a diet lacking balance, whether in terms of food quality or consumption behaviours, is one of the main risk factors for non-communicable diseases such as cardiovascular disease, metabolic diseases (obesity, diabetes), ischaemic strokes, and so on. Furthermore, food waste in rich countries – estimated at 20% in France according to the French Agency for Ecological Transition (ADEME) – puts unnecessary pressure on agriculture and on soils that are already overstretched.

Figure 2 – Main links between nature and human well-being (adapted from The Global Health Observatory, WHO [3]).

Infectious diseases

The links between biodiversity and infectious diseases are complex [13]. They can be caused by exposure to pathogenic organisms such as bacteria, viruses, fungi and parasites. Zoonoses are infectious diseases transmitted by vertebrate animals to humans. Infectious diseases fall into three categories:

- Direct transmission: the host, a sick animal or human or an asymptomatic carrier, transmits a pathogen directly to a human through close contact (HIV, Ebola, avian flu, Mpox, etc.);
- Indirect transmission by vectors[8]: a vector (mosquito, tick) transmits a pathogen, from an animal or a human who may or may not be sick, to a human (dengue fever, Lyme disease, Crimean-Congo haemorrhagic fever, malaria, etc.);

• Indirect transmission via environmental contact (water, soil): examples include aspergillosis[9] and tetanus. They may also be transmitted due to temporary contamination of the environment: drinking water contaminated by the cholera bacterium, vegetable gardens contaminated by echinococcus eggs[10], water and mud contaminated by the leptospirosis bacterium[11], and so on.

Biodiversity collapse can lead to an increased risk of infectious diseases. The reduced diversity of host animal species increases the risk of transmission to humans. Furthermore, when humans encroach on ecosystems, they increase their exposure to zoonoses and the risk of new zoonoses (*see article* Human health suffers from a simplistic view of biodiversity *in this issue*). The degradation of ecosystems is giving way to invasive species, reservoirs or vectors, which are sources of infectious disease outbreaks.

A high level of biodiversity tends to regulate epidemics but it can also entail a risk of infectious diseases, either by encouraging pathogen reservoirs to develop, or through direct or indirect contact with humans. Consequently, sensitive environments require management strategies in order to promote biodiversity conservation and simultaneously reduce the risk of infectious diseases [14].

Microbes in the environment and in the human body

Microorganisms include bacteria, viruses, fungi, archaea[12] and protists[13] (such as algae and protozoa[14]). In humans and in natural environments, microbes form complex communities made up of thousands of individuals belonging to multiple species. Although invisible to the naked eye, microbes are an important component of global biodiversity and play a fundamental role in the functioning of all ecosystems [15], including those in the human body. Disruptions to microbial populations can have lasting repercussions on ecosystem services and human health [16].

Ecosystems that support and promote health include diverse microbial communities. Those in the human microbiome[15] inhabit the gastrointestinal, urogenital and respiratory tracts, as well as the skin, and are an extremely important determining factor in various aspects of physical and mental well-being. A high level of biodiversity in the microbiome contributes to the correct operation of various functions (metabolic, immunological, etc.).

Environmental and human microbiomes interact. Different environmental exposures can introduce factors that promote or suppress the growth of certain microbes. A lack of diversity in the human microbiome is associated with various non-communicable pathologies such as obesity, diabetes, asthma, allergies and certain autoimmune diseases, which are observed in urban environments [17]. There is also growing interest in the interaction between the microbiome and psychiatric disorders [18].

Medicine and healthcare

Biodiversity provides pharmaceutical and cosmetic active ingredients. Plants, animals and certain ecosystems are used in traditional medicine, the beneficial functions of which have yet to be fully explored [11; 19]. Around a third of modern pharmaceuticals are derived from compounds found in the natural world, and many other medicines are designed to mimic natural products. Penicillin, aspirin and quinine are well-known examples. Thanks to these medicines derived from nature, many previously fatal diseases can now be treated. The discovery of new compounds derived from the biodiversity of natural ecosystems will also play an important role in future healthcare [19].

Access to nature

Being out in nature and interacting with quality green and blue spaces is good for physical health and mental well-being. Greater exposure to green spaces is associated with indicators of good health (lower cortisol[16] and blood pressure) and better self-reported health [20]. Spending time in nature is also associated with a lower risk of health problems and a reduced risk of death from all causes [21]. These benefits stem from the availability of safe spaces for physical activity, enjoying food, relaxing and socialising with friends and family. In dense and artificial urban environments, access to natural spaces is key to a better quality of life, health and well-being for humans. However, this access to nature must not compromise the ecosystems and all the communities that live there.

Key messages that call for action

Nature provides the basic conditions for the survival and health of all organisms, including humans. It is essential for regulating the water cycle, maintaining air quality and enabling soil formation and food production, both on land and in the oceans. It is a resource with potential therapeutic properties awaiting discovery. The natural environment is a setting conducive to a healthy lifestyle.

Although nature can present health risks, it is not a hostile world that is set apart, but a living environment that is indispensable to humans. A healthy, functional and resilient natural environment plays a role in mitigating extreme events and the effects of natural disasters, limiting exposure to pathogens and protecting health.

The pressures exerted on natural environments threaten the health of humans and other living organisms. Climate change, overexploitation of soils, depletion of resources and biodiversity loss mean an increase in extreme events, the threat of ecological collapse and impacts on food systems as well as access to drinking water. Environmental degradation also leads to conflict and population displacement, with health consequences for the people concerned.

Measures to protect nature – and therefore human health – are becoming a vital necessity. Strengthening "environmental resilience" and ensuring diverse and functional ecosystems will help to mitigate long-term health effects. To achieve this, all sectors need to take the following action: consider and communicate the links between nature, biodiversity and health; prepare long-term strategies for sustainable management of the natural environment;

integrate nature, environment and health considerations into all policies, both national and local, taking a One Health approach; seek nature-based solutions to societal, economic, environmental and climate challenges; compile and use environmental data; share information on best practices. ■

1. A community of living beings, animals and plants, and the environment in which they live. (Editor's note.)
2. A view that sees humans as the centre of the universe. (Editor's note.)
3. The zone of the Earth where the conditions for life are found. (Editor's note.)
4. Infectious diseases passed from animals to humans. (Editor's note.)
5. The production of organic molecules by living organisms. (Editor's note.)
6. All technologies that use organisms to produce or transform substances on an industrial scale. (Editor's note.)
7. In the agricultural sector, the term "inputs" most often refers to fertilisers and pesticides. (Editor's note.)
8. See Santé publique France's "Vector-borne diseases" dossier. Online: https://www.santepubliquefrance.fr/maladies-et-traumatismes/maladies-a-transmission-vectorielle.
9. Disease affecting humans and various animal species caused by certain aspergilli, which are ascomycete fungi that are widespread in nature. Most species are moulds. (Editor's note.)
10. Larval forms of certain tapeworms that cause echinococcosis. (Editor's note.)
11. Infection caused by a spirochete – bacterium in the form of a long spiral filament – which is carried by certain animals, such as rats. (Editor's note.)
12. Prokaryotic microorganisms, morphologically similar to bacteria, but with unique molecular, metabolic and membrane characteristics. (Editor's note.)
13. Single-celled eukaryotes: organisms whose chromosomes are enclosed in a nucleus separated from the cytoplasm by a membrane. (Editor's note.)
14. Single-celled organisms. (Editor's note.)
15. A collection of microorganisms living together in an environment.
16. One of the most important hormones of the adrenal cortex, transformed by the body into cortisone in response to an enzyme. (Editor's note.)

REFERENCES

[1] FAO, OIE, WHO and UNEP. *Tripartite and UNEP support OHHLEP's definition of "One Health". Joint statement*. [Press release] World Health Organization, 1 December 2021. Online: https://www.who.int/news/item/01-12-2021-tripartite-and-unep-support-ohhlep-s-definition-of-one-health

[2] M. B. Potschin, R. H. Haines-Young. Ecosystem services: exploring a geographical perspective. *Progress in Physical Geography: Earth and Environment*, 2011, vol. 35, no. 5: p. 575-594. Online: https://doi.org/10.1177/0309133311423172

[3] *Nature, Biodiversity and Health: An Overview of Interconnections*. Bonn: WHO European Center for Environment and Health, 2021: 42 p. Online: https://iris.who.int/bitstream/handle/10665/341376/9789289055581-eng.pdf?sequence=1

[4] Water, sanitation and hygiene: exposure. The Global Health Observatory, WHO.int. Online: https://www.who.int/data/gho/data/themes/topics/topic-details/GHO/water-sanitation-and-hygiene-exposure

[5] A. G. McDonald, W. J. Bealey, D. Fowler, U. Dragosits, U. Skiba, R. I. Smith *et al.* Quantifying the effect of urban tree planting on concentrations and depositions of PM_{10} in two UK conurbations. *Atmospheric Environment*, 2007, vol. 41, no. 38: p. 8455-8467. Online: https://doi.org/10.1016/j.atmosenv. 2007.07.025

[6] M. Romanello, C. di Napoli, C. Green, H. Kennard, P. Lampard, D. Scamman *et al.* The 2023 report of the *Lancet* Countdown on health and climate change: the imperative for a health-centred response in a world facing irreversible harms. *The Lancet*, 2023. Online: https://doi.org/10.1016/S0140-6736(23)01859-7

[7] World Health Organization. Air pollution levels rising in many of the world's poorest cities. Geneva, 12 May 2016. Online: https://www.who.int/home/12-05-2016-air-pollution-levels-rising-in-many-of-the-world-s-poorest-cities

[8] Impacts of air pollution on ecosystems. [Web Report] European Environment Agency, November 2022. Online: https://www.eea.europa.eu/publications/air-quality-in-europe-2022/impacts-of-air-pollution-on-ecosystems

[9] World Wildlife Fund. How climate change relates to oceans. Worldwildlife.org, 2021. Online: https://www.worldwildlife.org/stories/how-climate-change-relates-to-oceans

[10] Food and Agriculture Organization of the United Nations. *In Brief to the State of World Fisheries and Aquaculture 2024. Blue Transformation in Action*. Rome: FAO, 2024: 40 p. Online: https://doi.org/10.4060/cd0690en

[11] N. Papon, B. R. Copp, V. Courdavault. Marine drugs: Biology, pipelines, current and future prospects for production. *Biotechnology Advances*, 2022, vol. 54: 107871. Online: https://doi.org/10.1016/j.biotechadv.2021.107871

[12] H. Ritchie. What are the environmental impacts of food and agriculture? *In:* Our World in Data 2019. https://ourworldindata.org/env-impacts-of-food

[13] P. R. Hosseini, J. N. Mills, A.-H. Prieur-Richard, V. O. Ezenwa, X. Bailly, A. Rizzoli *et al.* Does the impact of biodiversity differ between emerging and endemic pathogens? The need to separate the concepts of hazard and risk. *Philosophical Transactions of the Royal Society B. Biological Sciences*, 2017, vol. 372, no. 1722: 20160129. Online: https://doi.org/10.1098/rstb.2016.0129

[14] B. J. McMahon, S. Morand, J. S. Gray. Ecosystem change and zoonoses in the Anthropocene. *Zoonoses and Public Health*, 2018, vol. 65, no. 7: p. 755-765. Online: https://doi.org/10.1111/zph.12489

[15] M. Delgado-Baquerizo, F. T. Maestre, P. B. Reich, T. C. Jeffries, J. J. Gaitan, D. Encinar *et al.* Microbial diversity drives multifunctionality in terrestrial ecosystems. *Nature Communications*, 2016, vol. 7: 10541. Online: https://doi.org/10.1038/ncomms10541

[16] L. Flandroy, T. Poutahidis, G. Berg, G. Clarke, M.-C. Dao, E. Decaestecker *et al.* The impact of human activities and lifestyles on the interlinked microbiota and health of humans and of ecosystems. *Science of Total Environment*, 2018, vol. 627: p. 1018-1038. Online: https://doi.org/10.1016/j.scitotenv.2018.01.288

[17] E. J. Flies, S. Mavoa, G. R. Zosky, E. Mantzioris, C. Williams, R. Eri *et al.* Urban-associated diseases: Candidate diseases, environmental risk factors, and a path forward. *Environment International*, 2019, vol. 133, part A: 105187. Online: https://doi.org/10.1016/j.envint.2019.105187

[18] Mireia Valles-Colomer *et al.* The neuroactive potential of the human gut microbiota in quality of life and depression. *Nature Microbiology*, 2019. Online: https://www.nature.com/articles/s41564-018-0337-x

[19] M. R. Howes, C. L. Quave, J. Collemare, E. C. Tatsis, D. Twilley, E. Lulekal *et al.* Molecules from nature: reconciling biodiversity conservation and global health care imperatives for sustainable use of medicinal plants and fungi. *Plants, People, Planet*, 2020, vol. 2, no. 5: p. 463-481. Online: https://doi.org/10.1002/ppp3.10138

[20] M. C. Hunter, B. W. Gillepsie, S. Yu-Pu Chen. Urban nature experiences reduce stress in the context of daily life based on salivary biomarkers. *Frontiers in Psychology*, 2019, vol. 10. Online: https://doi.org/10.3389/fpsyg.2019.00722

[21] M. P. Jimenez, N. V. DeVille, E. G. Elliott, J. E. Schiff, G. E. Wilt, J. E. Hart *et al.* Associations between nature exposure and health: a review of the evidence. *International Journal of Environmental Research and Public Health*, 2021, vol. 18, no. 9: 4790. Online: https://doi.org/10.3390/ijerph18094790

THE AUTHORS DECLARE NO TIES OR CONFLICTS OF INTEREST WITH REGARD TO THE CONTENT OF THIS ARTICLE.