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UNLOCKING THE HEALTH BENEFITS OF NATURE

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Abstract

Nature's benefits to human health are so well-attested, that the medical profession is now actively engaged in fighting for a clean, healthy environment as a human right and prescribing it as treatment across the world from Shetland to Japan. So how does being close to nature improve your health and well-being and how can this help us achieve UN Sustainable Development Goal 3 to 'ensure healthy lives and promote wellbeing for all at all ages'?

Introduction

Good health and well-being are essential elements in building prosperous societies. As we have seen, in the context of the Millennium Development and Sustainable Development Goals, major progress has been made in improving the well-being of millions of people by placing health at the heart of development. Maternal mortality rates have been reducing; the total number of deaths of children under 5 years of age dropped from 9.8 million in 2000 to 5.4 million in 2017; since 2000, measles vaccines have averted nearly 15.6 million deaths, resulting in an 80% drop in death rates from 200-2017, and overall life expectancy continues to increase.

However, the list of improvements and successes fall short of what the world is hoping to achieve. For example, 17,000 fewer children die each day than in 1990, but more than 5 million children still die before their fifth birthday, with 80% occurring in Sub-Saharan Africa and Southern Asia. The mortality of mothers not surviving childbirth is 14 times higher in developing regions compared to developed regions. Over 6.2 million malaria deaths have been avoided and the incidence rate of malaria has decreased by 37%, but progress on malaria has now stalled.

The linkage between health and poverty remains, what has not been established is how nature can be incorporated into our thinking to help speed up the improvements in health we are seeking. For example, children born into poverty are almost twice as likely to die before the age of five as those from wealthier families, this is as true for children in cities such as London and in the developing world. And in both rich and poor countries, a health emergency can push people into bankruptcy or poverty. If we do nothing, non-communicable diseases alone will cost low- and middle-income countries more than USD7 trillion in the next 15 years.

We know from past experience that to achieve the Sustainable Development target 3.4 of reducing by one third premature mortality from non-communicable diseases by 2030, investment in prevention and treatment is essential. The United Nations and World Health Organisation estimate that if we spent USD1 billion in expanding immunization coverage against influenza, pneumonia and other preventable diseases, we could save 1 million children's lives each year. Whist this is a relatively modest figure, we could potentially imagine a situation where many deaths could be averted by investing in ways which explicitly seek the health benefits of nature and a healthy environment.

Over the past decade, improvements in health and healthcare, in addition to education, have led to a 24 per cent increase in income growth in some of the poorest countries. We also understand the critical role that a healthy environment plays in delivering mental health and well-being.

In this lecture I will examine the scientific evidence of nature as a means of delivering health benefits and well-being but also delve into how different cultures and traditions perceive and have perceived over millennia the relationship between humans and nature and whether this might create a different, more effective model for future healthcare.

Historical and Indigenous Perspectives on Nature and Naturalism

Looking back over human evolution, we see that many populations have shown resilience to significant changes in their environments and by association high levels of stress. Yet today, if we look at the major health patterns, much of what we see is reported through the lens of a loss of resilience, often linked to the build-up of stress. These have been linked to changes in biochemical reactions and the cellular impacts of exposure to pollutants such as pesticides and other persistent organic pollutants, which accumulate in living organisms and cause long-lasting changes in blood chemistry, and hormonal and immune systems (UN Environment Pollution Free Planet 2017).

From a scientific and medical perspective, the way in which the human body responds to these types of external pressures, is based largely on underlying physical and biochemical processes. For example, difficulties in breathing in places with high concentrations of particulate matter, constrictions in the flows of blood, or tumours arising from exposure to hazardous chemicals and heavy metals (European Environment Agency 2013 Late lessons from early warnings: science, precaution, innovation https://www.eea.europa.eu/publications/late-lessons-2). Very little research exists on how human perceptions of nature might influence these types of health outcomes. And yet over millennia, humans have had to adapt and change and essentially control these very same biochemical processes to survive – if they had not, humans would not be present today!

If we look at how nature has been depicted over the ages in different cultures, we can begin to get a sense of how large parts of the world consider the nature as a source of well-being as well as remedies. In China the most popular subject in art has always been nature. In the Shanghai Museum there is a painting by the Ming dynasty artist Jin Dai (1388-1462) called Dense Green Covering the Spring Mountains which shows the majesty of nature in which people are embedded. A similar message is captured in the famous painting by the Yuan dynasty Wang Meng (1308-85) *Secluded Dwelling in the Qingbian mountains*. These and other such works of art capture the very essence of the difference between western and eastern philosophies. Western art has tended to contrast the natural versus human made. In eastern art, humanity does not stand apart but is fully part of it. Since the time of Confucius, there has been no God or focus on the afterlife depicted in art, rather the emphasis has been on philosophy, with no sharp divisions between mind and spirit, heaven and earth as commonly found in other traditions.

Mencius (385–303 BC), a Chinese Confucian philosopher known as the second Sage, wrote " all who speak about the natures of things, have in fact only their phenomena to reason from, and the value of a phenomenon is its being natural". Chinese philosophy is profoundly non-dualistic: yin and yang represent two aspects of the same whole, not two things that need to be reconciled. The distinctive nature of Chinese views on the importance of the natural world in achieving well-being is even more evident in Daoism, the most associated with nature of all the global philosophies. Daoism can perhaps be best summed up by the famous story of Zhuangzi who awakens in a state unable to tell if it was he or the butterfly who had been dreaming of the other. The implication being that it doesn't matter.

Japanese naturalism is close to that of China. Japanese artistic styles include the yamato-e seasonal painting from the Muromachi period (1392-1573) which has an extraordinary example Landscape of the Four Seasons depicted on a scroll over 10 metres long, attributed to Sesshu, at Kyoto National Museum. Zen ink paintings are also mostly of nature. An example is Zhongfeng Mongben meditating; this is in strict contrast to the Buddhist traditions which focus exclusively on the paintings of the Buddha.

Nature is ubiquitous in Japanese paintings. But Japanese nature is not the same as European Nature with its capital letter and separateness. Instead it is nature very near to you; it is not a paradise and may contain bad, destructive elements such as tsunamis and earthquakes. Japanese paintings often capture the sense that the humans do not do things to nature from the outside, but with nature, from the inside. For example, a tatami mat is not natural in that it is found replicated in nature, yet much of the sensory experience of straw remains. In other words, there is no distinction between the natural and the artificial because it is all part of nature.

Aboriginal Australian ideas are broadly similar. For example, throwing a beer can out of the window is not seen as despoiling nature because the beer can will find its place in nature! What this really means is that aboriginal Australians do not see the need to protect nature from humans as humans are already part of nature. In Japanese culture, a misplaced beer can or waste in general is more about not disturbing the purity of an environment rather than thinking of waste as unnatural. Nature and human endeavour go together in Japanese and Chinese culture. In this way, different environments can be created; domesticity is thus a hybrid between wild nature and technology. The famous cherry blossoms of Japan – sakura- were the result of a massive deliberate cherry tree planting before the Nara period 710CE. In much of Africa, true of many oral philosophies, there is no place for a distinction between the material world and spirituality. Instead vitalism abounds in which everything is seen to be alive, and in some areas even panpsychism in which everything is conscious. This is similar to Japanese and Chinese philosophies and what is quite different to western philosophies, where even those who accept naturalistic views still distinguish between humanity and nature. If we remove the mind body distinction and the interior exterior distinction (because there is no matter for the immaterial mind to be housed in) we can begin to understand why some indigenous peoples, such as the aboriginal Australians, show little interest in what goes on in the mind. The mind itself is not even a concept and any notion of psychological interiority or of a soul is not part of their world. Everything is exterior - this is what matters. Contrast this to western cultures, where the connection of the inner spirit to the natural world has become a driving force in the multi-billion-dollar well-being industry.

With such differing attitudes and beliefs towards nature, what does the scientific evidence tell us about how the natural world shapes the health and well-being of all living organisms, and in particular humans, noting of course that the scientific revolution has only been in effect for approximately 400 years, and that ancient traditions and indigenous wisdom, have been in play for at least 5 millennia!

The Scientific Evidence that Nature Benefits Our Health and Well-Being

In a recent review, Aerts and colleagues (2018) looked at the mechanisms and evidence of effects of biodiversity, nature and especially green spaces on human health[1]. Their basic premise was that natural environments and green spaces provide ecosystem services that can enhance human health and well-being by improving mental health, mitigate allergies and reduce all-cause, respiratory, cardiovascular and cancer mortality. Across the literature, they found that the presence, accessibility, proximity and greenness of green spaces determined the magnitude of any positive health effects, but that the role of biodiversity (including species and ecosystem diversity) within green spaces was still not properly understood.

What evidence there is shows positive associations between species diversity and psychological and physical well-being.[1–5] and between ecosystem diversity and immune system regulation, although high species diversity has been associated with both reduced and increased vector-borne disease risk. However, few relate measured biodiversity to well defined and measured clinical outcomes; rather there is more evidence for self-reported psychological well-being. Although the actual biophysical causality is not understood in most instances, there is evidence that the physical and mental health benefits related to human interactions with natural and man-made green environments, depend on the duration and timing of the exposure.[6–8] Short-term exposure to forests, urban parks, gardens and other (semi-) natural environments reduces stress and depressive symptoms, restores attention fatigue, increases self-reported positive emotions and improves self-esteem, mood, and perceived mental and physical health.[9–14] Access to natural environments also tends to enhance outdoor physical activity, improving physical health, for example by reducing the prevalence of obesity and type 2 diabetes.[15–20] Long-term exposure to natural environments, such as residing in areas with high greenness or in diverse landscapes, is associated with reduced all-cause, respiratory, cardiovascular and cancer mortality [4,21] and to improved respiratory and mental health.[22,23] Such positive effects of green spaces have been demonstrated over distances varying between 150 m and 5 km.[23–27]

There is evidence that exposure to green or natural environments is particularly important during prenatal development and early life. The greenness of mother's neighbourhoods has a positive effect on the birth weight of their infants.[4,28,29] Childhood exposure to natural environments reduces the risk of developing schizophrenia.[30] Residential greenness has been associated to reductions in obesity prevalence and atopic

[1] The references cited here are drawn from the review.

sensitization in children[1,31] and has a positive effect on blood pressure in adolescents.[32] Early life exposure to natural environments also has a number of important long-term effects. The exposure to beneficial microbiota in the environment during the early life also has profound effects on the development of the immune system and on the prevalence of chronic inflammatory diseases.[33–37] In addition, early exposure to nature amplifies the potential beneficial effects of green spaces in later life,[38] including the stress-reducing effects of therapeutic immersion in nature.[39,40] Conversely, the lack of interaction with nature during early life, for instance, due to the limited time spent in nature or green space in urbanized environments, has been associated to a number of emotional, cognitive and physical difficulties in children. The set of mental disorders linked to this disconnection with nature has been described as 'nature deficit disorder' (NDD).[41]

The short- and long-term benefits that natural and man-made green spaces provide, in terms of human health, can be classified in terms of different ecosystem services .[42- 49] A growing body of evidence shows that many observed associations between exposure to green environments and human health and well-being benefits are mediated by these ecosystem services. They include those that reduce harmful environmental exposures such as air pollution, extreme heat, urban heat and noise.[4,50–53] Biodiversity as a service delivers a variety of species (animals, plants, fungi and microorganisms) and their gene pools plus the variety of ecosystems in which the species reside.[54] And there is some evidence of cascading links between green environments, biodiversity, ecosystem services and human health and well-being.[55–62] For example, high plant diversity can result in high structural and functional variation which determines the potential of green spaces to mitigate air pollution.[63] Also, biodiverse green spaces may host a high diversity of environmental microbiota,[64] which may mediate biodiversity effects on human health through their impact on the immune system.[33–37] Thus, plant diversity may have direct and indirect impacts on the potential of green spaces to reduce the acute and chronic health effects of air pollution, including allergies, asthma, cardiovascular diseases and premature death.[65–68]

There are three main theories about how biodiversity and ecosystem services support human health: the ecosystems resilience theory, the biophilia hypothesis and the dilution effect hypothesis. In urban settings, where there are many disturbances, diverse systems are more robust and resilient. [69,70] The 'biophilia hypothesis' proposes that humans have an intrinsic affinity to other species and nature because the interaction with the natural environment drove the evolution of our species and so are expected to prefer and select biologically diverse environments and derive mental benefits from exposure to green space. This gives rise to the idea of stress recovery and attention restoration recovery. [71-76]

The 'biodiversity hypothesis' proposes that exposure to biodiversity improves the immune system by regulating the species composition of the human microbiome and reducing the prevalence of allergies, asthma and other chronic inflammatory diseases.[33-35,77-79] A reduced early life exposure to parasites and environmental bacteria is associated with an increased risk to develop allergic diseases, asthma and other hypersensitivity disorders because it has detrimental effects on the development of the human (intestinal) microbiome (dysbiosis) and the infant immune system.[80–83]

The 'dilution effect hypothesis' proposes that high vertebrate species richness reduces the risk of infectious diseases of humans because pathogens are 'diluted' among a high number of animal reservoir species that differ in their capacity to infect invertebrate vector species lowering the prevalence of infected vectors.[84-91] A large number of studies on Lyme disease have looked at the impact of biodiversity on the spread of the disease with mixed conclusions. [92-98] Further studies are listed on the biophilia theory [99-108], biodiversity hypothesis [109-110] and the dilution theory [111-115] and on measured and perceived benefits of nature on health, including the impacts of invasive alien species. [99-120] More recently, novel approaches to measuring actual exposures and direct health impacts have begun to emerge; these include a range of mobile applications, high-resolution hyperspectral imaging technology have enabled the fine-scale functional characterization of vegetation and the spatio-temporal mapping of biodiversity in different environments such as schools, urban landscapes, and areas of tree planting and wildlife conservation.[121-130] The popular Japanese treatment known as Shinrin Yoku of therapeutic forest bathing is also an area of wide interest but evidence of direct health benefits is still rather limited.[131]

Reviewing the literature, Aerts et al. (2018) conclude that the indirectly, by reducing biodiversity, nature is likely to not deliver health benefits in the same way as a well-functioning, biodiverse environment [131-136]. However, whereas positive effects of green spaces and nature contact on mental and physical health are well documented,[19,124,140] there

is rather limited evidence for direct biodiversity effects and conflicting evidence in terms of infectious diseases.[141] Novel methods, including epidemiological studies are needed to accurately quantify the quantity and quality of exposure to different dimensions of biodiversity, including microbial diversity.[79,142-144] These will be needed to guide biodiversity-based therapy and inform environmental policies that aim to maintain and develop nature beneficial to human health.

Natural Medicinal Healthcare

Nature offers many benefits for human health in terms of medicines. From ancient times, herbalists and doctors have drawn from nature a huge repertoire of medicines to treat different ailments. The famous library housed in the St Catharine's Monastery in the Sinai Peninsula contains palimpsest and books documenting the importance of nature in generating health benefits going back millennia to the time of Galen and others in Greek history.

The active molecules and therapeutic aspects of many plants are the source of much research. In recent times we have seen several that have had a global impact. For example, Artemisinin, which is used as an anti-malarial treatment, is a natural extract from *Artemisian annua* (sweet wormwood). Its discovery goes back to 1969 when chloroquine was failing. Tu Youtou screened thousands of Chinese herbal medicines and produced 385 extracts which he then used. It has saved millions of lives and Tu Youtou received the 2015 Nobel Prize in Physiology and Medicine. It is now being screened for cancers where it targets tumour cells and anti-parasitic and inflammatory drugs.

In the 1950s, scientists discovered that the traditional herbal remedy, the Madagascar periwinkle (*Vinca rosea* or *Catharanthus roseus*) contained medicinally active 'vinca alkaloids', among which were the first phytochemicals used to treat cancer. Although the sap is poisonous if ingested, some 70 useful alkaloids have been identified from it including alstonine, ajmalicine, reserpine, vincamin, camptothecin, vinblastine, and vincristine (leurocrystine), all possessing powerful medicinal properties. Vinblastine, vincristine and other semi-synthetic derivatives inhibit division of cancer cells are used to treat Hodgkin's disease, non-Hodgkin's lymphoma, and testicular and kidney cancer plus acute lymphocytic leukaemia, neuroblastoma, sarcoma, and cancers of the breast, cervix, bladder and lungs.

Coral reef plants and animals are important sources of new medicines to treat cancer, arthritis, human bacterial infections, Alzheimer's disease, heart disease, viruses, and other diseases. They are highly effective in this area because as stationary animals they have evolved chemical defences to protect themselves from predators. They are also a source of nutritional supplements, cosmetics and natural pesticides and coral substrate is being used in used in reconstructive surgery and as a building base for new bone.

In the western world, there is an increasing preference of consumers towards traditional medicines (Ayurveda, Unani and Traditional Chinese Medicine). In 2019, the global herbal medicine market size was valued at more than USD 75 billion and is expected to continue growing. However, there is a poor regulatory framework across the globe and only a small number of institutes providing knowledge of herbal therapeutics and relevant research evidence. Amongst indigenous peoples, plants remain the main source of medicine, with some plant species used to treat many disorders as a result of the multiple active molecules such as phenols, glycosides, polysaccharides, alkaloids, resins, and terpenoids that they contain.

Natural Intelligence and Preventative Natural Healthcare

Today, a different field of medicine is emerging premised on the idea that nature is potentially far more engaged in our health than we have been able to determine through scientific research to date. For example, the discovery by Amour and Ardell in 1991[2] that there are at least two "brains" in the human body, the cranial brain, and the heart brain, a fast-reacting neural-like tissue which acts as a trigger for the more than 1300 biochemical reactions in the body as well as providing a conduit to the subconscious, means that we have multiple intelligences at work at any time. These "intelligences" can affect all parts of the body and can react to others; for example, electrocardiograms of mothers and babies in two separate rooms show how the mother's heartbeat responds to that of her baby. The

[2] Amour, JA and J Ardell 2004 Neurocardiology. Oxford University Press

integration of multiple intelligences in response to rapid change could in effect be a manifestation of resilience, built upon heart rate variability, increased immune response and biochemical balance.

Across the range of inspired writings about how we see nature, is the book by Howard Gardiner called *Multiple Intelligence*. In this he describes nine types including: logical-mathematical, musical, visual-spatial, interpersonal, intrapersonal, bodily kinaesthetic, linguistic, naturalist and existential. These hint at multiple interactions which are both short-term fast reacting as well as long term memory and bond forming. One hypothesis amongst the researchers working on the heart –cranial brain connection is that the loss of these linkages means that memories are lost.

Returning to the idea that different cultures view nature in very different ways, the question remains how this affects health. My own experience until recently had been one of a self-perception of health improved by living in a clean and biodiverse environment. This was partly because of the activities which took me into nature – hiking, swimming, diving, field work – and partly because of an absence of obvious pollution. But having had a blood test for exposure to chemicals, I was shocked to find how high the levels of flame retardant and other pesticides were and came to realise that even living in a relatively clean rural environment, spending time doing sports such as running and scuba diving - I discovered that the tank lining was a source of the flame retardants in my body - did not ensure that my accumulated body burden of hazardous chemicals was safe.

Today, I am living within a tribal indigenous community in the African bush, where pollution levels are minimal but environmental changes and extremes are growing ever more apparent. I observe that the reactions of community members is quite different to those of the non-indigenous community who try to block the changes. First and foremost, the separation between humans and nature does not exist and so the community changes with the environment. Building new mud huts that are swept away by rain is a given, but they are also choosing different plants to eat and altering their patterns of movement and it all happens seamlessly. Stress is ever present, but it is dissipated through communicating and sensing the changes within each other and nature in a continuum.

So let me leave you with a picture of the healing aspects of nature. Every Wednesday morning in Todedji, Benin, members of the women's co-operative (Houenoussou) gather to eat together before heading off to their market garden on the banks of the river Noire and next to the sacred forest of Oro. Their work not only provides food for the village but it ensures that the traditional knowledge about ancestral seed varieties – which are more resilient to climate change – is preserved and handed down to their daughters. Houenoussou provides a constant source of healthy food for the community all year round and their produce is increasingly sought after in the markets of the big cities, where good quality produce seldom exists. In August, the community gather in the sacred forest to sing and dance and pay their respects to the forest divinity, Oro, for the healing properties of their world in the forest.

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