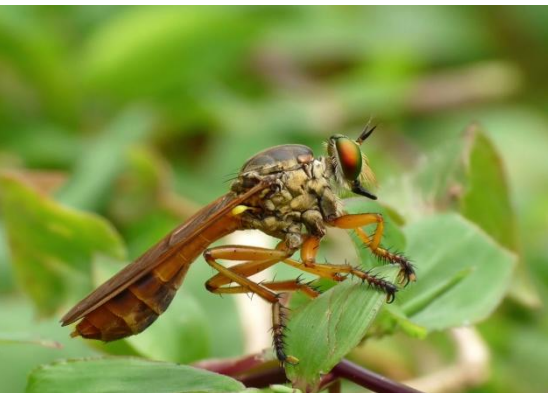


HEALTHY PLANET, HEALTHY PEOPLE



A Guide to Human Health and Biodiversity

UNEP, 2011-2012 declared “Year of the Bat” *Bats provide a range of biodiversity benefits to humans ... New drug synthesized from vampire bat saliva in development ... Could help stroke victims ...*

SAN FRANCISCO, Sep. 6, 2012 ... Yosemite National Park ... hantavirus warning ... 22,000 visitors may have been exposed to deadly mouse-borne disease ... confirmed cases growing

“Healthy people are better able to learn, be productive and contribute to their communities. At the same time, a healthy environment is a prerequisite for good health.” Dr. Margaret Chan, Director-General of the World Health Organization, 22 June 2012

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FOREWORD

Health means many things to many people. Often it means an absence of illness, but to the World Health Organization (WHO), health does not just mean freedom from illness, but a state of complete physical, mental and social well-being. This concept of well-being became translated into the language of biodiversity in a significant way through the work of the Millennium Assessment.

Life on Earth is inevitably changed by the actions of people, including actions, which cause biodiversity change and loss. Maintaining life on earth in a healthy state means biodiversity is sustainably used, conserved and its benefits shared in ways that enables it to survive, flourish, evolve and change. Well-managed and healthy life on earth is also essential to support healthy people, individually or in communities.

The need to integrate more fully the goals of biodiversity conservation, benefit sharing and sustainable use with health ethics to achieve a sustainable society is becoming ever clearer. To this end, we joined with the other two “Rio” Conventions (Climate Change and Combating Desertification) and the World Health Organisation to launch a key publication on health, biodiversity, climate change and land degradation (*Our Planet, Our Health, Our Future*) at the Rio+20 meeting in June 2012. We were pleased to be part of preparing and launching that publication, and decided that a follow-on strategy would include preparing a guide on health and biodiversity – hence the current publication.

The newly adopted *Nagoya Protocol on access to genetic resources and the fair and equitable sharing of benefits arising from their utilization* provides incentives for research on the genetic level of biodiversity by creating greater legal certainty and ensuring benefit-sharing for users and providers of genetic resources. The Protocol therefore has strong potential to enhance the contribution of biodiversity to human health.

This guide explores the issues surrounding, and the links between, biodiversity and health, characterised as human well-being. Many people, when they think of health, think only freedom from disease, yet health comes from a settled state of mind, largely promoted through a pleasant living environment. Such a pleasant living environment does not mean necessarily an abundance of riches, but it *does* mean freedom from poverty. We hope this publication will help health specialists understand better the links with biodiversity, and biodiversity specialists understand the health benefits of their work, in addition to all the other benefits from biodiversity!

Braulio Ferreira de Souza Dias
Executive Secretary

INTRODUCTION

Who is this publication aimed at?

In recent years the UN System and the key biodiversity conventions have discussed the important links between health and biodiversity. At international level the conversation continues, and becomes more intense. This guide has been developed for health professionals who are curious about how biodiversity can influence the outcome of their work, and for biodiversity specialists who would like to know more about how their successes (and failures!) can impact people's health. The guide does not attempt to "dumb-down" issues, but rather provides explanations as simply as the topic allows, in the hope that it will also be of interest to a wider public - especially non-government organisations (NGO's) dealing with health, biodiversity and indigenous issues – encouraging them to continue and extend the conversation to the national level and civil society.

The guide outlines a range of examples on the links between health, biodiversity and development. Detailed references for more information are listed in the primary sources we cite, and readers should "follow their noses" to the areas that are of most interest and relevance to them. While we widely quote from existing sources the aim is not to duplicate work that has already been done but rather to provide a comprehensive overview to develop a clear understanding of the different dimensions linking healthy biodiversity and human health. This publication may be read from beginning to end (and we hope you will do so!) but it also contains a detailed topic list for those with limited time or pressing needs..

We have tried to cover as many issues as possible. However, given the complexity of the subject, this guide is by no means exhaustive. While it is possible to print and read a hardcopy of the publication, we hope most readers will view and use it online as a reference, referring to the links to move through the guide and beyond to the World Wide Web for further information. The design of the guide has inevitably (and deliberately) led to some overlap and duplication, but we have worked to keep to a minimum. Since Chinese literature considerably contributes to the discussions on traditional medicines, we have sourced some material in Mandarin. We appreciate that these may not be accessible to everyone, but we have included them for completeness.

Gender issues often come through as important in health, and purple typeface is used where gender issues are specifically mentioned in the text. Finally, after each major section, we extracted a series of key messages, in maroon typeface to give the reader an idea of the most critical or significant issues, hints at good practices or action points.

What's the issue?

While writing this guide, there were reported outbreaks of hanta virus in several parts of the world, of Ebola haemorrhagic fever virus in several locations in Africa, and of West Nile virus in Texas (infecting over 2,000 people and causing 100 fatalities). All of these diseases are linked to biodiversity in direct or indirect ways, and our reactions to the diseases, their management and their prevention require focus on health care and also on biodiversity management. The New York Times (July 15, 2012) provided an overview of this reality in an article entitled, “Man-Made Epidemics.”

The biosphere is the thin living envelope that sits between the geosphere (rocks and soils), hydrosphere (freshwater and oceans) and atmosphere. Life in the biosphere, including human life, is known collectively as biodiversity, and right now biodiversity faces key challenges, including accelerating loss of species, changes in distribution of organisms and changes in functioning of ecosystems. All of these changes can have impacts on our health in direct and indirect ways. A “healthy biosphere” is a biosphere that continues to function effectively, producing a range of services from its component ecosystems that support people, as well as other ecosystems.

Concern about health and the biosphere is essentially concern about the relationships which exist between people and the rest of the biosphere and people have generally handled these relationships poorly. The need to integrate more fully the goals of conservation and ecosystem management and health ethics for a sustainable society is becoming ever clearer.

This guide addresses the linkage between health and biodiversity in the context of development and poverty reduction. It highlights the need to conserve and sustainably use biodiversity in order to protect human health and well-being and it aims to raise awareness of the interdependence between nature, human health and the wider environment. Although there is growing scientific evidence of the connections between biodiversity and human health, these linkages are not well-known, widely acknowledged or able to inform critical policy decisions in development. Campbell *et al.* 2012 call for 2 actions to redress this:

“First, we call for health and biodiversity professionals to promote greater awareness of the need for a more holistic approach by both sectors with a focus on human physical, mental, and social wellbeing in our environment. Second, we encourage a greater engagement of a broad range of organizations interested in health and biodiversity that will contribute and share their understanding of these essential linkages. ”

In the Foreword to the Millennium Assessment Synthesis Report on Health (2005) Lee Jong-Wook, Former Director-General of the [World Health Organisation \(WHO\)](#) wrote:

“Nature's goods and services are the ultimate foundations of life and health, even though in modern societies this fundamental dependency may be

indirect, displaced in space and time, and therefore poorly recognized. Health risks are also a result of broader pressures on ecosystems, from depletion and degradation of freshwater resources, to the impacts of global climate change on natural disasters and agricultural production (...) the potential for unpleasant surprises, such as emergence and spread of new infectious diseases, is (now) much greater.”

People depend on biodiversity every day, in ways that are not always obvious or understood clearly. Biodiversity, interacting with non-living parts of the environment, forms functioning ecosystems which produce services and benefits for people. And people anticipate good health until they fall ill: often without knowing why. In fact, human health depends upon ecosystem services (*e.g.* production, purification and protection of fresh water, soaking up of carbon dioxide and producing oxygen, food items and fuel) that are requisites for good human health and sustainable livelihoods. Biodiversity change can have significant direct human health impacts if ecosystem services become inadequate to meet human needs.

Indirectly, changes in ecosystem services affect livelihoods, income, and local migration and, on occasion, may even cause political conflict. For example, there are often no mechanisms for winning compensation from those who damage the environment for those who have lost as a result. Upstream mining activities do not generally pay those downstream for the fish they can no longer eat, or for health impacts such mining may cause. Additionally, species-level biodiversity is an important repository of knowledge that carries important benefits for the biological, health, and pharmacological sciences. Significant medical and pharmacological discoveries have been made through understanding of the earth's biodiversity over millennia. Biodiversity change, especially loss at species level, will inevitably limit discovery of potential treatments for many health problems.

Biodiversity also contributes to local livelihoods and development. 70% of the world's poor live in rural areas and depend directly on biodiversity for their survival and well-being. By increasing the vulnerability of the poor and reducing their options for sustainable development the current rate of biodiversity change, especially loss, will hamper efforts to meet all of the Millennium Development Goals (MDGs), especially those related to poverty, hunger and health.

Health, poverty, and biodiversity are often strongly manifest as gender issues, although this tends to be little explored in the literature. The Economics of Ecosystems and Biodiversity (TEEB) report has a box on Gender, poverty and biodiversity in Orissa, India, reproduced below.



The impact of the loss of biodiversity, often not very visible, has serious implications for poverty reduction and well-being for women as it severely affects the role of women as forest gatherers. Studies in the tribal regions of Orissa and Chattisgarh, states in India which were once heavily forested, have recorded how deforestation has resulted in loss of livelihoods, in women having to walk four times the distance to collect forest produce and in their inability to access medicinal herbs which have been depleted. This loss reduces income, increases drudgery and affects physical health. There is also evidence to show that the relative status of women within the family is higher in well-forested villages, where their contribution to the household income is greater than in villages that lack natural resources.

Source: Sarojini Thakur, Head of Gender Section, Commonwealth Secretariat, personal communication, May 15th 2008 – in Kumar, 2010.

But first to biodiversity itself: the [Convention on Biological Diversity \(CBD\)](#) text defines it as encompassing the three levels that constitute the organization of living organisms: genetic diversity, species diversity and ecosystem diversity.

Of the 197 countries of the UN, the CBD currently has near-universal membership of 193 parties, with a further country which has signed but not yet ratified, and 3 countries remaining to ratify. The Convention has three objectives – “the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding.”

Biodiversity also has social, cultural, economic and ecological dimensions, and is a complex, hierarchical concept. Recent work on ecosystem level biodiversity has focused on the provision of ecosystem services. And ensuring the provision of ecosystem services is maintained is seen as critical to maintenance of healthy human populations. But it is important to understand, from the outset that the terms

biodiversity and ecosystems services represent different actualities, they are not equivalents.

Human health and well-being is also an integrated and multi-faceted concept that goes beyond the purely medical – and healthy people are essential for sustainable living, and certainly for sustainable development!

After reading the guide

We hope reading or dipping into the guide will help you reach new levels of awareness on the two issues of health and biodiversity, and improve your skills in key areas of your profession - for example, if you are a:

Policy maker in health or environment, you will be able to:

- Understand and promote the WHO definition of health that embraces overall well-being;
- Link national health policies to biodiversity policies as a delivery mechanism for health services;
- Develop and promote benefit-sharing mechanisms for biodiversity, especially relevant health resources (especially at genetic level biodiversity);
- Promote compatible and equitable policies and legislation regarding access to biodiversity and health benefits of medicinal resources from biodiversity;
- Consider the implications for existing and emerging infectious diseases when making planning and management decisions relating to landscapes and seascapes;
- Develop and/or support initiatives that identify the importance of ecosystem services that ensure health and well-being.

Health (or social services) professional, you will be able to:

- Develop awareness of the various roles that biodiversity (and land-seascapes) can play in health promotion and illness prevention;
- Ensure that non-industrial ingredients in medicinal resources are sourced sustainably and where the surrounding human communities share appropriate benefits from the resource used;
- Develop partnerships with natural resource management agencies in implementing health-related activities.

Biodiversity manager, you will be able to:

- Develop links with health professionals and ensure access to best available information by the public;
- Ensure sustainable use of biodiversity including uses related to health and well-being;
- Minimise risk of adverse health impacts from management decisions relating to biodiversity conservation and use;

- Promote benefit-sharing mechanisms relating to health benefits from biodiversity;
- Develop specific habitat management practices for known positive and negative impacts on human health, and attempt to anticipate the unknown effects;
- Consider the values of traditional and indigenous knowledge of biodiversity on the promotion of health generally in the community;
- Raise awareness of health issues across all projects and activities and of the risks of emerging /increasing diseases from wildlife, arising from increased contact between people and wildlife;

Biodiversity or health researcher or academic, you will be able to:

- Incorporate integrated health-ecosystem teachings in health and in natural resource courses at all levels;
- Promote research links between emerging infectious disease and ecosystem-based management;
- Promote ethnobotanical studies in so as to increase understanding of plant biodiversity use in medicines and to identify potentially new medicinal material;
- Help develop monitoring and harvesting protocols for wild plant resources used as medicines;
- Ensure equitable benefit-sharing options from biodiversity research.

If you have reached this far, you will have understood this guide IS different. The interactive publication offers links to web pages or publications where much more detail can be found, as we do not believe in duplicating what is already available. Because we want to encourage use of this on computer or online many of these links will take you straight to the pages you seek. But the printed version can work well too; just remember where the paper has come from. This work is meant to be useful, but also enjoyable. We hope you find it both!

Topic Finder

We have designed this with a selection of topics people often raise with respect to biodiversity and health or both. To use it, control-click (cmd-click on a Mac) on each of the symbols in the section column, and you will be brought to the start of the section where the topic is discussed.

TOPICS & SUBTOPICS		section
Aichi Targets		α
Climate Change		β ββ β β ββ β ββ
Connecting with Nature		°C
Disease	Zoonosis	Δ
	Bushmeat	○
	Communicable & Infectious disease	☆ ☆ ☆ ☆ ☆ ☆ ☆ ☆ ☆
	Vectors	¥ ¥ ¥ ¥ ¥ ¥ ¥
Ecosystem	Ecosystem Approach	\$ \$ \$
	Ecosystem Management	@ @ @
	Ecosystem Services	! ! ! ! ! ! ! ! ! ! ! !
	Ecosystem Change	* * * * * - - - - -
Human & Wildlife Interaction	Bushmeat	&
	Vectors	% %% % % % % % %
	Zoonosis	±

Invasive Species		◆ ◆ ◆ ◆ ◆
Local and Traditional Knowledge		§ § §
Medecine	Natural Medecine	□ □ □ □ □
	Synthetic Medecine	◇
Mental Health & Cultural Wellbeing		※ ※ ※ ※
Nutrition	Food Security	≡ ≡ ≡
	Food Safety	≤
	Diversity of Diet	≥ ≥ ≥ ≥ ≥
Water Management		● ● ● ● ● ● ● ●
Women		Σ Σ Σ Σ Σ



Living long and healthily with biodiversity.....

A LITTLE HISTORY

There is growing scientific evidence of the connections between biodiversity loss, ecosystem degradation and poor-quality human health, as well as the health benefits that we can derive from biodiversity. The links are complex and our understanding is far from complete, however current findings indicate that biodiversity loss and ecosystem disturbances may have significant consequences for human health in both developing and developed countries. The link between the ecosystems and human health is becoming more widely acknowledged, but indicators to measure these links remain difficult to quantify.

But when did the links between biodiversity and health start to be manifest? Linnaeus, sometimes said to be the father of biodiversity, was a physician as well as a botanist and a zoologist. And many of the natural scientists, especially botanists, in that era were also physicians and herbalists. The boundaries between these sciences were far more blurred than today. Although links between biodiversity and medicine have a long and inter-twinned history, in the last century that relationship became somewhat distant – certainly in the industrialised world.

Yet in the latter decades there came again the realisation that healthy people could not thrive unless they were in a healthy environment, with one clear goal - a functioning biosphere, supported by biodiversity that is not subject to changes that reduce its quality and performance. Health, environment and development issues have been dealt with at the four main global conferences on Human Development and the Environment (Stockholm; 1972, Rio de Janeiro 1992; Johannesburg; 2002 and Rio de Janeiro 2012.). Key results from these important meetings and a number of other significant initiatives are described below:

Stockholm Conference, 1972

The Key result from the [Stockholm Conference](#) was a proclamation with a short preamble and 26 principles. The proclamation contained only three references to health (two in the preamble, and once in a principle).

Of course, since the term biodiversity was only coined in 1986 there is no explicit reference to it in the Proclamation – rather terms such as living beings, biosphere and living resources are used. The latter term is especially interesting since it shows a view leaning to exploitation. It is indeed sobering that 40 years ago we knew the problems, and even had good ideas on the solutions – now the problems are in sharper focus, the answers more difficult to implement.

Rio Conference on Environment and Development, 1992

The World Conference on Environment and Development (WCED) in 1992 became the first global policy discussion where health and biodiversity was given

prominence. Because the CBD was signed into life at that meeting, use of the word biodiversity in the meeting and its outputs was not always consistent or consonant.

Principle 1 of the [Declaration on Environment and Development](#) from that conference states: “Human beings are at the centre of concerns for sustainable development. They are entitled to a *healthy and productive life in harmony with nature.*” The italicized portion shows that there was clear understanding of biodiversity-health links, even though expressed through the term “nature” rather than “biodiversity”, which at that time was barely used by scientists, and generally unfamiliar to policy makers.

Millennium Development Goals (MDGs), 2000

In 2000, the UN General Assembly issued the “*Millennium Declaration*” which included eight ambitious Millennium Development Goals some of which have specific component targets dealing with public health and environment:

The Millennium Development Goals have much to say about health and the environment, and this guide explores some of those issues. However it is not our purpose to comment on poverty alleviation, food and water security, and biodiversity education for all *per se*; rather to examine the critical nexus of biodiversity and health.

World Summit on Sustainable Development, 2002

A further summit (World Summit on Sustainable Development – WSSD) was held in Johannesburg 2002. The then UN Secretary-General proposed five major and linked areas for discussion at the World Summit where he saw concrete results as both essential and achievable. The areas were: **Water, Energy, Health, Agriculture, and Biodiversity** - the so-called [WEHAB](#) initiative - which recognised for the first time the critical importance of biodiversity in delivering services in each of the other sectors. By including water, biodiversity, health and agriculture it also brought together key concerns for existing and developing the Multilateral Environmental Agreements dealing with biodiversity. And four of the five are important to this guide, especially the two topics in this Guide’s title!



So, what is important about the key WEHAB issues? Simply put; the links existing between all elements of WEHAB. One of the report’s conclusions is that; “Biodiversity can be seen therefore as a ‘life insurance policy for life itself’ – something

especially needed in this time of fast-paced global change". Taking the analogy to health care, biodiversity is the ultimate health insurance – and, just as the TEEB report notes "biodiversity is the GDP of the poor", it is also the *health insurance of the poor*.

Yet still now, in 2012, just as in 1992 and 2002, there remains a need to convince policy makers and the public of the need for good management, conservation and benefit sharing of biodiversity for maintaining human health. While natural scientists have been important in shaping this debate, the help of social scientists and experts in public opinion is needed urgently, and the developing Intergovernmental Programme for Biodiversity and Ecosystem Services (IPBES) will certainly be of help here.

Libreville Declaration 2008

In 2008, a regional effort for Africa to link biodiversity and health, under the auspices of the international organisations WHO and United Nations Environment Programme (UNEP) resulted in the Libreville Declaration. Key points from that Declaration, by the African Ministers of Health and Environment, were:

"The emergence of new environmental risks (climate change, industrial expansion, and new technologies) presents new threats to public health;
 - Africa is, of all the world's geographic regions, the most vulnerable in the face of these challenges;
 - Health security can be achieved through a healthy environment;"

[United Nations Conference on Sustainable Development](#) Rio+20, 2012

Twenty years on from the WCED meeting in Rio de Janeiro the so-called Rio+20 meeting was convened in the same city. In terms of biodiversity and health a number of issues were raised, which only served to echo outcomes of previous meetings.

For example, the outcome document noted:

"We are deeply concerned that one in five people on this planet, or over 1 billion people still live in extreme poverty, and that one in seven - or 14 per cent - is undernourished, while public health challenges, including pandemics and epidemics, remain omnipresent threats. "

And, again:

"We call for holistic and integrated approaches to sustainable development that will guide humanity to live in harmony with nature and lead to efforts to restore the health and integrity of the Earth's ecosystem."

And on gender especially; “the empowerment of women and to protect human health, and to significantly improve the implementation of integrated water resource management at all levels as appropriate.”

Convention on Wetlands (Ramsar, 1971)

Within the same time-frame another biodiversity-related convention, the [Convention on Wetlands \(Ramsar, 1971\)](#), often referred to simply as the Ramsar Convention, was focussing on health issues more and more. It adopted for its 2008 Conference of the Parties (COP) in Korea the theme “Healthy Wetlands, Healthy People”.

From the perspective of human health, wetlands have a real identity crisis. They are often seen simply as human health hazards, with malaria, bilharzias, and a whole host of other parasitic diseases typically associated with them. Yet mismanagement of wetlands can complicate the human-disease pathways already existing, and introduce new ways of interaction between disease and people.

Many of the people and sites affected adversely by ecosystem changes are highly vulnerable - and ill-equipped to cope with further loss of ecosystem services. Ecosystem changes, with an increasing risk of unpredictable changes in ecosystems, including accelerating, abrupt and potentially irreversible changes are likely to have a catastrophic effect on human health. The increased likelihood of unpredictable changes arises, in part, from the loss of biodiversity and growing pressures from multiple direct drivers of ecosystem change. The Ramsar Convention has reacted to this situation by promulgating policy decisions, and releasing Technical reports on wetlands and health and diseases of wetlands.

Non-Government efforts

While the intergovernmental meetings were proceeding, non-government efforts were also developing. Three of the important ones are:

[The Health and Environment Alliance \(HEAL\)](#) is a leading European non-governmental organisation with the geographic area of the European Union and which examines the links between environment and health. It touches on topics broader than biodiversity, but is a useful source for information on Europe, but with wider application. It began in 2003 as the environmental ‘wing’ of the European Public Health Alliance (EPHA).

[The Manhattan Principles](#) were set forth at the first One World – One Health conference, held in 2004 in New York. Subsequent congresses have been held in Beijing, Bangkok, Brasilia and Paris. The preamble of the Manhattan principles includes this statement:

“Phenomena such as species loss, habitat degradation, pollution, invasive alien species, and global climate change are fundamentally altering life on our planet The rise of emerging and resurging infectious diseases threatens not only humans (and their food supplies and economies), but also the fauna and flora comprising the critically needed biodiversity that supports the living infrastructure of our world. The earnestness and effectiveness of humankind’s environmental stewardship and our future health have never been more clearly linked. To win the disease battles of the 21st Century while ensuring the biological integrity of the Earth for future generations requires interdisciplinary and cross-sectoral approaches to disease prevention, surveillance, monitoring, control and mitigation as well as to environmental conservation more broadly.”

Following the First International Conference on Health and Biodiversity (COHAB) held in 2005, the [COHAB Initiative](#) was established. COHAB also responds to the results of the MA. The Initiative has partnership arrangements with a growing network of organisations worldwide, working together for a “healthy planet with healthy people”. The initiative has six key aims:

- Highlighting the importance of biodiversity and ecosystems services to human health and international development;
- Illustrating how biodiversity is an essential component in achieving each of the eight United Nations MDGs;
- Highlighting the risks that human impacts on ecosystems present to human health and welfare worldwide;
- Promoting collaborative approaches to conservation for sustainable human development;
- Generating interdisciplinary and international communication;
- Creating greater awareness among policy makers, scientists, health professionals, natural resource managers, local authorities and the general public.

AICHI 2010 BIODIVERSITY TARGETS, GOALS, AND STRATEGIES

The Aichi Biodiversity Targets, as contained in the Strategic Plan for Biodiversity 2011 – 2020 and adopted at the 10th meeting of the Conference of the Parties (COP) to the Convention on Biological Diversity (CBD) in 2010 do not deal directly with health (with the exception of target 14 under Goal D, which says: *By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.*); none-the-less health is linked intrinsically with those targets and *vice-versa*. The Targets also show how the relationship between *biodiversity health* and *human health* is linked and the complexities of those links with our changing climate, and the rapid progress of land and sea degradation.

The vision for the CBD’s Strategic Plan for Biodiversity 2011-2020 is:

“By 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people”.

Implementation of this Strategic Plan, up to 2020 is through 20 targets, divided into 5 goals. It can be argued that all five goals and 20 targets relate to human health as well as biodiversity health. Below we examine the health-biodiversity links at Strategic Goal level, and the Annexe shows how each target will contribute to better health and well-being on achievement, or the reverse:

STRATEGIC GOAL A: Address the underlying causes of biodiversity loss by main-streaming biodiversity across government and society. *This goal includes targets for public awareness, integrating biodiversity values, improving incentives and sustainable production and use.*

Impacts on better human health will come through developing better awareness of changes in biodiversity, the causes of that change and how the changes can affect health, among other human problems. Human health can benefit from achievement of this goal by raising awareness also of the links to, and need for, sustainable use.

- Recognize and promote dietary diversity, food cultures and their contribution to good nutrition
- Integrate “value of nature” into health policy including mental health and non-communicable diseases

STRATEGIC GOAL B: Reduce the direct pressures on biodiversity and promote sustainable use. *This goal includes targets on habitat loss, sustainable fisheries and land use, pollution, invasive alien species, and ecosystems particularly vulnerable to climate change.*

Understanding pressures and drivers on biodiversity and implementing appropriate management will help maintain status of species and ecosystems, reduce the impact of invasive species and the especially synergistic effects of climate change.

- Recognize synergies between human health and sustainable use of biodiversity (e.g. moderate consumption of meat)

STRATEGIC GOAL C: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity. *This goal includes targets for protected areas, and for conservation of wild and domesticated species.*

Implementing this goal will ensure wild stocks of species used in traditional medicines will be maintained, ecosystem function over wide areas will be ensured, and the stress relief afforded by natural spaces enhanced.

- Recognize contribution of genetic resources and traditional knowledge to medicine
- Recognize and monitor impacts of drug accumulation (human, veterinary and agricultural sources) on ecosystems.

STRATEGIC GOAL D: Enhance the benefits to all from biodiversity and ecosystems. *This goal includes targets for maintaining and restoring ecosystem services, and for benefit sharing.*

Human health will benefit from implementation of better efforts for restoration and management of ecosystems, as well as the development of better and more equitable ways to share benefits of biodiversity.

STRATEGIC GOAL E: Enhance implementation through participatory planning, knowledge management and capacity building. *This goal includes targets for national strategies, participation of indigenous and local communities, improving knowledge, technologies, and mobilisation of financial resources.*

This goal is all about implementation, but emphasising the need for local level participation, as in the ecosystem approach. Local implementation will help translate biodiversity management and conservation to promoting better health outcomes. The establishment of the [Intergovernmental Platform for Biodiversity and Ecosystem Services \(IPBES\)](#) will potentially provide great improvements to the availability and quality of knowledge at global and regional scales.

WHAT IS BIOLOGICAL DIVERSITY (BIODIVERSITY)?

Biodiversity is a term first coined in 1986, and elaborated extensively by the US Office of Technological Assessments in 1988. It formed the basis of the Convention which was signed into effect at the WCED meeting 1992. However, it is a concept that is frequently misunderstood, or misrepresented. The commonest fault is that it is used simply as another term for the diversity or richness of species. In fact the power of the biodiversity concept is that it links the hierarchy of diversity from genes, through species, populations, communities, ecosystems, landscapes and seascapes. It covers all life on earth, and that includes people!!

Then CBD has a very clear definition, which is:

"Biological diversity (or biodiversity)" means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

This is the sense in which we use biodiversity throughout the guide.

Genetic level of biodiversity

Much of the work on health and biodiversity has concentrated on the species and ecosystem levels. But understanding the role of genetic biodiversity (variation of

genes within a species) in human health issues is important from a number of viewpoints. With the development of new tools and techniques, scientists are able to investigate and understand the genetic level of biodiversity more thoroughly than ever. Understanding genetic diversity is critical to making best use of ethnobotanical knowledge as it relates to medicinal purposes. The newly adopted *Nagoya Protocol on access to genetic resources and the fair and equitable sharing of benefits arising from their utilization* provides incentives for research on the genetic diversity by creating greater legal certainty and ensuring benefit-sharing for users and providers of genetic resources. The Protocol also creates incentives to conserve and sustainably use genetic resources and therefore has the potential to enhance the contribution of biodiversity to human well-being.

Sarukhán, J. *et al.* 2010 make the point well:

“Knowledge about genetic structure and diversity of populations has important applications, not only in the conservation of species and ecosystems and in restoration projects, but also in public health, agriculture, livestock production, fisheries and forestry sustainability and productivity, the domestication of organisms, and biomedicine. Consequently, there must be a close relationship between the development and supply of genetically modified organisms (GMOs) and the assessment of their potential risks. This requires a case by case analysis considering three crucial factors: the environment, human health and socioeconomic activity.”

The issue of GMO's is a complex one and beyond the remit of this guide, but there are undoubted health risks, as well as benefits, from their use. Careful and cautious approaches to GMO's are therefore advisable.

What sorts of organisms are important for human health?

For most people the biodiversity they encounter daily are some of the other life-forms with which we share the planet, the plants and animals we see on the way to work, in our gardens, and in the landscapes we travel through. A summary of the main groups of organisms we share the planet with is in the box below:

<p>Archaea Domain</p> <ul style="list-style-type: none"> • Archaeobacteria Kingdom (ancient bacteria)
<p>Bacteria Domain</p> <ul style="list-style-type: none"> • Eubacteria Kingdom (modern bacteria)
<p>Eukarya Domain</p> <ul style="list-style-type: none"> • Protista Kingdom (single-celled organisms) • Fungi Kingdom (fungi) • Plantae Kingdom (plants) • Animalia Kingdom (animals)

For many decades the world of organisms was split into animals, plants (including fungi) and bacteria. There was also a group of “organisms” called viruses, which many believed to be non-living.

In the last two decades however enormous advances have been made into the complex relationships between the living creatures of the biosphere, using the new techniques available through genetic analysis. Current knowledge would have it that there are 3 domains of life.

A glance shows that all of the complexity to our eyes, (plants, animals, fungi) is in one domain, and that a fourth kingdom, the Protista, exists within our domain. The other two domains are “bacteria” but the complexity of life in these domains is as great as the variations of plants, animals and fungi!

From a disease point of view the bacteria domain is crucial – since many of the infectious diseases are caused by organisms from this domain. The Archaea also used to be part of the bacteria domain, but we now know them as very ancient organisms, certainly bacteria sized, but living in extreme environments and mostly not crossing the path of people! Other organisms which are of disease potential are found in the Protista kingdom, which contains the malarial parasite, dysentery amoebae and many other parasites.

Fungi can be inconvenient to us, and sometimes fatal. This is largely because fungi prefer acidic environments in which to grow and develop, so they tend to favour plants, as our “insides” tends to be slightly alkaline. None-the-less, in certain parts of the world, fungal diseases do pose a health threat to people and animals. Fungi also, of course, produce substances which are fatal to bacteria – antibiotics – which have moved from being extracted from fungi grown in fermentation vessels to synthetically produced compounds. Bacteria are also excellent at quickly changing their genetic structure to avoid chemical attack, and that is why the antibiotic industry is now in somewhat of a crisis mode.

Animals have many species which act as vectors for bacteria, viruses and for protists, chiefly insects, ticks and round worms. Flat worms are themselves gut parasites which can cause severe disease in affected individuals. And then there are animals and plants which are venomous i.e. administer a poison through bite or sting which can sometimes be fatal and is often very painful, or causes a secondary rash. Then, there are the viruses – where do they fit? They are perhaps now worse even than bacteria for causing loss of human life in pan- or epidemics. Many authors are now advocating that viruses should be seen as a form of “stripped down” life having lost most functions except to reproduce, using mechanisms and chemicals from the host. And that as such they should be seen perhaps to constitute a fourth domain of life.

Finally, diseases are not restricted to people. Passage of disease to people through another vertebrate animal, across a species boundary, is called a zoonosis. WHO and the World Organisation for Animal Health (OIE) identify over 200 zoonoses. In fact, of the more than 1400 known infectious pathogens of humans, roughly 60% are shared with animals. Organisms causing disease are not just bacteria or viruses; they can be parasites, fungi, and agents of uncertain provenance, including prions, which cause some nervous system diseases such as Bovine Spongiform Encephalopathy and Kuru. The term "prions" refers to abnormal, pathogenic agents that are transmissible and are able to induce abnormal folding of specific normal cellular proteins called prion proteins that are found most abundantly in the brain. This is an area of medical science which has many unanswered open questions, but the appearance of these diseases has become more obvious during the last decades.

Many people think of biodiversity as tigers and tropical forest trees, and little else; yet the brief sketch above shows that *diversity* is indeed the correct term, and the rich panoply of life is both delightful and also sometimes dangerous!! Knowing just which are the delightful or the dangerous is important for health professionals and for biodiversity specialists.

Ecosystem services

Following the MA the concept of ecosystem services has become widely accepted in policy discussions on biodiversity. Ecosystem services are derived from the interactions between biodiversity and the abiotic environment, and, in turn, these services produce goods and benefits for people and other ecosystems, which in turn are able to be valued economically.

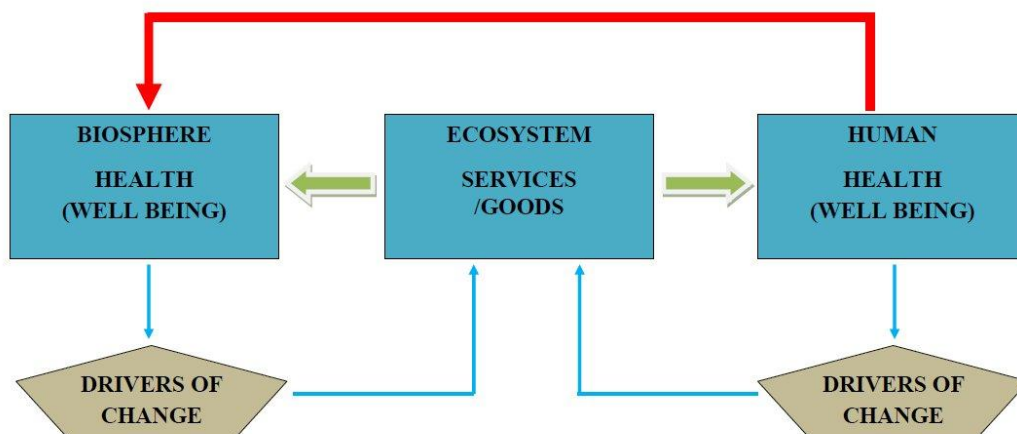


Figure 1. Links between ecosystem health, human health, ecosystem services and drivers of change that influence ecosystem service delivery.

Human intervention can cause drivers of change to change the mix of services available (or even to lose them altogether) through feedback processes, captured in Figure 1. Human activity can also directly affect the health of the biosphere.

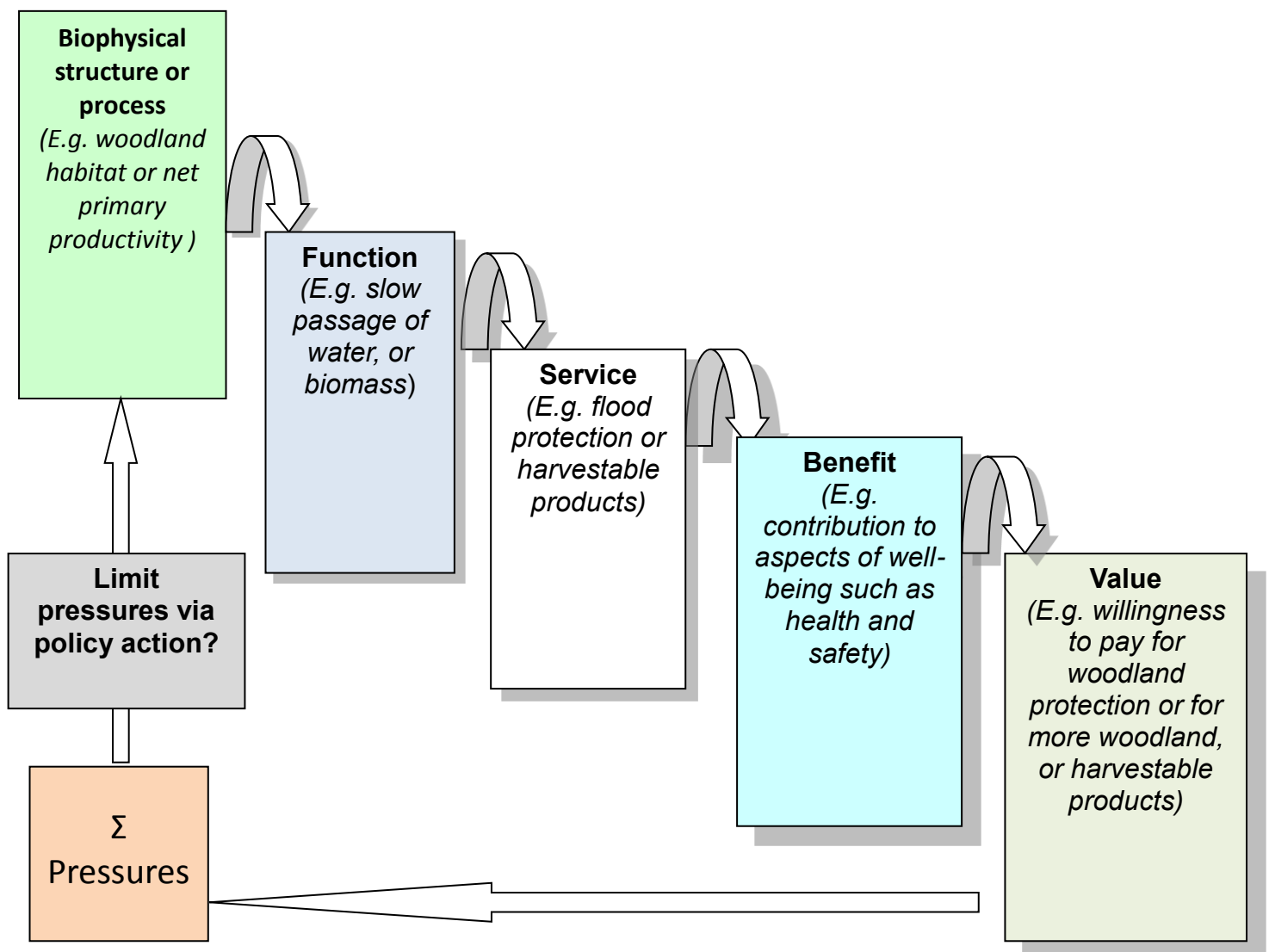


Figure 2. The relationship between biodiversity, ecosystem function and human well-being: links and feedbacks between biodiversity at ecosystem level, ecosystem functions, services and benefits.

(Reproduced with permission from Potschin and Haines-Young, 2011)

Policy development in human and ecosystem health needs thus to focus on managing the impact of the pressures, or drivers, of change, and shown in Figure 2, and explored in depth in the MA Synthesis on Health and Biodiversity (MA, 2005). Those ecosystem services and the goods they produce have considerable impact on human health in a positive way. If they are absent there are negative impacts on people's health, and such negative impacts should be limited by appropriate policy.

SCIENCE, HEALTH AND BIODIVERSITY

Both health and biodiversity are underpinned by scientific effort; without such effort there can be little advancement in either area. Just as importantly, both have components of cultural tradition and traditional knowledge which informs our understanding of the subjects, and how we as a species deal with them. One of the challenges is to ensure both conventional science and other forms of knowledge are accessible and useable in managing, and designing future strategies for, health and biodiversity (see also the Healthy country example [page 45.](#)). The IPBES has a clear goal of bringing together these mutual reservoirs of human knowledge, and, as its work programme develops over the coming years, will doubtless help human understanding of the links between health and biodiversity.

On science particularly, the [International Council on Science \(ICSU\)](#), published [five grand challenges for Earth system science](#) in October 2010 – observing, responding, confining, innovating and forecasting. These challenges, while each complete in themselves, are also highly interconnected, making the need for inter and transdisciplinary research efforts vital. Under each of the challenges they noted a series of priority research questions for the sciences, including health science. The following key and open questions are of particular relevance to professionals or academics wishing to explore the links between biodiversity and health:

1. Forecasting:

- 1.1 What significant environmental changes are likely to result from human actions? How would those changes affect human well-being, and how are people likely to respond?
- 1.2 What threats do global environmental changes pose for vulnerable communities and groups and what responses could be most effective in reducing harm to those communities?

2. Observing:

- 2.1 What do we need to observe in coupled social-environmental systems, and at what scales, in order to respond to, adapt to, and influence global change?

3. Confining:

- 3.1 Which aspects of the coupled social-environmental system pose significant risks of positive feedback with harmful consequences?

4. Responding:

- 4.1 What institutions and organizational structures are effective in balancing the trade-offs inherent in social-environmental systems at and across local, regional and global scales and how can they be achieved?
- 4.3 What changes in behaviour or lifestyle, if adopted by multiple societies, would contribute most to improving global sustainability, in the context of global environmental change, and how could they be achieved?
- 4.5 How can the need to curb global environmental change be integrated with the demands of other inter-connected global policy challenges, particularly those related to poverty, conflict, justice and human security?

5 Innovating:

5.2 Sectoral needs for innovation and evaluation:

- b. How can competing demands for scarce land and water be met over the next half century while dramatically reducing land-use greenhouse gas emissions, protecting biodiversity, and maintaining or enhancing other ecosystem services?
- c. How can ecosystem services meet the needs for improving the lives of the world's poorest peoples and those of developing regions (such as safe drinking water and waste disposal, food security and increased energy use) within a framework of global sustainability?
- d. What changes in communication patterns are needed to increase feedback and learning processes to increase the capacity of citizens and officials?

The developing [Future Earth](#) global research programme will be addressing these questions among others and developing research frameworks to provide coherent answers. It will be important that both health and biodiversity professionals ensure their research and information needs are met from this exercise.

In particular the DIVERSITAS programme has a particular ecoHEALTH project, which is undertaking collaborative research efforts on many of these questions. There are several sites of interest from this collaboration which you can find on [ecoHEALTH](#) main website, as well as on the following web pages of DIVERSITAS: [Biodiversity and Emerging Diseases](#); [Economics of Emerging Diseases](#); and [Surveillance of Emerging Diseases](#).

BIODIVERSITY, CULTURAL DIVERSITY AND HEALTH

Drugs from species –the theory and the reality

The TEEB report has the following note on this issue:

“Despite the enormous health benefits, plants are disappearing fast and will continue to do so unless urgent action is taken. The 2007 [International Union for Conservation of Nature](#) (IUCN) Red List of Threatened Species identified a significant increase in species under threat during this decade. It estimates that 70% of the world’s plants are in jeopardy (IUCN 2008). A recent global study reveals that hundreds of medicinal plant species, whose naturally occurring chemicals make up the basis of over 50% of all prescription drugs, are threatened with extinction. This prompted experts to call for action to “secure the future of global healthcare”.

People have lived with and understood the medicinal value of certain plants for millennia and plant biodiversity has helped thus our understanding of human disease and health. [Plant biodiversity](#) provides huge health benefits, and thus economic benefits. The corollary is that losing biodiversity incurs potentially huge costs. Significant direct links between biodiversity and healthcare are:

- Approximately half of synthetic drugs have a natural origin, including 10 of the 25 highest selling drugs in the United States of America.
- Of all the anti-cancer drugs available, 42% are natural and 34% semi-natural.
- Three quarters of the world’s population depend on natural traditional remedies.
- The turnover for drugs derived from genetic resources was between US\$ 75 billion and US\$ 150 billion in the United States of America in 1997.
- The ginkgo tree (*Ginkgo biloba*) provides substances which are highly effective against cardiovascular diseases, accounting for a turnover of US\$ 360 million per year. It is also a successful street tree in highly polluted urban environments, especially in Asia – a veritable cornucopia of health benefits.

Indigenous uses of biodiversity for healthy life styles

Every region has had, or continues to have, a form of traditional medicine. Referring to traditional medicine means it is deeply rooted in a specific socio-cultural context, varying from one community, country or region to another. Every community has its own approach to health and disease particularly regarding perceptions of diseases and therapeutic behaviour, which gives traditional medicine its diverse nature. According to the WHO, less than 15% of the population in developing countries utilise Western medicine. Most of those populations rely on traditional sources of products from (mainly) plants and animals in the wild. In spite of past marginalisation of traditional medicine, it is now much more widely accepted.

Loss of indigenous, traditional or local knowledge (TK or LK) through the displacement of indigenous cultures, land use change and migration of rural populations to urban centres pose thus a significant threat to people's health and well-being through loss of knowledge and experience. Traditional medicines continue to play an essential role in health care, and are estimated to be used by 60% of the world's population – and not just in developing countries. Medicinal plant use is the most common medication tool in traditional medicine and complementary medicine worldwide. Medicinal plants are supplied through collection from wild populations and cultivation.

Many communities rely on natural products collected from ecosystems for medicinal and cultural purposes, in addition to food – and some rely on earnings from local and wider sale of such products. Although industrially produced medicines are available for many purposes, the need and demand for natural products persists for use as medicinal products. Biomedical research relies on improving understanding links between human physiology and biodiversity to treat human disease in a more effective way.

WHO facilitated a Congress on [Traditional Medicine](#), held in Beijing in 2008 and developed a declaration which was designed to promote the safe and effective use of traditional medicine and to assist countries in taking steps to integrate traditional medicine (also known as complementary or alternative medicine) into their systems of national health care.

Traditional Chinese medicine

Traditional Chinese medicine covers a broad range of medicine practices sharing common theoretical concepts which have been developed in China based on a tradition of more than 5,000 years. As with the Ayurvedic system from India/Nepal Chinese traditional medicine includes various forms of herbal medicine, acupuncture, massage, exercise (qigong, taiji etc.) and dietary therapy.

Originating in ancient China, and introduced to Japan, Korea, and other Asian countries during the last millennium, the modern Chinese pharmacopoeia now includes nearly 6,000 medicinal substances, and has evolved as a complete health maintenance system..

The Korean pharmacopoeia has 506 medicinal components with nearly 450 being identical to counterparts in Chinese traditional medicine. Japanese Emperors sent envoys to visit China many times in the period AD 600-900. They returned with technology, culture and especially Chinese traditional medicine. The combination of Chinese traditional medicine and Japanese culture produced modern Japanese and Korean traditional medicine practices. Japan and Korea remain the most important export markets for components of Chinese traditional medicine.

Chinese traditional medicine is influential in keeping people healthy and free from illness. Yet many resources for Chinese traditional medicine are now under threat from overharvesting. Recent studies show demand for medicinal materials from the wild can lead to local extinction of vulnerable species in just a few years. More than 60% of recorded endangered species in China are used for medicinal purposes.

One example is the case of [Rhizoma paridis](#).

Rhizoma paridis is distributed primarily in Sichuan and Yunnan in Southwest China, and is a local term referring to the roots and rhizomes of *Paris polyphylla* var. *yunnanensis*, widely used in Chinese traditional medicine as a treatment against tumours for millennia. However, because of the new demands for treatment of diseases such as cancer, this species is under increasing pressure. Daping village in Sichuan province is a key production area of **Rhizoma paridis**.

Since 1980, villagers have built a business harvesting and selling this species. According to historical records, the price of **Rhizoma paridis** was initially about \$0.3 per kg. The price increased progressively over the following years until in 2003, when Severe Acute Respiratory Syndrome (SARS) erupted. **Rhizoma paridis** had a strong antiviral effect which ameliorated the effects of SARS, causing a surge in demand, and also in price to \$60 -80 per kg. While many *Paris* populations are still extant unless proper management is put in place local extinction is certain

Source: Chen Binghao, (1993).



Chinese medicines are available everywhere – here signs in Montréal's Chinatown.

Although TK/LK is normally associated with developing countries, it is not so restricted. In Europe for example, there is a considerable reservoir of local and traditional knowledge on these matters in the wider countryside. A case in point is the recent study by Carvalho and Frazão-Moreira (2011) of two natural parks in Trás-os-Montes, Portugal. The importance of local knowledge and of local communities'

participation in protected areas design, management and maintenance confirms that LK provides new insights and opportunities for sustainable and multi-purpose use of resources (including for wild food and medicines) and offers contemporary strategies for preserving cultural and biodiversity.

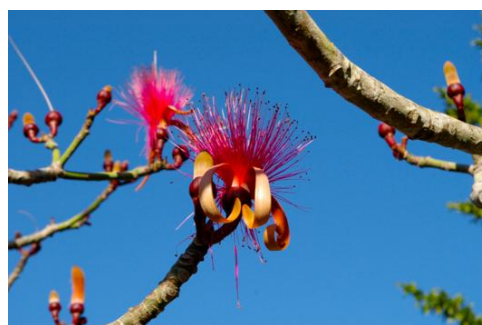
The Bolivian Pharmacopoeia

Recent work in Bolivia has identified 258 traditional medicine uses, used for a total of 13 disease categories and drawing on nearly 100 native (and non-native introduced) plant species. Gastrointestinal disorders (55%) were most frequently treated with medicinal plants, followed by afflictions of the musculoskeletal system (25%) and dermatological disorders (24%).

Hospitals also use medicinal plants, because generic drugs are often too expensive for hospitals, let alone individuals to use. Information indicates that the most common diseases treated in hospitals with natural preparations are acute respiratory infections (47%) and acute diarrheal disease (37%). Herbal remedies are mostly used in the form of teas and infusions – which is a related theme across the world for the use of medicinal plants. While native plants form the base of the pharmacopoeia, introduced species have been introduced into general use in recent years.

Source: Quiroga *et al.* (2012)

Traditional African medicine takes a holistic approach, with good health, disease, success or misfortune not seen as chance occurrences but arising from the actions of individuals and ancestral spirits according to the balance or imbalance between the individual and the social environment. Historically,



rural African communities have relied upon the spiritual and practical skills of traditional medicinal practitioners, whose botanical knowledge is much valued; and whose skills are much more available to village inhabitants than conventional medicinal practice. Throughout Africa, gathering of medicinal plants was traditionally restricted to such medicinal practitioners or their trainees. Knowledge of the distribution and biology of many species was limited to the traditional practitioners, through spiritual and ritual controls.

The same applies to Australia, where Australian Aboriginal people have a long history of living in harmony with their land, and using plants for medicinal reasons. Across Australia, from the temperate regions of south-western and south-eastern Australia to the tropical north and the arid lands in between, Aboriginal people have been using plants for medicine – varying according to the type of plants and the health issues presented. But irrespective of the actual plants used, and like African communities, medicinal plant use is really part of a holistic approach to land use. In fact recent Australian programmes designed to support activities of the Aboriginal people in remote areas have a “healthy country” focus, described in more detail in the section the ecosystem approach.

Ayurveda medicine

In northern India, medicinal properties of plant species have made an outstanding contribution in the origin and evolution of many traditional herbal therapies. These traditional knowledge systems are disappearing due to a lack of recorded material and poor knowledge transmission. Over the past few years, however, medicinal plants have regained a wide recognition due to an escalating faith in herbal medicine, often because of fewer side effects compared to generic drugs – not to mention the cost factor. Northern India has a rich diversity of valuable medicinal plants, and attempts are being made at different levels for sustainable utilization of this resource in order to develop the medicinal plants sector.

In far-west Nepal medicinal plant species have long been used as principal ingredients of traditional medicine, especially in Ayurveda. Herbal medicines in far-west Nepal are the basis of treatment of most illnesses and are made available *via* ancient, natural health care practices such as tribal lore, home herbal remedy, and the *Baidhya*, *Ayurveda* and *Amchi* systems.

Traditional herbal medicine has not only survived but also thrived in the trans-cultural environment with its intermixture of ethnic traditions and beliefs. A recent assessment by showed that traditional herbal medicine is flourishing in rural areas where modern medicine is difficult of access, because of the high cost of drugs and long travel time to health centres. Common species used in traditional health care are: *Acacia catechu* for colds and coughs, *Aconitum spicatum* as an analgesic, *Andrographis paniculata* and *Azadirachta indica* for fever, *Anisomeles indica* for urinary infections, *Taxus wallichiana* for tumour control (which resonates with the work done on Taxol in the US) , and *Tinospora sinensis* for diabetes.

Source: Kala *et al.* (2006) and Kunwar *et al.* (2010)

Unforeseen consequences: the Luehdorfia butterfly

Over-exploitation of medicinal plants not only leads to the extinction of medicinal plants themselves, but also triggers extinction effects of related or dependant species [the Chinese Luehdorfia butterfly](#) (*Luehdorfia chinensis*) is a relevant example. This butterfly species lays eggs only on one food plant for its caterpillars to feed on - Du Heng (*Asarum forbesii*). Here the butterfly competes with medicinal plant gatherers, since *Asarum* is a highly regarded medicinal plant for treating poor circulation of the blood. In 2011, the Chinese Research Academy of Environmental Sciences surveyed the population of both Du Heng and Chinese Luehdorfia butterfly. Results showed that from 1990 to 2010, due to over-exploitation, both populations decreased more than 90%. A number of other, examples of links between butterfly species and their caterpillar stage food plants have been reported.

Another consequence is [ecosystem damage](#). *Cordyceps sinensis* is a fungus which infects caterpillars, and then grows in them as they are hibernating underground, and kills them. It is particularly common in the open grassy ecosystems of the High plateaus in western china. Over-exploitation of this species by excavation, leaving small open holes in the soil fabric, has already resulted in damage to plateau ecosystems, as well as reducing the potential of the fungus to spread its spores around to infect new caterpillars. This means not only disturbing plant growth, but also causing loss of soil and water. One study showed that after 40 years, excavation holes are not only still open, they become larger. The thousands of holes left on the plateau have thus the possibility to cause soil erosion.

Source: Bao Zenghai, Liang Peiqiong.

Sustainable harvesting and management

But there are also examples of sustainable use of medicinal material. Seahorses (*Hippocampus* spp.) are globally exploited for use as medicines. They are considered beneficial for some sexual dysfunction conditions and are taken as powerful broad-spectrum tonics. Normally seahorses are combined with other plant or animal material before use. Seahorses are consumed by over twenty countries, including China , Vietnam, Japan, and Thailand . The number of wild seahorses has decreased dramatically in recent decades both because of habitat loss (seagrass meadows), overfishing, but also due to increase in direct harvest. Current demand for seahorse cannot be met by harvesting wild stock. One option, which seemed initially far-fetched, was aquaculture, through captive breeding and sea ranching to reduce pressure on wild seahorses. This culturing approach has, to some extent been successful and mitigates pressure on wild seahorse, slowing the extinction trends of wild seahorse.

Source: Koldewey and Martin-Smith (2010).

Another example is that of *Eucommia ulmoides*, where a small plantation of trees has been established near Xiangfan in the middle Yangtze valley to harvest leaves and bark for traditional preparations (*pers. comm.*). This kind of effort can help protect remaining wild populations, and provide for sustainable production.

Misuse of biodiversity for spurious health reasons

While traditional medicine can contribute to people's health and many people benefit from it there are still areas of misunderstanding, even malpractice. Such misunderstandings and misinformation include:

- mis-stating functions of specific medicines;
- overstating the effect of some medicines; and
- advocating that traditional medicines cannot be substituted by synthetic compounds.

Black bear bile farming

Bear bile is a good example of the mis-use of natural products. The active therapeutic substance in bear bile is ursodeoxycholic acid (UDCA). Before the manufacture of UDCA by pharmaceutical companies, bear bile was prescribed by practitioners of traditional medicine because it contained a higher percentage of UDCA than the bile of other mammals. However, modern chemistry has made this irrelevant. Today, UDCA can be artificially synthesized, although prior to chemical synthesis, bile was produced from Bears kept in captivity. This "farming" was carried out in China, South Korea, Laos and Vietnam. But this industry not only leads to pressure on the remaining populations of Asiatic black bear, there is also an animal ethics dimension.

Bears are commonly kept in a narrow cage where they cannot move or stand upright, suffering from a variety of physical problems which include loss of hair, malnutrition, stunted growth and muscle mass loss. This industry still survives, although completely against the basic tenets of animal welfare. The cost of the "natural" product can be provided more cheaply in rural areas than the synthetic compound leading to a need for governmental intervention and cost subvention to help end the practice.

Source: Fan Zhiyong, Zang Weiping.

As another example, tiger penis is said to have important therapeutic properties - especially against erectile dysfunction. However, despite considerable research, there is no evidence to support this contention. The same is true of Rhinoceros horn. People in parts of southeast China also consume tiger penis because of a belief that is

would enhance sexual prowess, not even to solve a physical problem. The function of tiger penis has been mis-stated by the traditional concept that people can benefit their own organs by consuming equivalents organs from large, vigorous wild animals. Of course all tiger and Rhinoceros species are in considerable danger of extinction, and as much of the trade in these products is illegal under the Convention on International trade in Endangered Species of Wild flora and fauna (CITES), most product is taken from animals killed by poaching.

Plant species as a source of synthesised medicines

There are numerous examples of medicines provided by wild plants that are significant in addressing health factors relevant to the MDGs. Perhaps the most famous drug has a rather complex history though – this is the drug Taxol and its now many synthetic and semi-synthetic derivatives. In the 1950's and 60's the US National Cancer Institute commissioned the United States Department of Agriculture (USDA) botanists to collect samples from about 1000 plant species per year for testing, especially seeking anti-cancer drugs. In 1962, the drug Taxol was discovered from the bark of *Taxus brevifolia*, a tree of the North American pacific north-west forests, and a genus widespread across the northern boreal regions of the world. Taxol was found to be effective for inducing remission in cases of advanced ovarian cancers that were unresponsive to other forms of chemotherapy. It also has significant therapeutic benefits for other advanced malignancies, such as lung cancer, malignant melanomas, lymphomas, and metastatic breast cancer.

Until the early 1990's most of the drug production (chiefly by Bristol-Meyers Squibb - a pharmaceutical company) was derived from bark from the Pacific yew and this harvesting actually destroys the tree – causing increasing controversy over the use of wild material for conversion to drugs. This was compounded by the fact that the forest source was also the subject of controversy related to logging in old growth forests, also the site of some important and endangered species. As the drug was found to be more and more effective, some European chemists attempted to develop a more sustainable production using leaves and branches harvested from a related species, *Taxus baccata*. However, by 1993, the drug and related compounds began to be manufactured by propagating *Taxus* cells in large fermentation tanks. Coincidentally, Taxol was discovered to be produced by a wide range of endophytic fungi (living in the bark of *Taxus*), opening the possibility of easier Taxol production by culturing one these fungal species. All this led to a search for more compounds related to Taxol, a process which continues. Taxol derived drugs now play an important role in chemotherapy for a number of cancers, but are now produced without threatening the viability of wild *Taxus* populations. An interesting perspective on Taxol and its history can be read in this article from the [Florida State University](#).

[Calophyllum – the elusive source](#)

The NCI also had some success with a drug Calanolide A, active against HIV-1, including strains resistant to existing drugs, which was isolated from a tree species collected in Borneo. Calanolide A, is derived from *Calophyllum lanigerum var austrocoriaceum*, an exceedingly rare member of the Guttiferae or mangosteen family. Samples of *Calophyllum lanigerum var austrocoriaceum* were first collected in 1987 on an NCI-sponsored expedition to the Malaysian part of the island of Borneo. Once it was determined that *Calophyllum lanigerum var austrocoriaceum* showed activity against HIV, researchers returned to the original forest near Lundu (Sarawak, Malaysia) to gather more plant matter for isolating the active compound. But the tree was gone -- likely felled by locals for fuel-wood or building material.

The disappearances of the tree lead to a frantic search by botanists for further specimens. Eventually some were discovered in the Singapore Botanic Garden which had several plants collected by the British over 100 years earlier, but none were located in the wild. A disadvantage of obtaining the drug from plant material is that there is only a low level of Calanolide A in *Calophyllum lanigerum var austrocoriaceum* (in fact only 0.05% can be extracted from the twigs and leaves). A drug Company, MediChem Research, Inc., has since developed and patented a process for the total synthesis of (+)-Calanolide A. A related species of *Calophyllum*, *Calophyllum teysmannii var. inophylloide*, produces a compound (Costatolide) that also exhibits activity against HIV. Costatolide, is recovered from the latex, which can be "tapped" like rubber, thus sparing the tree.

Source: Hanna, L. (1999)

Key messages:

- ✓ For most of the population in developing countries, traditional medicine is a known, reliable and inexpensive choice for the cure of their illnesses.
- ✓ To maintain availability of traditional medicine knowledge needs to be kept alive and passed on, and landscape quality maintained.
- ✓ It is critical to ensure the people who are knowledge keepers are active participants in protected area management processes, and for Park Managers to not simply integrate and “peer review” LK and expertise.
- ✓ Harvesting of sources for traditional medicines should not cause ecosystem damage, and should leave the area in an intact or restored state.
- ✓ Where components are from rare, threatened or endangered species populations a balance between use for medicine and mechanisms to maintain wild populations must be struck.
- ✓ Where it is possible to bring species into cultivation, this should be pursued.
- ✓ Where animals are source of products these should be harvested sustainably, in accordance with Addis Ababa principles, or farmed/ranched, and always in accordance with ethical standards of behaviour.
- ✓ Sensitive and managed approaches to traditional collecting grounds made off-limits by inclusion in protected areas should be developed
- ✓ Where possible scientific evidence should be sought to support the efficacy of traditional medicines. Where composition and chemical structure of the active compounds in traditional medicine is known, efforts should be made produce it through chemical synthesis.
- ✓ Although the Beijing Declaration of 2008 was global in scope, as it promotes the safe and effective use of traditional medicine Chinese traditional medicine especially can be further developed effectively and sustainably within its framework, without damaging biodiversity.
- ✓ In arid and semi-arid lands, gathering traditional medicines means health, biodiversity and desertification come together and offers scope for cooperation with the UN Convention on Combatting Desertification (UNCCD).
- ✓ Reinforce medicinal plant use as part of a holistic approach to land use, working with holders of local and traditional knowledge to develop a “healthy country” focus

HUMAN - WILDLIFE INTERACTION

Bad bug, good bug

The US National Institute of Health (NIH) is funding a large [Human Microbiome Project](#), an effort to uncover the scale and diversity of the microbes we carry within and on our bodies. The project is also analysing microbial genomes to provide tools to aid future researchers. Scientists working on the project found that people carry some 100 trillion bacteria from nearly 1,000 species, many of which, though known to cause disease, were found living non-threateningly among people sampled. Composition and activity of the gut flora and fauna develops with the person from birth and its development is subject to a range of factors that depend on the person's genome, nutrition, and life-style. Knowing how microbes interact with our bodies in ways that both promote health and cause illness could revolutionize how we understand and treat disease.

In the “ambiguous” basket, a bacterium, *Helicobacter pylori*, resident in the human stomach and causing chronic disease (peptic ulcer and gastric cancer) has another side. Recent work has shown that *H. pylori* is one of a number of bacteria that live in the stomach, although *H. pylori* dominates this community. *H. pylori* does not behave as a classical bacterial pathogen: the disease it causes is not solely through toxins, although certain *H. pylori* genes, including those that enable toxin production, increase the risk of disease development. Instead, disease caused by *H. pylori* seems to result from a complex interaction between the bacterium, the host, and the environment.

Studies of genetic diversity in strains isolated from various locations across the globe show that *H. pylori* has co-evolved with people throughout our history. This long association has given rise not only to disease, but also to possible protective effects, particularly with respect to diseases of the oesophagus. The story of *H. pylori* should make us look more deeply at the human microbiome (our internal microbial ecosystem) we all carry, and the complexity of its interactions, to gain a better understanding of health and disease.

Biting insects – problem solved or worsening?

How pathogens and ecosystem dynamics interact

Karesh et al. (2012) write in *The Lancet*: “The transmission of pathogens into human populations from other species is a natural product of our relationship with animals and the environment. The emergence of zoonoses, both recent and historical, can be considered a logical consequence of pathogen ecology and evolution, as microbes exploit new niches and adapt to new hosts. The underlying causes that create or provide access to these new niches appear to be in most cases human-mediated and include land use changes, natural resource extraction, animal production systems,

rapid transportation, antimicrobial drug use and global trade. While the underlying ecological principles that shape how these pathogens survive and change have not deviated from nature, humans have altered the environment in which these principles operate. Domestication of animals, clearing land for farming and grazing, and the hunting of wildlife in new habitats, has resulted in zoonotic human infection with micro-organisms such as rabies, echinococcosis, and the progenitors of measles and smallpox that had historically affected only animal populations by altering contact and increasing transmission opportunities among animals and people". This sets the scene for the following examples.

River blindness

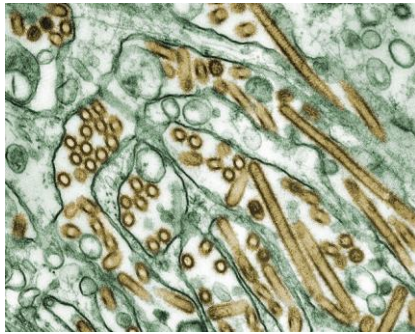
River blindness is a devastating eye-disease that affects more than 17 million people worldwide, with Black Flies (*Simulium*) as the vector. A particular threat in sub-Saharan Africa, river blindness is a disease caused initially by a nematode infection. Blindness is not caused by nematodes themselves, but a bacterium parasitic in them, *Wolbachia*, which is one of the biosphere's most common parasitic bacteria. When the nematode dies it releases the *Wolbachia*, triggering an inflammatory response in the infected person, causing changes in the skin and chronic inflammation. Eventually, the *Wolbachia* migrate out through the eyes, causing the cornea and lens to cloud, leaving infected people blind.

It appears the saliva of adult female black flies contains substances (complex proteins) that mute the human body's natural defences. These substances make the body more vulnerable to nematode infection and subsequent disease when infected flies bite into the skin. Another species of *Wolbachia* has been implicated in causing elephantiasis, but *Wolbachia* is also known to help in the control of dengue and malaria by eliminating older mosquitoes that contain more parasites. This story shows the levels of complexity and interaction possible between species, people, disease and health

Source: Tsujimoto, 2012.

H5N1 – a story in progress

Avian Flu, to give the virus H5N1 its popular title, burst onto the world with all its attendant hysteria and created a mass of muddle-headed reaction. Fear from unknown diseases which sound potentially life threatening to western city inhabitants is a driving motive for all kinds of knee-jerk demands for environmental management; resulting in this case in enormous culling of domestic bird stocks, attempts to drain wetlands, and threats to cull migratory birds – all on flimsy evidence(see, inter alia, Horovitz *et al.* 2012). In the wake of the H5N1 crisis the Ramsar Convention Conference of the Parties in 2005, for the first time in the Conventions' history, adopted a simple [resolution](#) which attempted to provide advice to wetland managers, biodiversity specialists and health specialists.



H5N1 under the microscope

Some conclusions from work of the Ramsar Convention and its scientific bodies suggest that reducing the number of long-distance migrations – e.g. changes to habitats and weather conditions may encourage birds to remain at one site instead of undertaking traditional migrations. In China rising temperatures causing increased glacial runoff into nearby wetlands is a possible reason why unusually large numbers of geese are remaining at Qinghai Lake over winter instead of migrating to India. This also offers longer opportunity for transmission of disease from wild birds to flocks of domestic birds. Qinghai Lake was reputedly the global source for H5N1 transmission.

Bushmeat

Infected bushmeat is a source for the HIV/AIDS pandemic and repeated outbreaks of Ebola haemorrhagic fever (see WHO website [here](#)). This has caused some to call for the cessation of the practice and trade in bushmeat. Yet the story is much more complicated. The commercial bushmeat trade is increasingly transnational. Even in remote and protected areas, commercial bushmeat hunting is often driven by markets beyond national borders – even to other continents. These markets exist in developed as well as developing countries. The CBD has developed guidelines on bushmeat ([PDF](#))



Major entry points for bushmeat exist at main airport hubs in Britain, France, Belgium and the United States. Illegally imported bushmeat involves lucrative prices and a wide range of species, many of which are CITES-listed. This smuggling

provides opportunities for introducing food-borne and tropical pathogens into novel environments as seen in the 2003 emergence of monkeypox in the United States from imported Gambian rats. Testing of illegally imported bushmeat confiscated at ports

of entry in the United States has revealed a number of viruses related to those that can infect humans (Smith et al, 2012)

Where wildlife hunting and bushmeat trade is regulated, a national strategy for disease surveillance including those transmitted by wildlife should be implemented. Appropriate public health information and capacity-building should emphasize prevention of disease and protection of both human and animal health. In regions with bushmeat trade, sanitary control and biosecurity measures are necessary to prevent the sale of tainted meat or contaminated animal products that may lead to the spread of harmful pathogens.

Leaping the species barrier – a new and growing threat

In autumn/fall 2011, over 150 young harbor seals were discovered stranded or dead on New England beaches. It appears a virus; H3N8 is likely to have caused the mortality. This virus may pose a continued threat to marine mammals along north-eastern coasts of North America. Adaptation of the H3N8 virus to mammals raises questions about whether this virus may be the latest example of an emerging infectious disease transmissible to people. This outbreak is significant because the virus has naturally acquired mutations that are known to increase transmissibility and virulence in mammals.

The National Oceanic and Atmospheric Administration (NOAA) assembled a team of scientists to investigate. Wildlife experts from the [United States Geological Survey \(USGS\) National Wildlife Health Centre](#) have isolated the virus from the tissues of the seals and were able to characterize the virus as a type of influenza virus most closely related to the influenza H3N8 viruses commonly found in wild birds. The virus found in the seals contained genetic changes that have been shown to increase mammalian infection. Monitoring the spill-over to, and adaptation of avian viruses in, mammalian species is critically important if we are to understand the factors that lead to both epizootic and zoonotic emergence. The highly pathogenic avian influenza H5N1 virus has been shown to cause disease and even death in cats, dogs and people. It is estimated that more than 70% of the emerging infectious diseases that can infect people have a wildlife origin.

Source: Antony, (2012).

West Nile and other Viruses

In summer 2012 the US city of Dallas launched an aerial insecticide spraying after 200 known cases and 10 deaths from West Nile virus. This virus appears to be on the rise – and virologists worry that this doesn't just mean more West Nile cases, but the emergence of more virulent diseases such as dengue, chikungunya and tick-borne encephalitis.

West Nile virus normally infects birds, and is carried between them by mosquitoes. In temperate regions, the number of infected birds rises steadily after mosquitoes become active in spring. By late summer, so many birds have been infected that mosquito species that bite both birds and people occasionally carry the virus from a bird to a human. Horses are also severely affected. Only one in five infected people develops any symptoms, and they are mostly flu-like.

West Nile virus was unknown in the western hemisphere until 1999, when it was identified in New York. Yet, the US [Centre's for Disease Control and Prevention](#) in Atlanta reports for the whole US around 700 cases (with 26 fatalities) at the time of writing (September 2012), the highest number since 1999, and with much earlier seasonal on-set. This "boom" could also be due to climatic factors e.g. hotter weather than average, which boosts mosquito numbers and makes the virus multiply faster. As winter normally kills off the mosquitoes that carry the virus, and 2011-2012 was a mild winter for the region more mosquitoes survived, adding to the problem.

Key messages:

- ✓ Given the complex relationship of the human microbiome with human health, eradication of organisms in people not expressing critical symptoms may not be the best course of action.
- ✓ Where disease causes relatively few deaths prevention measures such as change in human behaviour can be extremely effective and inexpensive.
- ✓ Proteins and other compounds used by vectors to assist their feeding could serve as the basis for developing drugs or vaccines against diseases.
- ✓ Ecosystem management may be able to offer better and more permanent control measures for viral vectors than large-scale spraying.
- ✓ Multidisciplinary surveillance for wildlife deaths can help in managing disease onset and spread. Reports about sick wildlife from the general public can contribute to awareness of disease onset.
- ✓ Robustness of any surveillance strategy relies on an appropriate sample size of the population. Skilled animal health personnel will be needed to determine sample sizes for wildlife, while biodiversity managers are likely to have good understanding of wild population structures and could help in the design and implementation of sampling.
- ✓ Interactions between wildlife, domestic livestock and human health need to be monitored and legislation, regulations, and enforcement need to be developed and implemented to reduce the threat of epizootics from newly emerging infections in the most "environmentally friendly" manner possible.

ECOSYSTEMS AND HEALTH

Health ecology

Considering people as part of nature, who must learn to live in balance with other species and within its ecosystems, leads to a realisation that biodiversity and human health are different aspects of this same issue. The concept of an “ecological public health” has emerged in response to a range of new health issues and risks. In effect this brings a shift in risk patterns – arising from a new set of global ecological risks. We need to have the ability to relate health of individuals to the health of ecosystems and landscapes in which they live. International legal instruments such as the CBD and other biodiversity- related conventions have a key role to play here.

A new (ecological) public health approach would move from reliance on behavioural epidemiology and surveillance to a more environmental and social approach, using an ecological paradigm as the organising framework. Links between ecosystem balance and human health are clear. Continued loss of biodiversity and subsequent reduction in the delivery of ecosystem services results in decline in health levels. Causal links between environmental change and human health are complex because often they are indirect, displaced in space and time, and dependent on a number of modifying forces. For example, many aspects of the world's hydrological (water) cycle are regulated by the natural functions of ecosystems and associated geophysical processes (such as evaporation and the functioning of the climate system).

Human intervention in the biosphere takes many forms - deforestation, afforestation, farming, irrigation, river damming and mining are a few examples. Recently, there has been an upturn in the rate of emergence or re-emergence of infectious diseases. Factors contributing substantially to this trend include: intensified human encroachment on natural environments; reductions in biodiversity (including natural predators of vector organisms); particular livestock and poultry production methods; and increased long-distance trade in wild animal species (including as food). Further contributors include: habitat alterations that lead to changes in the number of vector breeding sites or in reservoir host distribution; niche invasions or interspecies host transfers; human-induced genetic changes of disease vectors or pathogens (such as mosquito resistance to pesticides or emergence of antibiotic-resistant bacteria); and environmental contamination by infectious disease agents.

Ecosystem health

Even though there has been an [International Association for Ecology and Health](#) for over a decade, there is still considerable debate on the concept of ecosystem health. An apparently similar concept, widely used in North America (for example Parks Canada) is ecosystem integrity, and, although related, these terms are fundamentally different. Parks Canada defines ecological integrity as *“with respect to a park, a condition that is determined to be characteristic of its natural region and likely to persist,*

including abiotic components and the composition and abundance of native species and biological communities, rates of change and supporting processes. “

The Parks Canada enabling Act has ecological integrity as the first priority of National Parks of Canada. Healthy Ecosystems are typically seen in anthropic terms as: the preferred state of ecosystems, unmodified by human activity. There has been much scientific discussion on this issue and it is one which divides ecologists. One view would have it that because health and integrity are not inherent properties of ecosystems these terms should not be used.

On this point the Ramsar Convention technical report on wetlands and health (Horowitz *et al.* 2012) notes “Despite the Ramsar Convention’s text and language that centres around wise use and ecological character, the phraseology of ‘healthy wetlands’ (and healthy rivers, healthy ecosystems, healthy parks, healthy landscapes, and so on) persists in common and professional use.” Ecosystem health is often thus used, with a variety of meanings, by scientists, policy advocates, politicians, bureaucrats, and the general public – each with their own perception about what they mean!! So, in reality, as a value-based ecological concept ecosystem health is a perception- useful in general conversation, but impossible to quantify.

[Ecosystem health – a concept](#)

Healthy Waterways is a not-for-profit, non-government organisation working collaboratively in south-east Queensland, Australia, with government, industry, researchers and the community to promote healthy aquatic ecosystems. They have devised (for monitoring) a set of criteria to determine “ecosystem health” in freshwater and estuarine ecosystems, reproduced below. Taken together, these criteria are applicable to any ecosystem, and form a useful guide to determining if an ecosystem is actually “healthy” or not.

Vigour (the activity or rate of processes, e.g. slow/steady primary production)

Organisation (healthy ecosystems have a complex structure, e.g. high biodiversity, complex food webs)

Resilience (a system's capacity to maintain structure and function in the presence of stress; healthy ecosystems can recover after a disturbance, e.g. following a flood event)

Key processes operate to maintain stable and sustainable ecosystems (e.g. there is an absence of algal blooms)

Zones of human impacts do not expand or deteriorate (e.g. a reduction in the spatial extent of sewage nitrogen pollution)

Critical habitats remain intact (e.g. seagrass meadows)

Because ecosystem health and related concepts have become shorthand descriptors in political debates, they may be useful shorthand descriptors, but also may simply add confusion to an already complex mixture, and *should be used with forethought*.

National Ecosystem Assessments

Among a number of country-based ecosystem assessments which were part of, or followed the MA, the UK produced a [National Ecosystem Assessment \(NEA\)](#) in 2011. The main message from that assessment was:

“We also value the natural world, its biodiversity and its constituent ecosystems through contact with nature giving pleasure, providing recreation and having a positive impact on long-term health and happiness”.

The assessment asserted “Ecosystems provide three generic health benefits:

- First, ecosystems can have direct positive effects on the mental and physical health of individuals.
- Second, ecosystems have indirect positive effects on human health, including i) facilitating nature-based activity and social engagement (e.g. providing locations for contact with nature, or physical activity), and ii) providing a catalyst for behavioural change, encouraging the adoption of healthier lifestyles (e.g. improving life pathways, activity and behaviour, and encouraging the consumption of wild foods).
- Third, ecosystems can reduce the incidence of pollution and disease vectors, through a variety of purification and control functions, including local climate regulation, and the scavenging of air pollutants and waterborne pathogens.”

“Well-being is a broad term that is generally understood to encompass social and mental, as well as physical, aspects of the human condition. In common language it is sometimes referred to in terms of ‘*health, wealth and happiness*’. The UK NEA conceptual framework identifies three distinct types of well-being value: economic value, health value, and shared social value. Ideally all three types of wellbeing value should be considered when evaluating changes in ecosystems, the delivery of services and goods to different individuals and sectors of society, and the likely consequences of different policy interventions.”

México also developed an assessment separate from the MA process in 2009/10, which it termed [México’s Natural Capital](#)., Natural capital is a term becoming more widely used to describe the goods and services from ecosystems. The assessment noted:

“México’s natural capital offers a great potential for development and benefit generation for the entire population. Nevertheless, *historical natural resource exploitation policies have not favoured the conservation and sustainable use of biodiversity, nor human well-being*. A wide range of experiences, projects and initiatives in the transformed ecosystems across the country, has shown that a productive reconversion to agriculture and fisheries, focused on better access to markets and under criteria of sustainability, can raise income, employment

and productivity, controlling and mitigating negative effects on human health and the functionality of natural ecosystems, both aquatic and terrestrial”.

The ecosystem approach

The ecosystem approach (EA) of the CBD (Decision VII. 11 [PDF](#)) is:

“...the primary framework for action under the Convention of Biological Diversity. The ecosystem approach provides a framework within which the relationship of protected areas to the wider landscape and seascape can be understood, and the goods and services flowing from protected areas can be valued.”

The EA has 12 principles, and five guidelines to help put it into practice. The EA is, then, a coded way of “living well with nature”, and is rather more about people than it is about ecosystems. It is certainly about linking people with nature at various spatial and temporal scales and the framework against which the whole of the CBD can be realized, including full involvement of indigenous peoples.

EA’s five guiding principles, all relevant to human health and biodiversity are:

1. Focus on the functional relationships and processes within ecosystems;
2. Promote the fair and equitable access to the benefits derived from biodiversity;
3. Use adaptive management practices;
4. Carry out management actions at the scale appropriate for the issue being addressed, with decentralization to lowest level, as appropriate;
5. Ensure intersectoral co-operation.

Healthy ecosystems – an indigenous view

A recent relevant example is from the Aboriginal people from north-west Australia – the Kimberley region. They have recently concluded a “healthy country” exercise. A key aspect of this exercise was the development of a vision. In the words of the traditional owners of the country:

*Wunambal Gaambera Country is our living home - our Uunguu. Wunambal Gaambera Country and all things in it – including us, our culture and our traditions - came from our Wanjina and Wunggurr creators in the Lalai. Our Wanjina and Wunggurr Law gives us the rules and responsibility for looking after and keeping Wunambal Gaambera Country, all things in it and our culture healthy. Today there are also other ways of looking after country, using Western science and modern equipment. This plan will help us use these other ways with our traditional ways. By using both ways, we will look after our country and still make sure we follow our Law. **It is our vision that in ten years time our country will be giving us and our future generations a healthy life***

Source: Wunambal Gaambera Aboriginal Corporation (2010).

Burgess et al. (2009) have a more detailed health study on Aboriginal people in Arnhem land, Northern Territory, Australia, the key conclusion of which are: *Greater Indigenous participation in caring for country activities is associated with significantly better health. Although the causal direction of these associations requires clarification, our findings suggest that investment in caring for country may be a means to foster sustainable economic development and gains for both ecological and Indigenous peoples' health.*

For health, as for conservation, the concerns can be expressed in a continuum from species populations to earth-scapes. Although health is not mentioned as such in the EA, it is clear that its application can only be beneficial to human health and healthy ecosystems.

Drivers of ecosystem change

In order to protect human health, responses very often must involve actions outside of the health sector – particularly in agriculture, industry, urban planning, education, river basin and coastal zone management. Ecosystem changes, with an increasing risk of nonlinear changes in ecosystems, including accelerating, abrupt irreversible changes will potentially have a catastrophic effect on human health. The increased likelihood of these nonlinear changes arises, in part, from loss of biodiversity and growing pressures from multiple direct drivers of ecosystem change, including especially climate change.

Many infectious and chronic diseases are either directly or indirectly sensitive to the climate. Managing this climate sensitivity more effectively requires new working relationships between the health sector and the providers of climate data and information.

Climate, landscape and health in Ethiopia.

The Ministry of Health and the National Meteorological Agency of Ethiopia have made significant progress towards the development of a climate-informed early warning and response system for diseases such as malaria and other climate-sensitive diseases. An important enabling mechanism is a Climate and Health Working Group, which is a multi-sectoral partnership created to spearhead the use of climate information for health interventions. While this is a work in progress, the key ingredients necessary to sustain such a joint venture are designed to encourage similar activities in other countries faced with a growing climate-sensitive disease burden, which also involves understanding and monitoring landscape change and facilitating.

Source: [LINK](#)

Nutrition, Food and Water Safety

Access to a sufficiency of a nutritious variety of foods is a fundamental determinant of health. Biodiversity plays a crucial role in human nutrition through its influence on world food production, as it ensures the sustainable productivity of soils and provides the genetic resources for all crops, livestock, and marine species harvested for food. Nutrition and biodiversity are linked at ecosystem level, with food production as an ecosystem service. Other ecosystem services include natural pest management and pollination from adjacent ecosystems into agro-ecosystems



Nutritional composition between foods and among varieties/cultivars/breeds of the same food can differ dramatically, affecting micronutrient availability in the diet, which in turn can affect overall human health. So, healthy local diets, with adequate average levels of nutrients intake, come from good

management of local biodiversity.

Influences on availability of healthy local diets come from habitat destruction and degradation, exotic species invasion and climate change. Interactions between those negative impacts on food availability and the epidemiology and ecology of infectious disease are complex, yet increasingly evident. Climate change amplified by anthropogenic changes to land use and land cover has played an important role in promoting re-emergent and newly emergent disease transmission, especially in the tropics. As global trade and mobility increase, so do the risks from invasive alien species for food and timber production, infrastructure and health.

In October 2010, at the 10th meeting of the CBD, Parties to the CBD recognized in their decision X/20 the links between health, poverty and biodiversity, as well as [decision X/6](#) on biodiversity and poverty alleviation, the need to further strengthen collaboration with the WHO and with other relevant organizations to:

- investigate how implementation of the CBD Strategic Plan for Biodiversity can also support efforts to address global health issues; and
- explore avenues for bridging the gaps between work on climate change impacts on public health and impacts on biodiversity.

Collaboration is building on these issues with the [Food and Agriculture Organization \(FAO\)](#), the [World Organization for Animal Health \(OIE\)](#), the other two Rio Conventions ([United Nations Framework Convention on Climate Change \(UNFCCC\)](#) and UNCCD) and a range of other partners. Through collaboration with the scientific organizations [DIVERSITAS](#) and [Eco Health Alliance](#), provision of their scientific guidance to develop biodiversity-health activities to assist development of a global evidence base is also assured.

The CBD's cross-cutting initiative on biodiversity for food and nutrition aims to promote the sustainable use of biodiversity in programmes contributing to food



security and improved human nutrition. Efforts to link biodiversity, food and nutrition issues are expected to contribute to achieving the MDG's, in particular Target 2 of Goal 1 (i.e. to reduce by half, by 2015, the proportion of people who suffer from hunger). The initiative will thereby raise awareness of the importance of biodiversity, its conservation and sustainable use. Making more use of local

biodiversity contributes, thus, to human health directly and indirectly by ensuring much better ecosystem health.

Meat & climate change

The introduction of sharp hooved sheep and cattle to Australia in large numbers has had significant effects on the arid and semiarid ecosystems these animals range in, formerly solely the domain of the soft footed marsupials. There is an interesting argument on the intersection with climate change, based on the low levels of methane produced by kangaroo grazing, compared to cattle and sheep. The latter 2 species, through ruminant activity, account for 11% of Australia's greenhouse gas (GHG) emissions. A recent study postulated that removing 7 million cattle and 36 million sheep from Australia's rangelands, and allowing the kangaroo population to expand to 175 million would save 3% of Australia's GHG emissions. Furthermore the grazing patterns for sheep and cattle, together with their hooved feet has caused incalculable damage to the soil surface structures of Australia's arid areas. Around 20 of the mammal extinctions in Australia are due to grazing damage to native ecosystems from sheep and cattle. From the health perspective the nutritional value of kangaroo meat is better than sheep and cattle meat especially from the perspective of fat content.

Obviously, implementation of such a regime would require great cultural and social change –among rural landholders and especially conservationists/animal welfare organisations that see kangaroo culling by shooting as cruel and inhumane. By way addressing those concerns, the authors note that Bison in America, red deer in Scotland and Springbok in South Africa are now thriving on private lands integrated with agriculture. So there are ways to manage and maintain wildlife, within a changing ecosystem context. This study also highlights the complexities of our food choices – with a strong desire for meat being one of the least effective in an ecological sense, but highly desired from personal choices. Food choices can therefore have an impact on and influence the direction of ecosystem management.

Source: Wilson and Edwards, (2008)

LiveWell for life is a European Union (EU) funded project that is being implemented over the next three years by WWF and Friends of Europe, dealing biodiversity friendly and health friendly diets. A link to the project can be found [here](#)

Food diversity, health and food culture

Food is obviously a basic necessity for life, but the kind of foods we choose and have available all depend on, and are affected by biodiversity and cultural diversity. Hunter-gatherer societies had food choices determined by availability (economics), digestibility and nutrition, and there were specific roles for men and women in the hunting and gathering process. As societies became more agrarian and settled in different parts of the world, food acquired its own language and cultural connotations, in which climate, geography, pleasure, and health play a great role.

Different societies today often use key foods as a means of maintaining health in difficult climatic or geographic settings, from the mainly meat diet of the Inuit to the typically omnivorous diet elsewhere. The Mediterranean diet(with abundant use of olive oil), north European and Japanese diets featuring oily fish are examples of using local biodiversity to provide a diet which ensures – often without a clear intention - good health and longevity. City dwellers, however, become more disconnected from this reality and now over-eat meat and refined products – not only less good for health but also bad for biodiversity.

[FAO suggest \(PDF\)](#) making consumers aware of the benefits of having a sustainable diet, encompassing a high diversity of foods is the best way forward, for their own health and the health of ecosystems.

"There are already many well-established ways of improving both the sustainability of agriculture and its capacity to deliver safe, nutritious products for a healthy diet."

"Integrated pest management, conservation agriculture, ecoagriculture and organic agriculture are examples of approaches to agricultural production that improve sustainability in a variety of ways that are based on enhancing efficiencies of biological processes and agro-ecosystems, and that are being used over many millions of hectares around the world. Changing agriculture and food production in ways that ensure improved sustainability and a healthier and more nutritious food supply involve the increased use of biodiversity for food and agriculture."

"Food security encompasses the need to have access to not only sufficient energy intake but also to nutritious food that can meet dietary requirements. Agricultural biodiversity can deliver a diversified range of nutrients from local, adapted plant and animal species that perform well in low-input farming systems. The relationship between biodiversity and nutrition is highlighted in the Millennium Ecosystem Assessment itself. A further opportunity for developing comprehensive approaches to food security and sustainability comes from ensuring synergies between agricultural and nutritional policies at international, national and local scales."

“One of the outcomes of the International scientific symposium on Biodiversity and Sustainable Diets: United against Hunger, held in Rome in 2010, was a consensus on a definition of ‘sustainable diets’ - those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing use of natural and human resources.”

The role of women in food gathering

Women play a crucial role in interacting with natural resources as gatherers of medicinal plants and fuel-wood, fetchers of water, cultivators of crops, but they often not credited for being efficient local resource managers. An example is **seaweed farming on the island of Zanzibar**.

Introduced more than 20 years ago, arguments were advanced for this activity such as job creation for women and increased household income. Closer inspection however, shows another side. Seaweed farmers are largely female, and in a 2012 survey considered their health significantly poorer than non-seaweed farmers and reported issues like back pain, allergies, musculoskeletal pain, hunger, respiratory problems, eye related problems, injuries from hazardous animals and sharp shells; - problems clearly associated with poor working conditions, intensive work and long exposure to sun, wind and seawater.

Most seaweed farmers' earnings were below the absolute poverty level but a lack of stable economic activities and the abandoning of traditional activities force the women to continue. These problems are now being transmitted on to the next generation. However abolition of the seaweed farming is not necessarily the answer; more sensible are changes towards better working conditions for the farmers.

Source: Fröcklin, S., et al. (2012).

Key messages:

- ✓ Understanding resilience, tipping points, thresholds and how these concepts affect the ability of the biosphere to continue to provide ecosystem services is an increasing, but important, challenge. And more so in relation to ways in which climate change has multiplier effects on biosphere and human health.
- ✓ Future demands placed on wild living resources will require innovative strategies like the EA to help deliver effective biodiversity management, as well as to promote health and well-being.
- ✓ In developing countries sustainable use of wildlife has the potential to be applied as a strategy to create incentives to conserve species outside protected areas, using the Addis Ababa principles. In developed countries we need to find a new paradigm which makes space for all of biodiversity, including people, to live.
- ✓ Climate change amplified by anthropogenic changes to land use and land cover has played an important role in promoting re-emergent and newly emergent disease transmission, especially in the tropics.
- ✓ Where communities are particularly vulnerable, strengthened collaboration is needed to reduce the burden of climate related ill health.
- ✓ Wise use of wild and agro- biodiversity to provide good nutritional intake for communities is part of an overall health approach.
- ✓ Adopting whole of landscape approaches to biodiversity and cultural diversity management and support can improve health of indigenous communities.
- ✓ The role of women in food and other natural resource gathering and management needs better appreciation and recognition.

SPECIFIC ECOSYSTEMS

Wetlands



From the perspective of human health, wetlands (as [defined](#) by the Ramsar Convention on Wetlands) have a real identity crisis. They are often seen simply as human health hazards, with malaria, bilharzias, and a whole host of other parasitic diseases typically associated with them. Two centuries ago, the dank surroundings of lakes and, worse, swamps were enough to provoke people into believing that simply to be close to such a landscape feature was to risk catching a fever. Urban wetlands suffered especially as people were uncomfortable at living next to what was seen as a source of disease.

Water-related diseases

Water-related diseases affect over 2 billion people a year. Providing clean water and sanitation to poor communities would take pressure off their need to unwisely use wetland ecosystems, reduce waste flows and improve freshwater and coastal water quality. Many of the people and sites affected adversely by ecosystem changes are highly vulnerable - and ill-equipped to cope with further loss of ecosystem services.

But how should we react to water borne disease? Our natural reaction is to fight each disease as it appears a one to one battle. Yet over time it is clear this approach has limited successes and is costly economically and ecologically. Schistosomiasis, also known as bilharziasis, is endemic in 74 developing countries, infecting more than 200 million people. As in many areas it affects a large proportion of children, reducing its incidence is relevant to achieve MDG 4 (reducing child mortality). A case study from Lake Malawi found that overfishing resulted in the decrease of a predatory fish and subsequently in an increase in a species of snail that is the intermediate host for *Schistosomiasis haematobium*. Ironically, a practice causing biodiversity loss, and impacting the unsustainable use of biological resources seems was also the cause for an outbreak of schistosomiasis at Lake Malawi in 1992.

Source: Evers *et al.* (2006)

Recently, there has been an upturn in the rate of emergence or re-emergence of infectious diseases associated with wetlands, and those in urban fringes are especially concerned. Factors contributing substantially to this trend include

- intensified human encroachment on natural environments;
- reductions in biodiversity (including natural predators of vector organisms);
- habitat alterations that lead to changes in the number of vector breeding sites or in reservoir host distribution;
- niche invasions or interspecies host transfers;
- human-induced genetic changes of disease vectors or pathogens (such as mosquito resistance to pesticides or emergence of antibiotic-resistant bacteria); and environmental contamination by infectious disease agents.

Health and water – a new approach

The extent of communication between environmental and human health professionals has, in some instances, been excellent. The 1999 [Protocol on Water and Health](#) under the [United Nations Economic Commission for Europe's \(UNECE\) Convention on the Protection and Use of Transboundary Watercourses and International Lakes](#), can be taken as an example of success. The main aim of the Protocol is to protect human health and well-being by better water management, including the protection of water ecosystems, and by preventing, controlling and reducing water-related diseases, and it is now open to all member states of the UN.

The Protocol is the first international agreement of its kind adopted specifically to attain an adequate supply of safe drinking water and adequate sanitation for everyone, and effectively protect water used as a source of drinking water. This activity, spread more widely, will help the world achieve the MDG's, especially Goal 7. To meet these aims, its 25 Parties are required to establish national and local targets for the quality of drinking water and the quality of discharges, as well as for the performance of water supply and waste-water treatment. They are also required to reduce outbreaks and the incidence of water-related diseases.

Forests

Deforestation in tropical forests has considerably aided spread of malaria by creating and extending habitats such as stagnant pools for larval *Anopheles* mosquitoes and increasing its reproductive success. First, agriculture and human settlement bring with them novel mosquito breeding sites such as human-made stream edges, streambed pools and drainage channels at communal water supply points. Also, water accumulating in indentations and tracks left by vehicles, people and livestock acts as an ideal habitat for *Anopheles gambiae* mosquito larvae,

In fact, the degree to which *Anopheles gambiae* (the most important malaria vector) is linked with people at all stages of their lifecycle, suggests recent and human-mediated origin. Human population expansion in sub-Saharan Africa around 7,000 years ago followed by development of sedentary agriculture and associated

deforestation are likely to have intensified this specialisation. Recent genomic data provides evidence for on-going diversification of this vector species, with speciation driven by anthropogenic environmental change (White et al., 2011). Alongside this adaptation of mosquito behaviour to people has been the speciation of malaria parasites specific to people. Additionally, the production potential of non-timber forest products is considerable. Mexico is home to an estimated 3 000 to 6 000 medicinal species, on which the health of a significant percentage of the population depends, mainly those of lower income. Hundreds of non-timber products are used (leaves, fruits, seeds, bark, gum, wax, fibres, dyes, etc.), and these are obtained from 5 000 to 7 000 species present within the different ecosystems of the country.

Agriculture

[Agricultural biodiversity](#) is essential to satisfy basic human needs for food and livelihood security.

FAO has addressed the pace of [biodiversity loss and ecosystem degradation](#), coupled with emerging health issues related to diet, and believes it is urgent to address the quality of agriculture and food systems.

"Poor diets are linked to marked increases in non-communicable diseases such as diabetes and cardio-vascular diseases across the world. High-input industrial agriculture and long-distance transport have made refined carbohydrates and fats affordable and available across the globe, leading to an overall simplification of diets and reliance on a limited number of energy-rich foods. But such foods lack nutrient quality and have heavy carbon and water footprints. Cheap, energy-dense foods have also come at the cost of flavour, diversity and cultural connection. Currently just three major staples crops – corn, wheat and rice – provide 60 percent of the dietary energy from plant origin at global level, while, with rising incomes in developing economies, huge numbers of people are abandoning traditional plant-based foods in favour of diets rich in meat, dairy products, fats and sugar. "

"In Kenya, for instance, Bioversity have successfully helped reinstate a number of leafy green vegetables until recently considered as poor people's food into local diets and markets. Promotion of traditional plants, including African night shade, cowpea and pumpkin leaves, spider plant and vine spinach, has increased demand both within households and in the market. Smallholder farmers are also benefiting."

"In India, healthy cereals such as foxtail and finger millet have been reintroduced in areas where they had been abandoned due to government policies promoting cassava production for starch. Efforts are also underway to promote native Andean cereals such as quinoa and amaranth at the international level. The United Nations has declared 2013 to be the [International Year of Quinoa \(PDF\)](#)."

Agricultural biodiversity also performs ecosystem services such as soil and water conservation, maintenance of soil fertility and biota, and pollination, all of which are essential to human survival. In addition, genetic diversity of agricultural biodiversity provides species with the ability to adapt to changing environment and evolve, by increasing their tolerance to frost, high temperature, drought and water-logging, as well as their resistance to particular diseases, pests and parasites for example. This is particularly important regarding climate change. The evolution of biodiversity, and therefore both its and our survival, mainly depends on this genetic diversity.

The importance of agricultural biodiversity encompasses socio-cultural, economic and environmental elements. All domesticated crops and animals result from human management of biodiversity, which is constantly responding to new challenges to maintain and increase productivity under constantly varying conditions.

Arid lands

The need to integrate more fully the goals of conservation and ecosystem management and health ethics is especially true for arid ecosystems. Practising lower water consumption, even if there is currently apparently abundant water, is critical to maintaining water levels in the aquifers, wetlands and rivers for the health of arid ecosystems. Increasing water availability in arid lands through water-harvesting techniques that force rainfall and runoff to infiltrate the soil potentially contribute to recharging local groundwater tables is an essential part of living healthy in arid lands.



According to the UNCCD, growing unpredictability of rainfall in many drylands increases the importance of modern and traditional water-harvesting techniques, for agriculture and for daily living. To that end, farmers' innovation plays a key role. By adding organic matter

(manure, compost, tree litter, ash) to water harvesting pits, the combination of water management and soil fertility improving techniques allows farmers to cultivate crops where before nothing could be grown. This technique has been used in Burkina Faso to rehabilitate tens of thousands of hectares of strongly degraded land.

In the middle of the 1990s gullies on the China's loess plateau were leased in local public auctions to the highest bidders, who subsequently were supposed to make these gullies productive again. Those who won the auctions quickly began to level part of the gullies to conserve the soil, and to plant trees. As gullies always harvest

runoff the growing conditions are favourable, and by the end of the 1990s farm forests were emerging in gullies.

Women in drylands make crucial contributions to agriculture and rural processes in animal husbandry and as farmers, workers and entrepreneurs. Their roles vary across regions, but in every part of the world women face gender-specific constraints that reduce their productivity and limit their potential contributions to agricultural production, economic growth and the wellbeing of their families, communities and countries. While women's role in arid agriculture is often underestimated, so too is their vulnerability to the impacts of desertification, land degradation and drought. In times of crisis, women and children are often the last to leave their land

Closing the gender gap in arid land agriculture would generate large gains for the agricultural sector and for society as a whole. Studies have shown that 20 years ago women spent an average of 2.5 hours a day collecting firewood, as the natural vegetation was far away and scarce. Under agroforestry systems, women spend an average 0.5 hours a day on this task, as they can prune trees on the family fields. These two hours saved can be dedicated to productive tasks, bearing in mind that if women had the same access to productive resources as men, they could increase yields on their farms by 20–30 per cent. This could raise total agricultural output in developing countries by 2.5–4 per cent, which could in turn reduce the number of hungry people in the world by 12–17 per cent.

Urban

For urban areas, links between nature and health are often seen as important – yet often in opposition. The high human population density of urban areas and associated demands for intensive land use has led to the formation and flourishing of novel ecosystems (Hobbs *et al.*, 2013). In fact, novel urban ecosystems provide psychological and spiritual benefit, educational and recreational opportunities, and many direct health benefits. Vegetation in novel urban ecosystems, whether open parkland or areas with more developed tree and shrub layers is preferred by urban dwellers to a non-vegetated state. There is evidence for the presence of vegetation resulting in decreased levels of crime in otherwise similar housing blocks (Kuo & Sullivan, 2001).

Recent research in the United Kingdom suggests that people derive greater psychological benefit from more diverse vegetated areas, with a greater diversity of



habitats reinforcing a sense of personal identity (Fuller *et al.* 2007). Urban dwellers are typically unaware of the origins of the flora and fauna that they encounter, which means novel components in urban areas are able to enhance people's well-being. Such novel components fill vacant niches (e.g. *Buddleia davidii* forming extensive stands in many urban sites, and also providing

foraging for butterflies and other nectar-feeding insects) and non-native trees (e.g. *Plantanus x acerifolia*, *Robinia pseudacacia*, *Ailanthus altissima* in European and North American cities) and the extensive plantings of *Gingko biloba* in Asian cities. Despite its ancient lineage, the latter is one of the only trees able to thrive in an environment with high particulate pollution and root compaction; an environment unsuitable for the native woody flora which might be expected.

Partnerships in Urban parks

In addition to the psychological benefits provided by urban ecosystems, novel or otherwise, they also provide areas for recreation and education (which in turn can bring psychological benefit). Brownfield sites, often perceived as “wasteland”, may be used as playgrounds and also provide a means of providing sites for a range of species to survive. Urban park systems and their recreation programs offer one set of skills to promote healthy living in local communities. But there are also other agencies that share the goal and have their own set of skills to bring.

These include: Departments who often own significant quantities of land including Health, Water -, Public works and transportation agencies, as well as private and non-government actors including Insurers, Hospitals and “Friends of Parks” groups. These latter, of course, are classic park agency partners in most urban areas and may be an excellent source of volunteers, public outreach, advocacy, information, and local connections, to help the park management promote its role in securing healthier lifestyles

A completely different urban green space that can reduce stress and promote health, as well as enhancing biodiversity is the community garden. In the US many departments have designated garden areas within existing parks. A few have acquired established gardens and officially added them to the park system. In Europe many cities now have urban community gardens that benefit public health in numerous ways: by promoting physical activity, social connections, and mental relaxation; by fostering feelings of self-worth and self-reliance; and by producing healthful food - of particular importance in low-income districts, where residents may have less access to fresh produce.

In addition, the established global network of [botanical and zoological gardens](#) also provide space for relaxation, education, and backdrops for a range of other cultural and social pursuits. All should be seen part of our healthcare system, with green spaces being considered as important in helping reduce hypertension, anxiety, depression, childhood obesity, even diabetes. Parks and medical professionals are gathering additional data on these various effects and purported links between urban green space and health. Useful sources can be found on the following websites: [Sustainable Cities Collective](#) and [Healthy Parks, Healthy People Central](#).

Urban ecosystems may also provide surprising health benefits where biodiversity is maintained. For example, Lyme disease risk in the United States decreases with higher vertebrate diversity communities because there is the potential for dilution of disease transmission given greater range of hosts for ticks (the disease vector to people). Smaller remnants of ecosystems found in urban areas are unfortunately typical in suburban areas of most urban environments. To take account of these ecological values, urban design should include a range of restored and remnant vegetation patches.



Above all else, in urban settings we should be promoting living styles, and nutritional patterns that promote human well-being, rather than having a good system to cure illness when it occurs. And none of these ideas means living like a hermit, they are all possible to achieve without giving up the high standard of life enjoyed in

urban environments – adopting and implementing these ideas will enable urban dwellers to enjoy a better life.

Marine

An increasing number of marine products from biodiversity are used as pharmaceutical products, although, as marine ecosystems are less well-explored and documented than terrestrial ecosystems, knowledge is still relatively sparse. Some corals and algae are being examined as sources of natural sunscreen compounds. There is an irony in this because there are examples of coral death associated with popular diving spots, where divers enter the water covered in artificial sunscreens, the chemical composition of which attacks the algal symbiont of the coral causing coral death.



Marine ecosystems are actually suffering from a variety of debilitating symptoms which indicates that they themselves may not be healthy. And, since marine ecosystems do provide daily protein for around 1 billion people this is an important issue. Coral reefs are one such example,

where combinations of environmental changes and threats have caused destabilisation of the ecosystem and promoted disease (Hobbs *et al.* 2013).

Climate change effects, through warming of the waters in which corals grow, have been known to cause coral bleaching, although other factors such as increased nutrients and sediments in the water from bad land management practices magnify the effects of temperate increase in water. While these human-mediated factors can cause coral decline, in the Caribbean coral reef disease caused by a (yet unidentified)

bacterium has contributed significantly to the demise of large corals, and in turn led to simplification of a complex ecosystem.

And eventually the ecosystem disease will have effects which will cause a range of health problems for coastal communities. The cure is partly better knowledge of disease pathogens and vectors, but mainly better management of land and sea resources.

Key messages:

- ✓ Better knowledge of disease pathogens and vectors, and better management of land and sea resources is essential to manage disease in a range of ecosystems
- ✓ Climate change impacts on all ecosystems can amplify the possibilities of disease transmission.
- ✓ The [UNECE protocol on Health for its Convention on the Protection and Use of Transboundary Watercourses and International Lakes \(PDF\)](#) has practical suggestions which can be adapted to other ecosystems.
- ✓ Green and wild spaces, even of quite small size, are important for promotion of human well-being, as well as biodiversity benefits.
- ✓ Urban design should include a range of restored and remnant vegetation patches.
- ✓ Links with UNCCD can help in ecosystem and health co-management in arid and semi-arid lands.
- ✓ Women have key roles in managing and maintain ecosystem health across a range of ecosystems, and for managing community health in that context.

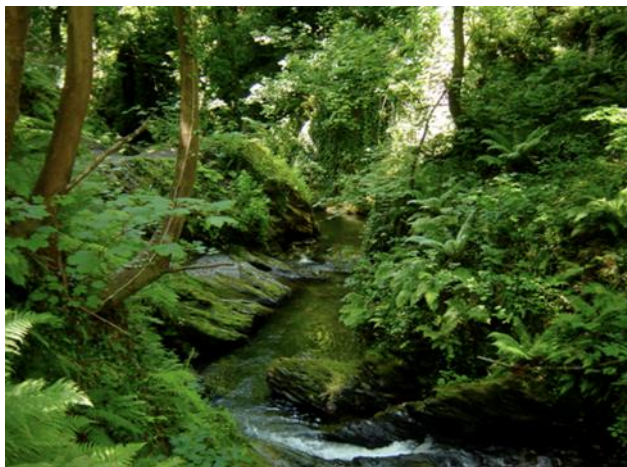
INVASIVE SPECIES AND NOVEL ECOSYSTEMS

Infectious diseases and their spread are increasing in severity due to biodiversity and climate change and land degradation processes. Human activities are disturbing both the structure and functions of ecosystems and changing biodiversity, especially causing a loss in species-level biodiversity and a reduction in ecosystem diversity. Such disturbances reduce the abundance of some organisms, cause population growth in others (invasive alien species), and alter the interactions between organisms and their physical and chemical environments.

While invasive alien species is a well-understood issue that has been thoroughly debated in the CBD, the concept of novel ecosystems is a relatively new concept. Although several definitions and terms (emerging ecosystems has also been used) exist, in general the concept addresses ecosystems that due to global change have transformed into a new ecological system. A recent definition of novel ecosystem was in Vanandel & Aronson 2012; *'an ecosystem without analogues that has developed in response to radically altered environmental and biotic conditions resulting from human*

activities in the past century or two.'

More information is available in Hobbs *et al.* 2013.



Novel ecosystems are evolving through direct and indirect anthropogenic effects, and those ecosystems are host to both existing and emerging infectious diseases of both wildlife and human populations. An emerging disease can be defined as a disease appearing in a new host

population or whose incidence is increasing in an existing host population as a result of long-term changes in its underlying epidemiology. Many anthropogenic influenced drivers of ecosystem change affect the distribution and persistence of infectious disease mediated through a range of vectors and pathogens.

Sometimes associated with these concepts are the activities of ecosystem restoration, re-wilding and reintroduction. All of these activities have potential to restore ecosystem health, but also change ecosystem structure and function, and sometimes in unknown and unforeseen ways. In both Europe and North America reintroduction projects have occurred for beavers, wolves, red kites, and several other species are under consideration. But besides simply bringing a locally extinct species back to an ecosystem which may itself have changed, re-introduction projects may present risks of disease in both re-introduced and resident wildlife with potential implications for the health of wildlife, domestic animals and humans. Disease risk analysis must be an essential part of any reintroduction strategy, and that should include the possibility of diseases which cross species boundaries. Management actions which could be undertaken should include elimination of suspected non-native parasites.

THE PSYCHOLOGICAL SIDE – NATURES’ FEEL GOOD FACTOR

Protected areas – can they help promoting health?

Could protected areas also help us to protect our health and well-being? In our now largely urban existence we have developed strategies to replace loss of surrounding habitat – urban and sub-urban gardens area classic example of this. Outside of urban



environments, protected areas provide the most “global” of strategies for ensuring that we conserve and manage biodiversity.

Stolton and Dudley (2010) propose four sets of health benefits from protected areas:

- ✓ Environmental benefits: direct benefits that come from the conscious management of ecosystems to reduce the risk of disease.
- ✓ Sources of local medicines.
- ✓ Sources of global medicines.
- ✓ Provision of direct health benefits.

Healthy Parks, Healthy People

Parks Victoria, Australia launched the [Healthy Parks, Healthy People](#) approach in 2000. Parks Victoria is manager of urban, regional and rural parks, waterways and cultural heritage and is established as a statutory authority in the State of Victoria, Australia. The goal of *Healthy Parks, Healthy People* is to emphasize the vital importance of visiting parks and natural reserves for the benefits that they provide as “healthy places for body, mind and soul”.

In 2010 the 1st International *Healthy Parks, Healthy People* Congress was held in Melbourne, Australia and attracted more than 1,200 participants from 38 countries. The Congress and subsequent [Melbourne Communiqué \(PDF\)](#) declared:

- that parks are integral to healthy people and a healthy environment;
- that human health depends on healthy ecosystems; and
- called on all sectors to work together for the benefits of humanity and the environment.

Since then, various other park management agencies in Australia, New Zealand, the United Kingdom, the United States and Canada have adopted similar approaches. The Parks Agencies in Australia and New Zealand, supported by some other Agencies in Canada, the US and the UK have come together to form [Parks Forum](#), an industry level body whose mission is to: *unite and provide leadership for the parks*

industry, assisting the industry to take up its role as a significant contributor to the health of our society and environment, and also as an important sector in the economy.

Collaboration for Environmental Evidence Review

This review of environmental evidence identifies that there is some evidence that activity in a “natural” environment compared to a human created environment can have a positive impact on mental well-being. However, this is primarily drawn from short-term tests on self-reported feelings such as ‘anger/aggression’, ‘sadness/depression’ and ‘fatigue/tiredness’. The validity of these psychological scores as measures of mental well-being is not clear. There is little evidence of an impact on physiological outcomes but this is limited by the low number of studies available which measured similar outcomes.

The review concluded there *were insufficient data to allow comparison of differences types of exposure to nature*. Clearly, a ‘natural environment’ has many components. It is likely that further investigation on this topic and the design of more appropriate studies would be aided by refining the hypotheses on how specifically nature might impact on health and which specific attributes are the most important. The evidence is suggestive that nature may be used within the context of public health promotion interventions but we require a more comprehensive evidence-base in order to make appropriate and effective use of natural resources.

This suggests that while individual people, and indeed physicians, may feel the effects of being in parks, and being surrounded by green space has positive effects on them/their patients, the physiological evidence is still insubstantial (see also UK NEA). The reviews *key findings* are:

- Positive effect on self-reported emotions/mood (anger, sadness-depression, fatigue).
- No evidence of any effect on physiological parameters (blood pressure, stress-related hormones) and anxiety.
- Inconsistent results concerning tranquillity, attention and energy.

Japanese practise of “bathing in forest air - Shinrin-yoku”

“**Shinrin-yoku** is the Japanese practice of taking in the atmosphere and energy of the forest to improve health and reduce stress. A recent scientific study considered the psychological effects of Shinrin-yoku and found that immersion in the forest environment reduced hostility and depression and increased energy levels. The research concluded that the practice balanced out acute emotions; particularly amongst those suffering from chronic stress, and that therefore forest landscapes could be considered as therapeutic landscapes. Another study looked at Shinrin-yoku’s effect on diabetic patients. It found that this practice of forest-air bathing and walking substantially decreases blood glucose levels, which in their tests dropped on average from 179 to 108. The researchers suggested that this was due to the changes in hormonal secretions and autonomic nervous functions that result from taking in the forest environment. Shinrin-yoku is therefore a type of aromatherapy that has enormous potential for many health disorders. Much more still has to be learned about the effects of the volatile compounds in the forest air and effectively protected areas will ensure that this natural treatment can be maintained and enhanced.”

Source: Stolton and Dudley (2010)

This type of approach is interesting as it links the psychological effects of being surrounded by greenery, often with sound effects from streams and birds – typically also incorporated into “relaxation” or ambient CDs – with the subtle effects of aromatherapy. Many forests contain species which have volatile compounds (typically essential oils), and almost all have some therapeutic property. For example Eucalyptus oil is harvested from Australian forests and used in many different kinds of medication, from stress relief to aiding breathing when suffering with acute respiratory diseases.

Key messages:

- ✓ Encourage activities in green space to contribute to mental well-being.
- ✓ Human health and ecosystem health is linked, but there remain open questions about the quality of the evidence base for the efficacy of open green space in promoting mental and physical health
- ✓ Promote new studies to assess effects on health with recommendations about:
 - sampling (compare specific groups, e.g. male/female, active/passive...)
 - characterisation of natural spaces (better described)
 - long term measurements of outcome (sustainable effects)
 - using validated tools for measurements
- ✓ Ensure that all programmes and projects are evaluated and contribute to an expansion of the evidence-base.
- ✓ Encourage and facilitate park managers to develop partnerships; with other public agencies, private foundations, corporations, citizens' groups, and volunteers.
- ✓ Monitor the development of novel and restored ecosystems, and undertake surveillance for possible disease effects from new ecological combinations.

HOW ARE OTHER ACTORS INVOLVED?

United Nations Environment programme (UNEP)

Millennium Assessment

UNEP led work on the [Millennium Ecosystem Assessment](#) (MA), which defined a new conceptual framework, placing emphasis on the management of the environment to deliver ecosystem services, and through those services to enhance human well-being. Well-being is more than simply human health, and reflects a more holistic approach. But to deliver better human health outcomes, we need to have healthy ecosystems – i.e. ecosystems which continue to deliver services to people and the biosphere.

Key conclusions on biodiversity and health from this work were:

- Ecosystem services are indispensable to the well-being and health of people everywhere;
- The causal links between environmental change and human health are complex because often they are indirect, displaced in space and time, and dependent on a number of modifying forces;
- The regions facing the greatest challenges in achieving the MDGs overlap largely with those facing the greatest problems related to the sustainable supply of ecosystem services. Many of these regions include large areas of drylands, in which the combination of population growth and land degradation is increasing human vulnerability to both economic and environmental change and, consequently, impairing well-being and health;
- Ecosystem changes may occur on such a large scale as to have a catastrophic effect on human health. There is an increasing risk of non-linear changes in ecosystems, including accelerating, abrupt and potentially irreversible changes; Measures to ensure ecological sustainability would safeguard ecosystem services and thereby benefit health in the long term.;

TEEB Economics, Health and Biodiversity

Putting price tags on ecosystem services, including estimating the economic effects of not having a certain ecosystem service and the consequences for human health, is problematic but nevertheless important. A recent project undertaken by several governments and supported by UNEP, *TEEB* has more on this issue.

“The biodiversity-healthcare relationship also has a strong distributional equity dimension. There is often a mismatch between the regions where benefits are produced, where their value is enjoyed, and where the opportunity costs for their conservation are borne. So the plant species that are the sources of many new drugs are largely found in poorer tropical regions of the world. The people that benefit are more likely to be found in rich countries where the resulting drugs are more readily available and affordable. People in these countries therefore have a great incentive to

conserve natural habitats in biodiversity-rich parts of the world. However, such conservation has costs for local people in these parts, in particular the opportunity costs such as the loss in potential agriculture returns of not converting such habitats. Transferring some of the rich world benefits back to local people could be one approach to improving incentives to conserve those natural habitats and species locally that clearly have wider benefits globally “.

UNESCO: World Water Development Reports

In 2003 a joint undertaking of twenty-three United Nations (UN) agencies ([World Water Assessment Programme \(WWAP\)](#)) published the first World Water Development Report. This report dealt with many issues around water security for people and the biosphere, including issues of human health and ecosystem health.

The WWAP was a response, *inter alia* to the Hague Ministerial Declaration of 2000 adopted by the Third World Water Forum.

The 2006 Report (WWDR, 2006) notes:

“The state of human health is inextricably linked to a range of water-related conditions: safe drinking water, adequate sanitation, minimized burden of water-related disease and healthy freshwater ecosystems. Urgent improvements in the ways in which water use and sanitation are managed are needed to improve progress towards meeting the MDG’s related to human health.”

World Health Organisation

The WHO launched a key publication on health and biodiversity, climate change and land degradation ([Our Planet, Our Health, Our Future](#)) at the Rio+20 meeting in June 2012. The Discussion Paper was co-authored by the Secretariats of the three Rio Conventions and makes important points about the links between the three “Rio” Conventions dealing with Biodiversity, Climate Change and Combating Desertification (increasingly seen as meaning preventing land degradation). The executive summary has the following view:

“Health is our most basic human right and one of the most important indicators of sustainable development. We rely on healthy ecosystems to support healthy communities and societies. Well-functioning ecosystems provide goods and services essential for human health. These include nutrition and food security, clean air and fresh water, medicines, cultural and spiritual values, and contributions to local livelihoods and economic development. They can also help to limit disease and stabilize the climate. Health policies need to recognize these essential contributions. The three so-called Rio Conventions arising from the 1992 Earth Summit – the Convention on Biological Diversity, the United Nations Framework Convention on

Climate Change and the United Nations Convention to Combat Desertification – together aim to maintain well-functioning ecosystems for the benefit of humanity.”

The Public Health and Environment Branch at WHO is the CBD’s key partner at WHO, and focuses its work on health and global change, including climate, biodiversity and other global environment changes. Information on much of its work and publications can be found [here](#).

Food and Agriculture Organisation of the United Nations (FAO)

FAO has particular interests in promoting nutrition, food safety and food security, based on best management of biodiversity. FAO is also co-convenor with the CMS in the [Scientific Task Force on Wildlife and Ecosystem Health](#). CITES is also a partner in the task force, and the CBD is a core affiliate.

World Organisation for Animal Health (OIE)

OIE plays an important global role in dealing with animal health. It is also a member of the [One Health](#) concept: - a worldwide strategy for expanding interdisciplinary collaborations and communications in all aspects of health care for humans, animals and the environment. The web site notes: “synergism achieved will advance health care for the 21st century and beyond by accelerating biomedical research discoveries, enhancing public health efficacy, expeditiously expanding the scientific knowledge base, and improving medical education and clinical care. While not a new concept, the “One Health” approach must be translated as a new and fundamental paradigm at national levels. Promoting a collaborative “One Health” approach at national levels, guided by international perspectives and support, will result in coordinated prevention of high impact diseases at the human-animal interface, through generating better political support.”

International Union for the Conservation of Nature

The IUCN Species Survival Commission oversees the Wildlife Health Specialist Group comprised of over 350 health experts from around the world.

Convention on Wetlands, Ramsar, Iran (1971)

Wetlands play a crucial role in the filtering of fresh water, including the removal of various chemicals and potentially toxic elements (e.g. heavy metals such as cadmium and lead). As Horwitz *et al.* (2012) note:

“Wetland ecosystems are settings that determine human health and well-being through a number of characteristic influences, such as:

- a source of hydration and safe water;
- a source of nutrition;
- sites of exposure to pollution or toxicants;
- sites of exposure to infectious diseases;
- sites of physical hazards;
- settings for mental health and psycho-social well-being;
- places from which people derive their livelihood;
- places that enrich people's lives, enable them to cope and to help others; and
- sites from which medicinal products can be derived.

These influences can either enhance or diminish human health depending on the ecological functioning of wetlands and their ability to provide ecosystem services. It follows then that losses of wetland components, and disruptions to wetland functions and ecosystem services, will have consequences for human health.”

Wetlands, both natural and constructed, provide a sophisticated water treatment service involving wetland vegetation and associated all contribute to the assimilation and extraction of pollutants and pathogens. Wetland landforms are also adjusted hydrologically to hold increased volumes of water

The “Healthy wetlands, healthy people” theme was agreed as the conference theme for the Ramsar Convention Conference of the Parties held in 2008. Specific strategies, tools and ways of measuring success are needed to develop and implement such work by parties to the convention through guidelines produced by the Ramsar Convention Science and Technical Review Panel working with WHO.

ACRONYMS

BSE: Bovine spongiform encephalopathy
 CBD: Convention on Biological Diversity
 CDC: Centre for Disease Control and Prevention(USA)
 CEE: Collaboration for Environmental Evidence
 CITES: Convention on International Trade in Endangered Species
 CJD: Creutzfeldt-Jakob Disease
 CMS: Convention on Migratory Species of Wild Animals
 COHAB: Co-Operation On Health And Biodiversity Initiative
 COP: Conference of the Parties
 DEFRA: Department for Environment, Food and Rural Affairs (UK)
 EA: Ecosystem Approach (CBD)
 EPHA: European Public Health Alliance
 EUROBATS: Agreement on the Conservation of Populations of European Bats
 FAO: Food and Agriculture Organization (UN)
 GHG: Greenhouse Gases
 GMO: Genetically Modified Organisms
 H3N8: Subtype of the species Influenza A virus that is endemic in birds, horses and dogs. More on Wiki: [LINK](#)
 H5N1: Also known as “bird flu”, H5N1 is a subtype of the influenza A virus which can cause illness in humans and many other animal species
 HEAL: Health and Environment Alliance
 ICSU: International Council on Science
 IPBES: Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
 IUCN: International Union for Conservation of Nature
 LK: Local Knowledge
 MA: Millennium Ecosystem Assessment
 MDG: Millennium Development Goals
 NCI: National Cancer Institute (USA)
 NEA: National Ecosystem Assessment
 NGO: Non-governmental organization
 NIH: National institute of Health (USA)
 NOAA: National Oceanic and Atmospheric Administration
 OEP: Ornithological Expert Panel (DEFRA)
 OIE: World Organisation for Animal Health
 PCB: Polychlorinated biphenyls
 SARS: Severe Acute Respiratory Syndrome
 TEEB: The Economics of Ecosystems and Biodiversity
 TK: Traditional Knowledge
 UDCA: Ursodiol, also known as ursodeoxycholic acid is one of the secondary bile acids, which are metabolic by-products of intestinal bacteria
 UK NEA: UK National Ecosystem Assessment
 UNCCD: United Nations Convention to Combat Desertification
 UNECE: United Nations Economic Commission for Europe

UNEP: United Nations Environment Programme
 UNESCO: United Nations Educational, Scientific and Cultural Organization
 UNFCCC: United Nations Framework Convention on Climate Change
 USDA: United States Department of Agriculture
 USGS: United States Geological Survey
 WCED: World Conference on Environment and Development
 WEHAB: Key priority areas that fed into the World Summit on Sustainable Development: Water, Energy, Health, Agriculture and Biodiversity
 WHO: World Health Organization
 WSSD: World Summit on Sustainable Development
 WWAP: World Water Assessment Program
 WWDR: World Water Development Report
 WWF: World-Wide Fund for Nature

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- Healthy Parks, Healthy People: [LINK](#)
- Co-Operation On Health And Biodiversity Initiative (COHAB): [LINK](#)
- Convention on International Trade in Endangered Species: [LINK](#)
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