

Healthy People Supporting a Healthy Planet

Harnessing Humanity's Desire for
Wellness to Protect Nature

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Introduction

"Human health depends, to a larger extent than we might imagine, on the health of other species and on the healthy functioning of natural ecosystems," former UN Secretary-General Kofi Annan wrote in the prologue to *Sustaining Life: How Human Health Depends on Biodiversity* (Chivian and Bernstein, 2008).

Since Annan penned those words, evidence has continued to emerge of links between ecosystem services and how well people are protected from, prepared for and resilient to major health threats. Scientists from the International Union for Conservation of Nature (IUCN) estimate that "current extinction rates for plant and animal species are 100 to 1,000 times higher than natural background rates" (IUCN, 2007). These accelerated extinction rates result from the unsustainable harvesting of species, pollution, and, above all, from the degradation and conversion of habitats for farming and urban development. The ensuing biodiversity crisis imperils the life support systems upon which humanity depends and reveals that the links tying healthy ecosystems and their long-term benefits to human health and well being are poorly understood and severely undervalued.

This white paper examines these links and then suggests unique opportunities for the John D. & Catherine T. MacArthur Foundation to play a leadership role in catalyzing a global effort to secure human health through sound management and conservation of ecosystems, biodiversity and the vital services they provide and upon which all life on Earth depends. Emphasis is given to *prevention* of human health crises through interventions that seek to better understand and mitigate urgent threats to these life-support systems. Like preventative medicine, such measures serve as a proactive and less costly means to protect human health over the long term, as compared to the costs entailed in further degradation of the biosphere and resultant health crises. This approach represents a fundamental shift in environmental stewardship. By building further evidence and awareness of the interdependence of human health and the natural world, the MacArthur Foundation has a game-changing opportunity to promote environmental stewardship as a principal and essential foundation of human healthcare.

Rationale for highlighting health security from nature

The ways in which nature prevents, mitigates and treats disease may be the least recognized but most important set of services humans enjoy from the Earth's biological diversity, systems and products (Pattanayak, et al., 2009; Corvalen, et al., 2005).

The need for food security and freshwater security make intuitive sense to most people because they personally want, need and use food and water on a daily basis, and many have known the discomfort of at least transient hunger and thirst. Climate security is more abstract, as daily temperatures have been both warmer and colder than usual since the advent of worldwide concern over greenhouse gases. Nonetheless, "climate change" and "global warming" have become household terms, thanks to the world scientific community's warnings being

popularized by Al Gore, Hollywood, Prince Charles, the news media and various other thought leaders in humanity's popular global discourse.

In contrast, the term "health security," especially when paired with "biodiversity" or "ecosystems," often draws a blank. Most people do not know or think about what natural systems protect them from disasters, keep them healthy or contribute to healing them once they are sick. Just as chicken comes from the supermarket for many people, so does health security come from a doctor's office and/or pharmacy, especially in the developed world.

However, most people do count health among "the first of all liberties." Arguably, natural ecosystems provide the most comprehensive "health insurance" package on Earth – not just for humans, but also for the plants and animals vital to human survival. Therefore, reframing the necessity for protecting ecosystems and biodiversity in terms of human health can help awaken sustained global interest in, insistence on and collective action for protecting intact nature. "Looking at biodiversity through a human health lens can... take it out of the unique realm of ministries of environment and put its conservation at the heart of efforts to tackle poverty, food security, climate changes and many other global challenges," say the IUCN's Jeff McNeely and Susan Mainka (2009).

The science of human & environmental health links

Increasingly science is documenting the essential role natural ecosystems play in health security through maintaining healthy climate, air and water flows; regulating infectious disease (incidence, emergence and reemergence); preventing and mitigating natural disasters; and supplying effective disease treatments, both traditional and modern.

Research indicates that climatic changes are altering the ecology of human, animal and plant pathogens (Bernstein and Ludwig, 2008; Patz, et al., 2006), in some cases increasing them and, in other cases, decreasing them (Harvell, et al., 2002). Rising average global temperatures seem to correlate with increased infectious disease vectors and incidence of disease, including malaria, Lyme disease, dengue fever, yellow fever, plague, tick-borne encephalitis, among others affecting humans and animals.

Rises in ocean temperatures correlate with increased incidence of cholera in humans and also marine bacteria that destabilize coral reefs (Harvell, et al., 2002). Econometric modeling of "ecosystem mediated" health inputs in Brazil indicate that while climate changes have negative human health effects, forest conservation mitigates those effects (Pattanayak, et al., 2009). Establishing direct causal relationships between climate change and changing disease patterns will require more research, but early findings indicate an urgent need to do so.

Natural ecosystems regulate the incidence of disease vectors and thus the flow of certain infectious diseases from animals to humans, notably SARS, Ebola and dengue fever (Weiss and McMichael, 2004). Due in part to global environmental changes, the close of the 20th century saw "resurgence of infectious diseases among humans, wildlife, livestock, crops, forests and marine life" (Epstein, 2001). Increased human infectious diseases have been traced to the disruption or destruction of ecosystems by deforestation, agricultural development, dams, water pollution and siltation, urbanization and climate change (Molyneux, et al., 2008).

Recent studies show a correlation between deforestation and increased numbers of disease vectors such as mosquitoes (Vittor, et al., 2009). Extreme weather events and flooding "create conditions conducive to 'clusters' of insect-, rodent- and water-borne diseases" (Epstein, 2001).

Emerging infectious diseases also have been linked to increased human-wildlife contact through the subsistence eating of “bush meat” and the global trade of wild animals as pets and exotic food (Karesh, et al., 2005).

Fewer Trees Bring More Mosquito Bites

The World Health Organization (WHO) estimates that there were 250 million cases of malaria worldwide in 2008, resulting in almost one million deaths, primarily among children in Africa. There are currently no effective vaccines for malaria and prevention efforts in developing countries primarily focus on vector control. Mosquito nets impregnated with insecticides and local indoor spraying with these chemicals have been the primary modes of vector control in most countries. However, concerns about the safety of these insecticides coupled with increasing mosquito resistance to some of the most commonly utilized chemicals like DDT have prompted research into other methods of malaria prevention and/or control (WHO, 2010). Tens of millions of dollars have been invested over the last several decades in efforts to develop new insecticides, medications, and vaccines to combat this deadly disease.

Deforestation has major impacts on malaria transmission, especially in Africa. Recent research has brought to light just how important intact ecosystems are to controlling malaria transmission. In 2008, researchers from the Kenya Medical Research Institute studied the infection rate of mosquitoes in deforested as compared to forested sites. They found that alterations in local temperature and humidity brought about by deforestation resulted in a 77% increase in “al capacity” among mosquitoes, thereby significantly increasing malaria risk in deforested areas (Afrane, et al., 2008). In another study, a team of researchers studied biting rates in deforested areas of one particular mosquito species, *Anopheles darlingi*, which is the primary vector for malaria in the Peruvian Amazon. They found biting rates were almost 300 times higher in deforested areas compared with areas where the forests were primarily intact (Vittor, et al., 2006).

Unfortunately, regions that suffer most from ecosystem-sensitive diseases tend to be those with the fewest means of treating illness. For instance, up to 80% of people in rural areas of sub-Saharan Africa depend almost entirely on traditional medicines taken directly from nature (Balmford, et al., 2008; Patz, et al., 2006; Troullier, 2002). At the same time, only 15% of pharmaceuticals in use today are used in developing countries. The global “drug gap” finds only 10% of spending on research for new medicines devoted to the so-called “orphan diseases” that account for 90% of the world’s disease burden (Morel, 2003) – the diseases targeted by the Millennium Development Goals (MDGs).

Globally, more than 50% of pharmaceutical medicines (Newman, 2008) and more than 90% of traditional medicines (WHO, 2002) are derived from active compounds in wild plants and/or animals. More than 70,000 plant species have medicinal uses, constituting “one of the most significant ways in which humans directly reap benefits provided by biodiversity” (Bamford, et al., 2008). Marine species have yielded many of the new compounds with potential for treating “orphan diseases” as well cancers, HIV/AIDS and antibiotic-resistant infections (Newman et al. 2008). The coral-reef dwelling cone snail *Cous magus*, for example, is the source of ziconotide, a new painkiller 1,000 times more potent than morphine but without the risk of addiction.

While many pharmaceutical companies have focused in recent years on searching their own chemical libraries for new medicines, these explorations have proven disappointing (Newman, 2008). In fact, the overall diversity of medicinal compounds in nature is millions of times greater than that in synthetic libraries (Newman, D.J., National Cancer Institute, pers. comm.).

As ecological changes are increasing disease risks, future development and supplies of modern and traditional medicines are at risk due to species declines and to disrupted ecological interactions that cause organisms to produce compounds of medicinal importance (Bernstein and Ludwig, 2008; Newman, et al., 2008). Overharvesting already is leading to scarcity of traditional *materia medica*, lessening supplies of raw medicinal materials and the income streams they produce, especially for the rural poor (Balmford, et al., 2008; Shingu, 2005). Ironically, the World Health Organization (WHO) is promoting an increase in the accessibility to

and use of traditional medicines in the developing world, while most sustainability measures remain in the talking stage (WHO, 2002).

Wildlife Trade Controls Essential to Health Security

Most people think of rhinos and tigers and bears when the term “wildlife trade” is mentioned. Many also associate the term with witchcraft, old wives’ tales and voodoo, as parts and products from these endangered species are used as traditional medicines.

However, wildlife trade associated with health care is a huge and serious business. The herbal medicine industry alone generates \$200 billion in global commerce annually, according to the World Health Organization (WHO). Additional billions of dollars are associated with trade in pharmaceuticals derived from wild sources, some of which are as vulnerable to extinction as rhinos and tigers and bears.

Consider, for example, the \$201 million the Bill and Melinda Gates Foundation invested in a joint venture with Novartis to develop a new malaria treatment made from wild sweet wormwood.

The active ingredient in sweet wormwood is Artemisinin, which is effective in treating multi-drug resistant malaria strains. Sweet wormwood had been used for centuries in traditional Chinese medicine (TCM) to treat malaria and was thought to only grow in the wilds of China until recently. According to Dr. Thomas Brewer, a Gates Foundation disease specialist, demand for sweet wormwood during development of the Novartis malaria drug sent prices skyrocketing and scores of collectors into the forest, nearly eradicating the plant in the wild.

While the Gates/Novartis team did not take sustainability into account during that project and plentiful supplies of sweet wormwood have since been discovered in other countries, Brewer said sustainability of wild medicinal resources could and should be of interest to future ventures undertaken by the Gates health program.

Landslides, flooding and tsunamis tend to have more severe consequences for human health when they occur in degraded landscapes, devoid of the forests and coral reefs that provide natural barriers to these calamities (Sudemeier-Rieux, et al., 2009; EJF, 2006). Evidence also indicates that these and other natural disasters, such as heat waves, fires and crop blights, are becoming more frequent and severe due to ecological degradation (Myers and Patz, 2009; Teketay, 2001). In the 1990s, the number natural disasters doubled over the 1980s, causing annually an average of 62,000 deaths, affecting another 200 million people and resulting in \$69 billion in economic loss (Myers and Patz, 2009). The UN estimates that from 2000 to 2007, an average of 400 natural disaster occurred each year, impacting 230 million people and costing \$80 billion (UNDP 2008). The majority of these natural disasters occurred in developing countries, disproportionately affecting the poor, and their number is expected to grow exponentially in decades to come.

By 2050, the human population is projected to surpass 9 billion, with nine out of every 10 people residing in developing countries. Overall, the world population will be more urban but also much older, with about 20% over age 60 (Hagmann, 2001). In terms of epidemiology, a more crowded, urban and aged population will suffer more heart and lung disease, more cancers, more hypertension (WHO, 3003) – the very diseases for which promising new medicinal compounds are being found in nature. At the same time, millions of additional people will find themselves in the path of devastating floods, hurricanes and other natural disasters, spawning more disease (Kerr, 2010).

In summary, scientific evidence shows that securing intact ecological systems may be the most fundamental, comprehensive and sustainable means of ensuring human health and well being on a global scale, favoring the developing and developed worlds alike.

Current peer-reviewed literature suggests the following key principles:

- By calling world attention to nature's direct contribution to human health, protection of intact terrestrial and marine ecosystems will become a priority for the global public, the private sector, governments and multi-lateral institutions.
- Raising awareness of nature's role in sustaining human health will generate more investment in and action toward protecting intact ecological systems and services.
- Benefit sharing linked directly to protection of ecological systems and services will provide health insurance for the world, while conserving terrestrial and marine landscapes, improving rural economies and preserving indigenous knowledge and cultures.
- Protecting nature's medicine repositories and disease prevention mechanisms will save millions of lives.

Current approaches to human health & the environment

Conventional population, health and environment (PHE) programs seek to improve family planning and maternal and child health in rural communities while developing awareness of and incentives for sustainable management of commonly held natural resources. Although PHE programs have achieved measured success in some places, the connection between human health and nature conservation remains mostly indirect for participating communities. Furthermore, the sensibilities and methodologies of health specialists and conservationists have sometimes proved incompatible (Gibbs, 2003; De Souza, et al., 2003).

To date, PHE approaches have done little to meld the agendas of the development and conservation communities or to improve and maintain ecological systems at scale. Despite years of discussion about integrating conservation and development, the world's leading development NGOs have only recently begun to mainstream conservation initiatives in the interest of sustaining socioeconomic gains.

On the disease front, the Bill and Melinda Gates Foundation has invested billions of dollars in developing new drug treatments for resistant malaria. The Institute of OneWorld Health has invested some \$90 million in its mission to fight infectious diseases in the developing world with new drugs. Novartis and other pharmaceutical giants have invested tens of millions of dollars in developing drug treatments for malaria, tuberculosis and other priority diseases specified in the MDGs. Few of these efforts target the causes or carriers of infectious disease – a point emphasized in the 2010 Earth Day lecture at the Gates Foundation delivered by Dr. Eric Chivian, Director of the Center for Health and the Global Environment at Harvard Medical School (pers. comm.).

The Emerging Pandemic Threats (EPT) program of the United States Agency for International Development (USAID) aims to “prevent” disease outbreaks through disease surveillance and outbreak response, particularly for avian and pandemic influenza (http://www.usaid.gov/our_work/global_health/home/News/ai_docs/emerging_threats.pdf). Again, the focus is on reacting to infectious disease once it emerges rather than proactively preventing or reducing outbreaks. At one time, USAID did consider systematically using ecosystem indicators as early warnings of health crises (John Borrazzo, USAID, pers. comm.). However, the President's Malaria Initiative (PMI) chose instead the reactive approach of bed nets, insecticides and drug treatments (<http://www.fightingmalaria.gov/about/index.html>).

Models for achieving health security through conservation

More holistic and proactive models for health security do exist, however, they remain small in

scale or in pilot phases because health security, as it is defined in this paper, is a new line of business for the conservation and human health communities. What follow are examples of best practices in a nascent sector that could be instrumental in shifting the world's health security paradigm toward protecting ecological systems that protect human health at scale over the long term. Some include health security components, while others do not but are well suited to adaptation for health security outcomes.

Health-linked economic development directly from nature

International Cooperative Biodiversity Groups (ICBGs) are part of an “experimental effort” by the U.S. National Institutes of Health (NIH), the National Science Foundation (NSF) and USAID, developed in 1991 to combine drug development, biodiversity conservation and economic growth (Rosenthal, et al., 1999).

Managed by the Fogarty International Center at NIH, the ICBG program “aims to integrate improvement of human health through drug discovery, creation of incentives for conservation of biodiversity, and promotion of scientific research and sustainable economic activity that focuses on environment, health, equity and democracy,” according to the NIH website. “This program is based on the belief that discovery and development of pharmaceutical and other useful agents from natural products can, under appropriate circumstances, promote scientific capacity development and economic incentives to conserve the biological resources from which these products are derived.”

ICBG projects are each supported for five years and are carried out by coalitions comprised of scientists, drug companies, host governments and local stakeholders. They take place in high-biodiversity areas and focus on finding natural leads for treatments of AIDS, malaria, tuberculosis, cancers, heart disease, drug addiction and central nervous system disorders, including Alzheimer's disease, as well as new agents for crop protection and veterinary medicines. In addition to bioprospecting, projects include biodiversity surveys, examination and preservation of traditional medicine practices, development of long-term strategies for sustainable harvesting of natural products, training of local experts and stakeholders, transfer of technology, building host-country research institutions, and plans for sustaining successful outcomes.

Penal Colony Becomes ‘Gold Mine’ for World

The subject of one of the most successful International Conservation and Biodiversity Groups (ICBGs) is a former penal colony in Panama, which happened to be located on a pristine forested island surrounded by abundant coral reefs (Kursar, et al., 2007). Researchers found many “hits” for new compounds of potential medicinal or agricultural value – a “gold mine for the whole world,” according to Flora Katz of the Fogarty International Center.

Before long, local fishers agreed to help protect the site, Panama had declared it a national park, and UNESCO was considering it as a World Heritage Site. Meanwhile, Panamanian scientists had become co-investigators in the bio-prospecting, promising medicine leads were in pre-clinical trials for treating tropical diseases suffered in Panama, and Panama had established its own national institutes of health.

When a new government came into power in Panama, the Cinderella story appeared to have met an abrupt and untimely end. Permission for samples of newly discovered compounds to leave the country for testing was denied. Project executants spent the next two years caught up in convincing the new government to allow the *ex situ* testing to continue. Finally, permission was granted, and this project continues to be a model among ICBGs worth replicating.

To date, Fogarty has supported ICBGs in 22 countries, mostly in the tropics but also in Central and South America and Central Asia. While projects focused mainly on plants at first, they

more recently have uncovered a “whole new world of bioactive molecules in the ocean,” according to Fogarty Program Officer Flora Katz (pers. comm.). Through trials and errors over nearly 20 years, the ICBG program has created a robust model and an in-depth institutional capacity for addressing intellectual property rights, public/private coalition building and myriad other aspects of managing field projects aimed at protecting health security through protection of ecosystems and their services and products.

Direct payment for ecological stewardship

Another emerging model for preventing health *in*security through conservation of natural systems comes from China’s “eco compensation” programs. Although these programs do not target health security per se, they could be adapted readily to achieving health security outcomes.

In the past decade, China’s government has supported some \$90 billion in programs at national, provincial and municipal levels based on payment for ecological services (PES) and markets for ecological services (MES). These programs are aimed at reducing forest consumption and waterborne siltation, increasing forest volumes, protecting watersheds and natural forests, sand storm control, preventing desertification and promoting organic agriculture (Bennett, 2009).

Among the programs suitable for health security goals is a “green certification” program which charges “biodiversity offset” fees for development in natural areas such as “economic forestlands” that are home to trees and non-timber forest products of medicinal value. An environmental label certification system that feeds into a Green Purchasing Network could be adapted to ensure a sustainable supply chain for China’s mammoth traditional medicine manufacturing sector.

The Natural Forest Protection Program (NFPP), initiated in response to catastrophic flooding, focuses on watershed protection in 53% of China’s natural forests. The program claims to have reduced forest consumption by 426 million cubic meters, increased forest volume by 460 million cubic meters, reduced river siltation by 30% and increased wild golden monkey and giant panda populations (Bennett, 2009). Adding protection of medicinal plants and future medical leads to the mix of goals could be a relatively easy and low-cost health security enhancement.

By law, China’s Forest Ecosystem Compensation Fund (FECF) gives compensation to those who restore and/or protect “public benefit” forests, which already include forests that produce plants of medicinal value. Since it was implemented in 2004, the FECF has spent more than \$250 million for protection of more than 100 million hectares across 30 provinces.

Costa Rica provides another PES model, which has been in place since 1997 and seen the investment of more than \$6 million a year from consumer taxes on fossil fuel, carbon trading and World Bank/GEF investments. In this government-led program, forestland owners have been paid directly for climate controls, fresh water supplies, scenic value and biodiversity brought by forest protection, reforestation and sustainable forest management (Sanchez-Azofeifa, et al., 2007). The program is well suited to incorporating health security, which would enhance the targeting of nature ecosystems for their contribution to health goals and increase the resources available for conservation and compensation.

The ICBG and PES models summarized above, adopted and adapted under a health security umbrella, provide a market basis for conserving the health safety net provided by natural ecosystems. Greater investment in identifying the health values, the consequences of degradation and the level and means of compensation necessary to secure health contributions

of natural ecosystems is recommended. However, the market mechanism exists and is now being adapted to climate change mitigation (REDD+). Expansion of PES schemes to include health benefits is conceptually straightforward. Developing the science and economics required to establish sound PES for health security is a fundamental need.

Arguments for a new approach

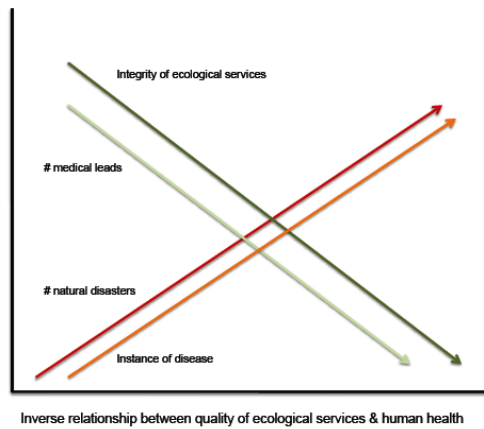
A few centuries ago, disease was widespread while medical expertise and medicines were in short supply. Today, modern medical technology is far more advanced, but disease remains widespread. New diseases are emerging while others are reemerging as they develop resistance to existing treatments. Fueling their spread has been unequal distribution of wealth and healthcare, and exponential human population growth. However, the degradation of natural resources and ecosystems has been the key initial cause of disease outbreaks. Disease crises loom as a potential global threat not just to human health but also to national and regional economic stability, as illustrated by the AIDS epidemic in Africa (Dixon, et al., 2002).

Examples of health security from intact ecosystems & their goods & services

Natural system	Health benefit	Risks from degradation
Forests	Climate control, pest control, water purification, wild foods, wild crop relatives, medicine and medicinal leads, disaster prevention and mitigation	Climatic change, increased disease vectors, increases in malaria, increased flooding and landslides, decreased water quality and availability, crop failures, loss of medicines and medicinal leads, heat-related illness
Rivers & stream flows	Clean drinking water for people & livestock; irrigation for food crops	Decrease in fresh water, crop failures, food shortages, water-borne illnesses, malnutrition
Coral reefs	Existing medicines and medical leads, source of recreation and jobs for ecotourism promoting mental health	Climate warming, reduced fish stocks, fewer medicines, fewer medical leads Malnutrition, untreated diseases

In some instances, the ties between intact ecosystems and health are clear, such as the protection of watersheds adjoining urban areas for the provision of ample clean drinking water to cities. About one-third of the 100 most populous cities in the world have already purchased land to protect their watershed (Dudley and Stolton, 2003). Planning for protection and provision of other essential ecosystem services at scale is largely neglected.

Human activity leads to loss of terrestrial, freshwater and ocean resources, which in turn leads to more contaminated water and air, more disease vectors and more devastating natural disasters, all of which lead to more human disease (Chivian and Bernstein, 2008). At the same time, leads for new medicines and agricultural protections from nature are lost. The good news comes in the reverse correlation: Preservation of ecosystems, and the biological diversity that underpins them, will prevent or mitigate human health crises and protect future disease treatments.



Unfortunately, the public and policymakers have little understanding of ecosystems and biodiversity, let alone what health benefits they provide. Modern social theory shows that behavioral change, even if it is beneficial to the individual or society at large, is unlikely to occur unless the rationale for change reaches deep moral values such as pride or security (Lakoff, 2004). Hence, there is a need for social marketing as well as science around health security.

The Alliance for Global Conservation's campaign for *The Global Conservation Act of 2010* in the United States is among a handful of start-up efforts to explicitly use the links between human and ecological health to generate public support for specific political action to protect ecosystems (<http://www.actforconservation.org/why-it-matters/human-health/>). This campaign is giving the cause a human face by enlisting spokespersons who have survived life-threatening diseases thanks to medicines from nature. Its messages include:

- Millions of people are alive today thanks to prescription drugs derived from pit vipers (high blood pressure), gila monsters (diabetes), marine sponges (AIDS) and the rosy periwinkle's little pink flowers (Hodgkin's lymphoma).
- One in three Americans suffers from a chronic disease that may be treated, or perhaps cured, by a drug from nature.
- Most people do not realize that half of all the drugs we use today came from places like forests and coral reefs, yet the loss of these natural areas is accelerating.
- At the current rate of destruction, we lose approximately one drug every two years – a drug that could cure a friend or loved one.

According to the text of *The Global Conservation Act*, each year nature contributes \$300 billion in benefits from wild species toward feeding people, brings clean water directly to at least 500 million people, keeps in check malaria, yellow fever, tuberculosis, AIDS, SARS and avian flu, and prevents \$9 billion in damage from flooding, drought and storms (http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=111_cong_bills&docid=f:h4959ih.txt.pdf).

New York Musician Saved By Rosy Periwinkle

My name is Dave Hahn and I'm a five-year cancer survivor. I believe that global conservation is vitally important, not just because it helps save Mother Nature, but because Mother Nature helped save me.

When I was diagnosed with cancer I was 24 years old and very sick. I'd lost 50 pounds, I was anemic, weak, and a large tumor had been found growing between my heart and spine. I was treated, and cured, by a chemotherapy treatment that included Vinblastine, a drug that originally came from a little flower in Madagascar.

The drug that cured me is only one of many life-saving drugs that have come from chemicals and compounds originally found in the wild. In fact, one third of Americans struggle with a chronic disease that can be treated or cured with a drug originally invented by Mother Nature. Yet, the planet's biodiversity is shrinking at an alarming rate - including in Madagascar, where 85% of the island's natural areas have been destroyed.

It's possible that I may need nature's help again one day. As effective and incredible as the drugs that saved me are, one major concern with current cancer treatments is that they make survivors like myself much more likely to develop secondary cancers, as well as heart and lung diseases, several decades later. So it is important to me, and to all chemotherapy survivors past and future, that we continue to both protect natural areas that may hold cures, and to allow researchers to continue to look for these medicines.

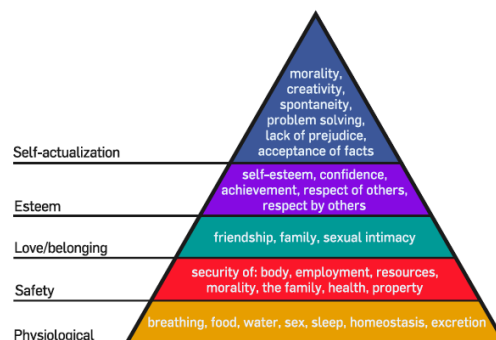
David J. Hahn

The Economics of Ecosystems and Biodiversity (TEEB) project of the United Nations Environment Program (UNEP) builds a similar case in economic detail and concludes that keeping natural systems up and running is far more economical than the nearly impossible and prohibitively expensive task of rebuilding or replacing the degraded natural underpinnings of human health and livelihoods (Balmford, et al., 2008). "An investment of \$45 billion could secure a global network of protected areas whose services are worth close to \$5 trillion annually," according to Achim Steiner, Executive Director of United Nations Environment Program (UNEP). "[That is] a return of 100 to one."

One estimate puts the cost of meeting the Millennium Development Goals (MDGs) for health at as much as \$100 billion (Pearson, 2009). This amount does not take into account the trillions of dollars spent on disease treatments in the developed world. What economies of scale – in terms of preventing suffering, deaths and costs – could be achieved if even 1% of that \$100 billion were invested in protecting intact ecosystems?

The Center for Health and the Global Environment, founded and run by doctors at Harvard Medical School, already has begun integrating awareness of health security from nature in medical schools and high schools across the United States; educating U.S. policymakers about the potential health effects of degraded ecosystem services; working closely with the American Medical Association to document and promote wider understanding of medical impacts of global climate changes; and collaborating with the Smithsonian Institution to create a major exhibit at the National Museum of Natural History illustrating the relationship between biodiversity and human health.

Intact ecosystems bring health and economic resources. The classic hierarchy of human needs (see figure below) puts security of health and resources right after the basics of air to breathe, food to eat, water to drink and sleep (Maslow and Lowery, 1998). These deep human values can be harnessed to motivate stakeholders at all levels of the global community to proactively participate in saving the ecological systems that will assure health security brought by nature over the long-term.



Health security opportunities for MacArthur

As an early investor in health security, the MacArthur Foundation has the opportunity to catalyze a new paradigm for nature conservation built around ensuring individual and communal wellness. Investments in specific sectors promise economies of scale due to existing programs and/or partners with the ability to leverage MacArthur funding manifold. What follow are suggested entry points for catalytic engagement:

1. Strengthening the science underpinning health security from nature

Scientific evidence already in hand points to ecological drivers of disease emergence, transmission and mitigation. Yet these complex interactions and relationships need to be better understood and more fully documented in order to target which ecosystems and which ecosystem services will be of greatest value to global health security over the long term.

The MacArthur Foundation could be instrumental in catalyzing a more expansive and robust body of research that, as a matter of urgency, 1) definitively documents the links between ecological disruptions and epidemiology, and 2) identifies key types and locations of ecosystems essential to preventing and/or mitigating health crises.

Epstein (2001) recommends integrating “health surveillance into long-term terrestrial and marine monitoring programs,” to better understand the many and changing synergies between ecological and human epidemiology. This knowledge could drive “early warning systems” to reduce the number of risks and deadly “surprises,” while facilitating more predictive and “timely, environmentally friendly public health interventions.” Furthermore, Epstein (2002) suggests that incidence of infectious disease could also serve as an early monitor of climatic changes.

2. Integrating nature’s ‘vaccine’ into philanthropy

The Bill & Melinda Gates Foundation alone has spent \$10 billion on health initiatives, most of which has been gone to treating (not preventing) malaria in Africa and Asia (<http://www.gatesfoundation.org/global-health/Pages/overview.aspx>). At the same time, the Intergovernmental Panel on Climate Change (IPCC) noted in its Fourth Assessment Report that computer models project two major changes in patterns of malaria transmission due to climate change: 1) many regions may experience longer seasons of malaria transmission, and 2) the incidence of the disease may increase in certain regions while decreasing in others (IPCC, 2007).

Given the many challenges that the public health and medical communities face in combating malaria and other infectious diseases over the coming decades, a more far-reaching and integrated approach to disease control is necessary. The MacArthur Foundation could be instrumental in convincing fellow donors to redirect some portion of the significant resources directed toward infectious disease treatments, insecticides, and vaccines toward promoting preventative measures from critical ecosystems that provide reduced health vulnerabilities locally and an increased pharmacopeia globally.

3. Mobilizing the private sector through CSR

The pharmaceutical and biotech industries are obvious partners for promoting global health security. Big pharma already is involved in two major tracks for corporate social responsibility (CSR) related to health. The first is the Pharmaceutical Industry Principles for Responsible Supply Chain Management, which mentions conservation of natural resources but actually focuses on preventing human health impacts from manufacturing waste and emissions. The second is development of treatments and vaccines for orphan diseases such as malaria, as specified in the MDGs.

Sustainability is definitely a key “horizon issue” for the pharmaceutical industry, according to Business for Social Responsibility (BSR), which advises the pharmaceutical and biotech industries on CSR strategies (Waage, et al., 2010). Ecosystem services considerations have caught the interest of corporate executives, however, creation and implementation of sustainability programs is not yet commensurate with the level of CEO interest (Bonin, et al., 2010). BSR suggests to its clients that while public discourse continues to focus on climate change, “a growing number of thought leaders are advocating that ecosystem services offer a way to aggregate multiple seemingly disparate environmental issues within a systems-based framework” and “business decision-makers are likely to find ecosystem services considerations relevant.”

Given this emerging private sector interest on ecological systems and the fact that big pharma and biotech are in the business of health and healing, the time seems exactly right for MacArthur to invest in ways to enlist these industries in sustaining health security brought by nature. CSR provides a credible entry point for catalyzing a new set of industry principles aimed at healing people through stewardship of ecological systems and the “health care” products they provide.

4. Targeting & scaling up payment for ecosystem services

Fiji hosted one of the Fogarty Center’s more successful ICBGs, in which three communities stopped harvesting natural coral from their reef in favor of growing coral for the aquarium industry on manmade “green rock” suspended above the reef. Meanwhile, they kept their fishing to sustainable levels and collected samples of compounds of potential medicinal or agricultural value (Leisher, et. al, 2007). The scheme was so successful that other communities wanted the program for their reefs (Aalbersberg, W., pers. comm.)

Unfortunately, up to the present, ICBGs have been one-off incubator projects, and none has been taken to national or even a regional scale. Under the umbrella of a health-security reserve system, MacArthur could bring the ICBG model to scale by applying it on a regional basis to an existing conservation focal area such as the Coral Triangle.

Large-scale opportunities also may exist in working with the governments of China, Costa Rica and other developing nations to link PES programs with targeted outcomes to health security.

Leveraging potential for health security investments

Sector with opportunity	Type of investment	Potential ecological impacts	Potential leverage amount
CSR	Incorporating ES into pharma industry ‘principles’	Millions of additional dollars spent annually on protecting ES	\$10 billion+
MDG diseases	Adding ES to investments in MDG diseases	Millions of additional dollars spent annually on protecting ES	\$21 billion+

TCM	Helping China's TCM industry manage for sustainability	Long-term sustainability of selected forests & coral reefs	\$1 billion+
ICBGs	Scale up existing models	Long-term sustainability of selected forests & coral reefs	\$6 million+/year

5. Bringing 'healers' into the mix

Traditionally, conservationists have played the primary role in advocating for efforts that promote environmental stewardship. Integrating health security into these efforts will attract new stakeholders, including public health advocates and the medical community. These two groups have extensive experience in increasing public awareness about threats to public health. In many countries, the public health and medical communities have established networks that reach even those in the most remote regions through campaigns that promote everything from vaccinations to clean drinking water.

The gravitas and established networks these groups can bring to promoting health security through environmental stewardship would be far-reaching and immediately credible with key target audiences. For example, public health advocates and physicians who currently work on malaria prevention through vector control could easily educate communities about the links between deforestation and malaria transmission. These groups often have earned the trust and respect of the communities in which they work, key policymakers and private sector partners critical to protecting the health security brought by nature.

Potential international NGO partners such as CARE, Doctors without Borders, and Family Health International, along with hundreds of smaller organizations, have decades of experience in disease prevention and economic development plus existing presence on the ground in key regions and communities. In the developed world, logical allies include the Center for Health and the Global Environment and medical associations in North America, Europe and Australia. Partnering with these organizations to promote health security through environmental stewardship could catalyze swift and lasting conservation and public health outcomes.

6. Securing traditional medicine supplies

As Thomas Bower of the Gates Foundation noted, supplying traditional medicines with raw materials from the wild is "tearing up the environment" (pers. comm.). According to the WHO, "The expanding herbal product market could drive over-harvesting of plants and threaten biodiversity" (<http://www.who.int/mediacentre/factsheets/fs134/en/>). Many plant and animal species over used in traditional and herbal medicines and health aids are so depleted that many are regulated in international trade under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

On March 12, 2010, the World Federation of Chinese Medicine Societies (WFCMS) in Beijing issued a groundbreaking statement urging its members to end all use of derivatives of endangered plants or animals. WFCMS is a quasi-governmental international organization associated with China's State Administration for Traditional Chinese Medicine (SATCM). Based in Beijing, the Federation has 195 member organizations spanning 57 nations where traditional Chinese medicine (TCM) is used.

This WFCMS statement marks the culmination of years of effort by the TCM and conservation communities to find common ground. The Federation and its member organizations are looking for guidance on how to create and manage a sustainable pharmacopeia. The MacArthur Foundation has a catalytic opportunity to foster collaborative efforts between the TCM industry

and conservation experts to ensure that ecosystems that produce today's TCM pharmacopeia are protected and sustainably managed, feeding safe, reliable and sustainable supply chains for wild medicinal products. Such an approach could leverage or expand China's existing "eco-compensation" programs and perhaps spawn a global system of sustainable management for traditional medicines from the wild.

7. 'Marketing' health from nature

The scientific evidence linking ecological systems and services with human health can only catalyze protection of nature if a communications "Trojan horse" is used to carry the information into the hearts and minds of the global public and key business leaders and policymakers. No one to date has marketed health from nature at a scale or level of professionalism worthy of note.

Only one social marketing campaign for conservation of any kind stands out worldwide, and that is WildAid's. WildAid uses "A-list" actors, athletes and politicians as spokespersons in Hollywood-quality productions carrying Madison-Avenue crafted messaging designed to grab the attention, hearts and minds of target audiences. WildAid does for wildlife conservation what Procter & Gamble have done for Crest toothpaste, Tide laundry detergent and Gillette razors. Using slogan's such as "When we all work together, we can do anything," WildAid ads, featuring Hollywood heavyweights and Olympic heroes, have been seen by millions of people in China and India, on television networks, in airports and taxis, aboard airlines and trains, and on billboards on some of the busiest thoroughfares in Asia.

To date, most conservation marketing dollars have been invested in branding conservation organizations rather than conservation issues. MacArthur investment in social marketing with WildAid's quality and reach could create a global "brand" and demand for protecting health security from nature. Target audiences would include the global public, industries linked to human health brought by ecological services (e.g. big pharma, biotech, traditional medicine and industrial agriculture), government policymakers and multilateral lending institutions.

8. Scaling up outcomes through collaboration

Conservation efforts often are weakened by competition between and lack of communication and collaboration among its key advocates – conservationists. Health security is a new "line of business" for conservation advocates, but already there are start-up enterprises related to health security appearing on the websites various organizations.

Before this new focus for conservation is further developed, the MacArthur Foundation could catalyze a more consolidated and effective global effort toward protecting health security from nature by supporting allied efforts that feed into a clearinghouse of news and information about who is undertaking and/or achieving what in the sector. This clearinghouse could serve the interests of NGOs, governments, the private sector and donors, helping them invest their contributions to health security in a ways that contribute to a rapid and measurable global response.

The Global Alliance for Conservation (<http://www.actforconservation.org/why-it-matters/human-health/>) would be a viable vehicle for fostering collaboration among health security efforts around the world.

Scale & scope of needed interventions

The need for greater awareness of the links between human health and ecological protection and/or degradation is global in scope and should include the general public, the private sector,

government policymakers, multi-lateral institutions and non-governmental organizations. Nothing short of a worldwide awareness-raising effort is needed.

With regard to on-the-ground protection and restoration of specific ecosystems or ecoregions to ensure health security, existing science does not point to China, India or Africa in particular, although the developing world certainly suffers most from untreated infectious diseases and deteriorating ecosystem services. Given that most of China's 1.3 billion people use medicines taken directly from nature, China is a logical starting point for catalyzing large-scale health security efforts. Existing science also suggests tropical and deep-ocean coral reefs as focal geographies, given their untapped treasure trove of leads for new medicines and agricultural protections.

At the same time, more biological and epidemiological research is essential for mapping the natural infrastructures that will be necessary to assure global health security through 2050 and beyond. UNEP's TEEB project is a logical source of better economic modeling of health security from nature.

Meanwhile, PES mechanisms already in place in China, Costa Rica and elsewhere provide operational means of relatively quickly integrating health values into payments for conservation and mobilizing growing donor and public interest in nature's preventative measures through on-the-ground results.

The authors recommend that the MacArthur Foundation invest simultaneously in the knowns and unknowns of health security from nature – supporting fundamental science while influencing public policy, enlisting logical donor partners, and forging market solutions with big pharma and helping the traditional Chinese medicine industry create a sustainable supply chain. Given the immediate opportunity to harness the desire for individual health to spur unprecedented support for protecting nature, it will be important to take high-profile field projects to scale at the same time as scientifically quantifying the myriad links between the state of ecosystem services and the state of human health.

Integrating health security to MacArthur's grant making

The MacArthur Foundation's Conservation and Sustainable Development grants have supported biodiversity surveys, community forestry frameworks, assessments of the vulnerability of ecosystems to climate change and coral reef protection. In many aspects, investing in health security as defined in this paper is a logical progression for MacArthur to build on its previous investments.

At another less critical time on Earth, an incremental approach to building a cohesive portfolio of health security investments would start with amassing additional scientific research on the links between human health and intact ecosystems. Unfortunately, the pace of ecological degradation on many fronts makes such an approach a luxury the world probably cannot afford.

What makes more sense at this critical point in history is phasing investment on multiple fronts. Research on causal links can certainly be stepped up while efforts are made to enlist potential donor partners such as the Gates Foundation and the pharmaceutical industry in joining MacArthur in support of securing natural systems already linked to health security (e.g. tropical and deep-water coral reefs).

Securing a sustainable supply chain for the massive traditional Chinese medicine industry is an immediate opportunity on offer by the industry itself and likely to garner support from the

Government of China, the World Health Organization, development agencies and donor partners.

Meanwhile, collaborations between NGOs in the public health and environmental sectors will be most successful if begun at the outset, before health security becomes as crowded a field as climate security, food security and freshwater security. The MacArthur Foundation holds enormous power to motivate otherwise disparate and competitive organizations to ally health security efforts in order to scale up conservation outcomes.

Potential results from MacArthur's entry into health security

Increasing evidence suggests life on Earth is entering a new period of emerging infectious diseases and increased natural disasters in terms of both frequency and magnitude. By implementing the health security program outlined above, the MacArthur Foundation could be catalytic in saving millions of lives while protecting irreplaceable health-sustaining natural systems over the long term.

Ecosystem degradation has been linked to diseases that impact millions of people per year and cost the world economy billions of dollars annually. Specifically, forest degradation and fragmentation have been linked to increased transmission of infectious diseases such as malaria, Lyme disease, schistosomiasis and leishmaniasis and may impact the distribution of many other disease microbes (Patz, et al., 2004). Mitigating the mortality, morbidity, and cost associated with these three diseases alone would make a health security initiative based on protection of ecological systems worthwhile.

However, the health security initiative being proposed for MacArthur is about so much more than three diseases and the 100 million+ lives they affect annually. It could yield health and wellness outcomes including:

- ✓ Sustainability for traditional medicines on which at least 80% of the world relies, valued at more than \$200 billion annually, along with protection of large tracts of nature forests and coral reefs stretching across multiple nations.
- ✓ Protection of medical leads for current diseases that have no treatment, including many cancers, Alzheimer's and antibiotic-resistant infections, along conservation of natural forest tracts and coral reefs in tropical seas and deep oceans.
- ✓ Prevention of illness and countless deaths from cholera and other water-borne diseases, along with protection of large tracts of natural forest and their watersheds.
- ✓ Prevention and/or mitigation of disease and death brought by natural disasters such as tsunamis, mudslides and hurricanes, along with protection of mangrove forests and coral reefs.
- ✓ Enlisting the vested interests of the entire global community in protection of and payment for natural ecological systems and services, along with sustaining a living planet over the long term.

In taking early leadership in ensuring continued health security from nature, the MacArthur Foundation can catalyze more equitable, accessible and sustainable health "insurance" for the world, while slowing and perhaps reversing what Epstein (2001) calls the "mounting environmental assaults on public health."

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