

The environment is closely linked to health issues and human well-being. Excessive and wasteful consumption, social inequality and inefficient use of resources perpetuate a vicious circle of pollution and resource degradation that fuels poverty and destroys livelihoods. These conditions severely harm adults and children,

particularly those living in ecologically vulnerable areas. Up to 20% of the disease burden in developing countries may be due to environmental risk factors (as with malaria and parasitic infections).

Environmental change and infectious diseases

By **Bruce A. Wilcox** and **Duane J. Gubler**, Asia-Pacific Institute of Tropical Medicine and Infectious Diseases University of Hawaii

Over the last 30 years the reversal in the declining death rate due to infectious diseases has alarmed international health experts. Dramatic successes in eradicating small pox, controlling polio and tuberculosis, and eliminating vector-borne diseases such as yellow fever, dengue and malaria from many regions convinced most experts the era of infectious diseases would soon be over. Unfortunately this optimistic prognosis was premature as a number of diseases have dramatically re-emerged. Tuberculosis, cholera, dengue, plague and malaria have increased in incidence or geographic range, as have new drug-resistant strains of bacteria. In addition newly recognised diseases, such as Aids or Sars, have emerged.

The present global emergence of infectious diseases is clearly associated with the social and demographic changes of the past 50 years, particularly urbanisation and globalisation, with the attendant spread of pathogens (agents causing disease) via infected humans, hosts, vectors or commodities. The change in the environment caused by human activities is also apparent in the transformation of much of our landscape and conversion of regional systems once dominated by natural ecosystems. Factors include expansion into urban or peri-urban habitat, deforestation, and the spread of intensive farming. The environment's role in the emergence of diseases is apparent in the connections between the direct consequences of human changes to urban and rural landscapes and ecosystems, and the secondary effects on disease emergence factors. Developing irrigated agriculture, for example, can create breeding grounds for mosquitoes, a vector for malaria. Likewise the inadequate storm drainage and sewerage systems often associated with rapid urbanisation not only increase the breeding habitat for disease vectors but facilitate the spread of water-borne pathogens causing cholera and leptospirosis.

Overwhelming evidence points to human demographic changes as the major driver

and indirect factor contributing to the increase in infectious disease, with somewhat different dynamics and mechanisms at work in urban and rural environments. In the first case the increasing number of people crowded into dense settlements has dramatically increased opportunities for food, water, rodent and vector-borne pathogens to "colonise" and persist in human populations. Each pathogen has unique transmission and adaptive characteristics that determine a minimum population for survival (the threshold for measles is about 250,000 people). Whether the threshold is 100,000 or a million the number of large urban settlements and the average settlement size has been growing fast in recent decades. The number of cities of one million or larger was 76 in 1950, 522 in 1975, 1,122 in 2000, and is set to exceed 1,600 by 2015. This 20-fold increase translates to a roughly similar increase in global infectious disease vulnerability due to this one factor alone.

This type of growth has indirect social and environmental consequences that contribute to multiplying the actual increase in population. Poverty, poor living conditions, including lack of sanitation and infrastructure for waste-water and solid waste management, increases opportunities for vector-borne diseases and others passing from animals to humans. The geographic spread and expansion into peri-urban areas of the mosquito *Aedes albopictus*, exquisitely adapted for breeding in discarded plastic containers and used automobile tires, is a good example of how a potential vector of viral diseases has taken advantage of environmental change. Lack of sanitation and waste water treatment, and industrial-scale intensification of animal production systems the world over, contribute to exotic species, and the proliferation and spread of water and food-borne pathogens. Increasingly frequent outbreaks of infections are caused by these and other organisms, many of which may eat alongside or prey on wild mammals and birds as natural parasites. The contamination of surface waters and spread of pathogens is further promoted by the alteration of catchments and watersheds accompanying urbanisation, and intensive farming around cities. Channelling streams, removing vegetation on the banks, and filling in wetland – all

of which accompany unplanned urbanisation – eliminate the natural retention and nutrient recycling systems, as well as barriers to surface run-off contaminated with intestinal pathogens. Nutrient pollution leading to oxygen depletion in estuaries, lakes, streams and even stretches of ocean, such as the Gulf of Mexico, helps such pathogens survive too.

In rural areas population and consumption play a less direct role in contributing to disease emergence, particularly as rural emigration is fuelling the demographic explosion in cities. It is more that urban areas are driving a sustained increase in the timber trade, agriculture, stock raising and mining, resulting in turn in deforestation and changes in land use that are transforming rural landscapes and natural areas in ways that often facilitate the emergence of disease. Deforestation or even "patchy" reforestation leads to ecological changes such as increased edge habitat and local extinction of predators that favour some disease vectors and reservoir species. Encroachment of individuals and settlements on natural ecosystems brings humans into contact with known and novel

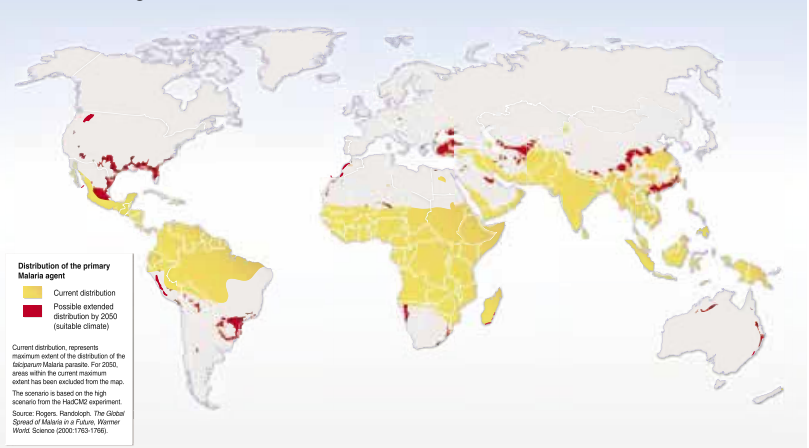
pathogens. The spread and intensification of farming results in the development of irrigation systems, ideal breeding sites for mosquitoes and a habitat for opportunistic insects and rodents that may be vectors or reservoirs for disease. Dams provide a favourable habitat for other vectors.

Climate change represents a potential environmental factor affecting disease emergence. Shifts in the geographic ranges of hosts and vector, the effect of increasing temperature on reproductive, development and mortality rates on hosts, vectors, and pathogens, and the effects of increased climate variability on flooding and droughts all have the potential to affect disease incidence and emergence positively or negatively. At present there is insufficient evidence to indicate what the net effect will be once climate changes begin to have a major affect on ecosystems. However, a dominant theme emerging from research on the ecology of infectious disease is that accelerated and abrupt environmental change, whether natural or caused by humans, may provide conditions conducive to pathogen emergence: pathogen

adaptation, host switching, and active or passive or dispersal.

The resurgence of infectious diseases worldwide reflects our quick-fix mentality, with poor development planning, a lack of political determination and institutional inertia. It is not the inevitable result of development, environmental change, or even incremental population growth. On the contrary much can be done to reverse the current trend. As well as rebuilding the public health infrastructure for infectious diseases, there is substantial evidence and a growing number of examples of how regional planning and development, including urbanisation, agricultural expansion, and the management and conservation of forests and other ecosystems can minimise and even reduce outbreaks of infectious disease as well as environmental damage. Basically we need an integrated approach to pathogen control. This approach will involve meshing social and economic development programmes, environmental and natural resource management, with intervention based on the reinvigorated field of disease ecology and methods involving community participation.

Climate Change and Malaria



The burden of sub-Saharan Africa: Aids, poverty and natural resource degradation

By **Melissa Thaxton**, policy analyst for the Population Reference Bureau

Over the last few decades, the isolated villages of Tanzania's northern coast have been transformed into a highly competitive market economy based on the marine fish trade. Many young men have been lured to the region by the prospect of seasonal employment.

The arrival of a highly mobile male population – ill-informed about condom use and HIV-Aids generally – in a region, where poverty is chronic and women experience very low status, has generated a culture of high-risk sexual behaviour and soaring HIV prevalence rates. Indeed Aids is now an important part of poverty, natural resource degradation, and ill health in these communities.

This vicious circle is hardly confined to coastal Tanzania. In sub-Saharan Africa, where HIV-Aids is most prevalent, the links between Aids, poverty, gender roles and natural resource degradation are just beginning to be understood. The integrated nature of these issues will require creative solutions that combine

sustainable and appropriate community-level interventions, with district- and national-level policies and practices based on good governance principles.

Women in northern coastal Tanzania – who have always had primary responsibility for rearing children and securing adequate household resources – have been particularly hard hit both by a declining economy and a degraded environment. Fish catches and agricultural productivity are dropping, and their husbands are spending more on alcohol and sex, driving many of these women to seek cash income.

But such opportunities have been dwindling. Increased shoreline and near-shore ocean water temperatures have killed off large portions of the area's seaweed farms. Disease and marauding wildlife have decimated cashew and fruit crops. Women in Tanzania also have severely limited access to education, employment, credit and transportation. As a result they are increasingly turning to sex work, running a high risk of HIV infection.

Because Aids often affects people in their prime working ages – between 25

and 45 – the poverty that the epidemic precipitates can severely degrade natural resources and agricultural productivity. These impacts can be particularly severe in regions and communities where livelihoods depend a great deal on forests, agriculture or fishing.

As men and women with Aids die or become too ill to work, their family members are often forced to find new income sources – which can ultimately lead to more intense and less sustainable use and extraction of resources. In eastern and southern Africa such practices often include the unsustainable harvesting and sale of forest products such as wild foods and medicinal plants. Woodcutting is on the increase to produce charcoal for sale, especially when families face severe food shortages. In coastal areas widowed women and their children, desperate to make a living from declining shallow water fish stocks, are increasingly using small-mesh fishing nets fuelling the vicious circle of resource depletion.

In Malawi poaching has increased over the past two decades in forested areas near communities where HIV-Aids rates are particularly high. Local forest managers

and community members responsible for law-enforcement connect the two developments. Poaching has apparently provided a lucrative source of income for Aids sufferers or their families.

Increased demand for coffins because of high death rates from Aids has contributed to unsustainable harvesting of some forests in southern Africa. Along the Limpopo watershed – which crosses the boundaries of Mozambique, Zimbabwe and South Africa – surveys show increased timber extraction from community and national forests to make coffins. Firewood is also being cut to cook food and provide warmth at a seemingly endless succession of funerals. Finally such events keep working adults away from their jobs, lowering productivity and increasing poverty.

Governance plays a crucial role in the long-term fight against environmental degradation, particularly when it is brought on by poverty and ill health. Governments must start by engaging participatory decision-making processes at all levels. They must then deliver good quality public services, especially health (including voluntary counselling and test-

ing) and education (including access to information about nutrition and Aids).

In many developing countries reasonable, profitable use of forests and coastal resources will require increasing local organisational and enterprise-management capacity to stem corruption and favour transparent, collaborative participation by local communities. A number of specific actions may be required. The level of environmental advocacy can be increased and robust policies adopted to promote gender equality. Laws must be framed and enforced guaranteeing women's right to land and property inheritance. District and local authorities need greater capacity to set priorities and manage budgets, particularly for Aids activities. Lastly it is urgent to improve access to and control of natural resources by communities and other local organizations.

Sources: The Population, Equity, Aids, and Coastal Ecosystems Project (PEACE) implemented by the University of Rhode Island/Coastal Resources Centre, Tanzania Coastal Resource Management Project (TCMP), Population Reference Bureau (PRB), and IUCN; and the Wildlife and Environmental Society of Malawi.



Armenian artwork depicting the Millennium Development Goals (UNDP Armenia)

Maximising returns on development investment

By **Diarmid Campbell-Lendrum**, HELI secretariat, World Health Organisation; **Hamed Bakir**, WHO Regional Centre for Environmental Health Activities, Amman, Jordan; and **Pierre Quilber**, HELI secretariat, UNEP

Even while his country was still recovering from the impact of the devastating tsunami that hit southeast Asia late last year, Maumoon Abdul Gayoom, President of the Maldives, urged the international public health community to think ahead about less apparent but equally critical long term threats to health and well-being.

Opening the World Health Assembly in May 2005, President Gayoom noted that while natural disasters and global pandemics such as Aids grab headlines, local forms of environmental pollution, as well as global environmental changes, can also have profound impacts on health. In the case of Small Island States like the Maldives, trends such as climate change, can threaten the "very survival of the nation".

"Rising temperatures could kill the coral which forms the basis of our habitat. We would indeed suffer economic ruin if corals die, but it would also starve the nation of essential supplies of fish which forms part of the staple. Moreover, global warming would also alter the epidemiological pattern, with an increase in vector-borne diseases and the emergence of more virulent forms of tropical diseases. And perhaps what is worse, as the seas rise, the water aquifers and the soil are likely to be poisoned by excess salination," he told an Assembly focused on tackling the most urgent threats to health.

"The links between the environment and health show that addressing the challenges in both areas calls for a global partnership, where everyone becomes part of the solution and none a problem... at the end of the day, prevention is still

better than cure. And let that be our goal in promoting environmental health," he added.

There are some grounds for hope; partnerships are beginning to be formed that view environment and health as integrally linked, and consider the threats posed by emerging issues, such as global environmental change, in an integrated manner. The recent Millennium Ecosystem Assessment, carried out by the UN and specialised agencies from climate stabilisation to food production, underpin all aspects of human health and well-being. The report stresses that the Earth's natural resources are being strained to capacity and the harmful consequences of this degradation to human health are already being felt. Impacts could grow significantly worse over the next 50 years.

The assessment's health synthesis report notes, for example, that at least five out of the top 10 infectious disease killers globally, from malaria to dengue to diarrhoea, are closely related to environmental factors, such as water availability and climate conditions. While such relationships are well established at a local level, the report also shows how global changes, such as the widespread degradation of freshwater supplies, and the fact that global temperatures are increasing at their fastest rates for at least the last 10,000 years can impact on local effects. It documents interconnections too, pointing out how actions to improve certain aspects of human well-being can have a wide range of important consequences, including for health. For example, it is becoming clear that certain consumption habits probably helped diseases such as Sars to cross over to human populations. Similarly agricultural practices that create new ecological interactions, have increased the risk of avian influenza becoming a global pandemic, with potentially devastating consequences.

Demonstrating a threat does not provide a solution in itself. As many health risks

arise from complex, competing needs, they cannot always be solved by simple fixes. For example, irrigation schemes can increase agricultural production and local incomes, but can also provide habitats for mosquitoes and snails, enhancing transmission of diseases such as malaria and bilharzia (schistosomiasis). These kinds of situation require integrated decision-making, taking full account of the services that the environment provides to all aspects of well-being, from health, to security and personal wealth.

The need for such cross-sectoral solutions is also increasingly recognised at an international level. The final report of the United Nations Millennium Project, "Investing in Development," outlines a practical plan for allowing the poorest countries to achieve the Millennium Development Goals by 2015. Underlining the vital link between the environment and defeating poverty, it notes that interventions that are implemented outside the health sector, such as improving the quantity and quality of water, or environmental conditions, provide the double benefit of addressing the MDGs on child mortality and environmental sustainability.

There are now some examples of an integrated approach to health, environment and development: the Canadian International Development Research Centre is promoting an Ecohealth approach; and a range of impact assessment procedures are being used in large-scale, donor-driven developments. But they are few and far between. Intersectoral actions are sometimes said to be "Blessed by everyone, and funded by no-one". The two most effective ways of convincing a sceptical decision-maker are, first, to demonstrate that integration makes sound economic sense, and second, to quote case studies in which a cross-sectoral partnership has actually worked on the ground, providing more convincing recommendations.

Recent work within the joint UNEP/WHO Health and Environment Linkages Initiative has shown that such partnerships can work, and that efficient integrated management of ecosystem services can show a big return on investment. One country assessment under this initiative is addressing water demand management in Jordan. It is one of the world's most water-stressed countries, and the water it does have comes from underground aquifers with finite reserves. At the same time water-efficiency in farming is low, and approximately 30% of the domestic supply is lost through leakages. Although the entire population is connected to a high quality piped water supply, many poorer households use very little water each day. The net result is wastage of a precious resource, with far-reaching implications. Along with the direct economic cost of lost water, rapid water extraction requires imported energy for pumping and brings forward the date at which aquifers will dry up. An initial assessment has shown that households with low levels of domestic water consumption also tend to have higher diarrhoea rates (a complete analysis of this relationship is still under way).

The WHO Centre for Environmental Health Activities in Amman formed a national team of academic researchers along with representatives of the national Ministries of Health, Water, and Environment to examine the costs and benefits of a series of government proposals for investment in water efficiency. The assessment identified a wide range of benefits, but assigned money value to only a few of these: economic gains from reduced water loss, health gains from fewer cases of diarrhoea, and environmental benefits in terms of reduced costs of water-pumping. A series of conservative assumptions were also made: a high discount rate on the investment (decreasing the apparent value of future benefits), and ignoring the probability that both water and energy costs may well increase in the future.

Even this "complete cost, incomplete benefit" analysis suggests that water efficiency measures are a good deal. Each dollar invested towards reaching the most ambitious water efficiency target should bring a return of \$1.71 to \$1.84 from the economic, environmental and health benefits examined, with the precise value depending on the degree to which it is assumed that increasing domestic water supply has a direct causal effect on reducing diarrhoea rates. A more complete account of benefits would make the investments look even more attractive; but this group reckoned they could already conclude that investing in water efficiency was money well spent.

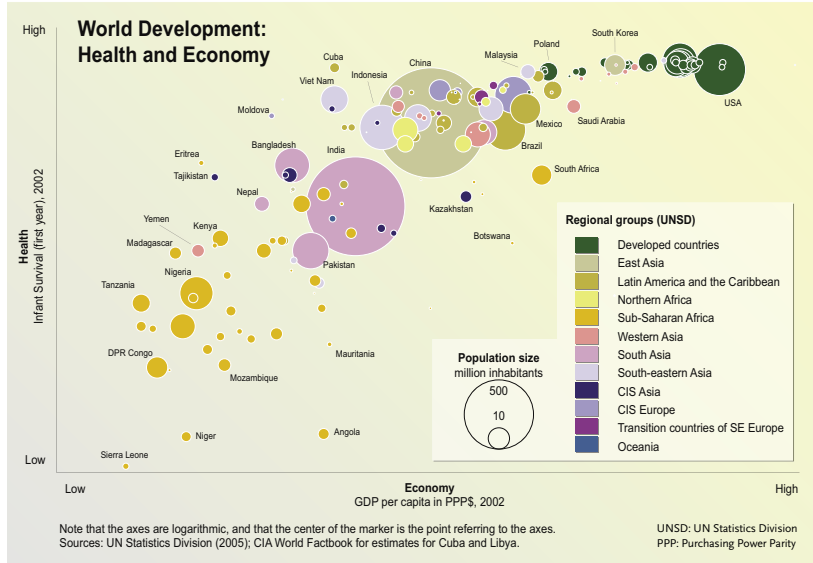
The intersectoral group recommended that the Government adopt the most ambitious of its options for improving water efficiency, and that it should consider accelerating implementation to maximise the return on its investment. They also went beyond the economic assessment, proposing that measures be introduced to ensure that water savings are directed to the poorest populations, in order to reap the greatest benefits.

Working across sectors is notoriously difficult, and requires flexibility and understanding from all concerned. But the fact that all of the major government agencies, along with other actors, were involved from the beginning of the process, increased the scope and quality of the assessment. The fact too that they shared data, and were able to agree a set of consensus recommendations, strengthens the case for coherent and cost-effective government action. In the Jordanian experience, all the partners involved are now convinced that it is only by addressing health and environment issues together that the real value of each can be fully appreciated. Through their efforts and results they demonstrate that, in the long run, investing time and understanding to build partnerships can also pay dividends.

Facts and figures

- Everyday HIV/Aids kills 6,000 people and another 8,200 people are infected with this deadly virus¹.
- In just two years between 2001 and 2003 the global number of children orphaned due to Aids has risen from 11.5 million to 15 million – the vast majority in Africa².
- Tuberculosis is the leading Aids-related killer and in some parts of Africa, 75 percent of people with HIV also have Tuberculosis³.
- Each year, approximately 300 to 500 million people are infected with malaria. Approximately three million people die as a result¹.
- In Africa, malaria is the leading cause of death for children under five years, causing at least 20 per cent of all deaths. Children recovering from malaria infections may be left with significant mental and physical disability³.
- Malaria was the fifth most common cause of death due to communicable diseases in 1999 after respiratory infections, HIV and Aids, diarrhoea and tuberculosis. It kills between 1.1 and 2.7 million people each year, of whom about 1 million are children under 5 years in sub-Saharan Africa³.
- More than 50 percent of Africans suffer from water-related diseases such as cholera and infant diarrhoea¹.

1. UN Millennium Project, 2005.
2. Orphans: Children On The Brink, 2004.
3. DFID Factsheet on Malaria, 2004.



Goal 5: Improve maternal health • Reduce by three quarters the maternal mortality ratio.
Goal 4: Reduce child mortality • Reduce by two thirds the mortality rate among children under five.