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**FORESTS AND
HUMAN HEALTH**

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Cover photo: Women gathering medicinal plants (*Combretum micranthum*) from the forest, Guinea
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Forests and human health

Human health is defined by the World Health Organization (WHO) as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”. This issue of *Unasylva* examines how forests and health are intertwined.

For the compilation of this issue, FAO is greatly indebted to the Center for International Forestry Research (CIFOR), which has been investigating this topic for the past three years. CIFOR researchers – especially E. Dounias and C.J.P. Colfer – helped plan the issue, contributed to it and enhanced its quality as guest reviewers. The first article, by Colfer and colleagues, reviews recent CIFOR research to provide an overview of the state of human health in forest areas (which are often remote from medical care) and a summary of the causal links between forests and human health.

A recently explored link is that between forest area change (particularly deforestation and forest fragmentation) and the emergence of new infectious diseases (e.g. HIV, Ebola virus) which often originate in animals. B.A. Wilcox and B. Ellis highlight the most prominent forest-associated diseases and summarize factors contributing to their spread: expansion of human populations into forest areas, with increased human exposure to wildlife; modified abundance or dispersal of pathogen hosts and vectors as a result of forest alteration; and altered hydrological functions that may favour waterborne pathogens.

Forest resource management measures can thus help mitigate disease. An example is the use of afforestation to reclaim swamplands, which helped control malaria in early twentieth-century Italy.

AIDS is having a large impact on woodland communities, particularly in Africa. C. Holding Anyonge *et al.* document the increased dependence of HIV- and AIDS-affected communities on forest resources – particularly for medicines, energy and food – and explore the resource management implications, highlighting some interventions that might help lessen the impact.

Local knowledge of medicinal plants forms the basis for traditional health care and is also used to derive modern pharmaceuticals. Protecting the rights of rural people to share the benefits from the use of their knowledge and resources is a challenge addressed by the Convention on Biological Diversity (CBD). A short contribution by J. Muriuki summarizes recent efforts in Africa to develop herbal antimalarial drugs (many based on forest species) – noting their enormous

potential, as well as implications for local populations and natural resource conservation.

Next, E. Dounias and A. Froment show how the settlement of nomadic forest dwellers exposes them to unfamiliar diseases and dietary influences – but also to societal ills such as economic insecurity, social prejudice and denial of traditional rights, which can have an equally profound impact on health. Thus in addition to improved medical care, sociopolitical support and access to education are key to the healthy future of these groups.

Forest ecosystems not only contribute to the diets and subsistence of forest dwellers; they also provide a significant portion of the food and medicines consumed by urban populations. T. Johns and P. Maundu examine the link between forest biodiversity and contemporary market-oriented food systems – providing an argument for integrating conservation of forest biodiversity with objectives of poverty reduction, food security and disease reduction in development policies.

Fuelwood is essential to the livelihoods of millions of households in developing countries, but when it goes up in smoke it can threaten respiratory health. K.R. Smith highlights efforts to ameliorate the problem, such as promoting improved stoves. Smoke from forest fires can also threaten the health of large populations – to the extent that in Southeast Asia, countries have adopted an Agreement on Transboundary Haze Pollution.

Forests also have a role in improving the human environment for better health – for example, by absorbing airborne pollution (a recognized role of urban forests, for example); by taking up heavy metals, radionuclides and other pollutants from soil; and by helping to ensure water quality. J. Křeček and Z. Hořická document the role of watershed forests in mediating acid rain caused by air pollution in Central Europe’s “Black Triangle”. A short contribution examines the degree to which mangroves and other coastal forests can help protect human lives by defending against tsunamis and other coastal hazards.

B. Moore, G. Allard and M. Malagnoux look at a prickly problem for some forest workers and others who spend time in the forest: allergens and irritants from forest insects, plants and trees which can cause skin and respiratory troubles.

Finally, L. O’Brien notes that many European countries are focusing on using trees and woodlands to improve people’s mental and physical health and well-being – as illustrated by varied initiatives in the United Kingdom.

These articles, far more than merely pointing out health problems related to forests, all underline the role that the forest sector and national forestry departments can and often already do play in ensuring human well-being through responsible forest management.

Forests and human health in the tropics: some important connections

C.J.P. Colfer, D. Sheil, D. Kaimowitz and M. Kishi

An overview of the state of human health in and around forests, and the causal links between forests and human health.

Why should foresters concern themselves with issues of human health? There are at least two important answers to this question. First, and perhaps most fundamental, forestry activities affect human health and human health affects forests. Second, the United Nations Millennium Development Goals (MDGs) (see Box), which the world's countries have committed to meet by 2015, reflect increasing global concern about human health. Four of the MDGs (1, 4, 5 and 6) address health directly. It can also be argued that improvements in human health (as part of human well-being) are a prerequisite for accomplishing the seventh goal, which is the most pertinent for foresters.

The second and third MDGs stress or imply gender equity. These goals also have fairly direct implications for human health, given the central role women typically play in family health maintenance. In most places it is women who

provide families with nutritious meals and maintain standards of hygiene. In forested areas, women's roles also involve interaction with forests and other natural resources (for non-wood forest products [NWFPs], clean and abundant water, forest agriculture, etc.). As the primary caretakers when other family members fall ill, women in forested areas often treat their family members with forest products. Finally, women are central players in decisions about family size; large families can adversely affect the health of both mother and offspring, and often adversely affect the health of forests as well.

Even the realization of the eighth MDG, related to global partnerships, could contribute to improved human and forest health.

As with many statistics pertaining to forests, global and regional statistics about the health of people living in forests are subject to some question. But a sense of the magnitude of both health problems for people and the links between forests and health can be grasped from the following sprinkling of statistics.

- Smoke from fuelwood and forest fires causes significant human respiratory problems. Smoke from simple biomass fuels may account for 1 million to 2 million premature deaths annually, mainly women and small children in developing countries (see Smith, this issue of *Unasylva*). Smoke plumes from forest fires can travel hundreds of kilometres, posing a great health risk; the extensive 1997 Indonesian forest fires caused an estimated 16 400 infant and foetal deaths

Millennium Development Goals

1. Eradicate extreme poverty and hunger
2. Achieve universal primary education
3. Promote gender equality and empower women
4. Reduce child mortality
5. Improve maternal health
6. Combat HIV/AIDS, malaria and other diseases
7. Ensure environmental sustainability
8. Develop a global partnership for development

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David Kaimowitz, an economist, was CIFOR Director-General until August 2006 and is currently Program Officer for Environment and Development for the Ford Foundation, Mexico.

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Remote forested areas may have difficulty attracting doctors, nurses and health system administrators (a clinic in Mexico)

(Jayachandran, 2005) (see page 45 regarding health guidelines for fire events).

- Anyinam (1995) reports that in India alone, some 2 500 plants are used medicinally, and Shankar and Majumdar (1997) add that for 400 million to 500 million Indians, traditional medicine is the only option.
- Seventy to 80 percent of Africans consult traditional medical practitioners who often rely on medicinal plants. The United Republic of Tanzania, for instance, was reported to have 30 000 to 40 000 traditional practitioners compared with only 600 western doctors (Cunningham, 1993).
- US\$75 billion of pharmaceuticals of natural origin are sold each year (Kate and Laird, 1999).

The ubiquity of serious health problems, such as human immunodeficiency virus and acquired immunodeficiency syndrome (HIV and AIDS), Ebola and malaria, is counterbalanced by the (sometimes) recognized value of traditional knowledge and use of medicinal plants as alternatives to modern medicine.

Because forests, almost by definition, have lower population densities than urban areas or agricultural landscapes, people living in forest areas tend to be

disregarded in formal health care systems and research. They are often difficult to reach, and remote forested areas may have difficulty attracting doctors, nurses and health system administrators.

There are both ethical and practical reasons for reversing this trend. Justice demands greater attention to those with inequitable access to good health, by whatever means; and forest dwellers have knowledge and capabilities that can meaningfully contribute to improved forest management. This article identi-

fies four central links between forests and human health, focusing on two central questions:

- What are the human health conditions in and around forests?
- What are the causal links between forests and human health?

Finally, the article provides some policy recommendations targeted to specific actors such as health professionals or foresters.

The article draws heavily on recent research of the Center for International Forestry Research (CIFOR) (see Box). Much of this research concerns topics covered in depth in the other contributions in this issue; this article focuses on those topics that are less fully developed elsewhere in the issue. Most of the findings concern humid tropical forests, with lesser attention to dry forests, forest margins and previously forested areas.

HUMAN HEALTH–FOREST LINKS

Forests do not have the same importance in the daily life of all people living in and near the forest; their importance varies along a continuum from hunter-gatherers to swidden farmers, to recent in-migrants, to agriculturists, to urban dwellers (see Figure).

CIFOR and human health research

The Center for International Forestry Research (CIFOR) recognized the importance of human health in forest management in the mid-1990s. Some 20 interdisciplinary teams of researchers, working in ten countries in the developed and developing world, looking at forests managed for timber, plantations, and community use, all concluded that human health was an important element in sustainable forest management. Health professionals have also identified important links between the environment and health (e.g. Engelman, 1998; Gardner-Outlaw and Engelman, 1999; Walsh, Molyneux and Birley, 1993; Patz *et al.*, 2000; Patz and Wolfe, 2002).

In 2003, CIFOR initiated a review of the literature on human health and forests which included specialist workshops, interviews with experts, continuing field observations and the collection of over 600 studies and analyses. The full results are reported in Colfer, Sheil and Kishi (2006).

More information on CIFOR's work on human health is available at: www.cifor.cgiar.org/Research/Livelihoods/MainActivities/ForestHealth

Hunter-gatherers and swidden farmers depend on forests most fundamentally in terms of subsistence, health, income and culture; their total way of life may depend on the forest. They are likely to have useful stores of indigenous knowledge that can be tapped to improve forest management. Recent in-migrants may be just as dependent on forests for subsistence, but may have neither in-depth knowledge of local species, habitats and behaviour nor the associated symbolic and cultural ties and values that still enrich the lives of many forest dwellers. Settled farmers and urban dwellers may want to buy forest products or may depend on the forest for fuel or medicine, but are far less enmeshed in its sustainability or cultural significance.

To improve human health and forest sustainability, it is necessary to consider which categories local populations belong to and to assess how forest dwellers can contribute to improving forest management. It is also necessary to take note of variations in forest knowledge and use within forest communities (by age, gender, caste, etc.). As the articles in this issue show, interventions in forests, both harmful and benign, have implications for other populations, as has been dramatically and negatively shown in



*People residing in and near forests typically obtain a considerable, although variable, amount of nutritious foods from forests – with poor people generally more dependent on such food (children eating fruits of *Borassus aethiopicum*, Senegal)*

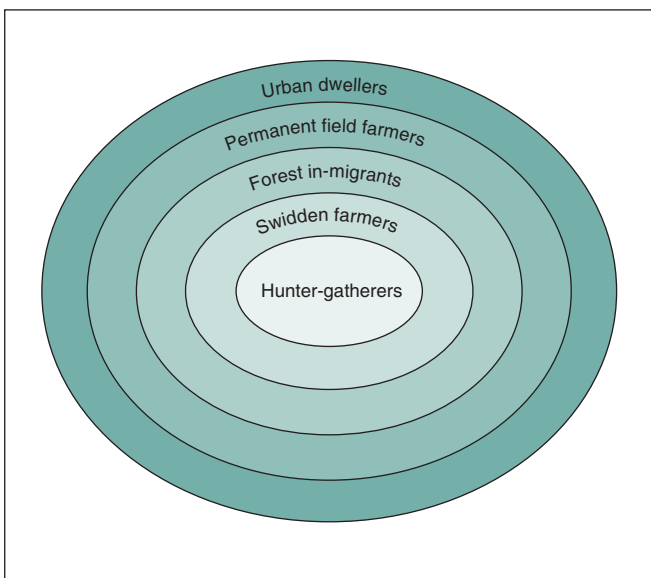
recent years with diseases emerging from forests such as severe acute respiratory syndrome (SARS).

Food and nutrition

Although the potential of forests for improving livelihoods may be small, forests serve as important safety nets. People residing in and near forests typically obtain a considerable, although variable, amount of nutritious foods from forests (see Dounias and Froment, this issue; Johns and Maundu, this issue). Poor people are disproportionately dependent

on such food. The adequacy of hunter-gatherers' access to nutrients from the forest and the nutritional value of many forest foods are still under investigation. It appears that no people on the planet are now wholly dependent on wild gathered forest products for their food; all cultivate, barter or trade to some degree. Nonetheless, wild foods continue to provide the major portion of the animal fats, proteins and minerals in the diets of millions of people.

Bennett and Robinson (2000) report that in 62 developing countries, people obtain more than 20 percent of their protein from wild meat and fish. People in the Congo Basin alone consume more than 1 million tonnes of wild meat yearly (equivalent to 4 million cattle) (Wilkie, 2001), while people in the Amazon Basin consume 67 000 to 164 000 tonnes per year (Bennett, Robinson and Eves, 2002). Wild forest-dwelling animals represent a mixed blessing, however,



Importance of forests for different groups of people living in or near them

with raids on crops counterbalancing ease of hunting.

Remaining forest habitats tend to be characterized by poor soils and plants whose defences make them unsuitable as food. However, forests are also important reservoirs of genetic resources which provide some foods at present and hold the potential to nourish a wider public in the future. The wild relatives of many common crops represent an important global heritage. Forests also supply numerous goods (and services) that indirectly support food provision, such as poles, beehives and fodder.

Commercialization often adversely affects the sustainability of plant and wildlife populations, spurred by the growth of markets in cities, entrance of loggers and others into forest areas, and improved weapons and transport (see Johns and Maundu, this issue). Sale of wildlife and other NWFPs represents a source of income for local families but sometimes takes food away from the kitchen. Seasonality results in serious hunger in some areas.

Landscape modification is often motivated by the need for food. Some manipulations maintain forest cover and increase food production at the same time. Changes in forest composition caused by logging, hunting and invasive species have diverse effects on food availability. Different stages of forest regrowth vary in food productivity.

The distribution of food within forest households can be inequitable, with women and girls particularly at risk. Forest (and other) diseases can adversely affect people's access to foods. Illness and death from HIV and AIDS, as well as care-giving responsibilities, reduce the effective working adult population – and thus family food supply (see Holding *et al.*, this issue). Food-related health problems that affect people living in forested areas include vitamin A and iodine deficiencies, mycotoxins and other toxins in foods, and viral diseases spread through contact with wildlife. Fuelwood is com-

monly used for cooking in forested areas and presents serious respiratory health hazards, particularly for women and children (see Smith, this issue).

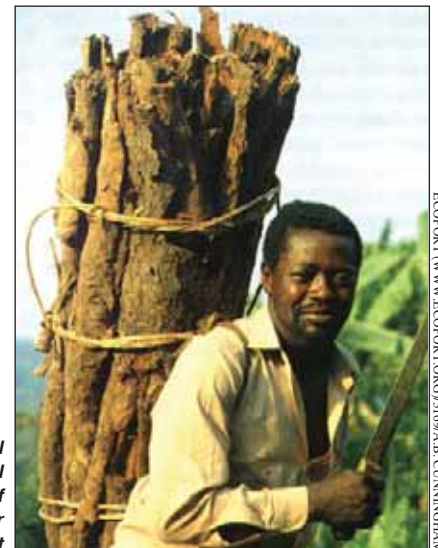
Diseases

Deforestation, population growth, human movement, economics, power and disease are intimately interconnected, but predicting the impact of specific landcover changes on human health will require analysis of local conditions. Emerging viral diseases pose significant threats to human and wildlife populations (see Wilcox and Ellis, this issue). Vector-borne diseases are particularly likely to be implicated in forested areas. These ailments have varying relationships with deforestation, but in most cases deforestation appears to increase the disease load of local people.

Handling and consumption of bushmeat increase exposure to many viruses and may underlie the emergence of various diseases including HIV and Ebola. Forest animals and insects serve as hosts and vectors to a number of important diseases such as yellow fever, leishmaniasis and Chagas disease, among others. Land use changes affect various hosts and vectors differently, thus affecting human disease incidence. The threat of emergent diseases such as Lyme disease in the United States or Ebola in Central Africa is worsened by their capacity to spread beyond forests (see Wilcox and Ellis, this issue).

HIV and AIDS, conflict, nutrition and women's low status are intertwined in East and Central African forests. Globally, households affected by HIV and AIDS tend to enter a downward spiral of gender inequities, poor nutrition, cultural breakdown and more poverty and disease (see Holding *et al.*, this issue). Social inequities in access to resources, seasonal labour and separation of families all increase vulnerability to AIDS in (and outside) forested areas. Practical steps that could improve the situation include acknowledgement of the role of medicinal plants and forest foods in patient care, increased access to fuelwood (reducing labour requirements), development of woodland-based income-generating activities, and sharing of forest revenues to support local community initiatives to deal with HIV and AIDS (Anyonge, 2004). Indigenous knowledge has an important role in such efforts (Lengkeek, 2005).

Malaria is another major killer and factor in the burden of disease in and near forested areas, particularly in Africa. The causal links between deforestation and incidence of malaria are difficult to distinguish. Some logging processes can lead to standing water and increases in mosquito breeding sites. In a few places, such as Panama and the Terai region of



*Many western pharmaceutical products derive from tropical forest species; shown, bark of *Prunus africana* destined for the European market*

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*Traditional health care systems are based on significant local knowledge of medicinal plants; shown, a herbalist preparing medicine from the fruit of *Kigelia africana*, Uganda*

Nepal, forest clearing has allowed populations to enter areas that malaria had previously rendered uninhabitable. (In contrast, see page 19 for an example of how afforestation was used to help control malaria in Italy in the early twentieth century.) However, in other areas the movement of non-immune peoples into malarial areas where local people have some immunity has been connected with increased prevalence of the disease. The enormous variability and adaptability of mosquitoes contributes significantly to the difficulty in distinguishing causal factors and in developing effective health maintenance strategies.

Mercury poisoning from consumption of contaminated fish is common in some forested areas. In the Amazon, gold mining and erosion (exacerbated by forest clearing) of soils containing naturally high levels of mercury have resulted in high levels of mercury in downstream waters. Exposure to mercury can lead to lowered resistance to disease, insanity, mental retardation and a number of less dramatic problems. Researchers and community members have worked together in some places to reduce exposure to mercury by altering local diets.

Medicinal products from forests

Many forest plants and animals produce poisons, fungicides, antibiotics and other biologically active compounds as defence mechanisms, and many of

these have medicinal uses. Compounds that have common medicinal uses such as cola nuts, caffeine, chocolate, chili peppers and cocaine are also found in forest areas. Many western pharmaceutical products derive from tropical forest species, e.g. quinine from *Cinchona* spp.; cancer-treating drugs from rosy periwinkle (*Catharanthus roseus*); treatments for enlarged prostate gland from *Prunus africana*; forskolin, which has a variety of medicinal uses, from the root of *Coleus forskohlii*; medicine for treating diabetes from *Dioscorea dumetorum* and *Harungana vismia*; and several medicines based on leaves of the succulents of the Mesembryanthemaceae family. Some of these products are now synthesized, but others are still collected from the wild. The economic value of traditional medicines is considerable; Achieng (1999), for instance, reported that the bark of *Prunus africana* alone was worth US\$220 million annually to the pharmaceutical industry.

Traditional health care systems are based on significant local knowledge of medicinal plants in all major tropical areas. These health care systems are important, particularly where formal health care services are absent (see Doungias and Froment, this issue). The market for traditional medicines is large and expanding, and much of it is in the hands of women, particularly that involving less commercially valuable

medicinal plants. There is also growing scientific evidence of the efficacy of some of these widely used traditional remedies.

At the same time, medicinal plants are threatened globally, via some of the same mechanisms outlined for forest foods (see Johns and Maundu, this issue). Some of the threats include slow growth patterns of desirable species, loss of traditional mechanisms that contributed to sustainable use, and competing uses of the same species, in tandem with growing commercialization and global markets. Certification of medicinal plants and better forest management techniques offer two possible partial solutions.

Pharmaceutical companies have sometimes been charged with reaping unacceptably large benefits from forest peoples' knowledge given the widespread poverty in forested areas. Issues relating to intellectual property rights, implications for cultural integrity, and amounts and recipients of benefits are complex. The Convention on Biological Diversity (CBD) aims to protect benefit-sharing rights, but adequate mechanisms for doing so are not in place, especially in many developing countries. Attempts to establish collaboration between the pharmaceutical industry and local communities in bioprospecting have had mixed results (Kate and Laird, 1999).

Cultural change and consequences of development

A sense of identity and community is central to the quality of all human life. It is increasingly recognized that culture greatly influences people's quality of life, sense of well-being and health. Among hunter-gatherers and many swidden farmers, the forest-health links are central. Important issues for those concerned with the health of forest people include the degree to which health beliefs and practices are integrated with other parts of cultural systems; differing philosophies about health and health care; and the variety of approaches to health

and illness that exist in the world's forests. A concern to maintain human health requires attention to the interconnectedness of forest peoples, their cultures and the forests. When people's food, rituals, health care, shelter and economic and political systems have always been intertwined with the forest, the loss of the forest has negative implications not only for their socio-economic status, but also for their mental health.

On a more global scale, protection of cultural diversity can serve as insurance against overdominance of western cultural models – which have often been characterized as stress-ridden and unhealthy, both physically and mentally (see O'Brien, this issue). Indigenous knowledge about foods and medicines can be assessed for its possible value to other cultures. It can also contribute to the self-confidence of forest peoples, with positive implications for mental health.

Development projects have often had adverse as well as beneficial effects on people's health, for example by reducing subsistence access to forest lands and foods and bringing indigenous people into contact with new diseases and cultures. For example, increases in leishmaniasis have been linked with deforestation, migration and agricultural development in the regions of the Amazon and the Nile (Patz *et al.*, 2000); a dramatic increase in schistosomiasis was observed in Ghana immediately following the construction of 164 dams (Hunter, 2003); HIV and AIDS exposure increased along the Nigerian highway system (Orubuloye, Caldwell and Caldwell, 1993); and worrying levels of mercury were reported in children living near a gold mining area in the Philippines (Akagi *et al.*, 2000). Nutritional status in East Kalimantan, Indonesia has repeatedly declined when "development" has arrived (Colfer, 1981; Dounias and Froment, this issue). Exposure to alien cultures has sometimes brought social problems such as prostitution, alcoholism, stress and dietary

disorders (e.g. Natshara and Ohsuka, 1999; Gracey, 2000).

CONCLUSIONS AND WAYS

FORWARD

The CIFOR review produced many specific recommendations for those on the ground: health professionals, foresters, development personnel, natural resource managers, administrators, industry (especially logging, pharmaceuticals, mining) and civil society (Colfer, Sheil and Kishi, 2006). Broader conclusions are given here.

What specifically has been learned about the two issues addressed – the state of people's health in and around forests, and the causal links between forests and human health? Looking at the condition of people's health in and around forests, there are some notable examples of increased health threats such as Ebola from forests. But tropical forests also provide essential foods, medicines, health care and mental health benefits to people all over the world. The amount of these benefits generally increases with proximity to the forest. However, forest communities, and those adjacent to forests, are not high on the agenda of most governmental health care institutions, often because the populations involved are small and the logistics of serving them are formidable. Although there is some evidence that some of the most forest-dependent people (hunter-gatherers) may have better health than other rural peoples (e.g. Melnyk, 1995; Santos and Coimbra, 1996; Koppert *et al.*, 1993), many people in and around forests suffer from a variety of debilitating and fatal ailments, including many of the same ones that beset non-forest dwellers in developing countries. There is also significant evidence that, in many cases, activities intended to promote economic development, such as construction of dams, roads and mines and other activities which may lead to deforestation, have worsened the health of those living near forests.

Although technical understanding of pathology, nutrition, pharmacology and epidemiology is crucial to making the links more positive and must be encouraged, it is not enough. There is a pressing need to fashion innovative solutions to the health care needs of forest people. Experience with adaptive collaborative management with communities (e.g. Colfer, 2005) suggests that the most direct and cost-effective way to do this is to use participatory, interdisciplinary approaches. In communities around the world, people have been ready and willing to work with CIFOR on health issues – for example, on medicinal plants in the Philippines (Hartanto *et al.*, 2003), Indonesia and Brazil (Shanley and Luz, 2003) and on monitoring of health status in various contexts (Dounias *et al.*, 2004); but so far funding has been insufficient to implement these ideas fully.

Participatory approaches make it possible to build on the biological and cultural diversity of forests and forest peoples. They allow the world to make benign and appropriately compensated use of local people's indigenous knowledge and natural resources and take into account the logistical problems of formal health care delivery systems, which cannot supply trained medical doctors and public health personnel to every village. The wider underlying goal must be a more equitable global system in which forest dwellers do not pay the costs of supporting the lifestyles of the better off.

Regarding the impacts of these links, effects of forest loss on the health of people living in and around forests vary but are often negative. Nutritional status has often declined with the arrival of "development"; new diseases have arrived and old ones have become more virulent; exposure to alien cultures has sometimes brought social problems such as alcoholism and stress. Diseases originating in forests can spread to neighbouring habitats and even around the world. The diversity of forest types,

wildlife, disease vectors, human populations and cultures, and interactions among these factors, all affect human health. It has been projected that as the climate changes, disease incidence in forested areas and elsewhere may increase (Chivian, 1997; Patz and Wolfe, 2002).

There has been little explicit analysis of the effects of human health or ill health on forests, beyond an occasional reference to the spread of human disease to forest animals. AIDS has caused a reduction in trained forest managers in parts of Africa, with probable negative consequences for forests. And forest degradation can in some cases be traced back to high population growth, which is part of a complex set of interrelated factors that are likely to include women's low status, social inequity, high infant and child mortality, low nutritional status, high disease loads and general poor health.

The CIFOR review showed that there is a significant, if dispersed, body of knowledge on this topic for use by foresters and others. However, communication of this knowledge needs to be strengthened:

- between researchers, practitioners and policy-makers on the one hand and local communities (or segments thereof) on the other, since the complexity of health/forest interactions means that no single external party is likely to be able to make appropriate plans for any given locale without the direct involvement of the people who live there;
- among disciplines, since forests, cultures and diseases all represent complex systems requiring diverse expertise;
- between researchers and policy-makers, so that research findings can be more quickly available and more effectively used.

The most fundamental conclusion, for those concerned with improving human health and forest management, is the need for various groups to work

together better. Foresters, health professionals and communities need to work together in identifying opportunities and addressing problems; but they also need the help of government agencies whose policies and procedures have an impact on forest peoples' lives. One impediment to progress has been the general view that the concerns expressed in this review were someone else's problem. All groups with activities, responsibilities and resources in forested areas are urged to take on the difficult but important challenges of promoting good health in forest areas. ♦



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Forests and emerging infectious diseases of humans

B.A. Wilcox and B. Ellis

With the interweaving of forests, pathogens and the development of human civilization, deforestation and other land use changes have an important part in the emergence of disease.

Infectious diseases have always been an important part of human life. They have significantly influenced human biology and society, even determining the course of major historical events.

Infectious diseases can be viewed ecologically as an extension of host–parasite relationships. They are as much a part of any ecosystem as predator–prey or plant–herbivore relationships. In fact, disease-causing viruses, bacteria and protozoans are commonly and collectively referred to as “microparasites” in infectious disease epidemiology. Moreover, infection by a microparasite is not inevitably a disease-causing event. Most often, host and microparasite coexist peacefully, because highly pathogenic genotypes that eliminate the host are selected against, as are susceptible hosts lacking acquired or native immunity (inherited resistance). Thus disease emergence is a transient phenomenon in a human population, and in its most severe form is typically a consequence of rapid social and environmental change or instability.

The first plague-causing pathogens such as smallpox are believed to have originated in tropical Asia early in the history of animal husbandry and large-scale forest clearing for permanent cropland and human settlements (McNeil, 1976). Crowding and the mixing of people, domestic animals and wildlife, along with a warm humid climate, were as ideal for pathogen evolution, survival and transmission several millennia ago as they are now.

The concept of emerging infectious diseases (EIDs) was prompted by the appearance of novel pathogens such as

human immunodeficiency virus (HIV) and Ebola virus; the evolution of more virulent or drug-resistant pathogenic variants of known microbes; and the geographic expansion and increasing epidemic outbreaks of the diseases caused by these pathogens as well as older diseases such as malaria and dengue. More recently, the concept was reinforced by the dramatic outbreak of severe acute respiratory syndrome (SARS) virus.

The recent upsurge in infectious diseases, which began to attract the attention of the World Health Organization (WHO) and leading national health agencies in the 1980s, is often attributed to the dramatic increase in human population size and mobility, as well as social and environmental changes since the Second World War. Actually, such transitions have caused major upsurges in infectious diseases at the regional level since antiquity. The most notable difference today is the speed, scale and global dimension of the transition, and its occurrence in the era of modern biomedicine and public health programmes. Overconfidence in the former and inadequate deployment of the latter are major contributors to the EID problem, especially in the tropical developing regions.

An increasing number of studies on EIDs point to changes in land cover and land use, including forest cover change (particularly deforestation and forest fragmentation) along with urbanization and agricultural intensification, as major factors contributing to the surge in infectious diseases. Indeed the current increase coincides with accelerating rates of tropical deforestation in the past

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Expansion into the forest, involving more frequent contact with wildlife, exposes humans to pathogens that are foreign to them and is a frequent cause of disease outbreaks – for example yellow fever in the case of this forest-adjacent settlement in Kenya

several decades. Today, both deforestation and emerging infectious diseases remain largely associated with tropical regions but have impacts that extend globally. Both are similarly intertwined with issues of economic development, land use and governance, requiring cross-sectoral solutions.

This article provides an overview of the role of forests and deforestation in EIDs. It highlights the most prominent forest-associated diseases and briefly describes the current state of understanding of the mechanisms by which forest conversion and alteration contribute to EIDs. Finally, it identifies forest resource management measures required to mitigate the EID problem.

ASSOCIATION OF EMERGING INFECTIOUS DISEASES WITH FORESTS

In all, about three-fourths of recognized EIDs either once were, or currently are, zoonotic, i.e. transmitted between animals and humans (Taylor, Latham and Woolhouse, 2001). Not surprisingly, the ancestry of the pathogens causing these diseases can usually be traced to wildlife. Pathogens whose current emergence patterns show a direct association with forests (see Table for examples) represent about 15 percent of the approximately 250 EIDs (Despommier, Ellis and Wilcox, 2006). Some EIDs not currently associated with forests originated from a sylvatic cycle but have since “escaped” and are now solely maintained by human–human transmission or a human–vector–human cycle independent of forests. The two most prominent EIDs in this category are HIV and dengue, which broke free from their primate transmission cycles in African forests and eventually spread globally, two decades ago in the case of HIV and several centuries ago for dengue. Still other EIDs such as tuberculosis, hepatitis A/B/C/E/G, most

sexually transmitted diseases, opportunistic infections of individuals who are immunocompromised (as a result of HIV, for example), and a growing number of infections caused by bacteria resistant to antimicrobial drugs are mainly attributable to dramatic social and ecological changes associated with the explosive rates of urban growth in recent decades.

For those EIDs currently associated with forests, the proximate causal factors in their emergence include a combination of deforestation and other land use changes, increased human contact with forest pathogens among populations lacking previous exposure, and pathogen adaptation. Many may be transmitted among non-human primate hosts or insect vectors, and involve a variety of potential intermediate hosts including domestic animals. Of most concern, following initial local emergence a number of these diseases have demonstrated the potential to spread regionally or globally and become a significant threat to humans, domestic animals and wildlife populations.

Although relatively few plant parasites or pathogens are known to infect

Examples of forest-associated emerging infectious diseases

Agent/disease	Distribution	Hosts and/or reservoirs	Exposure	Possible emergence mechanisms
Viruses				
Yellow fever	Africa South America	Non-human primates	Vector	Deforestation and expansion of settlements along forest edges Hunting Water and wood collection Domestication of vectors and pathogen
Dengue	Pantropical	Non-human primates	Vector	Mosquito vector and pathogen adaptation Urbanization and ineffective vector control programmes
Chikungunya	Africa Indian Ocean Southeast Asia	Non-human primates	Vector	Pathogen and vector
Oropouche	South America	Non-human primates Others	Vector	Forest travel Vector composition changes
SIV	Pantropical	Non-human primates	Direct	Deforestation and human expansion into forest Hunting and butchering of forest wildlife Pathogen adaptation
Ebola	Africa	Non-human primates Bats	Direct	Hunting and butchering Logging Outbreaks along forest fringes Agriculture Alteration of natural fauna
Nipah virus	South Asia	Bats Pigs	Direct	Pig and fruit production on forest border
SARS	Southeast Asia	Bats Civets	Direct	Harvesting, marketing and mixing of bats and civet cats Wildlife trade for human consumption
Rabies	Worldwide	Canines Bats Other wildlife	Direct	Human expansion into forest
Rocky Mountain spotted fever	North America	Invertebrate ticks	Vector	Human expansion into forest Forest recreation
Protozoa				
Malaria	Africa Southeast Asia South America	Non-human primates	Vector	Deforestation, habitat alteration beneficial for mosquito breeding Human expansion into forest, non-human primate malaria among humans
Leishmaniasis	South America	Numerous mammals	Vector	Human expansion into forest Domestication of zoophilic vectors Habitat alteration, habitation building near forest edge Deforestation Domestication of zoonotic cycles by non-immune workers
Sleeping sickness	West and Central Africa	Humans	Vector	Human expansion into forest, disease incidence associated with forest edge
Bacteria				
Babesiosis	North America Europe	Humans Wildlife	Vector	Disease often found among ticks in forested areas
Lyme disease	Worldwide	Humans Deer Mice	Vector	Possible association with deforestation and habitat fragmentation Forest workers at increased risk of disease
Leptospirosis	Worldwide	Rodents	Indirect	Watershed alteration and flooding
Helminth				
<i>Echinococcus multiocularis</i>	Northern Hemisphere	Foxes Rodents Small mammals	Direct	Deforestation Increase in rodent and fox hosts Pathogen spillover to dogs Human expansion into forest, exposure of susceptible population

animals, including humans, the impact of emerging plant diseases on plant populations is also an increasing concern. The problem of EIDs includes not only the impacts of diseases from forests, but also the impacts of disease on forests, including forest wildlife as well as vegetation (Ostfeld, Keesing and Eviner, 2006).

Forests or deforestation *per se* are not the cause of either forest-associated infectious disease emergence or the globally increasing EID trend overall; EID causality is more complex than this. The main driver is the exponential growth in population, consumption and waste generation of the past several decades, which has driven the combination of urbanization, agricultural expansion and intensification, and forest habitat alteration that results in regional environmental change (see Box). The disease emergence process typically appears to be associated with a combination of these environmental factors. But the common factor is change – relatively abrupt or episodic social and ecological change. Most often this is reflected in changes in land cover and land use (unplanned urbanization and land use conversion), agricultural intensification (dams, irrigation projects, factory farms, etc.) and displacement and migration of people.

Episodic population migration and resettlement, associated with road building and the opening up of new transportation routes along with forest clearing and fragmentation, can be described as local or regional drivers of disease emergence. Such changes, particularly when unplanned and a result of political or economic instability or even military conflict in some cases, can have catastrophic consequences. The prime example is AIDS, which originated in tropical forest (Sharp *et al.*, 2001) and expanded throughout a region that was undergoing such changes and lacked public health infrastructure, including systems of disease surveillance and control.

Like AIDS, most forest-originating

EIDs are caused by viruses, although others are caused by bacteria, protozoans, helminths (worms) and fungi. These diseases are frequently not research priorities until they have become a threat to affluent populations, so knowledge about their distribution and biology is very limited in most cases. The historical orientation of tropical medicine towards understanding disease natural history and ecology was, unfortunately, abandoned with the advent of modern biomedicine and the mistaken belief that infectious diseases had been conquered by science (Gubler, 2001). Today's biggest research challenge is posed by the disciplinary gaps between infectious disease researchers, wildlife experts, ecologists and social scientists. The problems are of course compounded by the increasing numbers and densities of poor people living without potable water, sanitation and adequate public health infrastructure in developing countries.

Forest zoonotic and vector-transmitted diseases

Yellow fever is the most well-studied disease from the standpoint of its association with forests (Monath, 1994). The virus that causes yellow fever is maintained in a transmission cycle of arboreal monkeys and sylvatic mosquitoes. Expansion into the forest by human settlements is a frequent cause of outbreaks. For example, the first outbreak of yellow fever in Kenya (1992 to 1993) involved a settlement where cases were limited to people collecting fuelwood and water, or possibly hunting in the forest. Much larger outbreaks occur when the transmission cycle leaves the forest canopy and extends to peri-urban and urban areas where the much higher density of humans and mosquitoes can fuel large epidemics (Sang and Dunster, 2001). This occurred in the Sudan in 2005, probably exacerbated by people fleeing areas of armed conflict and soldiers returning from forested areas. Environmental factors including abnormal rainfall may

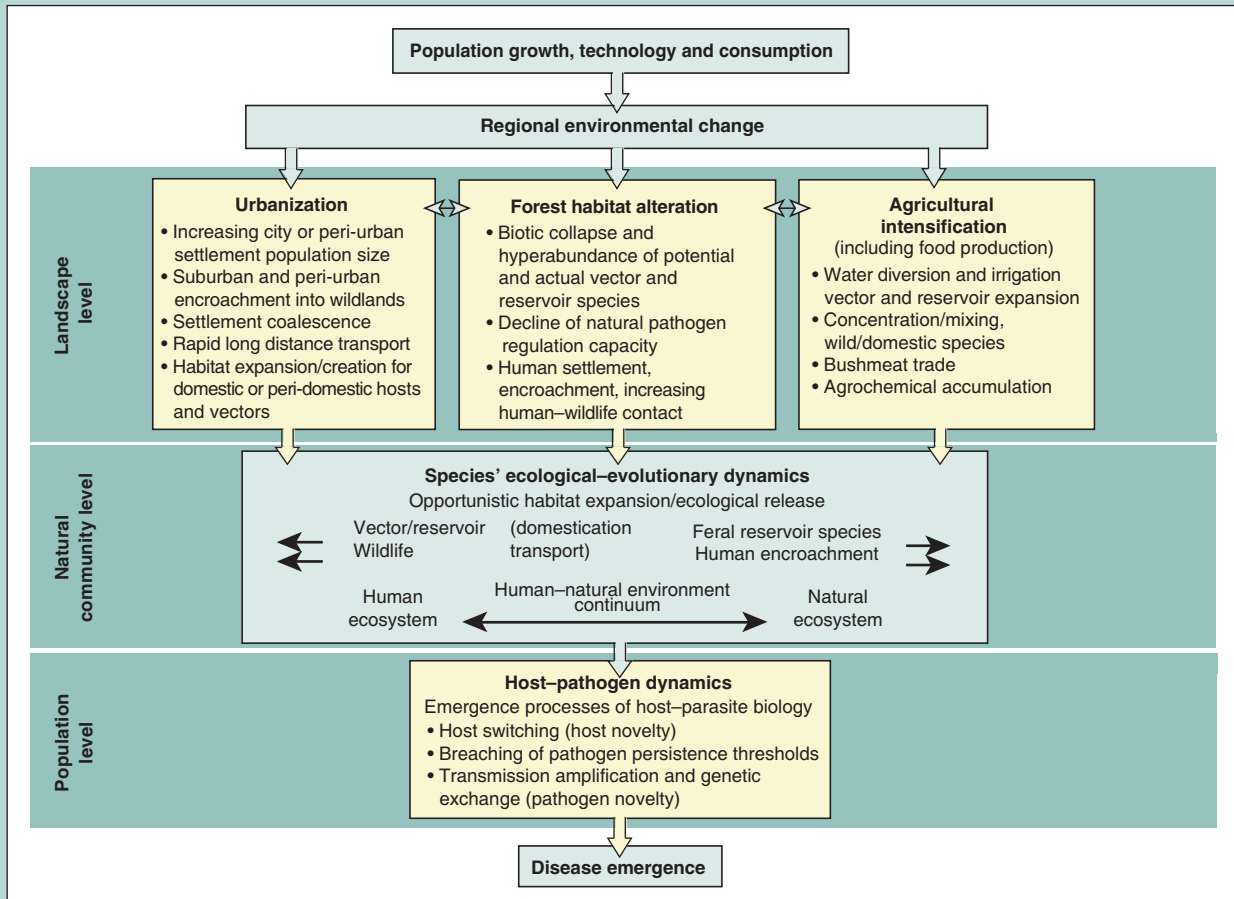
also have contributed to spreading the disease. The evolutionary capacity for rapid adaptation enables viruses to be transmitted efficiently in domestic or peri-domestic cycles.

Dengue haemorrhagic fever, caused by a type of dengue virus, is very similar to yellow fever in its ecology, at least historically (Monath, 1994). Originating as a sylvatic disease with a similar set of primate hosts, mosquito vectors and niche, it acquired a domestic cycle at least several centuries ago. It has recently developed into one of the world's most rapidly emerging diseases, infecting as many as 50 million to 100 million people annually (Holmes and Twiddy, 2003). The key to dengue's success as a pathogen is believed to be its adaptation to the domestic mosquito *Aedes aegypti*, which has allowed it to become endemic in an increasing number of cities and surrounding peri-urban areas, particularly in Asia and Latin America (Moncayo *et al.*, 2004).

Malaria, a much older disease which contributes by far to the greatest number of deaths and disability of any infectious disease (300 million to 500 million cases annually, with a death toll as high as 2.7 million), has less definitive zoonotic origins (Mu *et al.*, 2005). It is nonetheless transmitted in many areas by forest-associated mosquitoes. Recent research suggests that increased disease incidence in some areas of Africa, South America and Southeast Asia is linked to deforestation (Vittor *et al.*, 2006; Walsh, Molyneux and Birley, 1993). Road building, tree felling, reduced shade and increased pooling of water have been shown to promote breeding and more rapid development of mosquito larvae (Afrane *et al.*, 2005; de Castro *et al.*, 2006). Of additional concern, a form of malaria previously found in non-human primates has recently been found in humans in Southeast Asia (Jongwutiwes *et al.*, 2004; Singh *et al.*, 2004).

A number of other noteworthy forest-associated zoonotic EIDs do not

Causal schema of infectious disease ecology



The combination of increasing population and resource consumption, along with waste generation, drives the regional environmental change typically indicated by trends in land use and land cover change. Although the pattern of change varies from region to region, three characteristic processes occur in relation to land use: urbanization, agricultural intensification (including food production and distribution) and alteration of forest habitat.

The three categories of land use – urban, agricultural and natural habitat – represent an ecosystem continuum along a gradient from domestic to natural (left to right in the diagram). Three ecological trends are associated with these changes: vector and reservoir domestication (or peri-domestication); invasion of domestic habitat by oppor-

tunistic wildlife such as some rodents and blood-sucking arthropods (mosquitoes, ticks, midges and others); and invasion of the natural habitat by feral species such as domestic pigs, goats, rats, mice, dogs and cats. These species become pathogen reservoirs particularly in disturbed and fragmented forest adjacent to settlements. The convergence of human and animal hosts and reservoir and vector species within ecosystems, and the movement, shifting and mixing across the ecosystem continuum affects host-pathogen dynamics in a manner that facilitates disease emergence, as follows:

- pathogens have increased opportunities for host switching (including adaptation to a new host);
- transmission is amplified and the

opportunity for more rapid evolution is increased with multiple, interacting transmission cycles;

- pathogens' rate of infection exceeds the threshold required to produce an epidemic or an endemic disease owing to unprecedented population densities of the vector, the reservoir and susceptible human populations;
- pathogens evolve increased pathogenicity, infectivity and ability to avoid immune system detection, owing to increased opportunities for interaction of endemic infection cycles and pathogen strains, and greater density and genetic variability of pathogen populations.

Sources: Wilcox and Colwell, 2005; Wilcox and Gubler, 2005.

appear to involve mosquitoes as vectors although their transmission cycles are not yet entirely certain. These include chikungunya, Oropouche virus, Ebola and simian immunodeficiency virus (SIV). The dramatic consequences of Ebola and SIV emergence have been evidenced over recent decades. HIV is a zoonotic SIV. SIVs have recently been found to be common in Old World monkeys (Galat and Galat-Luong, 1997). The hunting, butchering or illegal procurement of these animals not only is a major concern for conservation but also increases the risk of disease emergence (Wolfe *et al.*, 2005).

Many of the Ebola outbreaks have occurred in forest fringe areas, where expansion of human populations is bringing them into contact with pathogens that are foreign to them, particularly through more frequent contact with wildlife. This has led to a hypothesis that mechanisms associated with agricultural land use changes bordering forests and changes in the natural fauna may be involved in emergence (Morvan *et al.*, 2000; Patz *et al.*, 2004). Recently, it has also been suggested that bats may serve as the reservoir for Ebola and that monkeys may contract the disease much as humans do (Leroy *et al.*, 2005). Fruit bats are also important hosts of additional EIDs including Nipah and SARS viruses (Field *et al.*, 2001; Lau *et al.*, 2005).

Water-borne diseases

Another category of infectious diseases – indirectly associated with forests or forest land management – is water-borne. Their natural cycles may or may not involve forest wildlife, but their transmission (both among their animal hosts and to humans) is facilitated by altered surface water quality and regimes, which may be influenced by upland deforestation and poor watershed management (including overgrazing, removal of riparian vegetation and stream channellization). Water-borne pathogens include the enteric viruses rotavirus and norovirus

and the bacteria *Campylobacter* spp. and *Vibrio cholerae*, which collectively cause millions of deaths annually, particularly among infants. *Vibrio cholerae*, which lives symbiotically (in mutually beneficial relationship) with marine and estuarine crustaceans, is responsible for an estimated 1 to 2 million cholera cases annually (WHO, 2006). All these pathogens are found in inland as well as coastal surface waters, especially (but not only) water contaminated with human or animal excrement. Other widespread water-borne EIDs include protozoans of the genera *Cryptosporidium* and *Giardia*, which along with *Campylobacter* spp. are maintained by wild and feral ungulates. These pathogens, along with leptospirosis, one of the world's most widespread zoonotic EIDs for which virtually all mammal species are natural or accidental hosts, are often associated with ecologically disturbed forested watersheds supporting high densities of pigs and rats. Epidemics of leptospirosis have been occurring with increased frequency globally in flood-prone rural and urban areas with poor drainage and sanitation, conditions commonly found in impoverished urban, peri-urban and rural environments throughout the developed and developing world (Vinetz *et al.*, 2005; Wilcox and Colwell, 2005).

MECHANISMS OF HUMAN PATHOGEN EMERGENCE

The role of forests and forest management in the emergence of infectious diseases of humans appears to involve three separate but interacting dynamics:

- land use change and expansion of human populations into forest areas, resulting in exposure of immunologically naïve human and domestic animal populations (i.e. those lacking previous experience with the microparasite fauna) to pathogens occurring naturally in wildlife;
- forest clearing and alteration producing an increase in the abundance or dispersal of pathogens by

influencing host and vector abundance and distribution;

- alteration of ecohydrological functions such as infiltration, peak discharge and runoff which facilitate the survival and transport of water-borne pathogens in watersheds and catchment basins.

These changes are often linked to forest clearing and increased edge habitat, with fragmentation of the forest landscape and disturbance of the vertical structure and diversity within the forest stands. The increase in the density of some pathogens' hosts and vectors effectively expands the pathogens' habitat and increases their infection prevalence in hosts. The increased number of hosts or vectors or both and their increased rate of infection not only increase the frequency of their contact with humans, but also the likelihood of the host or vector being infectious. Most importantly, it allows the pathogen to persist indefinitely and the disease to become endemic.

One of the best documented cases of this process concerns Lyme disease, an EID caused by a pan-temperate tick-borne spirochete bacteria of the genus *Borrelia*. The ecology of its emergence in the northeastern United States, studied in great detail, has implications regarding the role of forest management in disease generally (Allan, Keesing and Ostfeld, 2003). Lyme disease involves a complex sylvatic cycle in which the vector prefers different animal host species during different stages of its life cycle. The most important factor determining pathogen abundance appears to be the abundance of two animal species that proliferate in fragmented forest landscapes: white-footed mice, which act as pathogen "superspreaders", and white-tailed deer, the optimal adult tick host. These species are adapted to forest edges, and they have fewer predators in these landscapes than in unfragmented forest blocks. Moreover, the less diverse community of vertebrates in fragmented forests results in higher overall pathogen

Forest fragmentation affects disease dynamics by influencing host and vector abundance and distribution and thus the abundance or dispersal of pathogens



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transmission rates, since white-footed mice are among the most successful vertebrate hosts for this microparasite.

The finding that intact forest vertebrate communities provide a pathogen dilution effect, together with the well-known role of predators in regulating rodents and ungulate populations in healthy ecosystems, has prompted some ecologists to categorize regulation of pathogen emergence as a forest ecosystem service. The ecohydrological functions of healthy upland forests and watersheds can be said to have a similar role, regulating water-borne pathogen emergence by “capturing” and filtering pathogen-laden runoff and modulating the amplitude of peak flows during seasonal storms. The loss of these functions facilitates pathogen transmission and maintenance in host populations, increasing the amount of human pathogens contained in animal excreta. Epidemics of cholera and leptospirosis frequently occur following exposure of large numbers of people to the pathogens mobilized from soil and sediments and suspended in the flood waters (Wilcox and Colwell, 2005).

CONCLUSION

Emerging infectious diseases are considered to be among today’s major challenges to science, global health and human development. Rapid changes associated with globalization, especially the rapidly increasing ease of transport, are mixing people, domestic animals, wildlife and plants, along with their parasites and pathogens, at a frequency and in combinations that are unprecedented.

The role of and potential effects on forests and implications for forest resource management are significant. Forest land use changes and practices, particularly when unregulated and unplanned, frequently lead to increased prevalence of zoonotic and vector-borne diseases, and occasionally boost the prevalence of diseases capable of producing catastrophic pandemics. This should be a consideration in forest land use and forest resource planning and management.

In view of the enormous impact EIDs have on humans and economic development, including the economic impacts of diseases on agriculture and forestry, collaboration between the agricultural, forest and public health sectors is required to develop policies and practices for the prevention and control of EIDs. This will require substantial increases in the regulation, surveillance and screening of pathogens in transportation systems.

Research on EIDs, particularly that involving the ecological epidemiology of zoonotic and vector-borne diseases associated with forests, needs to be inte-

grated with forest resource management and planning. Greater emphasis is needed on integrating research and practice, for example through the development of forest management guidelines that can contribute to the control and prevention of EIDs. This will require increased interdisciplinary and collaborative research among foresters, forest ecologists, and wildlife and human infectious disease experts for better understanding of the role and impact of forests and forest land use and management on EIDs. ♦



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Forestry and malaria control in Italy

In the early twentieth century, reforestation was among the weapons used in the battle to eliminate malaria from Italy.

Malaria was already diffuse in the Mediterranean region by the fifth century BC. In ancient Rome, the severity of the problem worsened towards the end of the Republican era with the arrival of *Plasmodium falciparum* (which causes the most severe form of the disease), probably from Africa. Climatic changes together with landscape degradation, deforestation and the abandonment of agricultural lands, provoked by war, led to the expansion of swamplands – favouring the diffusion of efficient vectors such as *Anopheles labranchiae* and the spread of the disease. Towards the end of the nineteenth century, more than one-third of the Italian population was affected by malaria. The first Italian medical bulletin,

published in 1897, stated that 21 000 people died every year because of the disease.

Although malaria was definitively eradicated from Italy in the 1950s with the introduction of DDT, this represented only the final stage in a long series of antimalarial interventions that had been undertaken since the end of the nineteenth century. These included not only public health interventions, but also socio-economic and environmental measures, including direct intervention in land settlement, water management, soil conservation, reforestation and dune stabilization.

Between 1920 and 1940, the first laws on “integrated reclamation” (*bonifica integrale*) were introduced to encourage cultivation of the swamp areas to reduce the foci of mosquito reproduction. The concept of integrated reclamation as presented in the Forestry Law of 1923 involved land restoration, conservation and protection through hydrological management (including water supply and drainage systems), road construction, and reforestation of degraded lands, unstable slopes, grasslands and grazing lands.

One of the best known examples of such integrated intervention in Italy is the Feniglia dune on the Tuscan coast. Beginning in the early 1800s, the area’s dense Mediterranean maquis had become severely degraded by human activities and grazing. The disappearance of the vegetation from the coastal land favoured the movement of sand towards the interior. This created a marsh that was extremely dangerous for the spread of malaria.

The reforestation process initiated by the government in the early twentieth century involved the construction of a dam towards the sea, the placement of several rows of wattle fences to arrest the movement of the sand, and the planting of *Pinus pinaster* along the sea line and *Pinus pinea* on the inner part of the dune. The seedlings were protected by the planting of herbaceous species (*Arundo arenacea*, *Ulix europaeus*, *Medicago marina*, *Euphorbia parialis* and *Cakile maritima*).

Today these woodlands are a forest reserve, important for amenity, recreation and nature conservation.

**The Feniglia forest reserve,
originally planted to reclaim
malarial swampland**



Fuelwood, food and medicine: the role of forests in the response to HIV and AIDS in rural areas of southern Africa

C. Holding Anyonge, G. Rugalema, D. Kayambazinthu, A. Siteo and M. Barany

The HIV pandemic has increased the dependence of woodland communities on forest resources, with natural resource management implications that merit attention in forest policies and programmes.

The miombo woodlands in Mozambique are a primary source of energy (fuelwood and charcoal) and a crucial source of essential subsistence and commercial goods for rural communities – but the HIV epidemic is putting these resources under increased pressure



C. HOLDING ANYONGE

The HIV pandemic is deeply entrenched in the countries of southern Africa and has had dramatic effects on rural livelihoods. This article examines the role of forest resources in the response to HIV and AIDS, particularly in terms of herbal medicines, energy and food. It is based on the findings of studies commissioned by FAO and carried out in 2003 to examine the impact of the pandemic on the utilization of woodland resources in the miombo woodland zones of Malawi (Kayambazinthu *et al.*, 2005) and Mozambique (Siteo, 2005). Data collection methods included a household questionnaire survey, focus group discussions, transect walks, and key informant interviews. The results show that HIV and AIDS increase the dependence of communities in woodland zones on forest resources and that the pandemic has environmental and natural resource management implications. The article highlights some forest policy and programme interventions that might help

lessen the impact of the pandemic on natural resources and the role the forest sector can play in the multisectoral response to HIV and AIDS.

KEY FINDINGS

While it is not easy to pin down a causal relationship between HIV and forest degradation, it is clear that in times of livelihood crisis, poor rural communities tend to increase their dependence on forest resources as a key part of their coping strategies. The HIV pandemic has intensified the crisis of livelihoods (Bryceson, 2006), placing an excessive burden on woodland resources. Thus it is not surprising that in the studies in Malawi and Mozambique, woodland degradation, as evidenced by decreasing resource availability (e.g. scarcity of both fuelwood and medicinal plants), was observed in communities where HIV prevalence is high.

The combination of the high incidence of HIV-related illnesses and the scarcity of health services near the communities

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In Mozambique, Aloe spp. (left) and Hypoxis spp. collected from the woodlands are sold in the market and used in the treatment of HIV for about one-sixth the price of antiretroviral therapy

studied has led to a greater dependence on medicinal plants to alleviate some of the symptoms and conditions associated with HIV (see Box). At current prices, the treatment of HIV using antiretroviral therapy can be as high as US\$200 per person per year. In poor rural communities only a few people have access to this therapy because of the high price, poor health infrastructure and distance from the nearest health centre. Medicinal plants, however, are easily accessible products for most people. Thus it is no wonder that their collection and use has increased, as has their price.

This dependence on herbal remedies has led to overharvesting of medicinal trees and shrubs. Respondents indicated that, in comparison with the years before HIV and AIDS, they could now find few such trees within reasonable walking distance. Thus medicinal plant resources are becoming scarce at a time when their use is increasing, in urban as well as rural areas.

The survey found that the higher mortality rate of adults has increased the demand for fuelwood, in part to prepare food for increasingly frequent funerals. People now have to trek long distances to collect enough wood for fuel. Similarly, HIV has complicated existing livelihood crises resulting primarily from droughts, lack of fertilizer and poor marketing services. Communities surveyed indicated that the impact of HIV and AIDS on household labour has intensified depend-

ence on forest food products (fruits, roots and tubers, vegetables).

Taken together, these findings show that HIV is contributing to deforestation and forest degradation. This process has negative implications for communities in general and for HIV-affected households in particular, as such households are likely to experience greater distress from loss of woodland resources. They have to increase the time and amount of

labour spent collecting forest products or spend an inordinate amount of cash to buy them.

The relationships between HIV and household woodland activities (specifically collection of fuelwood, medicinal plants and other non-wood forest products) appears to correspond closely with the stage of the disease. Labour constraints brought on by illness and care-giving may prohibit household participation in collection of woodland products during the symptomatic stages of the disease. However, as the epidemic advances and mortality rates increase, the collection of woodland products in affected communities appears to increase, as the immediate economic impact of adult illness (e.g. health expenses) makes some households more dependent on commercial woodland activities to provide income. The extent to which HIV affects woodland livelihood activities also depends on other factors such as gender, household

Opportunistic infections, traditional medicine and woodland resources

Weak health infrastructure and pervasive poverty continue to pose problems for the unprecedented challenge of providing and administering antiretroviral therapy in southern African countries. In such resource-constrained settings, local communities are obliged to rely on traditional remedies for the management of HIV and AIDS, and traditional medicine is being institutionalized in the response to the pandemic. The World Health Organization (WHO) has advocated the inclusion of traditional healers in national AIDS programmes since 1991, and national ministries of health are recruiting traditional healers in collaborative efforts to combat the disease.

Herbal remedies have been observed to improve the quality of life for people living with HIV. They slow the progression of the disease by helping to control infections such as candidiasis (thrush), herpes simplex (which was also recently recognized as a key factor in transmission of HIV in Africa) and herpes zoster (shingles), and they provide relief of appetite loss, nausea, fever, diarrhoea and cough. Recent research suggests, however, that some herbal remedies may inhibit antiretroviral therapy if used in combination with it, and further research is needed on their efficacy.

Herbal treatments are frequently derived from woodland resources; they typically include roots, barks and leaves of plants. In some areas, mushrooms are heavily used. Honey and beeswax are commonly used in the application of traditional treatments. Local uses of these remedies and current institutional efforts to scale up support for their use need to be managed to avoid compromising the sustainability of the woodland resources.

composition, household wealth, social safety nets, labour requirements, access to markets and of course access to forest resources (FAO, 2005).

When a crisis such as an illness or death occurs, affected households are more likely to obtain quick cash for medical expenses by selling domestic animals such as chickens and goats or by working within the community for wages than by collecting non-wood forest products such as mushrooms or honey. However, these products provide food supplements for households and/or an opportunity to increase income, which can also be used to cover unexpected expenses in times of crisis. Woodland activities are important in diversifying livelihoods and provide a buffer against shock for households in general, not only those affected by HIV.

Female-headed households are the most vulnerable because of their reduced participation in income-generating activities and often enter a spiral of deepening poverty (Bryceson and Fonseca, 2006). Given the disproportionate impact of the epidemic on women (in terms of HIV infection and socio-economic impacts) and their traditional roles in woodland activities (e.g. collection of fuelwood), enhanced understanding of gender issues needs to be a priority in future efforts.

The studies reported here were exploratory. Their findings regarding the impact of HIV on woodland resources are instructive; however, they tell only a part of the story. Questions remain, notably about how HIV is affecting forest management as a result of the death of forest rangers and extension officers. Furthermore, in an environment already characterized by severe livelihood insecurities, it is difficult to distinguish to what extent the impact of HIV is peculiar to the disease and to what extent it is part of the wider context of societal crises including other epidemics such as tuberculosis and malaria. In short, it is impossible to overemphasize the need for further research into the linkages and

The HIV epidemic has a disproportionate impact on women, partly because of their reduced participation in income-generating activities and their traditional roles in woodland activities (e.g. collection of fuelwood)



interactions between management and use of forest resources and social crises including contemporary epidemics.

WAY FORWARD: HOW SHOULD THE FOREST SECTOR RESPOND TO HIV/AIDS IN SOUTHERN AFRICA?

The forest sector undoubtedly has a role to play in the prevention, care and treatment of HIV and AIDS and the mitigation of their impact. Forestry institutions and their human resources, particularly forest managers working at the local level, can and should play an active role in the response to HIV. Forest products can play a part not only in the care and treatment of HIV-related illness, but also in income generation and other livelihood activities that can help alleviate the impact of the disease on households.

To mitigate the impact of HIV and AIDS, one component of interventions in the forest and natural resources sector should be directed towards supporting the sustainability of those forest benefits on which households and communities affected by HIV rely. Such interventions should also aim to alleviate those interactions that aggravate the impacts of HIV and AIDS on households (e.g. household labour reductions and scarcity of forest products to meet subsistence needs, in particular fuelwood).

More intensive forest management to

increase productivity and accessibility of forest resources is in itself a mitigation strategy (FAO, 2004). Within communities, there is a need to improve the management of natural woodlands for multiple purposes. However, it is also necessary to lighten excessive pressure on forest resources, either through an increase in the supply of wood and non-wood forest products (through forest planting, cultivation of medicinal plants and transport of wood from greater distances) or a decrease in the demand (through the use of more efficient wood stoves, possibly the switch to other fuel types and alternative income-generating activities that may not be woodland based).

Increasingly, ministries responsible for forestry and natural resources are showing an inclination to formulate sectoral strategies to address AIDS-related issues. The Government of Malawi has recently embarked on such an exercise. This is a step in the right direction given that it allows the entire sector to assess its vulnerability to HIV and AIDS and to plan and implement mitigating activities based on the sector's comparative advantages.

CONCLUSION

HIV and AIDS have dramatically changed rural life in sub-Saharan Africa, where close to 70 percent of the popula-

tion is rural. Most households remain poor, with limited resources to fight the pandemic. Rural areas are also absorbing a significant part of the burden of urban AIDS cases as those who fall ill in urban areas return to rural areas to seek family care.

Persistent shocks such as HIV and AIDS have long-term structural impacts for key facets of the livelihood system – availability of labour and expertise, accumulation and distribution of capital, flow of remittances, people's sense of long-term security and outlook for the future, use of natural resources (e.g. forest products for medicinal purposes) – with negative system-wide consequences that resonate far beyond the period of the shock.

The advent of HIV and AIDS found rural southern Africa already in a precarious state of declining small-scale agriculture and increasing utilization of natural resources, particularly forests and woodlands. The pandemic has intensified these pressures. It is clear that affected communities cannot overcome this conundrum without clear strategies and support from their governments. The studies discussed here have highlighted some policy proposals for addressing the impact of HIV and AIDS and helping households to diversify their livelihood base. ♦

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Forests as pharmacopoeia: identifying new plant-based treatments for malaria

J. Muriuki

A meeting on herbal antimalarials in Africa suggested that drug development based on traditional knowledge of indigenous plants may hold more promise for developing-country medicine than for markets in developed countries.

Malaria remains one of the most prevalent diseases in the tropical world. With 200 million to 450 million infections annually worldwide, it causes up to 2.7 million deaths. The disease remains endemic in more than 100 developing tropical countries, and its control is a major goal for improved worldwide health. In view of the widespread emergence of resistant strains of *Plasmodium* spp., the pathogen responsible for the disease, enormous efforts are being made to find alternatives to the usual treatments – quinine derivatives and synthetic antimalarials – which are still insufficient to meet the needs.

Control of malaria has been based on herbal drugs – and more specifically on forest products – for centuries. Wormwood (*Artemisia annua*) infusions have been used in China for 2 000 years; bark of *Cinchona ledgeriana* was used long before its active ingredient, quinine, was isolated in 1820. Many other plants such as *Warburgia ugandensis* and *Azadirachta indica* have been used either to treat the disease or as insecticides to control the vector (mosquitoes).

Herbal remedies have most often been used in traditional or natural medicine, although some have found their way into conventional pharmacies. Today, however, many medical authorities, including the World Health Organization (WHO), have come to recognize herbal medicine as a viable treatment for various ailments. WHO has recently devoted much attention, for example, to *Artemisia annua* and other new herbal antimalarials. The active ingredient of *Artemisia annua*, artemisinin, has recently been identified. Ethnobotanical research has reported over 1 200 species as having antimalarial effects, some of which might hold enormous potential to control this devastating disease if researched further.

Malaria may not be a neglected disease, given the WHO interest in its control, but since it mainly afflicts poor populations in the tropics it attracts scant rewards for bio-prospecting by big pharmaceutical companies for active molecules that could lead to new drugs – although developed-country interest could rise with speculation that global warming might extend the range of the disease. While traditional methods of treatment exist

throughout the tropics, little effort has been devoted to testing them as cheaper alternatives to conventional pharmaceuticals.

To coordinate research and investment efforts with a view to creating a steady supply of safe, appropriate and cost-effective forms of treatment for those affected by malaria, the Centre for Development of Enterprise (an institution of the African, Caribbean and Pacific Group of States and the European Union) and the World Agroforestry Centre (ICRAF) organized the Africa Herbal Antimalaria Meeting from 20 to 22 March 2006. Botany and agronomy experts, farmers, pharmaceutical manufacturers and marketers, researchers, herbal medicine practitioners, quality assurance and regulatory specialists, public health administrators and government representatives discussed prospects for new solutions and progress made in the wake of commitments made by African governments to control the disease, particularly through the Roll Back Malaria initiative, which especially promotes the use of insecticide-treated mosquito nets as a preventive measure.

A research report by the Kenya Medical Research Institute (KEMRI) (Rukunga and Simons, 2006), launched as a working document for the meeting, shows that many chemicals with antimalarial potential can be derived by researching traditional antimalarial formulations. From more than 300 species screened in over a decade of research, 84 species in 34 families were found to have high antimalarial activity. A further 138 species in 50 families were found to have moderate activity. The Research Initiative on Traditional Antimalarial Methods (RITAM) has launched activities to test the potential of traditional methods for vector control and repellents, prevention and treatment. Candidate species for further research such as *Azadirachta indica* and *Phytolacca dodecandra* were presented in the meeting.

Forest trees and shrubs such as *Entandrophragma angolense*, *Picralima nitida*, *Schumanniphyton magnificum* and *Thomandersia hensii* (Bickii *et al.*, 2007), *Mammea africana* (Okokon, Udokpoh and Essiet, 2006), *Annona senegalensis* (Ajaiyeoba *et al.*, 2006) and others (see Willcox, Bodeker

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Artemisia annua plant 10 weeks after field planting; the leaves are a source of artemisinin, a powerful antimalarial

ECOPORT (WWW.ECOPORT.ORG)/47713.P. GRIFFEE

and Rasoanaivo, 2004) have already shown potential, but obstacles remain in the product development path through to approval. Given the current death rate, participants at the meeting expressed dissatisfaction with the slowness of the process for conventional drug development based on isolating pure chemical compounds or derivatives of such compounds from medicinal plants. An alternative is to verify ethnobotanical information from traditional medical practitioners through scientific toxicity and clinical confirmatory tests. Many countries in Africa now have products formulated in this way. Examples presented at the meeting include Manalaria and Sansiphos (Democratic Republic of the Congo), Malarial (Mali) and Phyto-Laria (Ghana).

Concerns about the possible toxicity of drugs developed from herbal remedies and the potential that *Plasmodium* spp. could develop resistance to them were raised. Because of such concerns, only one of the many products derived from *Artemisia annua* had obtained WHO approval by March 2006.

Initiatives addressing issues related to drug safety, efficacy, testing and approval include the Association for African Medicinal Plant Standards (AAMPS), formed in 2005 to set quality standards and compile profiles of major medicinal plants, and a centre to coordinate research into traditional medicine established by WHO and based in the Congo.

What does the enormous potential of anti-malaria therapies from forests portend for their conservation? Interest in *Artemisia annua* has spurred cultivation efforts in China, India, Viet Nam and East Africa, creating opportunities for farmers to raise their income and for jobs in the extraction industry. There is great potential for cultivation of other medicinal plants in the tropics if appropriate germplasm and propagation technology is available. Estimates show that at least 60 percent of current medicinal plant products are from wild harvesting. Indigenous knowledge used in traditional therapies often incorporates conservation practices used by communities. If more commercial antimalarial products are

developed, however, potential profits accruing to collecting groups may lead to the extinction of useful species. Research to prioritize antimalarial species should therefore be in tandem with efforts to spur their cultivation, while guaranteeing rights to forest-adjacent communities to gain benefits from sustainable collection of medicinal products.

The full proceedings of the meeting are available at: www.worldagroforestry.org/treesandmarkets/antimalariameeting/proceedings

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When forest-based hunter-gatherers become sedentary: consequences for diet and health

E. Dounias and A. Froment

Diet and health are sensitive indicators of human adaptive responses to change.

The future of forest ecosystems is inseparable from the future of people living in these forests. Accordingly, challenges to the health of both the forest and humans should be investigated jointly. Unfortunately, research devoted to the consequences of biodiversity loss on human health has long focused on the ecological and global systems and persists in neglecting sociological and psychological factors. Environmentalists, ecologists, anthropologists and medical scientists need to sit around the same table to investigate the threats that simultaneously compromise the health of people and the sustainability of their ecosystems. Forest managers and policy-makers need solutions that combine ecosystem management and health-sector interventions to improve human health and well-being while maintaining a healthy ecosystem. The dramatic situation of the few remaining hunter-gatherer groups that still greatly depend on forest resources is emblematic of what is at stake when

rapid land use conversion occurs in forest regions.

Changes in diets and exposure to emerging diseases are sensitive indicators of the ecological and cultural costs that former hunter-gatherers are paying to get their share of modernity. Such indicators illuminate sensitive sociopolitical problems that necessitate concerted and urgent interventions that will respond to both development and conservation interests. Recent hunter-gatherers provide insight into how humans lived when their lifestyles and genetic endowment were more compatible. The cumulative experience of hunter-gatherer societies can be viewed as a benchmark for present-day efforts to promote health and prevent disease, even in the world's industrialized countries.

This article examines the changes in diet and health that occur when nomadic forest dwellers settle. Examples are drawn from African Pygmy groups such as the Kola, Medjan and Baka of Cameroon, the Aka of the Central African Republic

A changing way of life: a work team of Kola Pygmies employed on the Chad-Cameroon pipeline project which crosses over their forest land in coastal southern Cameroon



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and the Efe and Mbuti of the Democratic Republic of the Congo; and in Asia, the Punan, formerly nomadic forest dwellers of Borneo, in particular the Tubu Punan from the Tubu watershed of East Kalimantan, Indonesia. These formerly nomadic groups were all pushed to settle in permanent villages in the course of the twentieth century, but they still depend on hunting and gathering for their livelihoods and continue to migrate seasonally into the forest in search of forest resources.

HIGH FOREST BIODIVERSITY ALSO MEANS RICHNESS IN PATHOGENS

The number of plant and animal species declines with distance from the equator. This pattern has also recently been documented for parasitic and infectious species. Climatic factors are of primary importance in explaining the link between latitude and richness of human pathogens (Guernier, Hochberg and Guégan, 2004). The high correlation between the diversity of parasitic and infectious diseases and the distribution of tropical humid forests has nourished the persistent belief that forests are inhospitable environments for humans. This perception overlooks, however, the numerous services provided by natural ecosystems to control the emergence and spread of infectious diseases. The protective function of biodiversity, for instance, includes maintaining the balance among predators and prey and among vectors and parasites in plants, animals and humans (Chivian, 2001).

In the developed world, the image of Rousseau's noble savage living in harmony with his environment has persisted through the centuries, but excessive romanticism has perversely reinforced the conviction among many forest management practitioners and conservationists that the forest is insalubrious for humans. Governing officials may use this view to justify decisions to push forest dwellers outside the forest, supposedly for their own sake.



Delousing is common social behaviour among the Baka Pygmies of southern Cameroon, who temporarily abandon their permanent villages for seasonal camps in the forest; excessive parasites in the camp often provide motivation to move to another place

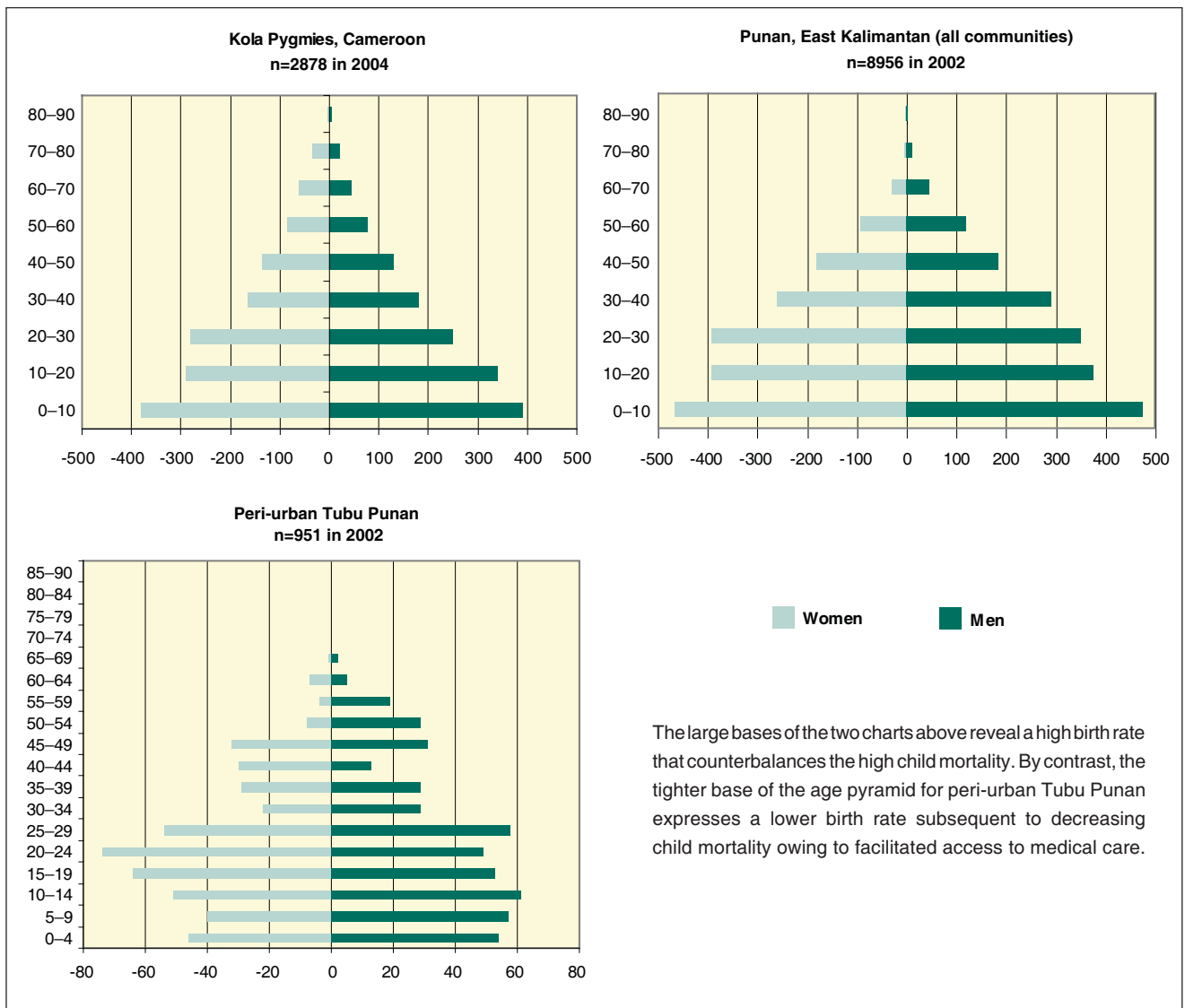
Nevertheless, the economically, environmentally and politically driven relocation of nomadic people jeopardizes their health conditions by exerting enormous pressure on their natural environment and their cultural systems. Once these groups become sedentary and spend time in larger aggregations, a reservoir that encourages the proliferation and maintenance of a heavy pathogen load is established. In addition, environmental changes in local land use after settlement may combine with global climate alterations to disrupt the natural ecosystem, producing new favourable habitats for vectors and causing an increased risk of transmission of viral and parasitic infections to humans (Patz *et al.*, 2000).

FORMER HUNTER-GATHERERS HAVE LOST THE ECOLOGICAL ADVANTAGES OF NOMADISM

Nomadism and maintenance of small communities were efficient adaptive responses to high diversity in parasitic and infectious diseases. Formerly nomadic hunter-gatherers lived in small and scattered residential groups within vast and sparsely inhabited forest lands (typically less than one inhabitant per square kilometre). The impermanence of

their settlements significantly reduced their exposure to transmissible diseases, airborne and food-borne parasites and faecal pollution. More than the scarcity of food, excessive parasites (fleas, lice and ticks) in the camp provided a strong motivation to move to another place. The death of a member of the community also prodded the community to split and shift to new settlements, reducing at the same time the risk of any lethal factor contaminating other members of the group.

High mobility was facilitated by light burdens and a limited number of surviving children. Groups migrated along extended and linear territorial trails. Regular migrations along these trails not only reduced obstacles to obtaining food – as the hunter-gatherers owned and managed the forest resources within these linear territories, influencing their spatial distribution and density (Donnias



2001) – but also ensured good aerobic fitness, which resulted in low body fat, low blood pressure, low cholesterol levels and prevention of cancer and cardiovascular complications (Eaton and Eaton, 1999).

Although still a matter of controversy, the “Palaeo diet” hypothesis (Wiss, 2006) argues that hunter-gatherers had a healthy food regime that was rich in protein and fibre while low in salt, milk and sugar.

Relatively good fitness was however counterbalanced by relatively high mortality resulting from hunting accidents,

falls from honey and fruit trees, snake-bites and human conflict. The life span of remaining hunter-gatherers is relatively short: among both the Punan and the Kola Pygmies, people over 65 years of age represent less than 2 percent of the population (Figure). Today’s child mortality is comparable to that reported in Europe a few centuries ago. Short life span and high child mortality are necessary regulating factors in a Darwinian selection process which has ensured a stable demography and the related sustainability of the lifestyle in relation to resource availability (Froment, 2001).

Recent pyramids of age for sedentary Kola Pygmies and Punan and for peri-urban Punan

NEW SEDENTARY WAY OF LIFE EXPOSES PEOPLE TO NEW DISEASES ...

Although a few authors argue that permanent settlement may lead to improved health conditions, there is strong evidence that the shift from nomadic to sedentary lifestyle generally compromises health and well-being. Today, forest populations are mostly farmers. Populations of hunter-gatherers who chose

TABLE 1. Comparison of parasitic load among different formerly forest-based hunter-gatherers who are currently settled (percentage of infested population)

Sedentary hunter-gatherers	Country	Hookworms (<i>Ankylostoma</i> spp. and <i>Necator</i> spp.)	Whipworms (<i>Trichuris</i> spp.)	Roundworms (<i>Ascaris</i> spp.)	Amoeba	
					Pathogen	Non-pathogen
Southeast Asian groups						
Tubu Punan	Indonesia	35	9	60	5	6
Semang	Malaysia	93	56	12	9	30
Temiar	Malaysia	78	23	2	3	18
Jahut	Malaysia	52	29	20	8	28
Semai	Malaysia	74	12	13	10	39
Jakun	Malaysia	64	62	65	3	31
Semelai	Malaysia	70	72	71	6	17
Temuan	Malaysia	79	91	59	12	37
African Pygmies						
Mbuti	Democratic Republic of the Congo	85	70	57	36	–
Aka	Central African Republic	71	–	–	–	–
Kola	Cameroon	–	85	51	–	–
Medjan	Cameroon	–	83	90	–	–
Amerindians						
Yanomami	Brazil	59	80	86	49	85
Ticuna	Colombia	83	77	76	69	55
Palikur	French Guyana	90	19	76	31	16
Campa	Peru	45	20	28	21	37
Xingu	Brazil	81	–	18	61	87

Note: – = no data

not to shift to agriculture are currently undergoing a sociological transition. They are confronted with demographic expansions that test the carrying capacity of wild edible resources (i.e. the ability of the resource to supply the needs of the consumer group without detrimental effect on the survival of the resource) and force hunter-gatherers to become more sedentary.

Even more threatening than food insecurity to the survival of forest people is the burden of transmissible diseases, which are particularly diverse in moist and hot ecosystems.

The following are some direct detrimental effects on health of the transition to a sedentary way of life.

Cleared lands in which permanent villages are established have a greater range of daily fluctuations in temperature and humidity. The alternation of colder,

damp nights with warmer, drier days favours pulmonary pathologies.

Poor sanitation and increased promiscuity bring more frequent contact with human and animal wastes, thus encouraging faecal pollution and increasing parasitic load. Rates of intestinal worms – which cause anaemia and possibly delayed growth, with potentially dramatic consequences for the psychic development of children – have generally risen with a sedentary way of life. However, the sedentary Punan suffer lower rates of parasitic loads than, for instance, many African Pygmy groups, because they have settled along river banks and use rivers for sanitary purposes (Table 1). The rich aquatic fauna ensures a quick and efficient recycling of human waste. Faecal pollution is also a source of bacterial as well as viral infections of the gut, which are major

causes of malnutrition, infectious diarrhoea and child mortality.

The wearing of European clothes is strongly encouraged by missionaries and local authorities. In the absence of soap, however, the same clothes are worn dirty until they become dilapidated and thus form a propitious ground for skin diseases.

The risk of contracting zoonotic diseases (diseases transmitted between animals and humans) is elevated in human-inhabited or domesticated forest by the proliferation of rodent-borne disease vectors, as rodents are attracted by domestic garbage and food storage. Frequent contact with a broader range of domesticated animals also raises the probability of pathogen transfer between species. In addition, standing water near the habitat attracts disease-carrying insects.

By living in permanent and more crowded villages, former hunter-gatherers who continue to depend on bushmeat contribute to the diffusion of wild zoonotic diseases, such as new hantaviruses spread by ticks hosted by wild boars in Borneo



The emergence of novel zoonotic diseases also becomes more acute with settlement. It is probable that new zoonoses have historically emerged from wildlife many times but failed to spread from the focus of emergence because infected victims living in scattered small hamlets either died or recovered before coming into contact with larger human populations. In modern times, the exponential rise in volume and speed of trade and travel has transformed the epidemiology of emerging infectious diseases, giving them global rather than local importance. By living in permanent and more crowded villages, the former hunter-gatherers who continue to depend on bushmeat – for their own diet and for trade – are more exposed to zoonotic diseases and more likely to contribute to their diffusion. They have higher levels of immunoglobulins in their blood than do agriculturists, which indicate a higher propensity for infection. Infection often leads to malnutrition, which in turn leads to low resistance and thus to further infection, in a vicious circle.

Increased exposure to transmissible diseases (e.g. smallpox, measles, mumps, cholera, rubella, diphtheria and influenza) is associated with dense concentrations of human settlements. In a

small, isolated group of people, these pathogens cannot last for long: they race through the group and every person is infected; subjects either perish or develop an enduring immunity, and the pathogen dies out once there is no one left to infect. But wherever humans gather to form a large, concentrated population, these diseases have a sufficient critical mass of inhabitants to permit propagation. The pathogen can persist even after an epidemic, because births and immigration continually provide enough new hosts. The pathogen can prosper indefinitely, and another epidemic may ensue when the number of new hosts has grown sufficiently. In Kalimantan, smallpox caused severe damage among Dayak farmers, but the nomadic Punan had little trouble with it because they practised silent barter to avoid direct physical contact during epidemics: they marked a site where outside traders could deposit their goods, and after the traders were gone they took the goods and left their payment in forest products in the same place (Knapen, 1998). However, today it is no longer possible to resort to protective silent barter or simply to find refuge further inland. Among the various re-emerging infectious diseases occurring today among former hunter-

gatherers, tuberculosis is the greatest contributor to human mortality (Barrett *et al.*, 1998).

Low population density and scattered settlements related to the nomadic life effectively protected against vector-borne diseases as human potential hosts were diluted in the environment and thus less visible to vectors. Nomadic Punan and Pygmies were free of malaria since they constantly moved outside the flight range of the mosquito vectors before the malaria-causing parasites (*Plasmodium* spp.) were able to reproduce. Landscape alterations and developments that accompany the resettlement of nomadic societies, such as the building of roads, timber extraction, mining and agro-industrial plantations, lead to outbreaks of malaria. Temporary workers in areas of high and endemic malaria (e.g. logging camps, agro-industrial villages) sometimes bring back acute forms of *Plasmodium* spp. which may set off an epidemic. In 2002, this happened in two remote Punan villages of the Tubu watershed when workers returning from Malaysia brought back a severe form of malaria, which killed 28 children (half the population under five years of age) within just a few months.

Industrialization and urbanization,

which generally follow economic growth in tropical forests, bring in their wake changes to a population's diet and nutritional status. The shift to a sedentary way of life affects food availability and distribution and particularly influences children's nutritional status and health. Resettled peri-urban Punan and sedentary Kola and Baka Pygmies, for example, tend towards an excess intake of energy-dense foods that are rich in fat and free sugars but low in complex carbohydrates. Evidence from epidemiological studies has confirmed a link between such a diet and risks of degenerative chronic diseases of middle and later adult life, particularly cardiovascular diseases and certain types of cancer. Other nutritional disorders such as anaemia, obesity, hypertension, elevated cholesterol levels and diabetes are also appearing among these former hunter-gatherers. Their legendary good fitness is compromised and is currently inferior to that of their farming neighbours.

Alcoholism is a new rampant social pathology among sedentary Baka villagers



A. FROMENT

TABLE 2. Body mass index (BMI) of some former hunter-gatherer societies compared with that of some of their fishing and farming neighbours

Population	Men	Women	Source
Coastal Kola, Cameroon			
Pygmies	20.2	19.7	Froment <i>et al.</i> , 1993
Yasa fishers	22.3	21.9	Froment <i>et al.</i> , 1993
Mvae farmers	22.0	22.5	Froment <i>et al.</i> , 1993
Continental Kola, Cameroon			
Pygmies	20.0	19.8	Kesteloot <i>et al.</i> , 1996
Bulu and Ngumba farmers	20.7	21.0	Kesteloot <i>et al.</i> , 1996
Efe, Democratic Republic of the Congo			
Pygmies	20.2	20.2	Bailey <i>et al.</i> , 1993
Lese farmers	21.6	21.7	Bailey <i>et al.</i> , 1993
Borneo, Indonesia			
Tubu Punan (remote)	20.6	19.9	Dounias <i>et al.</i> , 2004
Tubu Punan (peri-urban)	19.9	19.6	Dounias <i>et al.</i> , 2004
Iban farmers	20.9	22.2	Strickland and Duffield, 1998

The body mass index (BMI) – an estimate of the relative percentages of fat and muscle mass in the human body based on an equation relating weight and height – is widely used to assess the nutritional condition of a given population. The indexes of sedentary hunter-gatherers are significantly lower than those of their farming neighbours. However, the BMI of the Tubu Punan who have chosen to stay in the forest (referred to as “remote” in Table 2) is much better than that of their relatives who were encouraged by the Indonesian authorities to settle down near the city of Malinau in the early 1970s (referred to as “peri-urban” in the Table).

... AND CAUSES NEW SOCIAL DISORDERS

Modernization – often hastened by government incentives – is generally associated with increased poverty. It contributes to a series of social disorders that indirectly affect the health of forest dwellers (Levang, Dounias and Sitorus, 2004).

Facilitated access to education, markets and trade, job opportunities and local health services is the usual argument for imposing resettlement of hunter-gatherers. However, for several

practical reasons these advantages are seldom achieved. Permanent settlements are generally distant from cities, and remoteness from services remains a constraint. For instance, the sedentary Baka Pygmies are much more affected by yaws, a non-venereal form of syphilis, than their farming neighbours (80 percent versus 37 percent, respectively) as a direct consequence of their unequal access to health facilities. Civil servants, many of whom still perceive the forest dwellers as primitive, often refuse to be posted to remote settlements or leave after a few months. For the forest dwellers, the illusion of development gives way to frustration and the feeling of being left behind. Social support such as mutual aid, collective activities and food sharing is in constant decline and is being replaced by more individualistic attitudes.

Stress and depression are fairly common mental diseases, which may lead to conjugal violence and various types of addiction. Heavy alcoholism and smoking are sources of direct intoxication and can be indirect causes of pathologies such as tuberculosis. The conversion of the Punan to Christianity has limited the impact of alcoholism, but emphysema and cancer have increased, probably



The younger generation of Punan growing up near the city enjoy electricity and television but suffer discrimination in the job market, and nutritional disorders and increasing social pathologies are symptoms of their ecological and sociocultural maladaptations

as a consequence of heavy cigarette smoking (Strickland and Duffield, 1998). The fast-rising prevalence of sexually transmitted diseases such as acquired immunodeficiency syndrome (AIDS) is another sad example of the “fatal attraction of development” (Froment, 2004).

Traditional healing is inefficient in treating diseases that the hunter-gatherers did not meet when they were still nomadic. For instance, compared with their Dayak farming neighbours, the Punan know little about plants with antimalarial properties (Leaman *et al.*, 1995). Healers and wise elders are consequently losing their political influence, and social conflict between generations is becoming more common. A lack of social controls results in dramatic misuse of manufactured medications, such as analgesic pills which are sold without restriction in local retail shops and wide-spectrum antibiotics which are often taken without regard for directions for use. Self-medication and related addictions have become a major health problem among formerly nomadic societies.

CONCLUSION

If forest ecosystems are dynamic, so are the human societies that depend on the forest. Forest dwellers have had to adapt to permanent changes in forest ecosystems. However, the changes that they face today are much more brutal and radical than those they have experienced in the past. With increasingly rapid deforestation, drastic modification of resource availability and the invasive influence of a cash economy, these groups have an increasingly difficult time adapting their social, cultural, economic and political systems. The choices made today by former hunter-gatherer societies are no longer validated by experience, and the shift from a nomadic to a sedentary life style is revealed to be costly in terms of ecological success.

Social change is not necessarily accompanied by biological balance. It may sometimes invalidate defence mechanisms and jeopardize nutritional status. Such biological imbalance may in turn compromise the social and cultural integrity of the society.

However, declining diets and increasing illnesses are only symptomatic warnings of the ecological and sociocultural

maladaptations that former hunter-gatherer societies are undergoing. More acute than malnutrition and diseases are the insecurity and discrimination caused by social prejudice. The healthy future of these groups depends on socio-economic and sociopolitical factors such as access to education and the acknowledgement of traditional rights. Medical assistance to cope with the malnutrition and diseases of these people would calm the symptoms, but should not preclude other more wide-ranging interventions, considering the ecological, social, political and economic drivers of change that indirectly affect the health of forest people. Improving their health is not in the hands of medical doctors alone. ♦



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Forest biodiversity, nutrition and population health in market-oriented food systems

T. Johns and P. Maundu

Diversity in production systems and natural ecosystems strengthens the opportunities for diversity in diets and the prospect of a sustainable future.

Forest ecosystems contribute to the diets and subsistence of forest dwellers, and in increasingly market-oriented economies they provide a significant portion of the food and medicines consumed by urban populations. Recognition that the sustainable use of forest resources is essential for local livelihoods and the well-being of national populations provides a foundation for investment in conservation of forest biodiversity and its integration with objectives of poverty reduction, food security and disease reduction in development policies. However, it is first necessary to demonstrate more fully that biodiversity is indispensable for combating malnutrition and diseases of vulnerable populations in a global context of unprecedented population growth and resource demand. This article outlines key components of the link between forest biodiversity and the viability of contemporary food systems.

BIODIVERSITY AND THE DIETS AND HEALTH OF FOREST DWELLERS

Most societies recognize that food, medicine and health are interrelated. Food is typically associated with cultural identity and social well-being. Indigenous peoples' foods form part of rich knowledge systems. Traditional food systems typically draw on local biodiversity and are based on local production and management of land and specific environments (Johns, 2006).

Ethnobiological literature documents the historical and current importance of an array of resources consumed by communities living in and around the world's

forests. It also demonstrates the richness of the traditional knowledge of indigenous and local communities related to the gathering and hunting of plant and animal foods and the medicinal value of forest species. From a wide range of ecosystems, some 7 000 of the earth's plant species have been documented as gathered or grown for food (Wood *et al.*, 2005), and thousands more have medicinal properties (Napralert, 2006).

From a nutritional perspective, forest environments offer ample sources of animal (vertebrate and invertebrate) protein and fat, complemented by plant-derived carbohydrates from fruits and tubers and diverse options for obtaining a balance of essential vitamins and minerals from leafy vegetables, fruits, nuts and other plant parts. Although many forest types have scant wild sources of carbohydrate, this lack can be overcome through forest-based agricultural production of cereals (e.g. maize), roots and tubers (e.g. cassava and yams) or bananas. Similarly, traditional cultivation systems drawing on agrobiodiversity can make adequate food available in spite of potential intermittent and seasonal shortages of many forest foods. Thus forest food resources can provide a valuable safety net in case of shortage of food crops. Undoubtedly, then, forest biodiversity is the basis for nutritional sufficiency for some populations. Some forest products, such as the fruits of *Mauritia vinifera* and other Brazilian palms that are rich in provitamin A (beta-carotene and other carotenoids), are recognized as exceptional nutrient sources (Rodriguez-Amaya, 1996, 1999) (see Table). However, the

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Some neotropical fruits in Brazil that are excellent sources of provitamin A

Fruit	Portion analysed	α -carotene ($\mu\text{g/g}$)	β -carotene ($\mu\text{g/g}$)	β -cryptoxanthin ($\mu\text{g/g}$)	Other carotenoid ($\mu\text{g/g}$)	Vitamin A activity in mixed foods (Retinol activity equivalents/100 g)
<i>Mauritia vinifera</i>	Pulp	80.5	360		γ -carotene, 37	3 050
<i>Astrocaryum vulgare</i>	Pulp		107	3.6		930
<i>Eugenia uniflora</i>	Pulp		9.5		β -zeacarotene, 5.9	830
<i>Acrocomia makayayba</i>	Pulp		55			490
<i>Bactris gasipaes</i>	Boiled pulp	3.2	22		γ -carotene, 18	270
<i>Malpighia glabra</i>			26	3.6		230
<i>Mammea americana</i>	Pulp		14		β -apo-10'-carotenol, 5 β -apo-8'-carotenol, 11	195
<i>Spondias lutea</i>	Pulp and peel		1.4	17.0		93
<i>Cariocar villosum</i>	Pulp		1.2	4.4		30

Source: Adapted from Rodriguez-Amaya, 1996.

Note: By comparison, mango (*Mangifera* spp.) and papaya (*Carica papaya*) provide 38–257 and 25–150 retinol activity equivalents per 100 g, respectively (USDA-ARS, 2004).

nutrient composition of most wild species and minor crops has been poorly studied (Burlingame, 2000).

Links between food and health are increasingly understood in terms of the functional benefits provided by phytochemicals, including numerous carotenoids and phenolics, apart from their value as essential nutrients (Johns and Sthapit, 2004). Stimulants of immunity and antioxidant, glycaemic and lipidemic agents can moderate communicable and non-communicable diseases such as diabetes, cancer and cardiovascular

disease. Guava, for example, is rich in the antioxidant lycopene, which has recognized anti-cancer properties. Many nuts have a high content of specific oils such as omega-3 fatty acids (walnut) and mono-unsaturated fatty acids (almond, macadamia, pistachio, hazelnut) which reduce the risk of cardiovascular and other diseases. Argan nuts (*Argania spinosa*) from the southwestern part of Morocco offer similar benefits, but many forest species with commercial potential have not been characterized for their specific fatty acid composition

(Leakey, 1999). Leaves of many forest species are rich sources of xanthophylls which contribute to optimal eye function. Examples include leaves of *Gnetum* spp. and *Adansonia digitata* (baobab), which are widely eaten in sub-Saharan Africa, and *Cnidocolus acontifolius*, which is locally important as a vegetable in Central America (Serrano, Goñi and Saura-Calixto, 2005).

While these kinds of functional properties of foods are seldom recognized by local communities without the benefit of scientific analyses, people often attribute to particular foods value in treating or preventing disease. Indeed the distinction between food and medicine which characterizes scientific perspectives stands in contrast with traditional concepts of health which recognize the therapeutic and sustaining values of food more holistically.

The widespread use of roots, barks and other forest plant parts as



Leaves of *Cnidocolus acontifolius*, an excellent source of beta-carotene (provitamin A) and lutein, make important contributions to diets of forest dwellers in southern Mexico, Guatemala and neighbouring countries

medicine appears to offer public health benefits, but these are difficult to validate scientifically. Ethnobotanical studies in tropical forest areas typically document knowledge of hundreds of species within local communities and widespread use of plants in primary health care. Much of the recorded data on the use of medicinal plants is anecdotal and idiosyncratic, and their specific contribution to the health of individuals cannot be effectively evaluated without controlled investigations. Ethnopharmacological research, including clinical studies, demonstrates the efficacy of many traditional remedies while failing to substantiate the pharmacological value of many others. Long-term epidemiological studies would be needed to confirm the contribution of specific remedies, phytomedicines or foods to the health of populations. Even these remain inadequate to measure the efficacy and contributions of traditional healing practices to physical and mental health.

Nonetheless, for forest-based societies that draw on traditional knowledge for most of their subsistence needs, the use of a diversity of resources can be expected to contribute to health. Although many traditional subsistence systems depend on one or more staples such as cassava, sago, rice or maize, such diets are kept diverse and balanced through small but complementary

amounts of animal-source foods including birds, fish, insects and molluscs, as well as sauces, condiments, snacks and beverages obtained from plants.

FOREST BIODIVERSITY IN CHANGING FOOD SYSTEMS

Changes in developing-country food systems affect both human health and the health of ecosystems. When rural populations lose access to important natural resources because of environmental degradation, economic changes (including changes in land use), cultural erosion or poverty, their reduced diet results in food insecurity, malnutrition and disease. Similarly, when people move to cities they lose ready access to the beneficial products of local biodiversity because these are either unavailable or unaffordable.

Urbanization, in conjunction with the commercialization of the food supply and other subsistence items, results in considerable changes in patterns of consumption and resource use. In Latin America 78 percent of people live in cities. Forty percent of Asians and Africans are urban, and in both regions this figure is expected to rise to 50 percent by 2025 (United Nations, 2004). With the global population expected to grow to 8.3 billion by 2030, this elevated urbanization rate represents a tremendous increase in the number of humans who depend on foods that are purchased and

produced by others outside cities. Simply meeting present and future food security needs necessitates intensification of production systems of cereals, sugar, oilseeds, other staple crops and animal-source foods. Production increases will draw heavily on technology and greater exploitation of land and natural ecosystems, including forests.

Three crops alone – rice, wheat and maize – already provide over 50 percent of the global human food supply (Wood *et al.*, 2005). Along with rice and wheat, a couple of other products of high-input, high-yield agriculture, sugar and edible oil (soy and other), are important commodities in global trade. Together these staples form the bulk of the diet of urban dwellers in Africa, Latin America and Asia. Large-scale commercial agriculture responds to the demand for these crops for export and local markets. On the other hand, the food supply of urban dwellers in many developing countries increasingly depends on food imports.

The availability of calorie-rich food at affordable prices contributes to food security and has reduced the number of undernourished people. However, for poor people whose food choices are determined foremost by economic means, dietary options are limited. At the same time local producers, particularly small-scale farmers, have difficulty competing with inexpensive (often subsidized) imports. Deficiencies in infrastructure and support for small-scale production contribute to keeping local forest products unavailable or expensive in local markets. As supermarkets take a larger market share in developing countries, opportunities for local producers to sell diverse products, particularly wild foods from forests, may be reduced (Reardon *et al.*, 2003). However, although it is difficult to compete, local producers need not be excluded, especially if they can highlight the unique nature of their products and fill speciality niches.

In many areas, as use of local biodiversity decreases, a diet that is reduced



Even small amounts of animal-source foods, including insects, complement staple foods and keep traditional diets diverse and balanced (roasted termites on sale in Limbe market, Malawi)



*Traditional concepts of health tend to view the therapeutic and sustaining values of food more holistically; for example, the nutritious roots of *Mondia whitei* (white ginger), an African woody climber, lends flavour to foods and tea while also serving a variety of medicinal purposes (street vendor in Kenya)*

in variation but high in calories contributes to increasing problems of obesity and non-communicable disease (Popkin, 2002). The globalization of culture and commerce fosters a westernization of developing country food systems and diets. Where high rates of infectious illness persist and undernutrition and overnutrition co-exist, communicable and non-communicable diseases create a double burden. Chronic diseases pose a staggering cost, particularly for developing countries and economies in transition. A recent report by the World Health Organization (WHO, 2005) estimated that the loss in national income as a result of heart disease, stroke and diabetes over the next ten years for populous countries such as China, India and the Russian Federation will be in the hundreds of billions of United States dollars each, while other developing economies such as Brazil, Nigeria, Pakistan and the United Republic of Tanzania will lose US\$49.2 billion, \$7.6 billion, \$30.7 billion and \$2.5 billion, respectively. The challenge is to address a problem whose causes and consequences span health, agriculture, culture, markets and environment.

While the impacts of rapid sociocultural changes can be seen throughout the world, those countries that retain strong traditional food systems in which

diet has recognized health, cultural and ecological roles are better able to avoid the concomitant increases in disease. Asian and Mediterranean diets provide the clearest examples (Kim, Moon and Popkin, 2000; Trichopoulou and Vasilopoulou, 2000).

Important lessons on linking traditional sources of food and dietary diversity to rural and urban health are emerging from research and promotional activities led by the International Plant Genetic Resources Institute (IPGRI) in sub-Saharan Africa and other regions (Frison *et al.*, 2005). In East Africa, for example, the link between traditional food culture and health is related to an attachment to rural and ethnic origins coupled with social and spiritual values. In a recent cross-sectional survey in Nairobi, Kenya, ethnic identity was found to be the main determinant of

patterns of traditional food consumption, more important than economic status (Johns *et al.*, 2005). In other regions, connections among sociocultural, health and environmental factors take other forms. In the Republic of Korea, social marketing draws on cultural traditions to link healthy cuisine with concern for rural producers and production systems (Kim, Moon and Popkin, 2000). Brazil has undertaken a multisectoral initiative to mobilize the biological resources of its Amazonian and other forests to address national health needs. The Slow Food Movement, with origins in Italy and growing influence in Europe, North America and elsewhere, aims to link producers and consumers of excellent quality foods, to protect traditional foods at risk of extinction and to conserve biodiversity in the food supply, further illustrating the connection of sociocultural values to human and ecosystem health (Petrini, 2004).

Market and economic factors act as powerful determinants of the transformation of food systems. Consumer demand for forest-derived foods and medicines ensures their continued presence in markets as long as supply is affordable and sustainable.

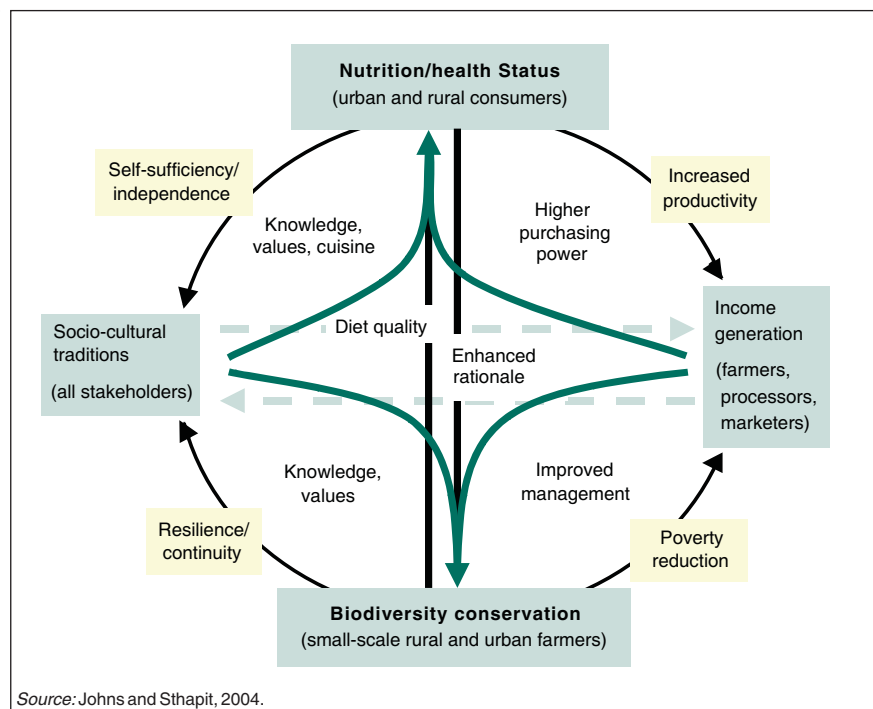


*Although the spread of supermarkets may reduce opportunities for local producers, consumer demand for forest-derived foods and medicines ensures their continued presence in markets (sale of *Uapaca kirkiana* fruits in Mutare town market, Eastern Zimbabwe)*

Population-level synergies linking biodiversity conservation and human nutrition in developing countries

POPULATION-LEVEL SYNERGIES: LINKING MARKETS, HEALTH AND HUMAN BEHAVIOUR

Most of the world's poorest households are in countries harbouring the largest amounts of biodiversity, much of it in and associated with tropical forests. As a consequence, conservation and poverty cannot be addressed independently. Since most of the world's population today depends at least in part on purchased foods, improving accessibility to a range of unprocessed and processed forest products offers nutritional benefits to the rural and urban poor. This can be best achieved within a model linking local producers and consumers in which biodiversity contributes to poverty reduction and viable economies within a supportive sociocultural context. The model draws on recognized and potential synergies among biodiversity conservation, income improvement, sociocultural values and health outcomes (see Figure). For example, while direct use of plant and animal resources coupled with income generation and integrity of sociocultural traditions can contribute to better nutrition and health, a healthy population is conversely more likely to have the incentive and resources to better manage its natural environment. Local communities can manage and use gathered and cultivated species to improve their livelihoods by developing products that can be marketed to meet demands of local food cultures and offer nutritional and cultural benefits to (increasingly



urban) consumers. Thus, linking biodiversity and health is both a response to the consequences of economic growth and a way to direct growth in a positive manner.

Promotion of dietary diversity at the local, national and regional levels is a priority and can include the transfer and sharing of information and successful experiences in defending and enhancing the dietary use of plant and animal diversity.

Consumption of more diverse foods by urban dwellers depends on the affordability and accessibility of a range of products from the wild. Nonetheless, experience indicates that urban consumers will pay high prices for speciality foods if they consider them to be of high quality and/or desirable from a cultural perspective. Viable markets depend on demand from consumers which can be driven through availability, education and promotion and by reinforcing traditional food culture (Kim, Moon and Popkin, 2000). Demand translates into opportunities for income generation and improved livelihoods when rural farmers are linked with consumers. Reduc-

tion in poverty has a crucial indirect impact on health. Greater diversity within production systems and natural ecosystems strengthens the opportunities for resource sustainability and for diversity in all diets.

In practice, contemporary food systems exist within an increasingly commercial context. In developing countries, supermarkets and other commercial entities are desirable partners in any effort to combine economic and social rationales in support of traditional use of biodiversity in food. For example, in Nairobi, Kenya, a local non-governmental organization called Family Concerns successfully promoted African leafy vegetables by linking small-scale producers with a supermarket chain (Johns *et al.*, 2005).

International policies and regulations related to trade and to human rights, including cultural and food rights, must ensure the viability of food systems that guarantee the sustainability of local ecosystems and respect cultural traditions. The international voluntary guidelines on the right to food (FAO, 2005),

for example, explicitly recognize the importance of customs and traditions on matters related to food. The rationale for the Cross-Cutting Initiative on Biodiversity for Food and Nutrition of the Convention on Biological Diversity (CBD, 2006) acknowledges that “traditional food systems provide positive synergies between human and ecosystem health, and culture offers an essential context for mediating positive dietary choices”.

RESEARCH AND ACTION PRIORITIES

While a good case can be made for the importance of biodiversity for providing nutrients and medicinal agents that can improve health, a strategy involving research, improved marketing, consumer education, policy and the strengthening of partnerships will reinforce the usefulness of biodiversity. The contributions of traditional foods and medicines to health and well-being are sufficiently understood to warrant a new prioritization of the marketing of forest foods within the context of strategies to support forest-based livelihoods and food-based approaches to health.

Basic research that can support these activities should include:

- laboratory analyses and compilation of data on the nutrient and phytochemical composition of underused forest products, including consideration of seasonal variability;
- documentation of links between forest biodiversity and dietary diversity within traditional food systems;
- survey on the state of traditional knowledge of food diversity and its uses among population subgroups;
- study of factors, including seasonality, that contribute to food choices of rural and urban dwellers, specifically those involving foods coming from forests;
- testing of hypotheses on the relationship of forest and agricultural biodiversity to dietary diversity and health, including the use of epide-

miological methods to demonstrate contributions of biodiversity to the health of human populations;

- development and testing of methods for measuring the dietary diversity of rural producers and urban consumers, and its association with nutritional and health status;
- analysis of production, marketing and other factors that contribute to the availability of a diverse diet.

Developing-country scientists with knowledge of local resources, customs and cultural values should have a fundamental role in identifying sustainable approaches to improving diets and health. A growing body of reliable data collected in developing countries addresses the health properties of indigenous foods and medicines. Although a few developing countries can support extensive research and development programmes, in general progress will depend on improvements in the scientific resources, opportunities and infrastructure available.

CONCLUSIONS

Successful interventions to support the use of forest biodiversity for health objectives are likely to be multisectoral, multidisciplinary and problem focused. They will recognize dietary diversity as a fundamental, cost-effective and sustainable way of resolving health problems related to malnutrition, but also that diversity-based approaches to improving nutrition and health depend on the conservation and sustainable use of forest and other wild species and biodiversity.

Formulation and implementation of effective strategies involves the participation and integration of the expertise of multiple stakeholders from the scientific, health, government and private sectors. While few would dispute the importance of health and of environmental sustainability, different development sectors have different priorities. Dialogue is needed, for example, between environ-

mentalists with concerns for underlying processes and health professionals focused on providing essential health care. Food systems and nutrition offer a common ground.

At the national level, ministries responsible for environment, health and nutrition, agriculture, forestry, economic development, culture and education could promote forest products within collaborative initiatives for human and ecosystem health, in conjunction with infrastructure and programme support for producers and marketers of priority foods. While international policy instruments such as CBD can offer direction to national initiatives, they also underline the need for coherent policies that unite environmental, health, agricultural and economic development priorities within the framework of the Millennium Development Goals. ♦



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Health impacts of household fuelwood use in developing countries

K.R. Smith

Incomplete combustion of household woodfuel releases smoke that is damaging to human health; efficient stoves and adequate ventilation are essential.

A large part of the world's population uses fuelwood for household cooking and space heating, mostly in developing countries. Energy from traditional biomass fuel is thought to account for nearly one-tenth of all human energy demand today (more than hydro and nuclear power together), and wood-based fuels probably make up some two-thirds of household use.

In poor developing-country households, wood, charcoal and other solid fuels (mainly agricultural residues and coal) are often burned in open fires or poorly functioning stoves. Incomplete combustion leads to the release of small particles and other constituents that have been shown to be damaging to human health in the household environment. Too little is known, however, to distinguish any differences in health effects of smoke from different kinds of biomass.

Given that levels of household solid fuel use are expected to remain high, efforts to improve household air quality are concentrated on improving stove

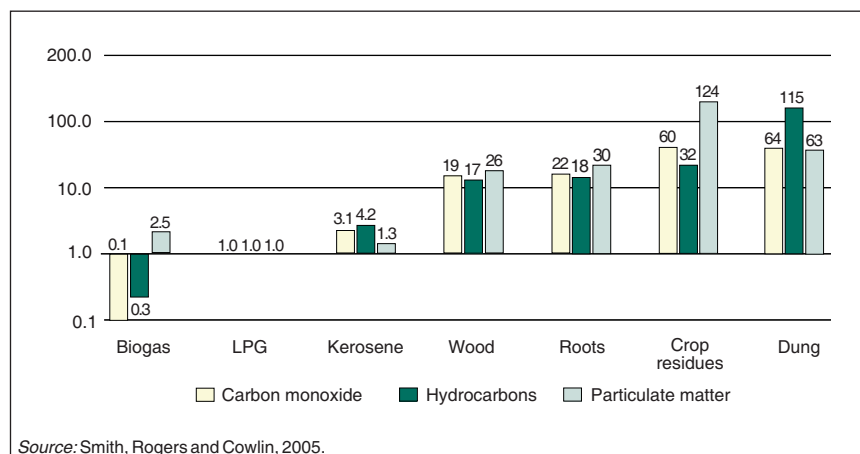
efficiency and venting the smoke away from the home.

AIR POLLUTION FROM WOOD BURNING

With proper stoves and good fuel burning practices, fuelwood and charcoal as well as other biomass can be burned cleanly, producing mostly carbon dioxide and water. Such conditions are difficult to achieve in poor rural and urban areas where small-scale inexpensive wood-burning stoves are used, however. Woodfuel that is not properly burned to carbon dioxide is diverted into products of incomplete combustion – primarily carbon monoxide, but also benzene, butadiene, formaldehyde, polyaromatic hydrocarbons and many other compounds posing health hazards. The best single indicator of the health hazard of combustion smoke is thought to be small particles, which contain many chemicals.

Figure 1 shows the emissions of major toxic pollutants from fuelwood per meal in typical cookstoves in India, relative

1
The energy ladder: pollutant emissions per meal by cooking fuel, relative to LPG (1.0 on the scale) (measured in India; note log scale)



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to the most common clean fuel available, liquefied petroleum gas (LPG). The two wood species measured (*Acacia* spp. and *Eucalyptus* spp.) produced some 25 times more small particles than LPG, with other biomass fuels producing even more. Studies comparing emissions from hardwood and softwood species are not available from developing countries, although anecdotal accounts suggest some differences. Studies in the United States and other developed countries (e.g. Fine, Cass and Simoneit, 2002; Environment Australia, 2002), however, have suggested that hardwood species generally have somewhat lower emissions than softwood species for combustion in fireplaces, which may provide the closest comparison with typical stoves in developing countries. Differences by species, however, are unlikely to be significant compared to those resulting from other parameters affecting human exposure, such as fuel moisture, burning rate, ventilation and cooking behaviour.

It should be noted that use of wood charcoal, a relatively clean-burning fuel, may be increasing in some developing countries, especially in urban Africa, while the use of household fuelwood and other solid biomass is slowly decreasing. Charcoal fuel, however, can pose other kinds of health risks as well as forest impacts.

HOUSEHOLD LEVELS AND FAMILY EXPOSURE

Many developing-country households use woodfuel stoves that lack working chimneys or hoods for venting the smoke outdoors. Although there have been no large-scale statistically representative surveys, hundreds of small studies around the world in typical local situations have shown that such stoves produce substantial indoor concentra-

tions of small particles – typically 10 to 100 times the long-term levels recommended by the World Health Organization in its recently revised global air quality guidelines for protecting health (WHO, 2005). Even stoves with working chimneys, however, do not completely eliminate indoor pollution, as there is often substantial leakage into the room and some smoke returns into the house from outside.

The significant emissions of health-damaging pollutants per unit activity, combined with daily use in close proximity to large human populations, means that household biomass fuel use produces substantial total population exposure to important pollutants – probably more exposure, in fact, than is caused by global fossil fuel use (Smith, 1993). Exposure is highest among poor women and young children in developing countries, both rural and urban, as these are the groups most often present during cooking.

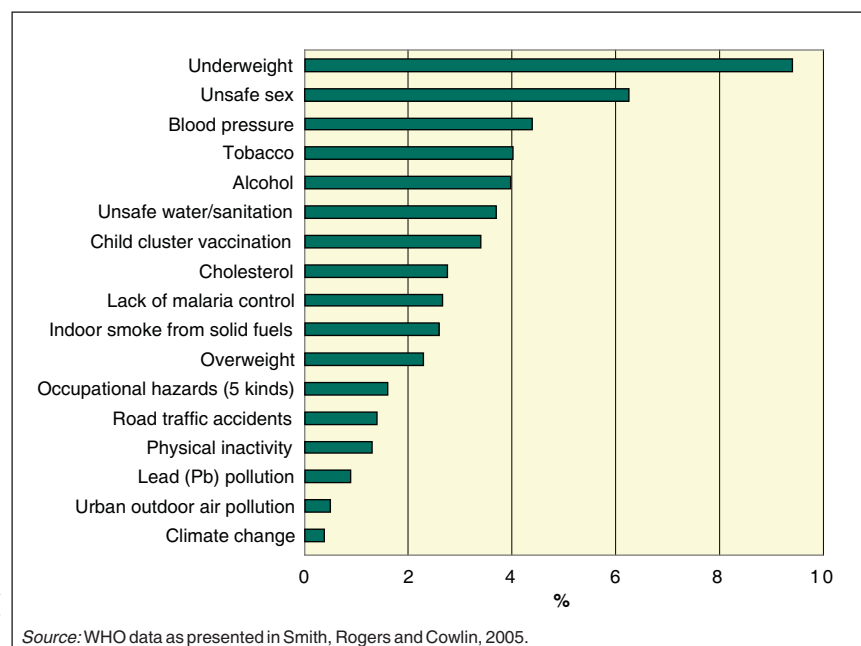
OBSERVATIONAL HEALTH STUDIES – SOLID FUEL AS A ROUGH MEASURE

Since the mid-1980s and more frequently since the mid-1990s, many dozens of

published epidemiological studies have examined a range of health effects from indoor air pollution due to solid fuel. Because of the difficulty and expense of assessing exposure in households, however, most have used a surrogate for true exposure – often simply whether the household was using biomass fuels or not. Moreover, most studies do not distinguish fuelwood from charcoal or from other biomass fuels or sometimes even coal. Although it is not possible to distinguish the health effects of different biomass fuels with current information, emission studies show wood to be generally somewhat cleaner than crop residues and animal dung, the other major biomass fuel types (Figure 1).

Despite the imprecision of the measure, health effects of several sorts have repeatedly been found for households that use biomass fuels, which in most cases include or consist entirely of woodfuel. The effects include:

- acute infections of the lower respiratory tract (pneumonia) in young children, the chief killer of children worldwide and the disease responsible for the most lost life years in the world;



2
Estimated burden of disease for major risk factors, measures as percentage of total healthy life years lost in the world in 2000



Women cooking on a traditional stove (three large stones) with high fuel consumption and uncontrolled fire (above) and on an improved smokeless stove (below), Ghana

- chronic obstructive pulmonary disease, such as chronic bronchitis and emphysema, in adult women who have cooked over unvented solid fuel stoves for many years.

WHO, in a risk assessment that combined the results of many published studies (Ezzati *et al.*, 2002), compared the burden of illness and premature death from solid fuel use with other major risk factors, including outdoor air pollution, tobacco smoking and hypertension. The results indicate that solid fuel use may be responsible for 800 000 to 2.4 million premature deaths each year (Smith, Mehta and Maeusezahl-Feuz, 2004). A comparison of the central (“best”) estimates for the risk factors examined (Figure 2) places solid fuel use approximately tenth among major health risks in the world in terms of potentially preventable lost life years. Biomass fuel is responsible for about 95 percent of this total – but the risk due

specifically to fuelwood and charcoal is not known.

Biomass fuel use has been found to be associated with tuberculosis, cataracts, low birth weight in babies of exposed expectant mothers, and other health conditions in a number of other studies. The evidence is not yet considered as definitive as that for the diseases above, however.

In 2006 the International Agency for Research on Cancer reviewed the global evidence and classified household biomass fuel smoke as a probable human carcinogen, while coal smoke was classified as a proven human carcinogen (Straif and IARC Monograph Working Group, 2006). This could be interpreted to mean that biomass smoke is only weakly carcinogenic. Most of the biomass fuel evidence was from wood smoke.

Given what has been seen in studies of outdoor air pollution and active and passive tobacco smoking, heart disease could also be expected from biomass smoke indoors, but no studies seem to have been done in developing-country households. Similarly, asthma might also be expected as an outcome, and this premise is currently being investigated.

AN INTERVENTION STUDY

It is one thing to determine that ill health is associated with a particular risk factor, but sometimes quite another to show that reduction in the risk factor will actually produce an improvement in health. One study of this type is currently under way, a randomized trial of improved wood-burning stoves in highland Guatemala. The study focuses on childhood pneumonia but is also examining heart and lung effects in women. Preliminary results have already been reported indicating a reduction in serious pneumonia among infants when households switch from an open wood fire to an improved stove with chimney (Smith, Bruce and Arana, 2006), as well

as a significant drop in blood pressure among women (McCracken *et al.*, 2005). Blood pressure is highly predictive of heart disease in all populations where it has been studied.

IMPROVED STOVES: PROGRESS AND CHALLENGES

Although the risk estimates will continue to be refined and new health effects will probably be recognized, the challenge in a development context is to find a viable intervention that can be relied on to reduce exposure and improve health cost effectively. Alternative fuels, such as LPG, are easier to use, produce fewer emissions and cause less exposure to pollutants. However they are expensive, not accessible everywhere and culturally unfamiliar, and they may not be feasible in developing countries, especially in poor rural areas (Smith, Rogers and Cowlin, 2005).

Properly cut and dried fuelwood and well-designed, well-built and well-used improved stoves with chimneys and hoods reduce kitchen pollution substantially. Successful dissemination of well-operating and durable stoves in large populations, however, has not been easy. In some areas, cultural constraints to the adoption of improved stoves are important. Cooking traditions are deeply rooted, and in many cultures the fire is the centre of the home and has much cultural and spiritual significance. Some improved stove designs fail to give adequate attention to the cultural and social significance of how fire is used in households. That such stoves may also have social (e.g. time-saving), ecological (e.g. tree-conserving) and economic (e.g. fuel-saving) benefits, however, encourages further work to find ways to disseminate them widely.

A national programme for disseminating improved stoves is currently under way in Nepal, but no air pollution or health assessments of the results have been done as yet. Since better standard methods and new equipment for assess-

ing the pollution and health implications of improved stove programmes are now being developed and field tested, there should be reliable information soon about the actual changes produced by this and other improved stove and fuel programmes around the world.

A national competition is under way in China to find the best of a new generation of biomass “gasifier” stoves which are now starting to be sold in the country. These stoves, which can be used to burn fuelwood as well as other types of biomass, promote internal secondary combustion of partially combusted smoke and also have chimneys; they are designed to produce extremely low emissions. Laboratory tests indicate that when such stoves are operating well they have emission levels rivalling those of LPG. Designing them to be reliable in household use as well as inexpensive is a challenge, but this second generation of improved stoves shows promise not only for high energy efficiency but also for the potential to reduce air pollution exposure substantially. This would imply substantial reduction in global warming impact as well. Measurements in households over time will be needed to verify these benefits.

CONCLUSION

It could be said that the smell of wood smoke from the hearth is as old as humanity itself, since many anthropologists define the beginning of humanity as the moment when our ancestors learned to control fire. With such a long association, the risks from wood smoke may be difficult to recognize. And wood, of course, dominated human fuel demand for hundreds of thousands of years in most parts of the world. Even today, it is probably true to say that biomass fuels provide most of the energy for most of humanity.

Nostalgia triggered by the sight and smell of a fire in the hearth has fostered complacency about the risk of an open wood fire and continues to do so today. Inefficient conversion of woodfuel – and

indeed of all fuels – to energy has negative economic, health and environmental impacts. Household use of woodfuel in devices that do not burn the fuel completely is not compatible with a long-term strategy of sustainable development. Cooking and heating processes are also important for the correct use of fuels and stoves, to ensure that less energy is used and less fuel consumed.

Wood and other biomass fuels can be burned cleanly with the right technology and thus can have a long-term role in sustainable development where they are renewably harvested. Thus programmes for the modernization of woodfuel use for household and cottage industries in the poorest areas of developing countries should be part of the development agenda.

If any population in developed countries experienced the high pollution levels found in hundreds of millions of poor village households from biomass fuel, no additional evidence would be needed to trigger massive intervention efforts – another sign of the extreme disparities in the world. In poor countries, however, reliable evidence and careful assessments are required to determine the most cost-effective means and priorities for addressing the wide range of health and other problems due to poverty. ♦



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Health guidelines for vegetation fire events

Fires in forests and other vegetation release polluting particulate matter, carbon monoxide and oxides of nitrogen, sulphur dioxide and organic compounds. Fine airborne particles (diameters smaller than $2.5 \mu\text{m}$) have potentially detrimental health effects because they can penetrate deep into the human lungs. The World Health Organization (WHO) has identified a link between exposure to fine and ultrafine particles and hospital admissions, visits to emergency and outpatient departments and mortality due to respiratory and cardiovascular diseases.

In developing countries, vegetation fires increase the risk of acute respiratory infections, which are a major killer of young children. Severe forest fires arising from forest clearing in Southeast Asia in 1997–1998, for example, affected some 200 million people in Brunei Darussalam, Indonesia, Malaysia, the Philippines, Singapore and Thailand. Massive movement of populations fleeing the fires and smoke and the proliferation of emergency visits to hospitals added to the crisis. The number of cases of pneumonia increased from 1.5 to 25 times in Southeast Kalimantan, Indonesia, while in Malaysia the number of outpatient visits with respiratory diseases increased two- to threefold. Partly as a result of this severe fire occurrence, in 2002 the Association of Southeast Asian Nations (ASEAN) adopted the ASEAN Agreement on Transboundary Haze Pollution to control activities related to land and/or forest wildfires that may lead to transboundary haze pollution. Signatory countries agreed on activities for monitoring, assessment, prevention and preparedness, as well as subregional cooperation and coordination in managing the impact of such fires, which continue to occur almost annually.

The United Nations Environment Programme (UNEP), WHO, the World Meteorological Organization (WMO) and the Institute of Environmental Epidemiology, Singapore

(IEE) have issued comprehensive guidelines for governments and responsible authorities on actions to be taken when their population is exposed to smoke from fires. *Health guidelines for vegetation fire events* (1999) gives information on vegetation fires at the global, regional and national levels obtained by remote-sensing, including information on the extent of the impact and the pollutants released. A related teachers' guide compiles educational material for use in training courses. These publications are also available on CD-ROM.

The guidelines examine acute and chronic health effects of air pollution from forest and biomass fire. Mitigating measures that can be taken during acute smoke emergencies include:

- remaining indoors;
- reducing physical activity and refraining from smoking;
- using air cleaners;
- using gas masks and respirators;
- evacuating susceptible people to

emergency shelters (e.g. schools or commercial buildings equipped with air conditioning and particle filtration systems).

The guidelines provide advice on effective public communications and mitigation measures, and guidance for assessing the health impacts of vegetation fires. They also describe measures on how to reduce the burden of mortality and preventable disability suffered particularly by the poor, and on the development and implementation of an early warning system for air pollution, based on monitoring and forecasting of ground and weather conditions.

Source: WHO. 2000. *Vegetation fires*. Available at: www.who.int/mediacentre/factsheets/fs254/en/index.html



Smoke from forest fire causes significant human respiratory problems

P. VUORINEN

Forests, air pollution and water quality: influencing health in the headwaters of Central Europe's "Black Triangle"

J. Křeček and Z. Hořická

Forests and forestry practices in mountain watersheds can moderate the effects of acid rain on water quality – essential for human health.



1
Jizera
Mountains
region

Water is essential for human health and development. Access to safe water is a basic human right and a component of effective policy for health protection. Water resource management is an integral aspect of the management of water quality. Prevention of microbial and chemical contamination of source water is the first hurdle in preventing water contamination of public health concern. Pollution in the catchment will influence water quality downstream. Therefore, the influence of land use on water quality should be assessed as part of water resource management (WHO, 2004).

On a global scale, headwaters – the small streams that are the sources of a river in its highest reaches – are strongly related to environmental security and human opportunities to live in a healthy environment. In the water cycle, the headwater environment is the recharge area. Adverse changes in headwater systems can have an impact over a large area which may include distant downstream regions (Křeček and Haigh, 2006).

The water protection role of forests is central in the "Black Triangle" area on the borders of the Czech Republic, the former German Democratic Republic and Poland (Figure 1). This area acquired its name because of its extreme air pollution caused by rapid industrialization after the Second World War. Many air pollutants (sulphur dioxide, particulates, carbon monoxide) have been more closely controlled over the past two decades and their impact has been reduced (Grennfelt *et al.*, 1995). However, in Europe there is a striking contrast between environ-

mental pollution levels in the east and in the west.

In addition to causing or exacerbating respiratory diseases, the air pollution in the Black Triangle, especially sulphur dioxide and nitrogen oxides, resulted in acid rain – meaning any wet deposition (rain, sleet, snow or fog drip) that has become more acidic than normal rain (i.e. pH <5.5). Acid rain is harmful to both forest and aquatic ecosystems. Acid rain that seeps into the ground can dissolve nutrients such as magnesium and calcium and can cause aluminium to be released into the soil. Forest stands located at higher elevations are at greater risk because they are exposed to acidic clouds and fog, which contain greater amounts of acid than rain or snow and strip nutrients from leaves or needles. The loss of nutrients makes it easier for diseases, insects and cold weather to damage forests. The reduced quality of water and soil also affects human health.

This article, based on research carried out by the authors since 1982, describes the effects of acid atmospheric deposition, and the role of forestry practices in moderating these effects, in the Jizera Mountains of the Czech Republic. Acidification in this area, which began in the early 1950s and peaked in the mid-1980s, resulted in large-scale dieback (40 to 80 percent) of spruce stands, a decrease in pH of surface waters and decline of life in streams and reservoirs. Since 1990, however, some recovery has been observed.

The headwaters of the Jizera Mountains in the Czech Republic have 83 percent forest cover. The region's bedrock (granite) and shallow podzolic soils

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Semi-natural beech stands at the north rim of the Jizera Mountains

are extremely sensitive to acidification. Direct runoff (particularly fast subsurface flow) is the dominant source of water; groundwater bodies occur only in shallow subsurface layers.

EFFECTS OF ACID RAIN ON WATER QUALITY

In the reservoirs of the Jizera Mountains, low pH, low hardness and high aluminium content were observed in the 1980s.

No health-based guideline value has been proposed for the pH of water. However, pH is one of the most important operational water quality parameters. National guidelines for drinking water quality often suggest that optimum pH is in the range 6.5 to 8.5 (WHO, 2004). Thus, not only acidification, but also high alkalization (which is related to extreme mineralization) affects drinking-water quality. Very low or very high pH may also affect recreational users, with negative impacts on the skin and eyes (WHO, 2003). Without pollution and subsequent acid rain, most lakes and streams would have a pH level close to 6.5 (Nordic Council of Ministers, 1988). Acid rain in the Jizera Mountains, however, caused many lakes and streams to have much lower pH levels in the 1980s, around 4 to 5.

Hardness refers to concentrations of dissolved calcium and, to a lesser extent,

magnesium in water. Low hardness (up to 10 mg of calcium and magnesium per litre), related to the low pH, was also observed in the area. Soft water with less than about 100 mg per litre has a low buffering capacity and may be more corrosive to water pipes. Epidemiological studies have shown a statistically significant inverse relationship between hardness of drinking-water and cardiovascular disease (WHO, 2004)—in other words, low calcium and magnesium content in drinking-water is related to higher rates of heart disease. There is some indication that very soft water may have an adverse effect on human mineral balance.

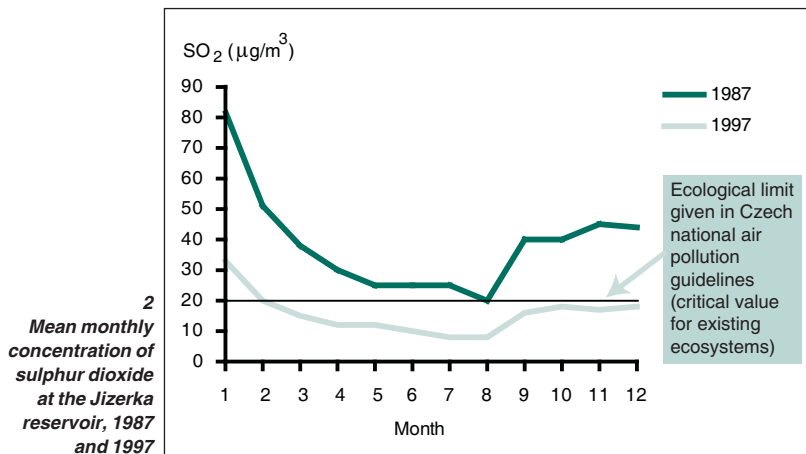
Aluminium released into the soil eventually ends up in lakes and streams. The aluminium content of the surface waters

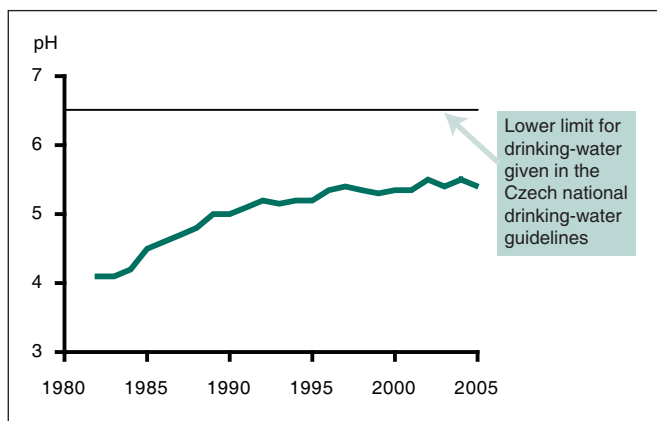
in the area in the 1980s was 1 to 2 mg per litre. The established limit of aluminium in drinking-water is 0.1 mg per litre for large treatment facilities, and 0.2 mg per litre for small facilities (WHO, 2004). Although aluminium is widespread in foods, drinking-water and many antacid medications, there is some indication that when ingested orally in concentrations exceeding hygienic limits (i.e. 30 mg of aluminium per kilogram of fish meat, or 0.2 mg of aluminium per litre of drinking-water) it is toxic to humans. It has been hypothesized that aluminium exposure is a risk factor for the development or acceleration of Alzheimer's disease in humans (WHO, 2004).

The elevated acidity and aluminium levels not only posed risks to human health, but were also deadly to aquatic wildlife, including phytoplankton, mayflies, rainbow trout, smallmouth bass, frogs, spotted salamanders, crayfish and other creatures that are part of the food web. This problem was observed to be much worse during events of episodic acidification from heavy downpours of rain or initial snowmelt (Křeček and Hořická, 2001).

INFLUENCE OF STAND TYPE ON ACID DEPOSITION

The native tree species in the Jizera Mountains are common beech (*Fagus sylvatica*), Norway spruce (*Picea abies*) and common silver fir (*Abies alba*). How-





3
Gradual recovery of mean annual pH in three reservoirs in the Jizera Mountains (Bedrichov, Sous and Josefuv Dul)

ever, following the introduction of clear-cutting in the upper mountain plateaus in the seventeenth century (provoked by the development of glass manufacturing), the forests were severely reduced in the eighteenth and nineteenth centuries. In the second half of the nineteenth century Norway spruce was planted for commercial reasons, and by the twentieth century spruce plantations made up 90 percent of the forests in the Jizera Mountains. Nursery practices were established with seeds imported from regions of Europe with a different climate, so the pure spruce plantations had poor ecological stability.

Within a forest stand, the atmospheric deposition of sulphur rises with canopy density (leaf area), height and roughness (the turbulence of the air mass above the canopy). Thus, the effects of acidification were found to be worse in spruce stands.

Beech stands have a lower canopy area, particularly in the dormant season when the concentration of sulphur dioxide in the atmosphere is highest (Figure 2).

Furthermore, native beech stands are more resistant to acidification problems. Their annual shedding of leaves helps them to suffer less than coniferous species which keep their needles for many years and thus accumulate more toxic substances.

Soils in beech stands have higher capacity to buffer acidification because of deeper root systems and higher nutrient content. Therefore, the stream water

at a beech stand was found to be twice as hard (i.e. its calcium and magnesium content was twice as high) as that at a spruce site.

Thus the commercial support for converting native mixed stands into spruce plantations over the past two centuries contributed to the degradation of forest health and water quality.

INFLUENCE OF HARVESTING PRACTICES

From 1984 to 1990, forest harvesting at Jizerka (clear-cut of mature spruce stands and skidding timber by wheeled tractors) also contributed to soil erosion and sedimentation, as well as to contamination of water by humic acids from related drainage of peat soils. On the catchment scale, the annual erosion

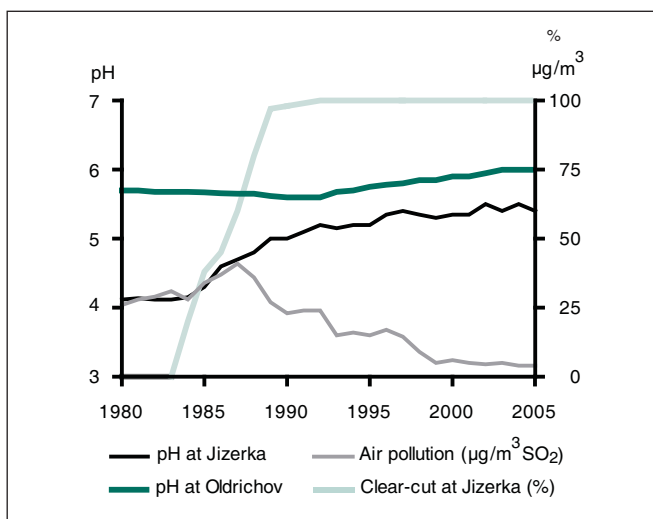
of soil, which was 0.01 mm between 1981 and 1984, intensified to 1.34 mm between 1984 and 1990. Sediment runoff increased from 8 to 30 percent of the eroded soil volume.

From field observation, negligible sheet erosion occurred in both forest plots (mature spruce stands) and clear-cut plots (invasive grass). However, the significant loss of soil was related to the length of erosion rills produced by the harvest of timber. Forest harvesting can be prevented from causing soil erosion, sedimentation and contamination of surface waters through the use of environmentally safe forest harvesting practices such as skidding timber by horses or cables and respecting riparian buffer zones.

SIGNS OF RECOVERY

In the Jizerka catchment a recent recovery in water quality has been observed, including an increase in mean annual pH values to 5 to 6 (Figure 3) and a drop in aluminium concentrations to 0.2 to 0.5 mg per litre. The improvement can be explained in large part by decreased sulphur dioxide pollution in the air (following the Sulphur Protocol of European countries, and observed in the field since 1990), and also by the annual liming of selected reservoirs after snowmelt to improve the drinking-water treatment.

4
Mean pH in stream water at two reservoirs, Jizerka (influenced by clear-cutting of spruce plantations) and Oldrichov (semi-natural beech stands), in relation to air pollution by sulphur dioxide





Introducing deciduous trees into spruce stands in the Jizera Mountains

J. KRČEK

However, it has also been attributed to significantly reduced leaf area index (from 18 to 3.5) resulting from clear-cutting of spruce stands between 1984 and 1990 (Figure 4) and decreased atmospheric deposition at cleared stands.

With the recovery of some physical and chemical parameters in surface waters, it has been possible to reintroduce fish, which had been extinct since the 1980s. Brook char (*Salvelinus fontinalis*, an acid-tolerant species) and brown trout (*Salmo trutta morpha fario*) were reintroduced in reservoir inlets in the 1990s. The char survived and reproduced, while the individuals of brown trout evidently starved and did not reproduce. However, because the char feed primarily on benthic Ephemeroptera (mayflies) and Trichoptera (caddisflies, *Hydropsyche* spp. dominating) containing extremely high values of aluminium, mercury, cadmium and lead, the concentration of aluminium and heavy metals in the fish tissues still exceeds national health limits.

CONCLUSION

The forests of the Jizera Mountains are among the most sensitive ecosystems in Europe. Slow-weathering bedrock and shallow podzolic soils with a very shallow pool of basic cations have a small buffering capacity with respect to the actual acid deposition. In the 1980s, watersheds in this area were stressed

by extreme acidification which brought parameters of pH, hardness and aluminium to levels incompatible with good health. The recent improvement in surface water quality seems to be a consequence of a combination of decreased air pollution, liming and reduced canopy density (leaf area and roughness) caused by clear-cutting of spruce stands. Although the recovery is reflected in the successful reintroduction of brook char in headwater reservoirs, the high content of pollutants in the fish (exceeding health standards) and benthic organisms reflects a still degraded environment.

The higher water quality observed in semi-natural beech forests results particularly from the limited acid deposition in the dormant season and the higher buffer capacity of beech stands.

Thus, in a long-term perspective, water quality might be improved by planting deciduous or mixed stands with lower leaf area and surface roughness, which can decrease the atmospheric deposition and increase buffering capacity in comparison with spruce plantations. Such planting is now being carried out, particularly in the upper mountain plateau, but it is too early to judge what influence it may have on water quality.

In addition, the management of mountain watersheds should include traditional environment-friendly forestry

practices (clear-cutting limits, skidding of timber by horses or cables, seasonal skidding and respect for riparian buffer zones) to avoid soil erosion, sedimentation and contamination of water.

These recommendations might be generalized to other forested mountain regions affected by acid atmospheric deposition, particularly in regions of Central Europe with a similar history of forestry development. ♦



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The protective role of coastal forests in human security – fact or illusion?

After the 26 December 2004 Indian Ocean tsunami, the protective role of mangroves and other coastal forests and trees in saving lives and property received considerable attention, both in the press and in academic circles. Many forest rehabilitation efforts were launched with coastal protection cited as one of the rationales. However, controversy arose over the effectiveness of forests in coastal protection. Many eyewitnesses reported that coastal forests had saved lives and villages from destruction, but some people claimed that forests could not provide significant protection from hazards of a certain magnitude. Others asserted that land elevation and distance from the coast were more significant determinants of protection than forest cover. It became clear that a better understanding of the degree to which forests and trees could provide protection from different types of coastal hazards was needed to provide an improved basis for formulation of coastal management plans and disaster mitigation strategies.

With this need in mind, the FAO Forestry Programme for Early Rehabilitation in Asian Tsunami Affected Countries, funded by the Government of Finland, sponsored a regional

technical workshop entitled “Coastal Protection in the Aftermath of the Indian Ocean Tsunami: What Role for Forests and Trees?”. The workshop, held in Khao Lak, Thailand from 28 to 31 August 2006, aimed at contributing to improved coastal area planning, coastal forest management and disaster mitigation by increasing the knowledge and understanding of the role of trees and forests in protecting populations and assets from the most common and destructive natural hazards affecting coastal areas of Asia, namely cyclones, erosion, tsunamis, wind and salt spray.

The workshop provided a rare opportunity for multidisciplinary analysis of this issue. Coastal engineers and oceanographers, forest ecologists and managers, disaster management specialists, coastal planners and social scientists brought together their combined experience. The 63 participants included government representatives from the eight tsunami-affected countries (Bangladesh, India, Indonesia, Malaysia, the Maldives, Myanmar, Sri Lanka and Thailand) and other experts from 15 different countries and from national, regional and international organizations.

The workshop confirmed that forests and trees can act as bioshields for protection of people and other assets against tsunamis and other coastal hazards, but they do not provide effective protection against all hazards (e.g. extremely large tsunami waves, flooding from cyclones, and certain types of coastal erosion). The degree of protection they offer depends on a number of variables, including the characteristics of the hazard itself (e.g.

type, force, frequency), the features of the site and the characteristics of the bioshield (type of forest or trees, density, height, etc.). Care must be taken not to generalize and to avoid creating a false sense of security. In cases where bioshields are not a feasible option or sufficiently effective, provision must be made for other forms of protection, including hard engineering solutions and a hybrid of “hard” and “soft” solutions. In extreme events, evacuation may be necessary.

In planning the development of bioshields, it is important to match the species with the site. Some forest types and tree species cannot survive or thrive in areas exposed to specific coastal hazards. Furthermore, development of bioshields is not possible in all situations because of biological limitations, space constraints, incompatibility with priority land uses, prohibitive costs, etc. It is important to recognize that many years are required to establish and grow bioshields to a size and density that could offer protection against coastal hazards.

Additional attention is needed for further understanding of the protective potential of coastal forests and trees, for example research on non-mangrove coastal forests and data collection and development of models on the interactions between physical and ecological parameters.

Detailed information on the workshop and its conclusions and recommendations may be found at: www.fao.org/forestry/tsunami/coastalprotection

Post-tsunami mangrove replanting at Ban Nam Khem, Phang Nga, Thailand



Itching for the woods: forests, allergies and irritants

B. Moore, G. Allard and M. Malagnoux

People working in, living in or visiting forest areas may need to be careful of flora and fauna that can provoke allergic (immunologic) or irritant (non-immunologic) reactions.

IRRITATING INSECTS

Forest insects serve many valuable roles within the forest ecosystem, for example as pollinators, as decomposers of organic matter in the carbon recycling process, or as biological control agents of other insects and weedy plants. They are also important sources of food, medicines, honey, wax, silk and other products for local communities. Some of these same insects, however, have evolved chemical defence systems involving poisons secreted or injected through bites or stings, which can cause simple localized reactions or more serious systemic reactions in sensitive people (Burns, 1992).

Bites from members of the orders Diptera (mosquitoes and flies), Siphonaptera (fleas) and Hemiptera (bugs) often elicit localized reactions which can involve swelling, redness, tissue hardening, itching, local hyperthermia, blisters, bleeding, urticaria (hives) and pain (Hoffman, 1986). Severe allergic reactions, most often associated with the

venomous stings of Hymenoptera (bees, ants and wasps), involve similar symptoms but can also entail fever, lymph node enlargement and anaphylactic shock (Evans and Summers, 1986).

Certain insects secrete substances that can provoke irritant or allergic reactions through mere contact, sometimes even after the death of the insect. The secretions of blister beetles, for example, produce severe blistering on contact with human skin (Burns, 1992).

The larvae and sometimes adults of many species of Lepidoptera (butterflies and moths) have urticating (barbed) hairs or spines which help protect them from predators but which may also cause skin irritation in humans after accidental contact (Burns, 1992; AFPMB, 2002) (see Box). Irritation is caused

Blister beetles (Epicauta spp.) secrete a substance that causes blistering on contact with human skin



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Hairy caterpillars: some examples of the problems they can cause

- Dermatitis and hives have been widely reported after contact with caterpillars of the gypsy moth (*Lymantria dispar*), one of the most destructive pests of hardwood forests and shade, fruit and ornamental trees throughout the northern hemisphere (Diaz, 2005). During a severe outbreak in Bulgaria in 1996–1997, it was necessary to close off some forest recreation areas to prevent people from coming into contact with the insects.
- Processionary caterpillars, such as *Thaumetopoea* spp. and *Ochrogaster* spp., are not only important causes of forest damage, but have also caused frequent outbreaks of dermatitis, ocular lesions and allergic reactions in Australia, Europe, Japan and the United States (Diaz, 2005; Vega *et al.*, 1999). The pine processionary caterpillar (*Thaumetopoea pityocampa*) can remain in the chrysalis stage for several years if environmental

Urticating hairs of caterpillars of the gypsy moth, Lymantria dispar, cause dermatitis and hives



WWW.FORESTRYIMAGES.ORG/1361064/J.H.GHENT

conditions are unfavourable. As a result, moths from several generations can emerge simultaneously when favourable conditions occur, causing severe outbreaks (Vega *et al.*, 1999). Contact with dead larvae, cocoons, nests and debris from infested pine forests can also cause dermatitis throughout the year. During outbreaks in France, media campaigns have been conducted to warn the public away from affected areas. In Israel, *T. pityocampa* occurs in pine plantations and on urban trees and is considered a serious pest of medical importance causing eye problems and even temporary blindness (Solt and Mendel, 2002).

- Direct contact with living or dead pine moth (*Dendrolimus pini*) caterpillars or their cocoons results in a condition known as dendrolimiasis, which is characterized by dermatitis, inflammatory arthritis, cartilage inflammation, chronic osteoarthritis and, rarely, acute scleritis (inflammation of the tough white outer coat of the eyeball) (Diaz, 2005). In Mongolia, the green belt surrounding Ulan Bator is periodically infested with Siberian moth (*Dendrolimus sibiricus*), and children living nearby have experienced allergic reactions to the hairy caterpillars, which enter their homes during epidemic outbreaks. Exposure to larval hairs or secretions produces severe dermatitis as well as systemic reactions affecting the joints and other

parts of the body. In the Democratic People's Republic of Korea, forest workers have experienced severe dermatitis from periodic outbreaks of the same insect.

- In Trinidad and Tobago, the hairy moth (*Hylesia metabus*) is considered a major public health problem, causing severe dermatitis as well as allergic reactions, breathing problems, fever, headache, nausea and conjunctivitis. Periodic heavy infestations of this caterpillar have resulted in the temporary closure of schools and businesses as well as interruptions in oil production and fishing activities (GISP, 2006).
- *Lononia* caterpillars (*L. achelous* and *L. obliqua*) can affect the blood's ability to clot and cause brain haemorrhage and acute kidney failure. Because of the high fatality rates, exposure to these South American caterpillars is a serious public health problem in Brazil and Venezuela. Increased conversion of forest lands to agriculture is expected to bring people in closer contact with these caterpillars, which is likely to intensify the problem (Diaz, 2005).
- In the United States, many forest workers in areas heavily infested with the tussock moth caterpillar (*Orgyia pseudotsugata*) have experienced itching of the skin and eyes, nasal discharge, cough and respiratory difficulty (Press *et al.*, 1977).

Pine processionary caterpillar, Thaumetopoea pityocampa, is a serious pest causing dermatitis epidemics and eye problems



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by a poison released when the hair tips break in human skin. The severity of the irritation varies. Symptoms may begin immediately after contact or be delayed for hours or even days; they are usually temporary, lasting about a week. They include itching, typically followed by the development of rash (hives); in severe reactions there may be symptoms of malaise and mild fever. In the eye, caterpillar hairs can cause conjunctivitis, ophthalmia nodosa (a round, grey swelling at the site of each hair embedded in the eye) and even inflammation of the whole eye.

The hairs of some species retain their urticating properties long after being shed. Airborne caterpillar hairs have also been known to penetrate the human respiratory system, causing laboured breathing and/or inhalant allergies. If ingested, caterpillar hairs can cause mouth irritation. Some forest visitors have exhibited skin, eye and/or respiratory symptoms without having had direct contact with caterpillars (Vega *et al.*, 1999). In Australia, an outbreak of caterpillar dermatitis and conjunctivitis was reported in indoor office workers exposed to the airborne urticating hairs of mistletoe browntail moth (*Euproctis edwardsii*) caterpillars feeding in a nearby eucalyptus tree (Balit *et al.*, 2001).

As the examples in the Box show, to avoid problems with these insects it is sometimes necessary to keep the public away from the forest during outbreaks. To avoid the loss of recreational value of forests from a high incidence of caterpillars, localized areas are sometimes treated with chemical or biological products, but these in turn may cause problems through spray drift and contamination of ground water as well as through the possible loss of certain non-target species. Monitoring of early build-up of local pest populations and appropriate management options should make it possible to prevent local populations of pests from reaching outbreak proportions.

TREE SUBSTANCE IRRITATIONS AND ALLERGIES

Some tree substances can cause irritant or allergic contact dermatitis (see Table). Substances causing irritant dermatitis can occur in the outer bark and sapwood, sap, gum, resin, or leaves, depending on the species. Species that can be problematic for forest workers include teak (*Tectona grandis*), white peroba (*Paratectoma* spp.), western red cedar (*Thuja plicata*) and iroko (*Milicia regia* and *Milicia excelsa*) (Wilkinson and Rycroft, 1992). In addition, the sawdust from many important timber species can be allergenic, including beech, fir, mahogany, maple, oak, obeche, ramin, walnut and teak (Lofarma, 2006).

The most commonly known forest plants causing allergic contact dermatitis are members of the genus *Toxicodendron* such as poison ivy (*T. radicans*), eastern poison oak (*T. quercifolium*), western poison oak (*T. diversifolium*), poison sumac (*T. vernix*) and the lacquer tree (*T. vernicifluum*) (Wilkinson and Rycroft, 1992). Urushiol, the chief allergenic component, is widely distributed throughout the plant, including the leaves, stems and roots. Allergic contact dermatitis results from direct contact with the sap from a portion of a bruised or injured plant, although indirect contact

via clothing, shoes, tools, pets and even smoke from the burning plant may also elicit a similar reaction.

The pollen from trees, shrubs, weeds and grasses is one of the main causes of allergy. Susceptible individuals can suffer from rhinitis, conjunctivitis, hay fever, asthma, dermatitis and even anaphylactic shock upon exposure to pollen (Barral *et al.*, 2004). In Italy, a pharmaceutical laboratory preparing allergens for desensitization therapy uses pollen from 23 tree genera (*Acer*, *Aesculus*, *Alnus*, *Betula*, *Corylus*, *Cryptomeria*, *Cupressus*, *Fagus*, *Fraxinus*, *Juglans*, *Juniperus*, *Ligustrum*, *Morus*, *Olea*, *Pinus*, *Platanus*, *Populus*, *Quercus*, *Robinia*, *Salix*, *Sambucus*, *Tilia* and *Ulmus*) (Lofarma, 2006). Pollen from western red cedar (*Thuja plicata*) results in frequent occupational asthma and rhinitis among sawmill workers in western United States and Canada (Frew *et al.*, 1993). Other forest trees eliciting pollen-related allergic responses include cedar (*Cedrus* spp.) and mesquite (*Prosopis juliflora*).

In North America, people who spend time in the woods learn to identify the three leaves of poison ivy (*Toxicodendron* spp.) – and take care to avoid it



Principal commercial tree species that can cause dermatitis (a non-exhaustive list)

Scientific name	Common name	Origin
<i>Azalia</i> spp.	Azalia, doussié, lingué	Africa
<i>Alnus</i> spp.	Alder	Temperate
<i>Andira inermis</i>	Cabbage tree, partridge wood	South America
<i>Aspidosperma</i> spp.	Peroba rosa, paddlewood, quebracho	Brazil, Argentina
<i>Aucomea klaineana</i>	Okoumé, gaboon	West Africa
<i>Bassia latifolia</i>	Moah, mahwa	Africa
<i>Brya ebenus</i>	American ebony, green ebony	South America
<i>Cassia siamea</i>	Tagayasan	China, Southeast Asia
<i>Chloroxylon swietenia</i>	East Indian satinwood	East Indies
<i>Dalbergia cearensis</i>	Kingswood, violet wood	South America
<i>Dalbergia latifolia</i>	East Indian rosewood, Bombay blackwood, sissou	India
<i>Dalbergia melanoxylon</i>	African blackwood	West Africa
<i>Dalbergia nigra</i>	Brazilian rosewood	South America
<i>Dalbergia retusa</i>	Cocobolo	Central and South America
<i>Dalbergia stevensonii</i>	Honduras rosewood	South America
<i>Distemonanthus benthanianus</i>	Ayan, Nigerian satinwood	West Africa
<i>Fagara flava</i> (= <i>Zanthoxylum flavum</i>)	West Indian satinwood	West Indies
<i>Fagara macrophylla</i>	Olon	West Africa
<i>Gonostylus bancanus</i>	Ramin, melawis	Southeast Asia
<i>Gossweilerodendron balsamiferum</i>	Agba, tola branca	West and Central Africa
<i>Guarea thompsonii</i>	Guarea	Africa
<i>Hernandia sonora</i>	Topolite	Trinidad
<i>Khaya anthotheca</i>	African mahogany	Africa
<i>Liriodendron tulipifera</i>	American whitewood, yellow wood, tulip tree	United States
<i>Mansonia altissima</i>	Mansonia, African black walnut	West Africa
<i>Milicia excelsa</i>	Iroko, African teak, Kambala	East Africa
<i>Milicia regia</i>	Iroko, African teak, Kambala	West Africa
<i>Mimusops heckelii</i>	Makoré, baku	West Africa
<i>Nectandra rodiaei</i>	Greenheart	West Indies
<i>Octoea</i> spp.	Louro, jigua, pisie	South America
<i>Paratecoma peroba</i>	Peroba	Brazil
<i>Pericopsis elata</i>	Afromosia, Kokrodua, Asamela	West Africa
<i>Phoebe porosa</i>	Brazilian walnut	South America
<i>Picea</i> spp.	Spruce	Temperate
<i>Pinus</i> spp.	Pine	Temperate
<i>Prosopis juliflora</i>	Mesquite	United States
<i>Tabebuia</i> spp.	Lapacho, suayacan, ipé, mayflower	South America
<i>Taxus baccata</i>	Yew	Temperate
<i>Tectona grandis</i>	Teak	Myanmar, Southeast Asia
<i>Thuja plicata</i>	Western red cedar	North America
<i>Ulmus</i> spp.	Elm	Temperate

Source: Wilkinson and Rycroft, 1992.

In urban areas, some of the most commonly planted trees are allergenic species known to be great pollen producers. Since these trees are situated in close proximity to humans, it is not surprising that allergies in urban populations are increasing (Thompson and Thompson, 2003). Clearly there is a need to evaluate what is being planted and to identify non-allergenic or low-allergenic plants and trees. Genetic engineering of complete or male sterility may help offer a solution

in reducing the production of allergenic pollen (Brunner *et al.*, 1998).

Studies have shown that allergic diseases such as asthma, rhinitis and eczema have increased fourfold over the past 30 years, particularly in developed countries (Davies, Rusznak and Devalia, 1998). Recently it has been suggested that urbanization, with its high levels of pollutants and vehicle emissions, is linked to the rising incidence of pollen-induced allergy observed in most industrialized

countries. Studies from Japan, for example, have shown that the incidence of rhinoconjunctivitis in urban residents living along heavily trafficked roads lined with old Japanese cedar trees (*Cryptomeria*) was almost three times higher than that in residents of the cedar forest where there was less traffic, despite similar cedar pollen counts in the two areas (Davies, Rusznak and Devalia, 1998). ♦



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“Strengthening heart and mind”: using woodlands to improve mental and physical well-being

L. O’Brien

In the United Kingdom, a number of efforts to improve people’s health and well-being focus on the value of trees and woodlands.

One of the British Government’s major concerns is the health and well-being of the population: “The government is absolutely committed to achieving better health for everyone” (Department of Health, 2004a). Wanless (2004) defined public health in broad terms as “the science and art of preventing disease, prolonging life and promoting health through the organised efforts and informed choices of society, organisations, public and private, communities and individuals”.

This article highlights some of the ways in which woodlands and green spaces can contribute to improving people’s health and well-being and provides examples of some current projects. While the focus is on Great Britain and the examples provided are primarily from England, similar work is being undertaken in many other European countries.

PROMOTING PHYSICAL AND MENTAL HEALTH

The recent white paper *Choosing health* published in 2004 for England sets out how the government will provide opportunities, information and support to enable people to choose health and adopt healthier lifestyles (Department of Health, 2004a). Key issues of current concern regarding the health of the population cover coronary heart disease, diabetes, physical inactivity, cancer and obesity. There is a strong focus on preventing ill health rather than only treating illness. An important element of the white paper is to tackle health inequalities because health tends to be poorer at the lower end of the social scale. Mental as well as physical health problems are

known to be more common in areas of social deprivation.

According to the World Health Organization (WHO) stress and depression are increasing. WHO has estimated that by 2020 depression and depression-related illnesses will be the greatest source of ill health. In England the cost of mental health problems has been estimated at £32 billion (46.8 billion euros) with more than a third of this attributed to loss of employment and productivity (Mental Health Foundation, 2006). Approximately 9.2 percent of adults in Great Britain experience mixed anxiety and depression (British Heart Foundation, 2004).

Emotional well-being is a strong predictor of physical good health, as shown by research in a range of countries (Goodwin, 2000; Seymour, 2003). The British Heart Foundation suggests that physical activity can improve mood and may protect against the development of mild forms of depression. Young people’s self esteem in particular is said to improve with regular physical activity. Berger (1996) identified four psychological benefits linked to physical activity:

- higher quality of life,
- enhanced mood,
- stress reduction,
- a more positive self-image.

WHO has rated physical inactivity as one of the major causes of death in the developed world. The estimated cost of physical inactivity in England is thought to be £8.2 billion (12 billion euros) annually (Department of Health, 2004a). This figure includes costs to the National Health Service as well as costs related to people’s absence from work. The number

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More information about the projects described in this article is available on the Web site of Forest Research: www.forestresearch.gov.uk/fr/INFD-5Z5ALT

of clinically defined obese people has tripled between 1980 and 2002 and there are concerns that life expectancy may fall as a result (Pretty *et al.*, 2005). According to the Department of Health, only 37 percent of men and 24 percent of women are active enough to gain any health benefit (Department of Health, 2005). The Chief Medical Officer for England (Department of Health, 2004b) recommends that adults should undertake at least 30 minutes of moderate intensity exercise five days a week, and young people one hour a day.

The British Government has invoked targets, activities, interventions and funding to try to bring about improvements in the mental and physical well-being of the British population, as WHO has done for the global population. These are being developed through a consultative approach rather than the traditional top-down approach. As the white paper noted, “the first and critical stage was to listen to the views of the people in England, to get in touch with their real concerns and to ask what they wanted and how they could be helped to realise their aims” (Department of Health, 2004a). The government recognizes that citizens need help and advice from a range of organizations if they are to choose and adopt healthier lifestyles.

CONTRIBUTION OF WOODLANDS AND NATURAL SPACES TO HEALTH AND WELL-BEING

Many studies and literature reviews from countries such as Australia, Japan, the Netherlands, Norway, Sweden, the United Kingdom and the United States have outlined the contributions of trees, woodlands and green spaces to people’s overall health and well-being (Ulrich *et al.*, 1991; Kaplan, 1995; Henwood, 2001; de Vries *et al.*, 2003; Tabbush and O’Brien, 2003; O’Brien, 2005; Pretty *et al.*, 2005). The benefits have been categorized in a range of ways but primarily include physical, psychological and social well-being. Such studies

have shown that benefits can be gained not only by being active in nature (e.g. walking or cycling), but also by viewing nature, for example from a window, or being near it in the course of everyday activities.

To enhance these benefits, in 2005 the Forestry Commission (the government department responsible for forestry in Great Britain) signed a health concordat with a range of countryside agencies in England. It outlined specific activities that these organizations will undertake to promote the use of the outdoors for health purposes. The Forestry Commission has also launched, early in 2005, an “Active woods – naturally good for you” campaign which aims to establish an association in people’s minds between health and well-being and woodlands, to promote physical activity among forest users and to help foster healthier lifestyles.

Attention restoration theory (Kaplan, 1995) suggests that people recover from directed attention (focusing on specific tasks such as work) through involuntary attention that requires no effort. Kaplan (1995) notes that natural environments are particularly helpful in

restoring attention, as they are gently stimulating to the senses and offer a range of interest such as sights, smells and sounds. Kaplan argues that “soft fascination – characteristic of certain natural settings – has a special advantage in terms of providing an opportunity for reflection, which can further enhance the benefits of recovering from directed attention fatigue” and that health and well-being can be promoted by providing opportunities for people to gain access easily and quickly to green spaces such as woodlands that support restoration. Hartig, Mang and Evans (1991) suggest that this may be particularly important in urban areas; thus it would be especially relevant in Great Britain, where approximately 80 percent of the population is now urban, a proportion that is above the global average. The United Kingdom ranks fifth among European Union member countries in urban population

Participants in COST Action E39 visit a “healing garden” in Alnarp, Sweden – helping researchers interested in forestry, health, environment and the social sciences learn from those in other participating countries



L. O'BRIEN



The Route to Health Project at Cannock Chase Forest created a one-mile community trail of artworks inspired by mental and physical health topics

rate (United Nations, 2002). Even with only 11.6 percent woodland cover (a proportion lower than in 16 of 20 major European countries) (Forestry Commission, 2003), the woodlands and trees are culturally important to the population and are extensively used.

Social well-being and the generation of social capital (i.e. the social networks, norms and trust that facilitate cooperation among people for mutual benefit) are also important (Putnam, 2000). Many of the interventions to encourage people to relax, eliminate stress and be active in woodlands and green spaces allow people the opportunity to meet others and extend their social networks. This social factor often motivates people to keep up their involvement in outdoor activities in the long term.

CURRENT EXAMPLES OF HEALTH AND WELL-BEING PROJECTS

COST Action E39

The European Commission-funded COST (Co-operation in the field of Scientific and Technical Research) Action programme is an intergovernmental framework that allows for coordination at the European level of nationally funded research. A range of themes is funded. Within the forestry theme, COST

Action E39 focuses on forestry and human health and well-being. It started in 2004 and will run for four years. Its aim is to increase the body of evidence on the contribution of forests, trees and natural spaces to health and well-being. Nineteen countries are participating. Five working groups focus on:

- physical and mental health and well-being;
- forest products, forest environment and health;
- therapeutic aspects including rehabilitation and outdoor education;
- evaluation in terms of best practice and economic contribution;
- physical activity, well-being and prevention of illness.

One of the key aims of COST Action E39 is for participating countries to learn from each other about current European projects, activities and research. A network of researchers and research institutions interested in forestry, health, environment and the social sciences is being developed.

Route to Health Project

The Route to Health Project involves a partnership between the Forestry Commission, the local Primary Care Trust (which focuses on improving people's

health) and the District Council in Staffordshire, England. The project set out to develop a one-mile community arts trail in Cannock Chase Forest managed by the Forestry Commission. A range of organizations, individuals and local artists worked together to create artworks inspired by mental and physical health topics of importance. The artworks are then placed along the arts trail and are enjoyed by the thousands of people who walk the trail every year. The aim of the project is to help tackle health inequalities. Artworks have been created by young people with emotional and behavioural difficulties (many from disadvantaged areas where health and access to health care services is often poorer), a day care centre that caters for adults with physical and mental health difficulties, young law offenders and patients from the local hospital. Health messages have included, for example, bicycling to combat stress and anger, and being active as a family unit. The artworks are regularly changed along the trail to maintain community engagement and address more health issues. All of the participants, their families, friends and the public are invited to an annual event to celebrate the project's achievements. The event includes health checks, advice on health, relaxation classes and children's activities.

An evaluation of the project has shown that visitor numbers along the one-mile trail have substantially increased. All of the partner organizations are using the work to deliver their own objectives. A more diverse range of visitors is using the trail, and the enthusiasm of the community to get involved has been shown by people's willingness to participate in the long term.

Chopwell Wood Health Project

Chopwell Wood is a 360 ha mixed woodland managed by the Forestry Commission and situated near Gateshead in northeastern England. The health project was designed to use the public forest

estate to contribute to the government's health agenda. The aim of the project is to improve health within local communities surrounding the wood. The project is run by a steering group that includes health promotion specialists from Gateshead Primary Care Trust and Derwentside Primary Care Trust along with the Forestry Commission, the Friends of Chopwell Wood (a voluntary organization) and Forest Research. The project has two distinct elements:

- **A general practitioner-based referral scheme.** Doctors can recommend that their patients increase their physical activity levels if they are overweight or mildly depressed, and patients can then be referred to a leisure centre or to Chopwell Wood. In the wood they can choose among activities such as walking, tai chi, cycling and conservation work. Referred patients agree to undertake a 13-week programme of activities.
- **School visits in support of the Healthy Schools Standard.** The Healthy Schools Standard is a government initiative to promote pupils' health and emotional well-being. Four schools have each made four visits to the wood. Two visits focused on physical activities such as orienteering. The third visit focused on nutrition and healthy eating, and the fourth visit explored complementary

therapy such as massage and stress-reduction techniques.

The project thus involves people from a wide range of socio-economic groups and from childhood to old age.

A qualitative and quantitative evaluation of the project, managed by Forest Research, showed that those who participated in the project increased their overall activity rates. When general practitioners refer patients to leisure centres or gyms, completion rates are often low. In contrast, 91 percent of the people referred to Chopwell Wood finished the 13-week programme of activities. The reason for the high completion rate was explained in interviews and focus groups, during which participants described the benefits of being out in the beautiful woodland surroundings, relaxing and being physically active. The title of this article comes from a survey undertaken in the wood: when asked to name the benefits of using Chopwell Wood, one respondent replied that it "strengthens heart and mind".

HEALTH WOODLAND IMPROVEMENT GRANT

The Forestry Commission administers a Woodland Improvement Grant which funds capital investment in woodlands to increase public benefits. Since 2003, part of the grant scheme has been used to deliver more public access and con-

tribute to the health and well-being of people in the West Midlands region of England. This area was chosen to pilot the programme because of the high rates of obesity in its population. Woodland owners or partnerships of organizations could bid for the grant.

Seven projects received funding in the first year. The money was used to improve infrastructure, install benches, create new trails for users of all abilities, set up walking schemes and provide information and interpretation in a number of different woodlands. One project produced 10 000 copies of a calendar highlighting woodland trails in the local area, their length and the number of calories that would be burned in walking them. The calendars were distributed to doctors' surgeries, libraries and local mental health teams.

An evaluation of the project indicated that walk leaders played an important part in encouraging people to get involved in healthy walks and to stay active. People started walking for a variety of reasons, including health concerns, encouragement to get involved and the desire to meet new people.

Wye Wood: the Wider Wood Project

The Wider Wood Project focuses on improving the health and well-being of people in rural areas of Herefordshire and Shropshire in England. A health



Creating artwork for the Route to Health Project is therapeutic for people whether they have health problems or not



In the Chopwell Wood Health project, patients referred by their doctors participate in outdoor physical activities such as cycling and tai chi

development worker has been employed to work with doctors and other health professionals in the area to develop a range of options and opportunities to get people active. This new project will include production of a young people's activity pack to motivate them to undertake exercise. Health walks will be organized in specific woodlands and targeted to those who are inactive and socially isolated. Family arts activities will be organized to familiarize families with the accessibility of woodlands and the fun projects in which they can participate in their area. The Forestry Commission is funding the project as a national rural demonstration.

CONCLUSIONS

There is a high level of interest in Great Britain in using woodlands and green spaces to improve people's mental and physical well-being in both urban and rural areas. As the population in western

societies undertakes less physical activity, becomes more obese and suffers from increasing levels of stress, changes in lifestyle are needed. The few projects outlined here provide a flavour of the wide range of activities currently taking place. Monitoring and evaluating how these projects work, to whom they are targeted and their impact on different groups of people is important.

A key issue is what can motivate people to become more active. The projects outlined in this article, and past research, have shown a relationship between access to nature and improvements in people's health and well-being. Less work has been done on the effects and impacts of different types of nature such as woodlands, parks or other green spaces. However, previous research highlights a number of particular advantages of woodlands:

- Woodlands and individual trees can hold specific cultural meanings for people; they are seen as representing nature, particularly in the urban environment.
- The age of veteran trees provides a link between the past, present and future.
- Woodlands offer a range of options for various types of activity.

- Many woodlands can host large numbers of people without seeming crowded.
- An attractive woodland may act as a motivating factor for taking up and continuing physical exercise.
- Woodlands can screen out noise, for example from nearby traffic.

The following are some key considerations for future work to further the use of woodlands and natural spaces as an option in enabling and encouraging people to improve their mental and physical well-being.

Health improvement needs to be made fun. A social and cultural approach to project development is needed to give people skills and confidence as well as a positive attitude to maintaining a healthy, active lifestyle. People require opportunities and information so that they have a range of options from which to make an informed choice. Fun is a big motivator, and enjoyment experienced through contact with woodlands and green spaces can help to change behaviour in the long term.

Reaching children and young people is critical. Research has shown that children are more likely to be active if their parents are active. They are also more likely to use woodlands and green spaces

as adults if they used these spaces as children. Yet opportunities for children to connect with nature are increasingly being lost as children spend more time indoors because of parents' concerns about their safety outdoors and increased computer and television use.

Finally, developing partnerships to include environmental and health sector organizations and local authorities is important and is often key to the success of projects. The activities outlined above have all involved partnerships between a range of organizations. The projects were designed to ensure that each organization could meet some of its own objectives. The work has often been developed through key individuals with a specific interest and the enthusiasm and willingness to get projects off the ground. From the evaluations of the projects outlined above, it is clear that health professionals who focus on preventing as well as treating ill health can readily engage with forestry organizations such as the Forestry Commission. Information about improving health and well-being can be adapted to show people how they can make a difference to their own mental and physical health in their everyday lives. ♦



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FAO FORESTRY

European countries discuss how to reduce forests' vulnerability to natural disasters

Response to catastrophic events was one of the main issues on the agenda when FAO's European Forestry Commission met at its thirty-third session in Zvolen, Slovakia from 23 to 26 May 2006. Representatives of 22 member countries considered case studies from France, Poland and Slovakia and discussed how policy-makers could reduce forests' vulnerability to extreme climatic events, insects, fire, climate change and other threats. They proposed that risk analysis should be a stronger component of future forest sector outlook studies. Several countries have compiled or are compiling information on their experiences in responding to disasters as a basis for future emergency action.

Noting the strong energy demand and higher prices for woodfuels, delegates considered opportunities and challenges for wood energy. In keeping with their recommendation, this will be a key subject on the agenda of the eighteenth session of the FAO Committee on Forestry in March 2007. Delegates requested FAO to continue collecting data and information on wood energy together with the United Nations Economic Commission for Europe.

Climate change was also high on the agenda. Countries expressed concern about projected temperature and precipitation changes in the region and noted that it is vital to address the challenges and opportunities offered by the Kyoto Protocol within a cross-sectoral perspective. The commission urged member countries to include strategies for mitigating and adapting to climate change in national forest plans.

Near East countries lament the low priority of forestry in national policies

At the seventeenth session of the Near East Forestry Commission, countries underscored the lack of valuation of forest and tree products and services and the low priority accorded to forestry in national policies despite forests' vital contribution to combating land degradation and desertification. The delegates noted that in many countries the political status of forestry is declining and forestry administrations are being downsized. The commission recommended that countries endeavour to undertake a proper evaluation of the goods and services offered by forests and trees in order to raise the awareness of decision-makers about their socio-economic and environmental roles.

Delegates agreed that capacity building, including education, research, training and extension, is urgently needed to enhance the ability of the sector to meet emerging societal needs. Furthermore, considering the strong linkages between forests, rangelands and agriculture, delegates underscored the importance of integrated approaches to resource management.

The commission also recognized the deficiencies in country data on forest and tree resources and the need to improve the information base with support from FAO and donors.

In response to presentations on best practices for planted forests and for fire management currently being developed by FAO, the commission recommended that FAO consider elaborating a specific code of practice for arid and semi-arid zone forestry.

Delegates recommended that member countries and FAO strengthen efforts to raise region-specific issues in the international dialogue, building on the Tehran Process on Low Forest Cover Countries.

Thirty-eight representatives from 12 member countries attended the session, which was held in Larnaca, Cyprus from 5 to 8 June 2006.

Latin American and Caribbean Forestry Commission asserts its importance in international dialogue

Delegates from 22 countries met at the twenty-fourth session of the Latin American and Caribbean Forestry Commission in Boca Chica, Dominican Republic from 26 to 30 June 2006. They emphasized the commission's role in supporting sustainable forest management and other global strategic forest objectives at the regional level, and highlighted its potential to play a more active part in the collaboration and dialogue between the United Nations Forum on Forests and regional processes.

The commission also proposed a more active involvement in decisions related to FAO's Global Forest Resources Assessment 2010, for example by involving a group of regional experts in defining methodologies and criteria for the selection of case studies. FAO support was requested for identifying and mobilizing funds to strengthen the technical capacity of countries to participate in the assessment.

The commission urged countries to strengthen the structures and activities of their national forest programmes and to establish mechanisms for fostering regional and subregional dialogue under those programmes.

A special seminar organized in collaboration with the Tropical Agricultural Research and Higher Education Center (CATIE), the Central American Commission on Environment and Development (CCAD) and the Convention on Biological Diversity (CBD) addressed practical approaches for conserving biological diversity in forests. In addition, FAO cosponsored two regional conferences prior to the commission meeting, one on national forest programmes (the "Puembo II" process), organized jointly with CCAD, the Amazon Cooperation Treaty Organization, Germany and the Netherlands; and one on regional cooperation on wildland fire management, held with the World Conservation Union (IUCN), The Nature Conservancy and the Global Fire Monitoring Center.

Fifth Kotka meeting anticipates FRA 2010

FAO, together with the United Nations Economic Commission for Europe (UNECE), periodically organizes international expert consultations to provide technical guidance for its Global Forest



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Resources Assessments (FRA). The first consultation was held in 1987 and subsequent ones took place in 1993, 1996 and 2002. The most recent consultation, the fifth, was held from 12 to 16 June 2006. Like the others, it was hosted by the Finnish Forest Research Institute (Metla) and held in Kotka, Finland, and is thus referred to as Kotka V. A total of 87 specialists from 45 countries and 17 international and regional organizations participated.

The primary objective of Kotka V was to provide guidance for the next assessment, FRA 2010, based on an in-depth evaluation of FRA 2005. It also focused on enhancing collaboration with other forest-related reporting processes and organizations, with a view to pooling resources and streamlining reporting.

The participants noted that increased country involvement and the network of national correspondents were key factors in the success of FRA 2005. National correspondents attending the meeting affirmed that the FRA reporting process offers countries an incentive to gather and analyse information that is valuable to national policy-making processes. Accordingly, participants recommended that country reporting should continue to form the basis for FRA, and that the system of national correspondents should be maintained and strengthened, including through regional networks. The experts proposed, however, that country-provided data be supplemented by special studies on specific issues and by a remote-sensing component providing complementary information on the spatial distribution of forests and on forest cover and land use change dynamics at the regional and global levels.

The experts felt that FRA 2010 should cover as a minimum the same topics as FRA 2005 and use the same basic reporting framework, based on the thematic elements of sustainable forest management. Building on FRA 2005, they suggested that FRA 2010 also cover the seventh thematic element (legal, policy and institutional framework, which was not included in FRA 2005), and they proposed changes to some of the tables used for reporting.

It was also recommended that FRA 2010 should provide forest-related information needed for the assessment of progress

towards the 2010 biodiversity target of the Convention on Biological Diversity (CBD).

The meeting recommended that collaboration with other forest-related organizations should be enhanced, with a view to pooling resources and expertise and reducing the reporting burden on countries. Participating organizations confirmed their willingness to contribute information to future FRA work and to indicate their specific needs in order to streamline reporting.

It was further recommended that a longer-term strategy for FRA be developed, including an analysis of the potential role of regional reporting and regional networks, a long-term reporting schedule and options for the further streamlining of reporting on forests at the international level. The next session of the FAO Committee on Forestry, to be held in March 2007, is expected to provide further guidance.

Helping poor people to benefit more from forest resources

International experts assembled at the International Conference on Managing Forests for Poverty Reduction, held in Ho Chi Minh City, Viet Nam from 3 to 6 October 2006, called for forestry policy-makers, forest-related development organizations, donors, the private sector and local communities to work together in ensuring that forests are managed for the benefit of the poor.

The conference emphasized timber harvesting and wood processing, which were recognized as providing the greatest income opportunities in most forest areas. Giving poor people rights and access to valuable timber resources is thus a logical choice for poverty reduction in such areas.

New and rediscovered technologies for timber harvesting, transport and processing are increasing the economic viability of small-scale wood production. New trends in wood marketing and institutional development also offer opportunities for generating income and livelihoods in rural areas.

In their conference statement, the participants called on policy-



makers to improve access rights to forest resources and to simplify forest laws and regulations to make it easier for local people to capture economic benefits from forests through sustainable small-scale operations. At the same time, they called on international development organizations and donors to help set up comprehensive support systems for wood-based enterprises in rural communities. They also urged the private sector to facilitate partnerships with local communities, households and forest associations.

FAO organized the conference jointly with the Netherlands Development Organization (SNV), the International Tropical Timber Organization (ITTO), the Department of Forestry of Viet Nam, the Tropical Forest Trust (TFT), the Regional Community Forestry Training Center (RECOFTC) and the Asia-Pacific Forestry Commission (APFC).

FAO helps draft a new forest policy for Liberia

At the request of the Liberian Government, FAO, together with the World Bank, helped to draft the first forest policy for Liberia, which came into force with the signing of the new forestry law on 4 October 2006. The signature marks the beginning of a new era in which forests will be used to benefit the country's people and alleviate poverty.

Between 1989 and 2003, forest revenue was used to fund armed conflict in Liberia, prompting the United Nations Security Council to impose three years of sanctions on Liberian timber exports starting in July 2003. During the years of civil war, indiscriminate logging and widespread illegal trade of forest products, carried out under the protection of private armed militias, destroyed much of the country's forest resources. When international agencies began to provide support for better forest management in June 2004, the country's leadership had no experience, weak understanding of good governance and no ability to enforce rules and regulations.

The new forest policy attempts to bring the Liberian forest sector back in line with international commitments and standards. The policy balances the social, conservation and commercial uses of Liberia's forests to produce a range of goods and services for the benefit of all Liberians. It recognizes the importance of community involvement in forestry, which did not exist before. It also emphasizes the importance of good governance. Its objective is to provide more equitable access to forest resources to reduce the potential of future conflict. The policy is expected to maximize forestry's contribution to income, employment, trade and the national development of Liberia.

FAO is also working with numerous international partners, through the Liberia Forest Initiative, to equip the Liberian Forestry Development Authority – the agency overseeing the management of the country's forest resources – with the staff, skills and means to regain control over forest resources.

In this regard, FAO is supporting the collection, analysis and dissemination of information to assist with policy-making and

good governance. It will also train future forest operators in good forest harvesting practices, together with the United States Department of Agriculture Forest Service. FAO is also assisting in the development of a national forest harvesting code based on the FAO model code for Africa (*Regional code of practice for reduced-impact forest harvesting in tropical moist forests of West and Central Africa*).

Improving wildlife management in the Commonwealth of Independent States

Wildlife is among the most valuable natural resources in the Commonwealth of Independent States (CIS), with potential to generate income and improve the livelihoods of rural populations as well as to contribute to national economies. Many animal species of great interest can be valorized through activities such as sustainable trophy hunting and ecotourism and can be conserved if managed properly.

To promote sustainable wildlife management, FAO, the Czech Forest and Wildlife Management Research Institute and the International Council for Game and Wildlife Conservation (CIC) held a workshop for CIS countries of the Caucasus and Central Asia from 11 to 15 September 2006. Government officials and representatives of non-governmental organizations gathered in Prague, Czech Republic, to discuss the main problems and issues to be addressed in the wildlife sector in their countries. Through facilitated workshop sessions, the participants identified three main problem areas:

- weak sectoral management – including institutional deficiencies, lack of inventory and monitoring, improper quota establishment mechanisms, insufficient knowledge and unsustainable hunting;
- weak wildlife policy and legislation and related issues – including lack of strategy and action plan, corruption, tenure problems, inappropriate allocation of revenues from hunting and weak control of international trade in hunting products;
- socio-economic problems – such as lack of local community awareness and involvement in the sector, undeveloped benefit sharing, lack of incentives for investing in wildlife, corruption at all levels, privileges, violation of rights and poverty.

For these problems the participants worked out possible solutions and activities needed to address them, as well as the stakeholders to be involved.

At the conclusion of the workshop, the participants drew up a short outline of projects that could address the most urgent needs and raise awareness among national decision-makers and the international community for possible support to the development of wildlife conservation programmes and projects at the country and subregional levels.

The workshop was funded by the Czech Government. More information is available at: www.fao.org/forestry/site/35813/en



Urban forestry and human health

How do forests and trees in the urban environment influence human health and well-being? This was the subject of a symposium held by the Asia-Europe Meeting (ASEM) which also served as a research conference for the European Commission-funded COST (Co-operation in the field of Scientific and Technical Research) action programme on urban forestry for human health and well-being (COST Action E39; for more information, see page 58 of this issue). The symposium, held in Copenhagen, Denmark from 28 to 30 June 2006, was jointly organized by Forest & Landscape Denmark (an independent centre at the Royal Veterinary and Agricultural University of Denmark), the Chinese Academy of Forestry, Turku University (Finland) and the Forest Research Institute Malaysia.

The Asia-Europe Meeting (ASEM), initiated in 1996, is an informal process of dialogue and cooperation that brings together the 25 member countries of the European Union with 13 Asian countries. Leaders of ASEM countries meet at biennial summits intended to strengthen partnership between the two regions on political, economic and cultural issues. At the third ASEM summit in 2000, the leaders endorsed a proposal to cooperate on forest issues.

The Copenhagen meeting focused on six topic areas:

- **Health and the experience of nature.** Presentations concerned the physical and mental health costs and benefits of forests and trees for individuals and populations. Research was presented on the physical, behavioural, psychological and social processes through which trees and forests affect individuals and populations, and on how variations in trees and forests may influence these processes.
- **Forest products and environmental services.** Participants examined the contributions of forest-derived products, such as certain nuts and berries exhibiting pharmaceutical activity, to human health, economic and social development, alternative medicine and industry. Evidence was presented on the role of forests in improving urban air quality. Forest substances that can have negative or hazardous effects on human health, such as polyamines in non-wood forest products, were also discussed.
- **Therapeutic aspects and environmental education.** Presentations addressed the role of outdoor recreation in healthy living and as a remedy against the shortcomings of modern life in a world separated from nature. Research has explored the role of urban green spaces in rehabilitation of disabled people, in alleviating stress and depression related to urban living, and in integration of marginalized sections of society.
- **Economic evaluation and health policies.** With health-related expenses constituting some of the largest public expenditures in many countries today, this session addressed whether using the forest as a basis for rehabilitation is economically favourable.



FRANC ALLARD

- **Promoting physical activity and health through urban planning and design.** Several questions were examined, for example: To what extent do attractive and easily accessible natural settings encourage people to be more physically active? Does physical activity have a greater effect on human health and well-being when undertaken in a wooded setting than when undertaken indoors?
- **Urban forestry as a tool for sustainable development.** A session of particular relevance for rapidly urbanizing Asian countries addressed experiences and challenges in incorporating the results of urban forestry research into policies and urban management and in transferring urban forestry knowledge into practice.

At the end of the discussions, the participants issued the Copenhagen Declaration, which sets goals, priorities and concrete follow-up actions for continued cooperation. A mission statement was adopted for the ASEM Urban Forestry initiative, and participants committed to establish, by 2007, the ASEM Urban Forestry Academy, an organizational and financial platform for promoting urban forestry cooperation among ASEM countries through such activities as exchange of policy information, twinning of European and Asian cities and research institutions, and education and training projects.

This was the second ASEM symposium on urban forestry; the first was held in China in 2004. Two ASEM symposia have also been held on forest conservation and sustainable development (China, 2001 and Thailand, 2002). A third ASEM Urban Forestry Symposium will be held in China in 2008.



International colloquium on human health and the environment held in Mali

The first principle of the Rio Declaration, adopted at the United Nations Conference on Environment in Development in 1992, states that: "Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature". A colloquium for French-speaking countries provided an opportunity to consider measures for ensuring success in applying this principle.

"Development, Environment and Health" was the theme of the eleventh international colloquium organized by the Secrétariat international francophone pour l'évaluation environnementale (SIFÉE). The event, held from 12 to 16 June 2006 in Bamako, Mali, was supported by the Institut de l'énergie et de l'environnement de la francophonie (IEPF), the Mali Ministry of Environment and Sanitation, the International Development Research Centre (IDRC) and several other partners.

The meeting brought together specialists in environmental and public health and sustainable development, local technical consultants, representatives from industry and agriculture, policy-makers, researchers and academics from 18 countries, mainly in Africa. The main theme was how to manage ecosystems to improve human health. The colloquium addressed two angles in particular: the impact of human activities on the environment, and the impact of the environment on human health. Tools and means were proposed for monitoring and assessing these impacts under diverse conditions, including crisis situations (risk analysis, emergency plans, etc.). The meeting examined potential policy interventions at different levels, from local to global, for integrating human health and ecosystems.

Although the meeting emphasized issues related to agricultural and urban environments, a subtheme on conservation and valorization of natural resources covered such forest-related subjects as the role of plants in traditional medicine (including a case study on the gallery forest of the biosphere reserve of La Mare aux Hippopotames in Burkina Faso), health concerns in the economic evaluation of mangroves in southern Benin, the transfer of *Uapaca bojeri* forest management responsibilities to local communities in Madagascar, and the relation between climate change and health.

The final day began with a tree planting ceremony at the Parc des hôtes.

SIFÉE is an international non-governmental organization founded in 1996 and currently based in Montreal, Canada, which brings together practitioners and organizations concerned with environmental assessment from all French-speaking regions.

New CIFOR Director General

Frances Seymour took up her post as the new Director General of the Center for International Forestry Research (CIFOR) in

late August 2006, assuming the leadership of CIFOR's global activities in support of the sustainable use of forest resources to fight poverty and protect the environment in tropical Asia, Africa, and Latin America. She replaces David Kaimowitz, who stepped down after five years at the helm of the organization. Seymour was appointed in June following an extensive international search which attracted 80 candidates from 36 countries.

Before joining CIFOR, Frances Seymour was the Director of the Institutions and Governance Program of the World Resources Institute. She previously worked for the World Wildlife Fund, the Ford Foundation and the United States Agency for International Development, acquiring experience in several tropical countries. One of her central concerns is that research be made relevant to policy-makers and practitioners.

Reducing carbon emissions from deforestation in developing countries

Climate change negotiations have tended to overlook greenhouse gas emissions in developing countries, where some 35 percent of emissions – and fully 65 percent in the least developed countries – are caused by deforestation.

About 200 experts, mostly from developing countries, simultaneously addressed two of the key environmental issues – deforestation and global warming – in the Workshop on Reducing Emissions from Deforestation in Developing Countries, organized by the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC) at FAO headquarters in Rome from 30 August to 1 September 2006.

Trees are 50 percent carbon. When they are felled or burned, the carbon dioxide they store escapes back into the air. According to FAO figures, some 13 million hectares of forests worldwide are lost every year, with most of this area in the tropics. More than three-quarters of the world's deforestation is a result of increased farmland to feed growing populations. Part of the solution is to increase agricultural productivity so that there will be less demand to convert forests into farmland.

The unusually high participation in the workshop was a clear sign that developing countries are ready to begin reducing their emissions from land use changes and that international processes addressing climate change are furthering their role in the global effort to reduce deforestation. Participants from 46 developing countries signalled their readiness to act on deforestation. But they also stressed financial help from the developed world is needed to do the job. A major flow of capital from developed to developing countries, under new instruments yet to be negotiated, would be required to help the developing countries conserve their forests. Such financing could take the form of carbon credits under the Kyoto Protocol, which governs greenhouse gas emissions from industrial sources in developed countries. It could also come directly under UNFCCC or from bilateral agreements



New executive secretary at the climate change secretariat

Yvo de Boer took up duty as the new Executive Secretary of the United Nations Framework Convention on Climate Change (UNFCCC) on 4 September 2006. A national of the Netherlands, de Boer was formerly the Director for International Affairs at the Netherlands Ministry of Housing, Spatial Planning and the Environment. He has been active in UNFCCC meetings since 1996. Before serving the Netherlands Government, de Boer was Chief of the Information Office for North America and the Caribbean of the United Nations Centre for Human Settlements (UN-Habitat) in Canada and its Human Settlements Adviser in Nairobi, Kenya.

between donors and developing countries on country-wide forest conservation projects. The workshop proposed several new mechanisms for transfer of payments from developed to developing countries. Negotiations will continue at a second workshop to be held in 2007.

The workshop was held at the request of the eleventh Conference of the Parties to UNFCCC and was hosted by the Italian Ministry for the Environment and Territory and FAO, with financial support from FAO and the Governments of Australia, Finland, Italy, the Netherlands, New Zealand and Sweden. The report (available at unfccc.int/resource/docs/2006/sbsta/eng/10.pdf) will be presented at the twenty-fifth session of the Subsidiary Body for Scientific and Technological Advice (SBSTA).

Integrating traditional knowledge in forest management

Traditional knowledge has contributed much to sustainable forest management, but scientific practice has not benefited from traditional practices as much as it could. The International Conference on Cultural Heritage and Sustainable Forest Management: the Role of Traditional Knowledge, held from 8 to 11 June 2006 in Florence, Italy, aimed to encourage improved information exchange among scientists, holders of traditional knowledge, and forest and landscape planners, managers and decision-makers. The conference was organized by the International Union of Forest Research Organizations (IUFRO) Task Force on Traditional Forest Knowledge and was supported by the Italian Academy of Forestry Science, the University of Florence, the United States Department of Agriculture (USDA) Forest Service and the Liaison Unit of the Ministerial Conference on the Protection of Forests in Europe (MCPFE).

The theme of the conference reflected the significant overlap of interests between the holders and users of traditional forest knowledge and a number of policy and planning issues and

initiatives within Europe and the global forest policy community.

These relate to:

- increasing recognition, including in international fora such as the United Nations Forum on Forests (UNFF) and the Convention on Biological Diversity (CBD), of the importance of traditional forest management practices to sustainable forest management and to maintenance of cultural landscapes;
- development and refinement of social and cultural criteria and indicators for sustainable forest management;
- ongoing research and activities focused on protecting and developing traditional ecological knowledge and applying it to sustainable natural resource management.

The meeting attracted 120 participants from 24 countries, including forest scientists, forest managers and planners, forest policy experts and representatives from numerous international organizations. Discussions addressed the history and conservation of traditional forest knowledge and its relation to forest management, and the integration of traditional knowledge in forestry education and research.

The discussions will contribute to efforts to address the cultural and social dimensions of sustainable forest management in national forest programmes, as well as to the development of specific indicators concerning cultural values for MCPFE's set of criteria and indicators for sustainable forest management.

An NGO in Armenia plants 1.3 million trees

In April and May 2006, the Armenia Tree Project planted about 340 000 trees in the Getik River Valley of Armenia, bringing the number of trees planted by this non-governmental organization since 2004 to 1.3 million. About 160 hectares of land, mainly degraded hillsides, have been reforested with indigenous tree species including chestnut (*Castanea* spp.), maple (*Acer* spp.), ash (*Fraxinus* spp.), oak (*Quercus* spp.), walnut (*Juglans* spp.), wild apple (*Malus* spp.) and wild pear (*Pyrus* spp.).

The project provides work to villagers and outsources the raising of seedlings to family backyard nurseries, thus contributing to improving the livelihoods of the local population. What started as a pilot project in 2004 with a backyard nursery programme in a single village has now expanded to many more villages and provides a stable income for 330 families. Thus the campaign has not only helped to reforest the degraded mountains around the villages, but has also addressed the root cause of deforestation, poverty.

Founded in 1994, the Armenia Tree Project aims to assist the country's socio-economic development through mobilization of resources to fund reforestation, environmental education and rural development through job creation.



Outlook for forestry in Latin America and the Caribbean

Tendencias y perspectivas del sector forestal en América Latina y el Caribe. 2006. FAO Forestry Paper 148. Rome, FAO. ISBN 92-5-305498-0.

For many years FAO, in collaboration with member countries, the private sector and international, governmental and non-governmental organizations, has carried out a series of forestry sector outlook studies in different regions of the world. These studies aim to identify the possible influences that can affect the future of forestry and options that may assist countries in reaching their objectives in the sector.

This publication, the final regional report of the Latin American Forestry Sector Outlook Study, builds on the national and subregional reports of 20 countries and three subregions. It describes and analyses the main trends in the region in recent years, covering such areas as forest resources, industry, products and services as well as international trade agreements, tenure issues, social and institutional capacity and law compliance. Then it analyses the main driving forces for change in the sector, such as evolving policies and institutions; demographic, technological, economic and environmental changes; and domestic and international markets. The study also considers the policies and strategies of other key sectors that can influence the forest sector.

The last section projects the likely situation of the forest sector in 2020. With regard to the extent of forests, it projects a decline in forest area from 924 million hectares in 2005 to 881 million hectares in 2020 (with 80 percent of the deforestation expected to take place in Brazil, Mexico, Peru and Venezuela). Planted forests, primarily of *Pinus* spp., *Eucalyptus* spp. and *Araucaria angustifolia*,

are expected to increase substantially, especially in Brazil and Chile, to satisfy the growing industrial demand, particularly for pulp and paper. The area of planted forests is likely to grow from 13.1 million hectares in 2005 to 17.3 million hectares in 2020. Accordingly, sustainable wood production from planted forests is expected to increase from 303 million to 480 million cubic metres. The report examines the implications of these changes, and the role that policies play in forest area change. It examines the prospects for management of natural forests and for sustainable production from planted forests.

Despite the negative forecast for the extent of natural forests, a number of opportunities are identified for the sector. These include carbon markets, the destination of increasing forest areas for ecotourism and conservation, greater development of the non-wood forest product economy, greater opportunities for forest products from certified forests, and integration of forests with other land uses, for example in silvopastoral and agroforestry systems.

The annexes provide statistics on subjects such as forest resources, protected areas, institutions and public administration, and direction of trade.

This book provides food for thought for all who are concerned with the future of forests and forestry in Latin America and the Caribbean. Taken together, the regional, national and subregional reports represent an important reference and source of information for strategic planning at all three levels, and will be of particular relevance to national forest programmes. The reports are all available at: www.fao.org/forestry/site/2404/en

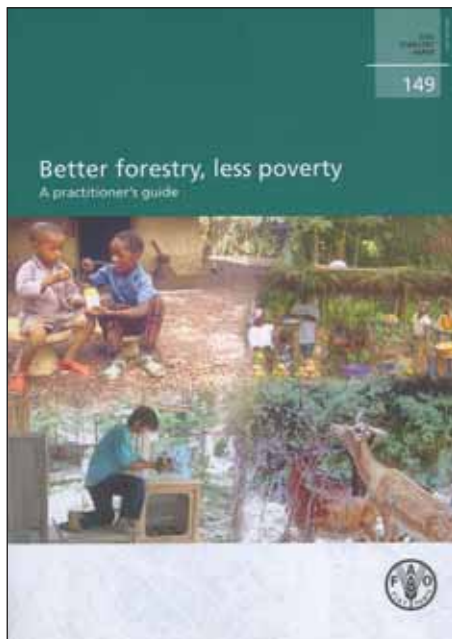
Using forests to reduce poverty

Better forestry, less poverty: a practitioner's guide. 2006. FAO Forestry Paper 149. Rome, FAO. ISBN 92-5-105550-5.

More than 25 percent of the world's population – an estimated 1.6 billion people – rely on forest resources for their livelihoods, and of these almost 1.2 billion live in extreme poverty, lacking the basic necessities to maintain a decent standard of living: sufficient and nutritious food, adequate shelter, access to health services, energy sources, safe drinking-water, education and a healthy environment. When governments signed the Millennium Declaration in 2000, they agreed to halve the number of people living in extreme poverty by 2015.

A significant number of people living in poverty depend on forests and trees outside forests for food, shelter, clothing and heating, as well as to generate income through employment and through the sale of goods and services. However, the extent to which forests can alleviate poverty and improve food security for vulnerable populations is not well documented.

Policy-makers need to be made more aware of the role of forests in poverty alleviation. However, action is not only the responsibility of governments. Foresters and others working with communities can assist poor people to increase their benefits from forest



resources by helping them to access markets, acquire processing skills, obtain improved varieties of trees, combine trees and crops on their land, and form associations to manage resources jointly, strengthen negotiation power and market products.

Better forestry, less poverty aims to increase awareness so that forestry and development practitioners can make poverty reduction a focus of their work. It suggests ways to design and implement forest-based interventions that have the greatest potential to reduce poverty. The guide examines the ways in which changes in forest management can cause poverty or worsen it, and how forestry practices can better contribute to poverty reduction and better protect the livelihood functions of forests. The guide outlines key issues related to timber production in both natural and planted forests, non-wood forest products, woodfuel, bushmeat, agroforestry and payment for environmental services, summarizing successful case studies for each and identifying sources of additional information.

The guide emphasizes helping forestry practitioners gain a better understanding of the forms of rural poverty and of how decisions made at the local level affect segments of poor rural communities in different ways – women, children and the elderly being the most vulnerable. It highlights the importance of using participatory approaches and of tailoring activities to local circumstances. It also discusses how to link national policies and programmes to local needs, and how to monitor and assess progress in reducing poverty through forestry interventions.

This publication will be of interest not only to forestry and development practitioners, but also to the communities they serve, including district forestry officials, extension workers, local planners

and administrators, and owners of small-scale enterprises and their employees.

Better forestry, less poverty is available online at: www.fao.org/docrep/009/a0645e/a0645e00.htm

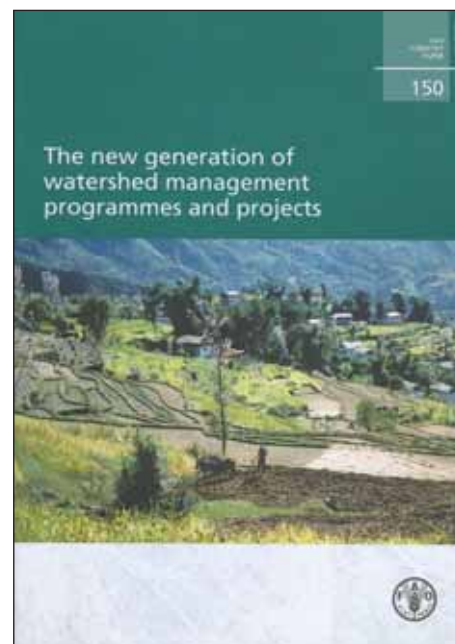
A new vision for watershed management

The new generation of watershed management programmes and projects. A resource book for practitioners and local decision-makers. 2006. FAO Forestry Paper 150. Rome, FAO. ISBN 92-5-105551-3.

Sustainable management of watershed resources to meet the demands of growing populations has been a high priority for many countries over the past several decades. Particularly during the 1990s, integrated watershed management through people's participation became widely accepted as a promising approach for conserving water, land and biodiversity, enhancing local livelihoods, improving the economy of upland inhabitants and people living in downstream areas, and ensuring sound sustainable natural resources management overall.

On the occasion of the International Year of Mountains – 2002, FAO and its partners undertook a large-scale global review of integrated and participatory watershed management projects carried out from 1990 to 2000, with a view to identifying a vision for a new generation of programmes and projects. Experts from Africa, Asia, Europe and Latin America contributed to the assessment through a workshop for each region and an international conference.

This resource book – prepared in collaboration with the European Observatory of Mountain Forests (EOMF), the



International Centre for Integrated Mountain Development (ICIMOD), the Red Latinoamericana de Cooperación Técnica en Manejo de Cuencas Hidrográficas (REDLACH) and the World Agroforestry Centre (ICRAF) – presents a critical summary of the FAO review's findings and recommendations. The first chapter looks at the history of watershed management, emphasizing how a discipline initially based on water engineering and forestry has become a multidisciplinary approach rooted in ecology and linked to agriculture, rural development, environmental economics and social sciences. The second chapter summarizes the conceptual background, presenting new perspectives on watershed biophysical processes, human ecology and environmental economics. The third chapter describes some ongoing changes in programme design and implementation strategy, and outlines the profile of the new generation of programmes and projects. The fourth chapter links the new watershed management approaches to the policy environment of the new millennium. It also deals with critical factors for the successful implementation of new approaches, such as capacity building and financing. The annexes provide additional information on specific methods and resources for watershed management.

To facilitate the retrieval and use of information, the resource book allows for different levels of reading and learning. Page-side callouts and subheadings facilitate a rapid scan of the contents of each chapter. Core information is summarized in the main text. Boxes illustrate key topics, burning issues and expert opinions, or present real-life examples. Short fiction narratives (a prelude and two interludes) illustrate the link between the everyday professional life of watershed managers and the subject addressed in the following chapter.

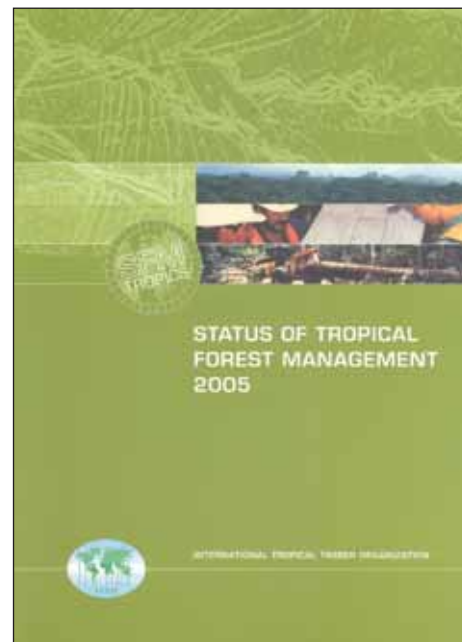
The publication is intended primarily for field-level watershed management practitioners and local decision-makers involved in watershed management at the district or municipal level, but it will also be a useful source of information for other readers such as evaluators, policy-makers and watershed management students.

The publication is available online at: www.fao.org/docrep/009/a0644e/a0644e00.htm

ITTO report on tropical forest management

Status of tropical forest management 2005. 2006. Yokohama, Japan, International Tropical Timber Organization. ISBN 4-902045-24-9.

A 1988 survey by the International Tropical Timber Organization (ITTO) found that less than 1 million hectares of tropical forest were being managed in accordance with good forestry practices. *Status of tropical forest management 2005* considers changes in the subsequent 17 years, providing a comprehensive analysis of the forest management situation in the permanent forest estate of the 33 ITTO producer member countries. "Permanent forest estate" refers to land that governments have formally set aside for forests and that is subject to some form of regulation or protection. It includes national



parks and timber concessions, both publicly and privately owned. About 814 million hectares fall into this category, or roughly two-thirds of the world's tropical forests.

Using information submitted by the countries themselves, supplemented by data from a wide range of other sources, ITTO addresses the policy and institutional settings in each country, the approaches taken to the allocation and management of resources, and the status of management of those resources. Part I gives the overall picture: introduction, methodology, overview of the status of forest management, analysis, conclusions and recommendations. Part II provides individual country profiles, by region. Each profile describes the country's forest resources, institutional arrangements and status of forest management.

The report notes that there has been significant progress towards sustainable forest management in the tropics since 1988. Countries have established and are starting to implement new forest policies that contain the basic elements of sustainable forest management. More forests have been given some security by commitment as permanent forest estate, or a similar concept, for production or protection. The study found that 15 percent of the permanent forest estate has a management plan. Moreover, some of the permanent forest estate is certified – a new development since 1988. More than 25 million hectares are sustainably managed for production, and more than 36 million hectares if the area managed for protection is included.

Despite this significant improvement, the overall proportion of the permanent forest estate known to be sustainably managed remains very low, at less than 5 percent of the total – about 7 percent of production forests and only 2.4 percent of protection forests.

This area is distributed unevenly across the tropics and within countries. Significant areas of tropical forest are still lost every year, and unsustainable (and often illegal) extraction of tropical forest resources remains widespread.

However, with most countries now attempting widespread implementation of sustainable forest management, ITTO is optimistic that progress will increase in the coming years. The report makes three recommendations to help quicken the pace of progress:

- the institution of regular reporting on the status of tropical forest management at the international level;
- increased resources from the international community to improve country capacity to collect, analyse and make available comprehensive data on the status of tropical forest management;
- the development of means for ensuring that sustainable forest management is as financially remunerative as other land uses.

This report adds considerably to the understanding and knowledge of the status of management in tropical forests and provides a basis for informed debate on how best to encourage further progress. It is available on ITTO's Web site: www.itto.or.jp

Woodcarving: impact on livelihoods, economies and resources

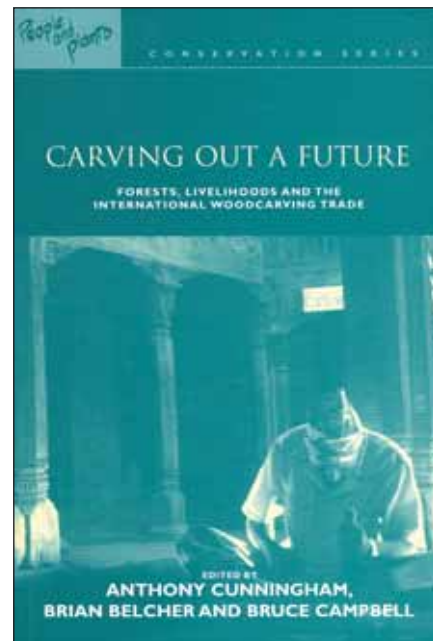
Carving out a future: forests, livelihoods and the international woodcarving trade.

A. Cunningham, B. Belcher & B. Campbell, eds. 2005. London, UK, Earthscan. ISBN 1-84407-045-X.

When international travellers buy handmade woodcarvings as souvenirs or gifts, few are aware of the social and environmental reality behind such objects; the woodcarving trade exerts severe pressures on both the producers and the natural environment from which the wood is sourced. The editors of *Carving out a future: forests, livelihoods and the international woodcarving trade* aim to tackle this unawareness by presenting a study of the craft's cultural and economic contributions to livelihoods around the world, as well as the consequences on the environment of providing the material necessary for the trade.

The book is the first of its kind. Although a number of organizations – including the World Wide Fund for Nature (WWF), the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Center for International Forestry Research (CIFOR) – have supported studies on woodcarving for over a decade, this is the first comprehensive book on the subject, bringing together the work of nearly 50 contributors. The 16 chapters cover a range of issues as well as diverse geographical regions.

Chapters 1 and 2 offer an introduction and overview of the history, culture and traditions of woodcarving. They examine wood supply and conservation as well as carvers' preferences for different types of wood, regional differences and distinct characteristics. They also explore the changes and innovation in the market and future trends. Several chapters tell about the



craft in African countries, describing, for example, the wooden giraffes of Kenya, the drums of Uganda and the Makonde African blackwood carving movement of Mozambique, among others. Another chapter focuses on carvers, conservation and certification in India, while yet another looks at the trade in Bali, Indonesia. There is also a chapter on Aboriginal woodcarvers in Australia. Two chapters examine the Mexican contribution to the world of woodcarving.

The final chapters explore the more institutional aspects of the trade. Chapter 13, for example, examines the role of woodcarving in livelihoods, comparing and contrasting a number of case studies on woodcarving with cases of various non-wood forest products. Chapter 14 delves into the ecological impacts of woodcarving, noting why carvers prefer certain species and examining the responses to scarcity of materials. Chapter 15 examines certification and its benefits, focusing on the Kenyan market. The concluding chapter considers the future of woodcarving and the steps that need to be taken to ensure that skilled artisans in developing countries get a fair economic return from the trade, and that the craft lives on in an environmentally sound way.

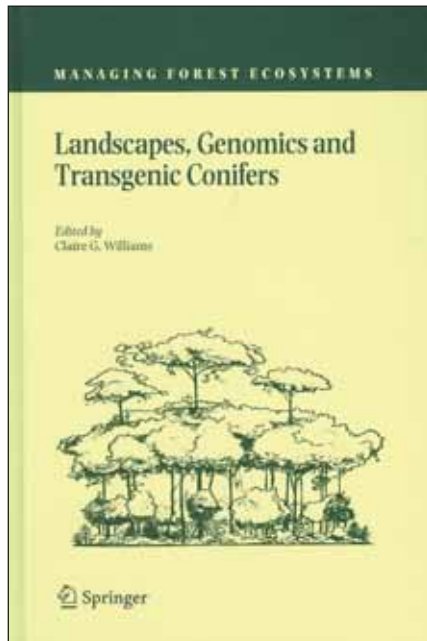
Richly illustrated, this book will be as interesting for anthropologists and general readers as for foresters.

Prospects for genetically modified trees

Landscapes, genomics and transgenic conifers. C.G. Williams, ed. 2006. Managing

Forest Ecosystems 9. Dordrecht, the Netherlands, Springer. ISBN 1-4020-3868-2.

Genetically modified organisms have been a source of controversy since their initial appearance. Now that transgenic forests are a



possibility, debate has been sparked over pros and cons regarding such plantations. Many people have concerns about genetically modified vegetables, but in reality transgenic forest trees and food crops have more differences than similarities. The controversy surrounding the field may eclipse potential advantages of forest biotechnology.

Landscapes, genomics and transgenic conifers aims to open a dialogue on the subject by presenting both benefits and risks of forest biotechnology. With five sections consisting of 14 chapters by 31 authors working in North and South America, Europe and Africa, it presents a cross-disciplinary approach designed for everyone from policy experts and life scientists to writers and social activists. The final product is an attempt to reverse the alienation of the general public from the subject as well as to provide content for science-based deliberations about it.

The discussion is narrowed to conifers because of their profound economic impact on the wood supply in developed countries, where most of the research in this field is carried out. The first section presents an overview of transgenic conifer plantations, broaching subjects such as public policy, natural resources management and forest biology and history. This section also examines arguments as to whether the commercialization of transgenic conifers would do more harm or good, leading to the conclusion that the risks and benefits of such plantations have not yet been analysed enough.

The next two sections expand on research in conifer genomics and ecology, examining the potential interface between transgenic conifer plantations and less managed ecosystems. Also highlighted is the movement of transgenic pollen and seeds in the

landscape, which is the main deterrent to commercial-scale use of transgenic forest trees. Finally, Section IV presents scenarios for the adoption of the technology from an economic point of view, and Section V considers the status of regulatory oversight of transgenic forest trees in Canada and the United States.

Including a lexicon of scientific terms frequently used in reference to transgenic conifers, this book will prove to be a useful reference for those wishing to acquaint themselves with the field of transgenic forest trees, or to increase their knowledge on the subject.