

# IUCN

The World Conservation Union

# Conserving Medicinal Species Securing a Healthy Future



Ecosystems and Livelihoods Group. Asia

# Conserving Medicinal Species

## Securing a Healthy Future

Edited by Sriyanie Miththapala

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Photo credit: Susan Earle

Musk Deer



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*Mecanopsis aculeata*



Women members of Jambi Kiwi

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*Asparagus racemosus* tubers

Photo credit: Sarah Gilbert

\* These papers were presented at a Global Synthesis Workshop 'Biodiversity Loss and Species Extinctions: Managing Risk in a Changing World', convened at IUCN World Conservation Forum 18-20 November 2004, Bangkok, Thailand.

# Preface

Wild species - particularly plant species - are used for medicine in almost every country in the world. A recent survey of published medicinal floras conducted by members of the Medicinal Plant Specialist Group of the Species Survival Commission, the World Conservation Union (IUCN) suggests that 72,000 species of higher plants are used medicinally worldwide, approximately 17% of the world's higher plant flora. This figure does not include the many species of terrestrial and marine animals, lower plants, and fungi that are also used medicinally by people from many different cultures. The World Health Organization (WHO) estimated previously that 80% of the world's population relied on primary health care based on traditional medicines, and there is every indication that this remains true today. There is also an increasing reliance of the pharmaceutical and cosmetics industries on wild biodiversity as a source of raw materials for research, development, and commercial production.

In recognition of the importance of medicinal plants and other components of biodiversity to human welfare, the World Conservation Union convened a Global Synthesis Workshop on 'Biodiversity loss and species extinctions: managing risk in a changing world', in November 2004 at the IUCN World Conservation Congress, Bangkok Thailand. As one of its themes, the Global Synthesis Workshop recognised the importance of the wild species that are the source of many of the medicines used in the world today, and that will continue to be required by humankind in the future. The theme of one of the workshop sessions 'Conserving Medicinal Species: securing a healthy future' - invited speakers and participants to consider the great number and diversity of plant and animal species which have importance for human medicine.

Many of the chapters included in this book, 'Conserving Medicinal Species: Securing a Healthy Future' published by the World Conservation Union, were based on presentations made to this workshop session. Others were solicited following the workshop to help draw attention to additional information and views on the use and trade of medicinal species. These latter papers were reviewed by IUCN Asia Regional Office staff prior to their inclusion in the publication. The papers reflect the wide range of experience, knowledge and opinions of the authors, and do not necessarily reflect the views of the Union.



*Catharanthus rosea*

Photo credit: (c) G. de Silva/Hunas Falls Hotel

This first section of this volume focuses on the value of medicinal species and explores the links between medicinal species, human health and livelihoods. Collecting, harvesting, trading, and processing plant and animal-based materials for medicines support long and complex networks of people who rely on these resources and activities for much of their livelihoods - from primary harvesters and traditional healers to multinational pharmaceutical companies. The global trade in medicinal plants has now grown to well over 800 million USD per year. African and Asian countries, for example, export about 400,000 tonnes of medicinal plants to Europe each year, with a final market value of over 1 billion USD. World sales of over-the-counter plant derived drugs are worth more than 40 USD billion each year. In many countries, economic output and growth from the household to global level arguably depends on a healthy and productive workforce with access to adequate medical support and services.

The second section of this volume addresses the risks to human health and livelihood security associated with the loss of medicinal species from several perspectives: a current global overview, a regional assessment, and a look toward the future at emerging threats to human health.

The third section focuses on the substantial and growing threats to the survival of medicinal species worldwide. Both in spite of and because of their substantial economic and health value, a growing number of medicinal species are becoming vulnerable, threatened or endangered. Some are already extinct. The depletion and loss of these resources not only undermines our current ability to prevent and treat illness, but also jeopardises future options to benefit from species and medical applications that have not yet been discovered, or to treat illnesses and diseases that we do not yet know. It also puts at risk the basic livelihoods and economic health of millions of people and businesses.

The fourth section of this volume addresses the challenges of conservation of medicinal species, from prevention and detection to sustainable use. Technology and community efforts that have helped to conserve medicinal species are highlighted in this section. Several case studies within the Asian region have been added to the original workshop presentations.

This volume concludes with a brief summary of the concerns and challenges that remain if we are to fully appreciate and continue to benefit from the immense value of biodiversity for human health and livelihoods. This volume highlights the broad range of issues relevant to the conservation of medicinal species, and provides a valuable reference for a wide readership, from decision makers and researchers, to practitioners and users of the world's medicinal biodiversity.

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My grateful thanks to Danna Leaman (Chair of the Medicinal Plants Specialist Group, IUCN Species Survival Commission), Sue Mainka (Senior Coordinator, Global Programme Team, The World Conservation Union), Jeffrey McNeely (Chief Scientist, The World Conservation Union), and Teresa Mulliken (TRAFFIC International) for agreeing, despite their busy schedules, to write the preface and concluding chapter for this volume.

Sue Mainka was responsible for organisation of a thematic workshop at the 3rd IUCN World Conservation Congress (Bangkok, 2004) that addressed the topic of 'Biodiversity Loss and Species Extinctions: Managing Risk in a Changing World.' Conservation of medicinal species was one of the sub-themes, and the subject of a Global Synthesis Workshop. Grateful thanks are extended to her. Many of the contributors to this volume presented their papers at the Global Synthesis Workshop. Their commitment to ensuring the publication of these presentations is much appreciated.

Grateful thanks are especially due to Dr. Eric Chivian for the outstanding keynote address he presented at this workshop.

Samuel Lee assisted in the organisation of the workshop at the World Conservation Congress and supplied many photographs for publication. Other authors also provided photographs for use; they are credited individually with each picture and listed in the index of photographers.

Thanks are also due to Guido Broekhoven, Lucy Emerton and Asheem Srivastav (Ecosystems and Livelihoods Group, IUCN Asia), as well as Sue Mainka, Jeff McNeely and Teresa Mulliken, for reviewing manuscripts for papers that were not presented at the World Conservation Congress.

Although many of the papers in this book have been produced earlier in electronic format, there were many requests from regional participants at the World Conservation Congress for a publication, as many people in developing countries do not have ready access to computing facilities. Lucy Emerton saw the validity of these requests and made this publication possible.

I am very grateful to Jeff McNeely for his continued support during the production of this volume.

Sriyanie Miththapala  
Editor



*Diceros bicornis*

Photo credit: Lewa Nature Conservancy



## Introduction



*Taxus brevifolia*

Photo credit: Robert Beall

# Medicines from Natural Sources: How Human Health Depends on Nature

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We have become increasingly isolated from the environment in which we live, as we became more and more urbanised. To very many, if not most, people, this disconnection takes another insidious form: that the global environment is seen as an infinite resource that exists for our use alone, from which we can take as much as we want, or as an infinite sink into which we can dump as much as we want; that we can alter and degrade the atmosphere, the oceans, the forests, and the soils; endangering perhaps millions of species with which we share this planet, some - such as sharks, dragonflies and frogs - of which have been on Earth for hundreds of millions of years longer than we have. We behave as if these alterations had nothing whatsoever to do with us at all - as if we were totally immune from their impacts.

This lack of connection to the environment, this fundamental failure to understand that our health and lives ultimately depend on the health of the natural world, is, in my view, the most important problem we will face in the years ahead.

We started the Center for Health and the Global Environment at Harvard Medical School to address this disconnection, to help people understand that they were an intimate part of the environment and thereby to motivate them to preserve it. My talk this morning will focus on medicines we obtain from natural sources to illustrate one of the ways that we depend on other species for our health and our lives. The loss of biodiversity, as you all know, is accelerating dramatically so that rates of species loss are now 100 to 1000 times normal background rates. According to a recent report by the World Wildlife Fund, populations of wild animals have decreased by 40% in the past 30 years, with species living in freshwater, grassland, savannah, desert, and tundra habitats faring even more poorly. Each person on the planet on average leaves an environmental footprint of about 2.23 ha; the average U.S. resident leaves one of about 9.51 ha. North American footprints are twice those of Europeans and seven times those of Asians and Africans. These levels are not sustainable.

With a loss of species, we are losing the possibility of discovering new medicines. Over the course of millions of years, species have developed chemicals that have protected them against infections, tumours, and other diseases, and have allowed them to capture prey and avoid being eaten,

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Extract from the keynote address given at the workshop on 'Biodiversity Loss and Species Extinctions: Managing Risk in a Changing World'

chemicals that have become some of today's most important Pharmaceuticals. Tropical rainforest organisms, for example the Cinchona tree (*Cinchona officianalis*) from South America, have given us quinine (the 1 st major treatment for malaria) and quinidine (a medicine for cardiac arrhythmias). Temperate species have also yielded some of our most useful drugs—the wonder drug aspirin, originally derived from salicin extracted from the willow tree, is still one of the best medicines around for pain and inflammation, as it significantly reduces the risk, in most people, of blood clots that cause myocardial infarctions and strokes. There is also evidence that regular use of aspirin lowers the risk of developing some cancers, for example those of the large bowel.

The synthetic drugs digoxin and digitoxin are derived from digitalis, which came from the foxglove plant are still used to treat heart failure, and atrial fibrillation.

More than half of the most frequently prescribed drugs in the U.S. are derived from, or are patterned after compounds derived from, natural sources. Further, 80% of people in developing countries still rely on traditional medicines, which largely come from plants.

I will discuss five examples of important medicines from nature: two from plants and three from animals that are important models for this session. I need to emphasize here that although I will not be covering medicines that come from microbes, it is clear that most of the world's species are microbial, and that as a group, they have an evolutionary history that is more than two billion years older than the rest of life on Earth so that they have had a much longer time to develop compounds that successfully defend them against infections and other threats. As you all know, many of our currently used antibiotics such as the penicillins, cephalosporins, and tetracyclines come from microbes, and there is very active research going on now to look for other antibiotics and other medicines in microbes, particularly from the marine environment.

## The Pacific Yew

The story of Taxol ® and the Pacific Yew tree (*Taxus brevifolia*) illustrates how we may be losing new medicines from common species that become extinct without ever having been analysed for their chemical content, and of course, from species that go extinct before they have even been discovered. Most of you know that we have identified only about 10% of species on earth, and maybe even less than that. The commercially useless Pacific Yew was discarded routinely as a trash tree during logging of old growth forests in the Pacific northwest, until it was found to contain the compound paclitaxel during the U.S. National Cancer Institute's massive screening program of plant species for anti-cancer activity.

When cells divide, the chromosomes, after division, move along micro-tubules in a structure called the mitotic spindle, paclitaxel kills cancer cells by a mechanism unlike that of other known anti-cancer or chemotherapeutic agents —by stabilizing the protein tubulin, which makes up these micro-tubules, thereby inhibiting the disassembly of the mitotic spindle, and preventing cell division. Other agents work by preventing the spindle's assembly. Early clinical trials reported that paclitaxel was able to induce a remission in advanced ovarian cancer cases that had been unresponsive to other treatments.

Recent experience has shown that Taxol® and the newer synthetic taxoids offer great promise for other malignant cancers as well, including malignant melanomas and those of the breast and lung. Taxol®, the most profitable cancer chemotherapeutic agent in the U.S, is also now used widely to coat arterial stents, devices that keep clogged arteries open, mainly in the heart, so they are not blocked by cell re-growth.

How many other species like the Pacific Yew are being lost without our ever knowing whether they contain drugs as useful as paclitaxel?

### Sweet Annie (*Artemisia annua*)

The plant *Artemisia annua* known as 'Sweet Annie,' 'Sweet Wormwood' or 'Qinghao' in Chinese, has been used in Chinese traditional medicine for more than 2000 years to treat fevers. Chinese scientists first extracted the active agent artemisinin during the Cultural Revolution and it soon became clear that it was an extremely effective anti-malarial agent. *Artemisia annua* works by forming reactive compounds called free radicals in the presence of iron, and these free radicals break cells apart and kill them. The parasites that cause malaria, one-celled organisms called plasmodia, are targeted selectively by artemisinin as they accumulate high concentrations of iron from the red blood cells they attack. Some recent studies have shown that artemisinin is also effective against some cancer cells such as leukaemia cells, which, it turns out, also have higher concentrations of iron.

Artemisinin has shown itself to be particularly effective against the deadliest form of malaria caused by *Plasmodium falciparum*, which has grown increasingly resistant to the conventional combination treatment for malaria of chloroquine and sulfadoxine-pyrimethamine. As there are at least 300 million cases of acute malaria each year globally, resulting in more than one million deaths, the importance of this ancient plant and of its very powerful anti-malarial compound cannot be overstated.

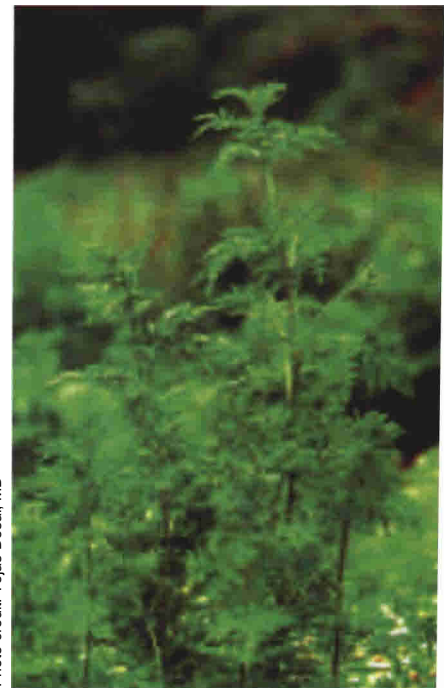


Photo credit: Tejas Desai, MD

*Artemisia annua*

### Cone snails

Cone snails are a large genus of more than 500 species that live in tropical coral reefs, mostly in the South Pacific. They feed by firing a poison-coated barbed harpoon at their prey — worms, fish, and other molluscs — paralyzing them. Each species is thought to make 100 distinct toxins, so that there are thought to be as many as 50,000 cone snail toxins in all. Only about 100 of these have been studied, and already, a large number of compounds have been isolated that have enormous potential for medicine. The reason they are so useful is that



A cone snail

Photo credit: J. P. Bingham

they bind with great potency and enormous specificity to an extraordinary number of receptors on the surfaces of all animal cells that regulate how cells function.

One calcium channel blocking toxin from cone snails binds with great specificity to neurons in the dorsal horn of the spinal cord, where pain impulses are transmitted up to the brain, without blocking pathways that mediate fine touch or temperature. Its synthetic form, called ziconotide, which may be on the market shortly, has been shown to be 1000 times more potent than opiates like morphine. In a study with AIDS and cancer patients who had severe chronic pain that was unresponsive to opiates, more than 50% of those receiving ziconotide had moderate or complete pain relief, without their developing addiction, or tolerance, i.e. the need to give more and more drug to achieve the same effect. Tolerance has limited the long term usefulness of morphine and other opiates, with the World Health Organization (WHO) estimating that on any given day, there are more than three million people world-wide suffering from severe chronic pain from cancer alone, so this new potent pain-killer would be an enormous breakthrough.

Several cone snail species are likely to be endangered, as they inhabit narrow ranges in coral reefs, mostly in the South Pacific. As coral reefs are increasingly endangered by a variety of human environmental assaults, mostly from global warming, with an estimated 30% already dead or damaged severely and as much as 60% threatened with loss by 2030, so are species like cone snails that live in them.

Other cone snail toxins are being tested for epilepsy that, cannot be treated by other medications, spasticity following spinal cord injury, and a host of other disorders. Cone snails may contain the largest number of medicines for human disorders of any known species group. To lose them would be a self-destructive act of unparalleled folly.

## Sharks

In recent decades, the exploitation of sharks has increased dramatically, with as many as 100 million sharks currently being caught each year. The result is that many species are now threatened or endangered, some critically.

There are several causes for the recent over-exploitation of sharks. For one, shark flesh has become increasingly sought after as a food staple, both as steaks and as an ingredient in 'fish and chips.' There is also a good deal of by-catch, for example, by the swordfish and tuna fisheries.

For more than two thousand years, Asian countries have used shark fins in soup, but it is only in the past two decades that shark fin trading has increased dramatically, threatening a great many shark species . A rapidly growing middle class in Asia, now able to afford shark fin soup, is largely behind this increase. For example, in 1995, in Hong Kong alone, more than six million kg of shark fins were imported. Shark fins of top quality command very high prices (as much as 500 USD or more per kg), resulting in thousands of shark fin long-lining vessels being launched from Taiwan, Japan, and many other countries. Traditional fishermen cut fins off and dry them on board , and throw out the fish, leaving sharks to die slow, painful deaths. This inhumane practice is finally being curtailed by legislation in the United States and in other countries outlawing the landing of shark fins without their bodies attached.

The 2005 IUCN Shark Status Survey indicates that cartilage is produced largely as a by-product of meat fisheries. Shark cartilage appears to have medicinal properties, and while there has been some preliminary evidence that these extracts may kill cancer cells, there is no conclusive evidence that this is so, and consumers are spending large sums on shark cartilage pills that are largely unregulated for purity or potency. In the meantime, sharks continue to be slaughtered.

There is, however, another compound, a kind of steroid called squalamine that is found in shark tissues, and it has shown a strong ability to prevent the growth of new blood vessels, what is called angiogenic inhibiting activity. As tumours require new blood vessels for their growth and for metastasising, squalamine and other anti-angiogenic agents, are being tested in a variety of human cancers, and in some disorders, such as adult macular degeneration (AMD). AMD affects 25-30 million people around the world and is a leading source of blindness.

Squalamine has also been shown to suppress appetite, and may become an important treatment for rising rates of obesity and Type II diabetes, both of which are epidemic in the United States today.

The decimation of shark populations has ominous potential impacts. As the apex predators of the open oceans, they help maintain the diversity and functioning of marine ecosystems and the health of the marine food web, culling, for example, diseased and weak organisms. They may also be the source of important new model compounds that can lead to the synthesis of powerful medicines to treat a host of human diseases.



Photo credit: J. Tamelander/IUCN

*Carcharhinus amblyrhynchos*

## Bears

Bear populations are threatened in many parts of the world because of the destruction of their habitats, and because of over-hunting for their organs, which are reputed to have medicinal value. Several species are in various levels of endangerment (See Miththapala, this volume), including the Asiatic black bear.

Bear gallbladders can be worth the equivalent of 18 times their weight in gold. There is a flourishing illegal trade in bear parts, for example in South Korea or in Thailand.

The tragedy is that living bears may be worth far more than the sum of all their body parts. Bears of the northern hemisphere enter a three-seven month period of hibernation, more accurately called 'denning' in which they neither eat, drink, urinate, nor defecate, yet they maintain a normal body temperature, are alert and reactive, can deliver as many as five cubs and nurse them, and grow new tissues. They accomplish these seemingly impossible physiological feats by recycling essentially all their body wastes.

For example, despite inactivity and a lack of weight bearing, bears do not lose bone mass, that is they do not develop osteoporosis. All other mammals, including humans, do so with a lack of weight bearing. A bedridden patient, for example, will lose one fourth to one third of his or her bone mass during a five-month period. Osteoporosis is an enormous public health problem — afflicting more than 10 million people in the U.S. alone (mostly post-menopausal women), causing 1.5 million bone fractures and 70,000 deaths each year, and costing the U.S. economy more than 18 billion USD annually. Bears have substances in their blood that are currently being isolated as medicines that prevent osteoporosis. If we understood how these substances worked, we could perhaps develop new preventative measures and treatments for this largely untreatable disease.

Bears also do not urinate for up to seven months. If we stopped urinating for only a few days, we would die. There is no cure for those people with end stage renal disease — they have to have either kidney dialysis or a kidney transplant to survive. If we understood how bears recycled essentially all of their urinary wastes, also because of compounds in their blood, and converted these into amino acids and new proteins, we could possibly treat renal failure, a condition that costs the U.S. economy



*Ursus thibetanus*

Photo credit: TRAFFIC East Asia



an additional 16 billion USD a year. We might also improve the health and survival of large populations of starving people in developing countries by reducing protein loss, one of the greatest problems during starvation.

I have mentioned these few species as examples of the scope and magnitude of what we are losing with a loss of biodiversity, the rich library of chemical information that is the result of billions of years of evolution and of all the evolutionary experiments that have taken place during that time. I could have mentioned countless others that have unique body processes like bears or that manufacture large numbers of powerful, biologically active compounds like cone snails that will help us better understand how our bodies work and that may help us prevent and treat human diseases that cause enormous numbers of deaths and suffering.

In closing, I want to call your attention to a project our Center has organized under the auspices of the WHO, UNEP, and UNDP called 'Biodiversity and Human Health'. In our website you will find the interim executive summary for this project, which covers, not only some of what I have said this morning about medicines, but also looks at the contributions that biodiversity makes to medical research, world food production, ecosystem services, and human infectious diseases. The final report will be published as a hard-bound book by Oxford University Press in early 2006, and we expect editions in French, Spanish, Chinese, and Arabic. Stay tuned.

We are in deep, deep trouble with what we are doing to the Earth, and the level of understanding about these issues is at such a primitive level, even at the very highest levels of government, including, I regret, my own government. I am convinced that people will protect other species and the ecosystems in which they, and all the rest of us, live when they recognize that their health and lives, and the health and lives of their children, depend on the health of the natural world. I do not believe that aesthetic and ethical and even economic arguments are compelling enough to motivate people to act as wise stewards of life on this planet. They must, instead, understand that they really have no other choice. And so our job is one of education, and that is something we can do. We must, all of us, learn as much as we can about these issues so that we can educate others - scientists, policy-makers, political leaders, and the public - so that we can help them understand that their health is ultimately dependent on the health of the global environment.

This is what was done in the successful efforts to protect the stratospheric ozone layer, and this is what must be done with the issues of global warming and the loss of biodiversity. And so, I urge all of you to do everything in your power to protect this incredibly wondrous gift we have been given, and to join me and my colleagues at our Center at Harvard, and all those around the world in this effort.

## The Value of Medicinal Species



*Saussuha obvallata*

Photo credit: CEMDE, Delhi University

# The Economics of Medicinal Plants: Are High Commercial Values Enough to Ensure Biodiversity Conservation? A perspective.

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## Introduction

This paper reviews studies pertaining to the economic valuation of medicinal plants, focusing on commercial values in the pharmaceutical industry. It reviews recent attempts to assess (a) the economic value of medicinal plants as raw materials for drug production, and (b) for bioprospecting.

The paper shows how valuation can be a powerful tool to highlight the economic significance of medicinal plants, as well as to plan for their conservation. However, it also contends that although in theory, high values can provide powerful incentives for conservation, in many cases the fact that the exploitation of medicinal plants presents such lucrative commercial opportunities can, if unchecked, lead to severe threats to biodiversity.

Using the case study of India, the paper shows that plants with the highest commercial values have often faced the greatest threat due to over-exploitation. It recommends that more equitable sharing of the economic benefits arising from bioprospecting is a critical condition in halting the over-exploitation of medicinal plants and species extinction.

## The value of medicinal plants as raw materials: an incentive for conservation?

One of the enduring questions in economic research on biodiversity values is whether high values provide private firms (such as the pharmaceutical industry) with incentives for the preservation of ecological habitats in resource-rich regions of the world. If a sustainably-used habitat is worth more in terms of the raw materials that it yields for pharmaceutical inputs than it would be for other (destructive) land and resource uses, then it may result in a powerful market-based instrument for conservation which requires no further external intervention. A number of economic valuation studies of medicinal plants have been conducted which attempt to demonstrate this argument.

One of the first major studies on the economic value of medicinal plants, conducted by Farnsworth and Soejarto (1985), estimated the value of medicinal plants that are expected to shortly become extinct from the US. This study looked at the active ingredients that were present in plants used in drugs in the US, using prescription data from the National Prescription Audit, which finds that

around 25% of all prescription drugs are based on at least one ingredient derived from higher plants. Farnsworth and Soejarto assumed a success rate for drug discovery of 1/125 (based on the number of flowering plants in the US actually having been proven to contribute to pharmaceutical products), and predicted that by the year 2000, 10% of all species will become extinct unless appropriate conservation measures are undertaken. Estimating the average value of a single plant at 203 billion USD, and with a total of over 20,000 species of flowering plants, this gave an economic cost of 3,248 billion USD associated with the loss of medicinal plants.

A second set of studies, drawing heavily on the framework established by Farnsworth and Soejarto, was carried out by Principe (1991, 1996). Adjusting figures to account for over-the-counter sales, hospital use, traditional and herbal medicines, Principe estimated the value of medicinal plant use in the US as 6.2 billion USD in 1985. Extrapolating these figures, he arrived at a figure of 33 billion USD for medicinal plant use through to the year 2000 for all Organisation for Economic Cooperation and Development (OECD) countries. Assuming a success rate for developing new drugs of between 1:1,000 to 1:10,000, and using ecological data to estimate that around 60,000 species of plants will have become extinct by the year 2000, he suggested that the value of medicinal plants threatened with extinction in OECD countries averaged 60 million USD per species per year.

Mendelsohn and Ballick (1995) provided a third example of a major study carried out to assess the economic value of medicinal plants as raw materials for the pharmaceutical industry. Aggregating the potential social value of as-yet undiscovered species of tropical forest plants, they found a total value of 147 billion USD, or an average of 48 USD per ha of tropical forest. Translating this total value into actual commercial returns, they come up with a potential market value for new pharmaceutical applications of medicinal plants of some 3-4 billion USD.

## The value of plants for bioprospecting: sufficient returns to ensure conservation?

With the progressive loss of biodiversity all over the world, and especially in the tropical areas that contain such a high diversity of species (the commercial applications of many of which are yet to be discovered), society is not only losing present benefits from the current use of medicinal plants, but is also being deprived of future use options. The economic concept of option value refers to the premium that is placed on maintaining species and ecosystems for possible future uses and applications, some of which are not known now. It is thus an incremental value that is associated from medicinal plants, in addition to the expectations of profits or economic returns from their actual or potential use.

It is critical to incorporate issues of future economic values and options when investigating the issues associated with generating sufficient economic incentives for biodiversity conservation.

Economic decisions relating to whether or not to conserve a species or ecosystem are not made only on the basis of current values and returns. Decisions are also influenced heavily by the expectation of future economic returns from conserving biodiversity, and the extent to which these future returns can also be translated into values that accrue today.

One way of calculating this option value, and of accounting for the value of medicinal plants in new and future uses, is to assess the economic worth of bioprospecting. An influential study by Simpson et al (1996) is based on the concept of the 'marginal value of species' (the extent of incremental value a species can contribute). The authors develop a model of bioprospecting as a sequential search of species (or leads) for the discovery of a new product, and derive a demand function for biodiversity in terms of pharmaceutical researchers' willingness to pay for species as inputs into commercial processes. They highlight the important point that once a successful product has been found, this may render new discoveries of a particular species that yields the same produce redundant, and in effect valueless. For these reasons, the study presents a strong argument that, in fact, the economic value of biodiversity for bioprospecting may have been over-stated.

A second set of studies, carried out by Rausser and Small (1998, 2000) presents contrasting results and conclusions. Using the same data set as Simpson et al, they conduct a numerical simulation to assess bioprospecting values. Focusing on units of land in 18 biodiversity hotspots of the world, Rausser and Small calculate the probability of a 'hit' as being in proportion to the density of endemic species in that area. The results of their study suggest that bioprospecting values are significant, and that the payments made for the provision of information on medicinal plants is high enough to provide sufficient returns to affect land use decisions. Rausser and Small conclude that, under plausible conditions, the bioprospecting value of certain genetic resources is sufficient to support market-based conservation of biodiversity.

The question of whether, in reality, bioprospecting can generate a sufficient level of returns to actually influence land use decisions remains largely unresolved in the literature as, indeed, do estimates of the economic value of biodiversity for bioprospecting (see Table 2). The fact that it is not only the hypothetical values, or even total values, associated with bioprospecting that matter from a conservation viewpoint, is however introduced in a useful review by Pearce and Puroshthothaman (1994). Pearce and Puroshthothaman are concerned about the prevailing institutional capacity to capture the value of medicinal plants used in the pharmaceutical industry for example as bioprospecting fees, royalties and payments to landholders. They make the important point that unless this issue is addressed properly, and incorporated in the estimation process, then the value of medicinal plants will remain over-exaggerated as will the claims that such values will lead axiomatically to the conservation of biodiversity.

## High commercial value and over-exploitation of medicinal plants: a case study of India

India has a long and rich history of medicinal plant use. Medical practices such as *Ayurveda* and *Sidhha* that are based on natural products and processes have been in existence for centuries. Even today, much of the Indian population relies on these highly effective traditional remedies and healthcare techniques.

Table 2. Bioprospecting Values in several ecosystems, as a function of density of Endemic Species

Biodiversity Hot Spots	Forest Area ('000 ha)	Density, Endemic Species/1,000 ha	Hit Probability (/1,000 ha)	Incremental Value (\$/ha) (Rausser & Small)	Scarcity Rent (\$/ha) (Simpson et al.)
Western Ecuador	250	8.75	1.05E-04	\$9,177	\$20.63
South-western Sri Lanka	70	7.14	8.57E-05	\$7,463	\$16.84
New Caledonia	150	5.27	6.32E-05	\$5,473	\$12.43
Madagascar	1,000	2.91	3.49 E-05	\$2,961	\$6.86
Western Ghats of India	800	2.03	2.44 E-05	\$2,026	\$4.77
Philippines	800	1.98	2.38 E-05	\$1,973	\$4.66
Atlantic Coast Brazil	2,000	1.88	2.26 E-05	\$1,867	\$4.42
Uplands of Western Amazonian	3,500	1.1	1.32 E-05	\$1,043	\$2.59
Tanzania	600	0.88	1.06 E-05	\$811	\$2.07
Cape Floristic Province of South Africa	8,900	0.71	8.52 E-06	\$632	\$1.66
Peninsular Malaysia	2,600	0.62	7.44 E-06	\$539	\$1.47
South-western Australia	5,470	0.52	6.24 E-06	\$435	\$1.22
Ivory Coast	400	0.48	5.76 E-06	\$394	\$1.47
Northern Borneo	6,400	0.42	5.04 E-06		\$0.99
Eastern Himalayas	5,300	0.42	5.04 E-06	\$332	\$0.98
Colombian Choco	7,200	0.32	3.84 E-06	\$231	\$0.75
Central Chile	4,600	0.32	3.84 E-06	\$231	\$0.74
California Floristic Province	24,600	0.09	1.08 E-06	\$0	\$0.20

Source: Small (1998) and Rausser and Small (2000), Simpson et al (1996)

The commercial exploitation of medicinal plants for export purposes has increased exponentially in recent years. This has occurred because of needs for foreign exchange, growing world demand and interest in natural remedies, and due to a rapidly expanding global bioprospecting industry. In turn, a rising number of medicinal plants are being harvested for external export from India, and various international and multinational companies have made significant inroads into the country. As shown in Table 3, India's exports of medicinal plants have grown almost three fold over the last thirty years while in general exports have remained stable or even declined.

Table 3. India's Pharmaceutical Exports in World Trade, 1970 to 1998 at current prices (in Rs. million)

Year	All Merchandise	Pharmaceuticals
1970	6	4
1975	5	4
1980	4	8
1985	5	8
1990	5	12
1995	6	10
1997	6	11
1998	6	10

Source: Task Force on Medicinal Plant Govt of India, 2000. Note: US\$1=approx. Rs 43

Commercially valuable medicinal species, and particularly those with a high export demand and value, have become eroded seriously over recent decades. Table 4 highlights some of the most endangered and over-exploited plants in India.

Table 4. Some Over-exploited Medicinal Plant Species in India.

Species	Use	Principle cause of decline and current status
<i>Saussuria obvallata</i> (kumaoni-brahmakamal, brahmakuti)	Used for cuts and wounds to stop bleeding	Locally extinct except for the upper reaches of the Kedarnath Sanctuary
<i>Ceropegia bulbosa</i> (marathi-Khapparkadu)	As a tonic for gastro-intestinal problems, also as a vegetable	Considered locally extinct in most localities for the last 50 yrs
<i>Erymostachys superba</i>	Used to induce milking in cattle	Only two populations remaining: one in Himachal and one near Dehradun
<i>Rauwolfia serpentina</i> (Hindi, Sanskrit-Sarpagandha)	Source of Reserpine and Rauwolfin; used for neurological disorders and in drugs that are of major pharmacological value	One of the most threatened medicinal plants of India, with major economic potential
<i>Mecanopsis aculeata</i>	Roots are narcotic	Restricted to high altitude Himalayas

Source: CEMDE. 2003

The high returns from harvesting medicinal plants for the export trade has clearly placed increased pressures on biodiversity. However, other factors are also important, and act as threats to medicinal species conservation in the country. One key factor is the lack of definite property rights over land and resources, and the way in which this translates into illegal exploitation. Despite the high value of medicinal plants in trade (and to the exporters and end-users of these products), very little value typically accrues to the harvester. Local communities are entering into contracts with pharmaceutical companies, but there exist weak mechanisms to regulate, monitor or control either such arrangements, or the harvesting and trade in medicinal species more generally.



## Economic incentives for biodiversity: the need to balance commercial values with conservation values

The growing body of literature on the economic value of medicinal plants to the pharmaceutical industry provides useful insights and data. In particular, the studies that have been described in this paper make the important point that medicinal applications typically constitute a significant component of the economic value of biodiversity and that ignoring such aspects could result in biodiversity being seriously under-valued. Yet, there remain many omissions in this literature, for example, animal species with medicinal value, coverage of marine and non-forest terrestrial ecosystems, and analysis of the value of medicinal plants in pharmaceutical applications outside the developed world.

Such valuation studies have also yielded contradictory, and sometimes conflicting, conclusions as regards implications for biodiversity conservation. Here, a serious gap in the literature remains. Whether or not the value of medicinal plants is immense or small, the critical issue as regards conservation is to what extent this value can be captured by the people who use and manage biological resources and natural ecosystems and, in turn, how far this can act as a sufficient economic incentive to conserve and sustainably use these species.

Many of the huge figures that are cited in valuation studies may in fact be misleading. Should all of these values actually accrue as real and tangible returns to those whose actions have the potential to impact on biodiversity, and should all of these values be associated with the sustainable use of medicinal species, then it would be reasonable (and logical) to postulate a clear link between economic value and biodiversity conservation. But in reality, this is not the case. Much of the 'immense value'<sup>1</sup> that is cited remains hypothetical, or potential, and the lion's share of such returns as are generated by medicinal species to the pharmaceutical industry tend to accrue to researchers, exporters and multinational corporations in developed countries. The people and countries who live alongside and manage key species of medicinal importance typically receive a much smaller proportion of this value.

Existing economic valuation studies do little to investigate these distributional concerns (and the broader economic, institutional, policy and legal factors that underpin them), to ascertain who captures the rent from exploiting medicinal species, or to make concrete recommendations as to how values could be maximized, sustainably, in order to ensure economic incentives for biodiversity conservation. Ultimately, it is unlikely to be total economic value *per se* that will ensure the preservation of commercially important medicinal species. Rather, their conservation will depend critically on how these rents are captured, and to what extent values translate into tangible economic incentives for their sustainable use.

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*Selimum tenuifolium*

Photo credit: CEMDE, Delhi University

# The Risks from the Loss of Medicinal Species



*Digitalis lanata*

Photo credit: <http://www.awl.ch/heilpflanzen>

# Risks to People of Losing Medicinal Species

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## Introduction: biodiversity and human health

Humans have numerous relations with other species, ranging from appreciating their existence to harvesting them for food or destroying their habitat. This paper will focus on one admittedly instrumental relationship: the role of other species in improving human health. It is helpful at the beginning to be clear about what makes a healthy human. The World Health Organization defines 'health' as a state of complete physical mental and social well-being, going far beyond the mere absence of disease or infirmity. Species can contribute to this state of well-being in many ways, as outlined below.

Human health is arguably one of the most important topics on everyone's mind - from the person in the street to those setting international agendas. One has only to look at the impact of HIV/AIDS or SARS to understand how critical this issue can be not only to our well-being but to economies and development plans. But how well do we understand that biodiversity is a foundation of human health? One answer is to review some of the many ways in which the diversity of plants and animals contributes to our physical and mental health:

### As sources of medicines and therapies

For thousands of years, or many more humans have used extracts of plants and animals to treat and prevent ailments and diseases. (See list below.) Such traditional medicines are still the primary source of health care for about three billion people in the developing parts of the world; the total value of the Chinese medicine market in wild products alone is estimated at between six billion and 20 billion USD per year, with 85% based on plants, 13% on animals, and 2% on minerals. But the dependence of people on medicinal plants is widespread and long standing. For example, the Paris Botanical Garden was established in 1626 by King Louis XIII for the cultivation of medicinal plants, and even in countries such as the USA, over 40% of the drugs being used today came originally from the wild. Examples include:

- ⊗ Foxglove, a flower in the snapdragon family, is the source of digitalis, for slowing heartbeat and increasing the strength of heartbeat.
- ⊗ Aspirin originated from the bark of the willow tree, but its active ingredient - salicylic acid - has now been identified in many plants.
- ⊗ Quinine comes from the bark of the Andean *Cinchona*, and kills the protozoan parasite that causes malaria in humans.
- ⊗ Vincristine from the Madagascar Periwinkle and paclitaxel from the Pacific Yew *Taxus brevifolia* and other *Taxus* species.

While medicinal plants have received considerable attention, medicinal animals are also important. Musk from glands of musk deer is used as a stimulant to treat apoplexy and to cure boils; scales of pangolins (scaled anteaters found in Asia and Africa) are used for a wide variety of skin ailments in China; bile from the gall bladder of bears is an important ingredient of many Chinese medicines; and powdered deer antlers are ingested for virility, kidney ailments and rejuvenation of aging tissues.

Some people may scoff at the 'unscientific' uses of animal parts, but many animal substances have been shown to have medicinal value. In the United States, bee venom is used to treat arthritis, and a substance secreted by blowfly larvae is used to promote healing of osteomyelitis and deep wounds. Snake and cone snail venoms are used as coagulants and painkillers, and are being tested in cancer research. In Russia, studies have shown that the velvet of deer antlers contains panocrin, a useful tonic that speeds the healing of wounds and ulcers; and research in Hong Kong has verified the anti-pyretic properties of rhino horn (But et al., 1992).

### As stimulants for new discoveries

While many plants have secondary compounds that may be toxic to animals (including humans), many other secondary compounds have been discovered by animals to be beneficial in at least some circumstances. Newton (1991) reported on numerous studies of chimpanzees, baboons, black lemurs, capuchins and other primates that feed on plants that have been shown to have potent anti-fungal, anti-bacterial, and anti-nematode effects. The rain forest sea of green may be a maze of nutrients, toxins and medicines requiring great sophistication on the part of primates to harvest and on the part of zoologists to understand', he suggests. The study of plants eaten by primates in health-related contexts may help discover new medicines, suggesting that primatologists and ethnobotanists should collaborate with pharmacologists to seek drugs that may improve human life and underlining the importance of conserving tropical forest.

It appears that humans have learned about many medicinal plants from observing how other animals may use them. Animals have been recorded to use medicinal plants for a wide range of ailments, using them as antibiotics, analgesics, and even hallucinogens; and chimpanzees have guided people to the discovery of chemicals that are effective in treating intestinal parasites and other maladies.

Judging from the presence of medicinal use of plants by various mammals, it is highly likely that the use of medicinal plants predated the evolution of our own species. Thus, people have probably been using medicinal plants since the very beginning of our existence as a species.

### As models for health research

Animals are essential models for research into human health. Research into the unique physiologies of animals is providing valuable insights that could greatly improve human health. For example, animals such as roundworms, poison dart frogs, cone snails, chimpanzees, bears, and sharks are studied to develop treatments for diabetes, renal disease, osteoporosis, HIV/AIDS, cancer, obesity, neurological and immunological disorders, and many other maladies.

In addition, all prescription drugs must be tested on animals before being marketed. In many countries, however, some animal welfare organisations object strongly to any such use, especially when it involves suffering in the experimental animals. But a 1999 survey in the UK by Market and Opinion Research International (MORI) suggested that the public generally is willing to be persuaded about the value of animal experimentation, especially to save human lives. The OECD countries have set standards that allow tests conducted in one country to be accepted by regulatory authorities in all 29 members of OECD, so tests need to be done only once. The ethical issues about use of animals in medical research will surely persist, and alternative testing methods are being developed.

## As sentinels of disease

Like the proverbial canaries in a coalmine, animals can warn us of an impending health hazard. For example, numerous wildlife species - among them mammals, birds, amphibians and fish - have suffered physical or behavioural changes from endocrine disruptors such as DDT and heavy metals, warning us that such changes may affect humans as well (Clotfelter et al., 2004).

Wild animals can also help to alert humans to disease threats. This was highlighted in 2000 by an outbreak of West Nile virus (WNV) that killed seven people in New York, where a substantial amount of pathological information pointing towards a WNV diagnosis had been collected by veterinarians at the Bronx Zoo working on an outbreak in captive birds, prior to the identification of WNV in humans (Boyle, 2000). Future collaboration between wildlife ecologists, conservation biologists, environmental biologists, veterinarians, medical scientists, and related disciplines could be particularly fruitful, especially for those who are able to view disease emergence in its broadest terms.

## As deliverers of therapy

Current research has demonstrated that pets provide many physical and physiological benefits to people. Caring for a pet results in physical health benefits, such as decreased blood pressure, lower cholesterol levels and lower triglyceride levels. Owning a pet can reduce morbidity and mortality related to heart disease, and pet ownership can lead to fewer visits to the doctor's office and a reduction in minor health problems. A study of stockbrokers who were given a pet found that they had half the increase in blood pressure from stress as stockbrokers without a pet. A Purdue University study of patients with Alzheimer's disease found that those patients exposed to an aquarium were more relaxed, alert and had a better appetite.

Understanding the impact that contact with animals can have both psychologically and physiologically, animals are also being used in new types of therapy, such as 'animal assisted therapy' (AAT). AAT programmes involve bringing recuperating patients into regular contact with dogs, cats, rabbits, horses and birds.

According to the University of Michigan psychologist Stephan Caplan, 'nature is not just "nice" ... it is a vital ingredient in healthy human functioning.' Indeed, some leading biologists assert that human evolutionary history has made a human connection with nature a necessity, not a luxury (Wilson & Kellert, 1993).

## As supporters of ecosystem services

Productive ecosystems are essential for human health, and indeed make all life on earth possible. Services provided by ecosystems include purification of air and water, mitigation of floods and droughts, recycling of pollutants and maintaining appropriate levels of gases in the atmosphere - all indispensable to human health. Looking at biodiversity and ecosystem services through the lens of human health can help provide new perspectives to the formulation of policy, indicating important linkages to a sector of human society that enjoys broad public support.

To the extent that humans depend on ecosystem services for providing food, clean water, and a habitable atmosphere, any species that contributes to these services might be considered 'medicinal.' But some ecosystem services provided by species have very direct beneficial impacts on human health. For example, in India, vultures perform the ecosystem service of recycling dead animals. The Griffin vulture that was once ubiquitous in India has now all but disappeared, with significant implications for human health. With the loss of Griffin vultures, packs of feral dogs are multiplying, carrying diseases such as rabies. The cause of death in the vultures is diclofenac, a veterinary drug used as a prophylactic with livestock that causes a deadly form of gout in the birds (MacKenzie, 2000).

Defining a 'medicinal species' is no simple matter because species of plants, animals, and micro-organisms can enhance human health in so many ways. However, for the purposes of this paper, a medicinal species is one that is used whole or in part directly in the preparation of medicines. While the impact of biodiversity on human health is vast, this paper will concentrate on medicinal species, and the primary threats to that resource.

## The threats to medicinal species

Given the human proclivity to overdo a good thing, it is not surprising that many of the species that provide very real health benefits are also subject to various forms of abuse at the hands of people. Overall, the threats to species in general also apply to those used in medicines, with the economic value of these species multiplying the threats. Primary among these are habitat loss and ecosystem disruption, over-exploitation (harvest and trade) and global change.

### Habitat loss and ecosystem disruption

Animal populations that are displaced by habitat alteration can provide new habitats for pathogens or can carry their pathogens to new areas and new species. Because populations of humans or animals exposed to a new infectious organism tend to experience disease in an explosive manner rather than the sporadic and lower-level outbreaks of disease that characterise endemic infectious organisms, these 'invasive species' are likely to be especially dangerous. Thus habitat fragmentation, already recognised as a major threat to biodiversity, can also increase human susceptibility to introduced diseases.



When predators are removed preferentially from an ecosystem, other species may proliferate, damaging human health. Lyme disease is a classic example. Ticks are born without the Lyme disease bacterium, which they pick up from feeding on other forest animals. Mice transmit the bacterium to the ticks much more efficiently than most other animals, but because ticks feed on a wide variety of forest birds and mammals, a greater diversity of species would proportionately reduce the chance of a tick feeding on a mouse that is at high risk of carrying the Lyme disease. Ecologist Richard Ostfeld calls this the 'dilution effect' of high biological diversity (Ostfeld & Keesing, 2000).

Development activities can sometimes have perverse effects on human health. In Argentina, herbicides introduced to increase maize crops also affected wild grasses, allowing a rodent species (*Calomys musculus*) that carries a haemorrhagic virus to dominate the fields and infect agricultural workers. In Bolivia, a mouse formerly inhabiting the edges of forests thrived in the houses built in small agricultural villages after the 1952 revolution and in the 1960s was associated with Bolivian haemorrhagic fever (Miller, 1989).

It appears that the main environmental changes associated with the emergence and/or re-emergence of relevant arboviruses (arthropod-borne viruses) are those which involve the loss of biodiversity - namely, deforestation, mining, dam and highway construction, human colonisation, and urbanisation. When an infected human returns to the community, an epidemic transmission cycle may sometimes be established in a human population without further need for the wild or domestic reservoir.

Jackson *et al.* (2001) point out that most recent changes to coastal marine ecosystems subsequent to over-fishing involve population explosions of microbes that lead to increasing eutrophication, diseases of marine species, algae blooms, and human diseases such as cholera. They suggest that the removal of higher trophic levels in the ecosystem is the underlying cause that needs to be addressed.

Resource extraction projects (e.g., forestry, mining) and the development of human habitations in previously undisturbed habitats must consider the potential for strongly elevating disease risk. Risk can be increased by creating new habitat for disease vectors (e.g., road-building and mosquitoes); changes in vector behaviour (e.g., switching to humans when alternative natural hosts become locally scarce); and the close juxtaposition of people with reservoirs and vectors of pathogens (e.g., settlements within zones of natural transmission among wildlife). Hazards flow in both directions, with both humans and wild species exposed to new health risks.

## Over-exploitation (harvest and trade)

Some animals have been pushed towards extinction because of their alleged curative powers. This has been especially true of those creatures also threatened by habitat loss: musk deer, rhinos, saiga antelope, and tigers, to name a few. When rural communities were harvesting medicinal animals for their own uses, over-exploitation was seldom a problem. But with the growing market demands and the promise of quick returns, hunters are being encouraged to concentrate on species with higher economic value. The current worldwide demand for medicinal animal parts is unprecedented, and the implications for many wildlife populations in Asia and Africa at least are not good.

Industrialised countries, too, are suffering from over-exploitation to feed the boom in health foods, which often include medicinal species of plants and animals. These species are often governed by food and agriculture legislation rather than more restrictive medical legislation, and many are sold over the counter. The soaring demand for medicinal species through such health food outlets has led to over-exploitation of species of plants such as Adonis (*Adonis vernalis*), Arnica (*Arnica montana*), Goldenseal (*Hydrastis canadensis*) and Black Cohosh (*Actaea racemosa*).

In addition to the impact of direct loss of species, trade in medicinal plants and animals may spread diseases that can affect both people and wildlife. For example, SARS may well be related to an animal coronavirus, which is found in many species kept in the live-animal markets of Guangdong and Guangzhou provinces in China. Researchers have found that several captive species, including palm civets and ferrets, can harbour closely related viruses, which then leap from animals to humans. A subsequent investigation by the Chinese government showed that 66 of 508 animal handlers tested at markets in Guangdong had antibodies against the SARS virus (Cyanoski & Abbott, 2003). Some experts believe that the SARS virus mutated in animals or humans so that it can jump readily between people, which is the most dreaded outcome in a part of the world that, historically, has generated deadly outbreaks of viruses (Pearson, 2004).

## Global Change

Human diseases, and the species to treat them, are influenced profoundly by the global ecosystem changes that are taking place. Urbanisation alters the dynamics of disease transfer as an increased density of hosts typically increases chances of transmission (e.g., influenza); large scale development projects may alter host dynamics or disease dynamics or both (e.g., irrigation projects increasing the incidence of schistosomiasis); climate change may alter the range of vector-borne diseases (e.g., malaria); human expansion into new territories may expose people to newly discovered diseases (e.g., haemorrhagic fevers such as the Ebola virus in Africa); and translocations of ballast water, changes in water temperature and marine pollution may cause toxic red tides which can promote the spread of bacteria and viruses such as those that cause cholera and hepatitis A.

Globalisation is, more broadly, bringing with it a series of new threats to both medicinal species and environmental health. Viruses are a particular problem because they are so difficult to cure; while vaccines for viruses such as smallpox, polio, and Yellow fever have proven effective, even very substantial investments to find a cure for AIDS have thus far proven only marginally effective. Even worse, the global changes that are affecting many parts of the world are expected to expand the ranges of many viruses that are potentially dangerous to humans. Moving into wilderness areas brings people into contact with a wider range of viruses, while air travel carries viruses around the globe, as a sort of excess baggage. A particularly worrisome mechanism is genetic exchange between viruses infecting people and wild or domestic animals, with the two viruses picking up genes from each other, enabling the virus to produce a new outer coat and so evade the human immune system (Miller, 1989). This is the main mechanism by which influenza pandemics arise, often involving an influenza virus that infects humans and one that is carried by ducks, including wild ducks, and other species of birds. As humans spread into more nesting areas of wild birds, opportunities for this genetic exchange may increase. As indicated by recent outbreaks of avian influenza in many parts of Asia, this is a very real threat.

Becoming part of the global economy appears to have encouraged many people to believe that human health is no longer dependent on a healthy natural world. Health has become a personal issue, with both prevention and cure centred on the individual (McMichael et al. 1999). However, health is also a characteristic of populations, and looking at the issue from the larger perspective of society can lead us in a very different direction. Of course, it is the individual who finally contracts any particular disease, but the risk of doing so is influenced significantly by the ecological context within which the population lives.

Climate change is likely to affect the ecology of many diseases and insect and arthropod disease transmitters (vectors) such as those responsible for malaria, dengue, schistosomiasis, yellow fever, onchocerciasis, lymphatic filariasis, leishmaniasis, and American and African trypanosomiasis. Increases in the incidence of viral tick-borne encephalitis in Sweden have been linked already to recent milder winters and the earlier arrival of spring.

Pollution is a significant global change factor that is threatening many species of animals. In the US, for example, some 27% of vertebrates and 66% of the invertebrates on the Federal Endangered Species List are damaged by pollutants; and almost all of the 70 species of threatened mussels are harmed by pollutants (Wilcove et al., 1998). Agricultural pollutants that enter lakes and rivers as run-off from farming operations are the worst problem (Richter et al; 1997), but the problem of persistent organic pollutants (POPs) affects many plant and animal species.

## What if medicinal species are lost?

The previous discussion may have left the impression that in some cases animals are disease reservoirs which are best done without, and some wild plants can be even worse (Anderson et al., 2004). However, the loss of medicinal species carries numerous hazards for people. Again, this discussion will introduce briefly a few points for consideration.

With the formidable array of threats discussed above, many medicinal species are at significant risk of extinction. Surely, an optimist might argue, alternative medicines can be found, and biotechnology is finding new ways of producing Pharmaceuticals that do not necessarily depend on a wild source. But that argument misses the point: the loss of medicinal species can have profound influences on many aspects of human health, of which losing a source of medicine is only the first.

## Losing medicines from nature

While lab researchers are certainly able to discover remarkable Pharmaceuticals, nature is even better and many of the pharmacologically active ingredients are highly unlikely to be found in the lab (Chivian, 2002). For example, the 500 species of cone snails (Conidae) each have an estimated 50-100 distinct toxins to immobilise prey. The toxins are highly selective in their receptor binding sites, making them very valuable to biomedical research, with over 2600 studies published since 1980. However, of the estimated 50,000 conotoxins, only about 100 have been investigated so far, leaving many more to be studied for their benefits to human health. These species are being

harvested heavily for both their toxins and their attractive shells, posing a very real threat to the survival of at least some populations. Chivian et al. (2003) conclude that "cone snails may contain the largest and most clinically important pharmacopoeia of any genus in nature. To lose them with be a self-destructive act of unparalleled folly."

Scientists already know many of the species that have medicinal value, but many more species have not yet been surveyed. While we will never know what we have lost before we knew about it, conserving the maximum biodiversity would seem a sound risk-adverse strategy in maintaining future options.

As noted earlier, biodiversity can provide mental as well as physical cures (Roszak et al., 1995). The 'biophilia hypothesis' advanced by the renowned Harvard zoologist E. O. Wilson, elegantly captures the importance to human mental health of the natural world. Judging from the popularity of visits to national parks, watching nature films, and purchase of nature-based coffee table books, it is apparent that many people have a deeply-felt need for nature, or at least knowing that nature is available if they wish to visit (as hundreds of millions do each year).

Some might argue that this is simply a preoccupation of the rich, and that the rural poor who are suffering from ill health have little time to worry about such niceties such as psychological well-being. But the well-recorded presence of sacred animals and plants among cultures throughout the world indicate the importance of this perspective (McNeely & Wachtel, 1988; Brown, 1997; Suzuki & Knudtson, 1997).

Beck and Myers (1996) conclude that "preserving the bond between people and their animals, like enhancing good nutrition and exercise, appears to be in the best interest of those concerned with public health."

## Losing insights into human health

Even if new Pharmaceuticals are found in the lab, their safety needs to be demonstrated before they can be unleashed on an unsuspecting public. Currently, this requires testing on mammals, often primates. High-value and rare species, such as chimpanzees, may soon be unavailable through lack of supply.

Other species can provide useful insights into human health problems when studied in the lab, and losing species of medicinal value could mean that human health is put at greater risk. In 1973 the new species of frog *Rheobatrachus silus* was described from south-east Queensland. The female frogs transport their young in their stomachs and give birth to fully formed baby frogs through their mouths, a reproductive mode unique in the animal kingdom. The jelly coating of the eggs contains a chemical compound termed prostaglandin that switches off the secretion of hydrochloric acid and converts the stomach into a womb. Prostaglandin is now used to treat gastric ulcers. No gastric brooding frogs of this species have been seen since 1980, so people have lost a valuable model for insights into gastric ulcers.

## Losing our sentinels of impending disaster

The impacts of endocrine disruptors on numerous species is just one example among many that could be cited about how animals have warned us of threats to our well-being. Given the globalisation of trade and transport, many disease threats are likely to be transmitted around the world far more rapidly than our surveillance systems can respond to them. A global system that monitors health in wildlife species may give us an early warning of impending problems for people.

## Losing the ecosystem goods and services upon which we depend

Once ecosystems start to change either through the addition of non-native species or through the loss of native species, changes can reverberate throughout the ecosystem, affecting the services provided to human health in terms of balance between predator and prey, lower productivity, etc.. For example, the increased mortality of the African cherry tree (*Prunus africana*), whose bark is used to treat certain prostate conditions, is suffering increased mortality throughout much of its range by people removing the bark for sale to pharmaceutical collectors. In Kenya's Kakamega Forest, Colobus monkey (*Colobus guereza*) populations are suffering because the African cherry tree is a key food source during certain times of year (Fashing, 2004).

## Conserving medicinal species

Because the threats to medicinal species are often very similar to the threats faced by other species, conservation actions often will also be similar. This provides additional justification to these actions, helping to build broader support for conserving species. Here are a few steps that should be taken:

### Monitoring the status and trends of medicinal species

Medicinal species, as a subset of biodiversity with particular relevance to people, deserve serious efforts to record their distributions, and subsequently to monitor their status and trends. Koopowitz and Kaye (1983) call for a priority list for conserving species of plants, starting with all known medicinal plants in their natural habitat. The IUCN/SSC Medicinal Plants Specialist Group has contributed to this list with their project on 'Centres of Medicinal Plant Diversity', and the wider efforts to develop the SSC Species Information System could also contribute.

Scientists should establish, ideally as an extension of pre-existing national health information systems, an international monitoring programme on ecosystem disruption and its effects on human health. Where such national health information systems do not exist, their creation should be encouraged through developing appropriate human resources, functioning infrastructure, effective inter-sectoral links, and the country's resources and capacity to deal with unexpected situations.

## Limiting the impact of medical research on medicinal species

It should be ensured that medical research does not threaten the survival of any species, for example by developing protocols, wherever possible, for using fewer animals in research and using tissue cultures, computer models and other surrogates for whole organisms.

There should be clear and compelling argumentation that explains any use of animals in medical research. New technology may replace at least some use of animals in medical research, for example designing 'biochips' which contain human genes that are activated by exposure to pathogens or toxic chemicals.

## Addressing medicinal species concerns as part of international agreements

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is especially relevant in this regard. Many species of actual or potential importance to human health are threatened: chimpanzees, rhinos, saiga antelope, tigers, as well as some species of sea horses, bears and pangolins are threatened or potentially threatened as a result of their confirmed or supposed medicinal value. As a result, these species are listed on one of the CITES appendices and their commercial international trade either banned or controlled strictly. Many medicinal plants are also listed, such as Hoodia from southern Africa and some species of yew trees that yield the powerful anti-cancer drug, paclitaxel.

The World Trade Organization (WTO) should be working with the Convention on Biological Diversity (CBD) and the World Health Organization to address issues of invasive alien species that may be harmful to human health and biodiversity. At the national level, governments will need to coordinate activities of various agencies that are responsible for human health, animal health, plant health, transport, tourism, trade, protected areas, wildlife management, water supply and other relevant fields, and develop an early warning system and rapid response capacity in each country.

The CBD seeks to ensure that the benefits resulting from the production of Pharmaceuticals derived from molecules derived initially from natural biological sources are shared fairly and equitably. The bioprospecting which elicits these Pharmaceuticals may be defined as 'the exploration of biodiversity for commercially valuable genetic and biochemical resources' (Reid et al. 1993) and, as suggested in CBD articles 11,15 and 19, benefits arising from the process of converting natural products into commercial Pharmaceuticals could also give economic incentives to source countries to conserve biodiversity. However, bioprospecting does not appear to be reaching its full potential either in terms of yielding the maximum production of drugs or in terms of producing maximum biodiversity conservation and long-term sustainability, let alone benefit-sharing. Bearing in mind the very large domestic use and trade in medicinal plants (raw materials), the sustainable use objectives of the CBD also need to be applied domestically and the potential links between sustainable raw material production, trade and biodiversity conservation need to be explored more thoroughly.

With regard to pollution, the Stockholm Convention on Persistent Organic Pollutants aims to reduce production and unnecessary use of Persistent Organic Pollutants (POPs) by ensuring that national governments enforce laws concerning liability for pollution. Financial and technical support is required to reduce the reliance of developing countries on hazardous pesticides such as DDT (for malaria control). More broadly, comprehensive impact assessments need to be carried out on newly-created chemicals that may be hazardous to human and environmental health.

## Incorporating human health issues into protected area management

A national system of protected areas can serve as an essential antidote to habitat destruction, a major means of adapting to changes in climate, a reservoir of medicinal species, and a means of maintaining ecosystem functions that are essential to human health. Virtually all countries already have systems of protected areas, but these need to be expanded and managed more effectively if they are to make their optimal contribution to biodiversity and human health.

Management plans for protected areas need to provide for the appropriate use of medicinal species. Protected areas can be funded in part by capturing the market value of the ecosystem services provided by the forests, coral reefs, wetlands and other habitats that are managed to maintain ecosystem integrity.

## Limiting habitat changes likely to affect human health

Infectious diseases affecting humans, whether caused by virus, bacteria, fungus, arthropod, worm or transmitted by insect vector, water or air, exist in complex ecosystems with varying factors affecting their transmission. Disruption to these ecosystems, such as the introduction of a new disease or a change in the facility of transfer between hosts, may cause massive mortality before the ecosystem regains its equilibrium via the evolution of host resistance and/or a less virulent strain of disease. The most dramatic disruptions are from habitat changes driven by development, for example when a forest is converted to a plantation or farmland, a coral reef is destroyed to harvest the coral for construction, or a wetland is flooded by dam construction.

As one example, the Brazilian Amazon appears to be very rich in arboviruses (arthropod borne viruses), reflecting its rich biodiversity in general. Nearly 190 new species of viruses were identified in the Brazilian Amazon from 1954 to 1998. Very little is known about most of these viruses even though several directly contagious viral haemorrhagic fevers (in some cases thought to be maintained in a rodent reservoir) have emerged over the past several decades following intensified land clearance, habitat disruption and human influxes. Settlement schemes in such areas will need to include health considerations if they hope to be sustainable.

In many countries, governments mandate risk assessment for all new projects that may affect the environment. However, such environmental impact assessments typically give insufficient attention to either health or biodiversity. At a minimum, an impact assessment should endeavour to protect sparsely inhabited ecosystems from further human impacts, until a fuller understanding is available of the nature of the infectious agents in the system as currently evolved.



Wildlife diseases are becoming a much more serious consideration in many parts of the conservation community, with the Wildlife Conservation Society playing an especially important role in this area. This because the potential conflicts seem to be increasing, or at least are becoming more likely as human encroachment into wildlife habitats continues to grow. 'Human population expansion has driven the emergence of EIDs (emerging infectious diseases) via increasing population density, especially in urban areas, and encroachment into wildlife habitat. This encroachment may have been a key factor in Africa for the global emergence of Marburg and Ebola viruses and human immuno-deficiency virus (HIV). Pressures of human encroachment on shrinking wildlife habitat also cause increased wildlife population densities and the emergence of wildlife EIDs. The international movement of livestock and modern agricultural practices have led to EIDs such as Rinderpest in Africa and Bovine Spongiform encephalitis (BSE) in Europe' (Daszak et al., 2000).

Waltner-Toiws (2001) recommends that relatively uninhabited ecosystems are protected from further human invasions by economic and political policies, until we have a fuller understanding of the nature of the infectious agents in the system as currently evolved. This will also help conserve the medicinal species found in these areas.

## Modifying human behaviour that depletes biodiversity and exposes people to health risks

Many researchers have remarked on the close relationship between chimpanzees and AIDS, with the SIV virus found in the Central African chimpanzee, which becomes known as HIV-1 when it is found in humans. The bush meat trade is linked to the spread of AIDS, through the exposure of the hunters to chimpanzee blood. Villagers who live close to the forests and hunt chimpanzees, bonobos, or gorillas often contract HIV. Jahme (2000) concludes: "AIDS may be thousands of years old but, due to the rapid growth in international travel, the latest wave of HIV keeps spreading. The AIDS virus is one of the planet Earth's most successful species. The rampant spread of HIV through humans could be interpreted as the chimpanzees' last defence against man. Ultimately, it seems the bush meat trade is responsible for the deaths of millions of HIV-infected' people. The extermination of these animals is genocide, and in eating these animals it now seems we are also committing suicide." On the other hand, the naturally infected wild chimps may hold the key to helping humans survive AIDS, as they are the best research models because they do not fully develop HIV or AIDS when infected artificially with the virus. "If wild chimps are exterminated and their habitat destroyed, the chances of finding an HIV vaccine for people will vanish too," Jahme (2000) concludes.

Hahn et al., (2000) conclude that "ultimately a satisfactory understanding of the pathogenesis of HIVs and of the risks of further zoonoses can only come from a full appreciation of the biology, natural history, and evolution of SIVs in primates. Along the way, it is likely that biological insights will be obtained that are relevant to some of the most pressing concerns facing AIDS investigators, not the least being the development of an effective AIDS vaccine, and a mechanistic understanding of HIV-1 persistence, pathogenesis, and immunity. Such work cannot be accomplished, nor such gains achieved, without a keen sensitivity on the part of scientists and policy makers to endangered species, environmental pressures, social stigma, resource allocation, and a host of factors unique to the African setting."

## Controlling harvest and trade at national/local levels

In many countries, over-exploitation is essentially a local problem, sometimes reaching the national level. Where protected areas are the last remaining habitats of medicinal species, they may be subject to considerable pressure from illegal harvesting. In the US, for example, American Ginseng is harvested illegally in some national parks. The species is also cultivated in large quantities in the US and Canada. However, wild specimens have a much higher value on East Asian markets than do cultivated ones, so demand for these remains strong despite high volume cultivation. Managing/regulating medicinal plant harvest and trade would seem even more relevant outside of protected areas than inside, including within countries such as Nepal. One alternative is to domesticate medicinal plant species, thereby increasing the supply and potentially helping to reduce pressure on wild sources. Another option is to establish a system of permits to help maintain collection of medicinal plants within sustainable levels inside protected areas. This would require the protected area management agency to establish clear guidelines for the collecting of medicinal plants within protected areas. Enforcement will remain a problem where management capacity is weak. In a country like Nepal, with about 570 species of plants known to have medicinal properties, a permit system may be the only effective way to prevent species from becoming threatened by commercial exploitation (Shrestha & Joshi, 1996).

## Preparing codes of conduct for producers of medicines based on medicinal species

While codes of conduct for researchers are now fairly well established, the producers of medicines, from those doing the primary collecting to the dealers to the final producers and retailers, also should be subject to appropriate guidelines to ensure sustainability. Such guidelines might include ensuring that all species are harvested legally, all necessary permits have been obtained, the wild populations are monitored as a means of determining status and trends, products are well-labelled, and so forth. The revised WHO/IUCN/WWF/TRAFFIC Guidelines on the Conservation of Medicinal Plants, now under preparation, may contribute to this need, but guidelines for medicinal animals may be even more important.

## Building public awareness

An informed public will be more likely to make informed decisions about the Pharmaceuticals that it wishes to use. A vigorous public awareness initiative that points out the status of medicinal species, highlights the threats to them, and underlines the potential risks of global change to human health, should be part of both health campaigns and conservation campaigns.

## Conclusions

The linkage between biodiversity and human health takes biodiversity issues out of the unique realm of ministries of environment and instead, puts them at the very centre of humanitarian concerns. Such linkages can help to influence public opinion in support of efforts to conserve species and ecosystems.

Urban living and modern technology have diminished general public awareness of the dependence of continued good human health on a healthy natural environment. Further, modern medical research has tended to focus on reductionist approaches to identifying the cause of disease by cataloguing proximate behaviours that put the individual at risk, or unique disease-causing organisms. But we must not ignore influences on health that operate at the population level, such as water quality; pollutants that may cause changes in the immune system, affect reproductive biology through accumulating organic chemicals that disrupt the endocrine system, and enhance the risk of certain kinds of cancer; and changes in climate that may influence the spread of vectors of certain diseases, such as mosquitoes carrying malaria or dengue fever. These factors also need to be considered in the more comprehensive approaches to human health being advocated here.

The case for conserving medicinal species is compelling, and far greater efforts are justified based on benefits received by humans. Equally, the threats are also very clear, and are, in fact, much more broadly-based and affect other species as well. Thus, significantly increased efforts to conserve medicinal species will benefit many others too. Finally, a focus on medicinal species will help take conservation beyond the narrow confines of ministries of environment and build a much stronger public constituency for conserving biodiversity in the interest of human welfare.

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*Pan troglodytes*

Photo credit: Karl Amman

# The Risks of the loss of Medicinal Plants for Livelihood and Health Security in South Asia

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## Introduction

It is estimated that nearly 80% of medicinal plant species in Asia are found in forests (FRLHT, 2002). Over 90% medicinal species are collected mostly from forests, from the wild (FRLHT, 2002). In India, over 70% of medicinal plant species are found in tropical areas - mainly in tropical forests - while about 30% are found in temperate forests and alpine areas of the Himalayas (FRLHT, 2002).

Over half a million tonnes of dry medicinal raw material is collected from the wild every year in India. In Pakistan (700 species), Nepal (900 species), Bhutan (300 species), Bangladesh (500 species) and Sri Lanka (1000 species) medicinal plants in use and those in trade are collected predominantly from the wild; very few species are cultivated, or originate from cultivation. (India records 88 cultivated species, while Pakistan has only five species.) Most of medicinal species that are cultivated are either exotics or are no longer found in the wild.

In recent decades, there has been growing over-exploitation of medicinal plants from the wild, exacerbated by accelerating national and international demand for botanicals. Insecure tenurial and rights arrangements of local communities over forest resources are believed to be at the root of extant free riding and the resultant 'tragedy of the commons.' Sometimes, traders use outsiders (common in the Himalayas) to extract medicinal plants from open access forests or wild lands. These conditions, compounded by absence of effective conservation policies and action and monitorable regulatory frameworks, have led to severe declines in wild populations of medicinal plants.

## The threatened status of Asian medicinal plants

Systematic IUCN Red Listing (versions 2.4 & 3.1) has been carried out for selected medicinal plant species in India and Nepal. Between 1995 and 2003, several assessments of threat categories that detail species and regions have been reported in India, and a similar assessment has been carried in Nepal. Table 1 details the result of these assessments.

Table 1. Threat categorisation of selected medicinal species

	India	Nepal
Total number of taxa assessed for threat category	397 species	51 species
Threatened: Critically endangered, Endangered or Vulnerable	263 (66%)	40 (80%) 03 14 23
Not threatened: Data deficient, Near Threatened Least Concern	34	07 03 01
Endemic	98 (25%)	06 (12%)

Taxa assessed have a global red list status only when they are endemic to a region, say a state or a few states in India. Otherwise taxa have been assessed for regional threat status within India. Thus, the red listing shown is either global (for endemic species) or regional (within India) for other species which have a wider distribution.

Source: CAMP & TAMP, 1996, 1996, 1997, 1999, 2001, 2002

Population decline turns out to be the major criterion on which threat categories have been assigned. This can be linked directly to galloping industrial demand, because over-exploitation has been listed as the most common threat to the 100+ traded species that have been red-listed. However, many of the endemics and species with restricted distribution do not feature in the traded species list though several are critically endangered, endangered or vulnerable in the wild as it is no longer viable to collect these. Decline in these species adversely impacts local use and has immediate and direct implications for a range of rural livelihoods, local health security and continuance of folk traditions that have used these species.

## The users of medicinal species

The users of medicinal species in Asia are ordinary people, and in South Asia, rural populations. However, increasingly, urban populations have been using manufactured herbal medicines and cosmetics. Export of botanicals to developed countries is a growing business in India and Pakistan, both of which rank high on the list of countries exporting raw ingredients for drugs (Schippmann & Leaman, 2003). Trends in the growth of demand for herbal products indicate that cures for common ailments and for skin/ hair care cosmetics are expected to jump significantly in the near future (Chakrabarti, 2004). (It should be noted that approximately half of India's population - i.e., about 500 million people - use twigs of *Azadirachta indica*, *Acacia nilotica*, the root bark of *Juglans regia* and some other species as toothbrushes every day. In terms of cost, as equivalent to a tube of toothpaste and a toothbrush at 1 USD a month, this works out to 6,000 USD million per annum. This is several times more than the combined value of all medicinal plant-related exports from the country.)

## Livelihoods at stake

### Livelihoods at stake

What holds true for South Asia also applies generally to the rest of the developing world; those whose livelihoods and health security are at stake - Gadgil (1992) calls them the ecosystem people – are those most affected by this decline of wild populations of medicinal plants and their extinction. In terms of the impact on livelihoods, it is the tribal and forest fringe dwellers who are most affected, and in terms of health security, it is rural populations.

To better appreciate what the risks of medicinal plant loss on the security of livelihoods mean, let us evaluate the case for India. Of the 84.3 million tribal population in the country, approximately 83.1 million (98.5%) live in or around forests that extend over about 61 million ha. Of this forest area, only about 22 million ha (36.25%) has dense forest cover<sup>1</sup>. There are also 147 million forest fringe-dwellers in 171,000 villages including tribal populations (FSI, 2001).

The incidence of poverty among the forest-tribal population is the highest among the rural poor. More than 50% of the total tribal population in India is estimated to live below the poverty line (BPL, Planning Commission, various reports). This translates into approximately 70 million forest-tribal people, more than the total population of Britain. The forest and the poverty maps for rural India show disconcerting congruence and this makes livelihood dependence on the forest critical for survival of the country's poorest people.

Non-timber forest products (NTFPs), including medicinal plants, are often the major and sometimes, the only source of cash income in an otherwise subsistence agro-silvi-pastoral economy. Loss of NTFPs due to forest degradation, loss and fragmentation of habitats and their alteration directly affects the livelihoods of collectors especially the poor and women. A study in the Gorkha district of Nepal showed that medicinal and aromatic plant collection contributed 15 to 35% of the villagers' income (Smith-Olsen, 1998). Another study reveals that over 70% of households are engaged in the collection and sale of medicinal plants at different times of the year and that all members - including women and children - are involved, depending on the season and distance of collection areas from the village (Tandon, 1997). Less is known about the valuation of medicines derived from herbs for self-use by hundreds of millions of rural people, but if the example of the medicinal toothbrush is considered, then it is a multi-billion dollar affair.

Given the extreme poverty, the enormous number of dependent tribal-forest people and open access to forest areas, the collection of medicinal plants, legally or illegally, will continue unabated even when the returns are diminishing. It is a livelihood activity and there are few viable options.

Consider next the enormous trade chain that carries medicinal plants all over the world. As medicinal plants decline the livelihoods of, *inter alia*, village agents, small traders, and transporters are affected. For India and Nepal, a recent 'Green Pages' directory lists 4,490 different medicinal plant stakeholders for India, including 300 cultivators, 914 dealers, 616 exporters, 117 extractors, 127 importers, 2301 manufacturers, 82 organisations and 33 research and development institutions (Medherb Green Pages, 2004). The Ministry of Health lists 7800 licensed manufacturing units in the country.

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<sup>1</sup>Dense cover is defined as forest cover that is over 40%

For Nepal, the total list has 232 entries with 59 dealers, 109 exporters, seven extractors, 16 importers and 41 manufacturers. In addition, there are thousands of village-level agents and traders involved in the medicinal plant trade and supply chain.

According to the World Health Organization (WHO), about 80% of the rural people depend on folk and traditional systems of medicine to meet their health care needs. In a country like Bangladesh, where the majority of the people are poor, low cost and safe health care is essential. Traditional systems of medicine are, therefore, familiar and affordable to a majority of the people (Begum, 2000). What the WHO does not mention is that in order to make health care accessible to 80% of rural people (and now, increasingly urban people), millions of rural livelihoods are dependent on the continued availability and access to wild medicinal plants. In order to sustain livelihood and health security, it is critical to sustain the medicinal plant resource base. While this appears to be quite straightforward, the bigger threat to livelihood and health security of the rural poor is linked to national and international policy: their response to the decline of medicinal plants in the wild, and how it affects the affordability of health care.

## The policy response

Planners and decision makers appear to be convinced that in order to 'ease' pressure on wild collection and thereby be able to conserve medicinal plants, they should be cultivated instead. The Ministry of Health and Family Welfare, Government of India (Gol) that oversees the department of Ayurveda, Unani, Siddha and Homeopathy (considered traditional medicine) has been at the forefront of the approach that focuses on cultivation, which is being spearheaded currently by the Indian National Medicinal Plant Board. Ironically, the Ministry of Environment and Forests of the Gol has endorsed this approach. The advocacy of large-scale ex situ cultivation of medicinal plants in the naive belief that such a development would automatically lessen pressure on the wild medicinal populations is unlikely to happen. As indicated, wild collection is a livelihood activity and will remain so until alternative livelihood opportunities are provided to poor people who depend on such extractions to earn their meagre cash income. With total disregard to the rural livelihood and health security, what is now being argued is that in order to make cultivated medicinal plants competitive in the market, the wild-collected ones should be priced higher.

The industry, true to its profit-seeking imperative and market demand, would prefer cultivated material despite still being dependent on wild collection. It is more reliable, can be controlled (nature and content), certified easily as organic, genetically modified etc. Therefore, research is being driven by these factors.

## The drivers of research

Research related to medicinal plants in South Asia is dominated by Government and/or semi-government institutions. This research has been geared almost exclusively to develop agro-technology packages for commercial cultivation of medicinal plants for export and the industry. Private research efforts and those of some large pharmaceutical companies are understandably also devoted to cultivation. The government's obsession with cultivation is half a century old, and



has been more intense before conservation issues became popular. Ironically, cultivation is now being touted as a means to securing conservation.

What is being advocated unthinkingly as a 'conservation' measure has several pitfalls: What sort and what scale of 'cultivation' is contemplated? Will poor herb collectors, small and marginal farmers and those living in mountains be in any position to undertake high resource input cultivation?

Achieving economies of scale and higher productivity (and therefore more profit) would entail continuous input and technological up grading and risk, something only richer farmers can afford. Most tribal forest dwellers are landless and are, obviously, not the intended beneficiaries of this new 'conservation.'

Despite the drive for cultivation, only a minute proportion of medicinal species are cultivated. The Indian herbal pharmaceutical industry is said to use more than 1,800 medicinal plant species in its various formulations based on ISMs (Indian Systems of Medicine). Most of these species are used in moderate or low volumes, typically below one metric tonne (dry)/ year. Presently, of the 880 species of medicinal plants traded in India, only 88 are cultivated and a substantial portion of the latter are spices and condiments (Ved, 2003). Only about 100 species are used in large quantities i.e. over 1000 MT (dry)/ year.

Out of the 880 species in trade, 71 % of the demand (1,20,817 tonnes for 1999-2000) comprises 162 species while the remaining 718 species' demand stands at 77,238 tonnes. Just two of the top 20 medicinal plant species in terms of demand originate from cultivation (Ved, 2003).

Interestingly, according to data compiled by the Ayurvedic Drug Manufacturers Association (ADMA), Mumbai (1999)(Government of India, 2000) out of 110 crude medicinal plant drugs being used, the percentage consumption by the ADMA varied between 1 to 60% of the quantity available. Only imported items were consumed fully. Though 45 crude drugs are shown to be available in quantities over 1000 MT, the ayurvedic pharmacies used typically less than 30 % in as many as 39 (out of the 45) items. If this is the rate of consumption of raw ingredients for making medicines, one wonders why the hullabaloo to cultivate everything to save medicinal species in the wild! How much is the scope for large-scale cultivation, the main objective of research in the country?

## Not seeing the trees?

It is more revealing to look at medicinal plants in use by type. According to the Foundation for Revitalisation of Local Health Traditions database (pers. com. D. K. Ved), analysis of about 5000 medicinal plant species reveals that 41 % are herbs, 30% trees and 29% shrubs. Because trees and most shrubs are perennial, they are not cultivated easily. A similar analysis of the 880 traded medicinal species shows a similar trend. Forty one percent are herbs while 59% are trees, woody shrubs and climbers. This means that about 59% of medicinal plant species will have to be made to flourish in the forest / wild habitats if we are to continue using them (assuming that all herbs will be cultivated some day).

Unfortunately, despite clear and incontrovertible evidence of the limitations and risks of cultivation of medicinal plants, the majority of scarce funding and resources are pouring into cultivation and related research. There is little or no money for conservation in the wild. A sound recommendation for species with declining populations unequivocally suggests, 'such funds as are available specifically for biodiversity conservation would usually be better spent on managing it in the wild, and on the captive propagation of selected, endangered species (for reintroduction into the wild) where this can be achieved at reasonable cost (Caldecott, et al., 1996).

The absence of policy or its failure (notwithstanding sporadic, feeble attempts to bring conservation of medicinal plants to centre stage) is especially relevant to South Asia, where millions derive sustenance from wild medicinal plant related activities. It represents the bigger threat to loss of medicinal plant diversity and its downstream impacts on livelihoods and health.

### Health security: *Quo vadis?*

The systematic neglect of the conservation of medicinal plants in policy and in action has major implications for the affordability of health care and the continuance of local health traditions. As medicinal plant populations continue to decline in the wild, not only can age-old home remedies be forgotten within one generation (as has happened in several pockets in India), but also, the very practice of folk medicine, which is the backbone of health care for the poor, begins to fall into desuetude. However, this is the health care with which people were familiar, could afford and where access was never a problem. Figure 1 and Tables 2 and 3 bring out the size of the human resource that is still accessible easily and generally affordable by common people - both rural and urban.

The entire system of traditional medicine, from home remedies to folk and classical, are largely dependent on plant-based raw materials. In the event of a failure to meet supplies from the wild, the attrition is likely to begin with access to home remedies, then folk healers, upwards, i.e., the impact will first hit the poor and it will hit them perhaps the hardest, because it is unlikely that access to modern health care on such a large scale as would be required in South Asia could be made available in the foreseeable future to the poor.

Figure 1. Population of India, 2001 Census

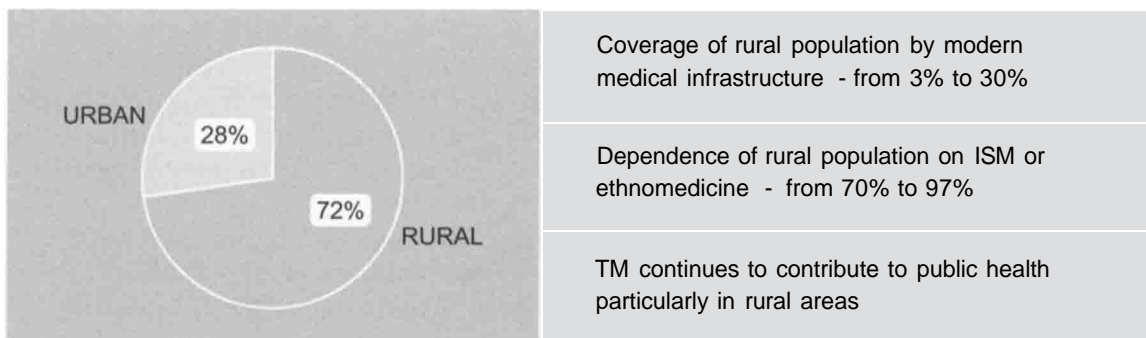


Table 2. Human Resource in Folk Tradition (India)

Traditional Carrier	Subjects	Estimated Numbers
Housewives & Elders	Home remedies	Millions
Birth Attendants	Normal deliveries	7,00,000
Herbal healers & quacks	Common ailments	3,00,000
Bone setters	Orthopaedics	60,000
Poison sting treatment	Natural poisons	1,000
Specialists	Eyes, skin, respiratory, dental, arthritis, mental disorders, liver, GIT, wounds, fistula and piles	1,000 each

(Source: LSPSS, Coimbatore. 1993)

Table 3 Human Resource in Classical Tradition (India and Pakistan) \*50000, for Pakistan

Indian Systems of Medicine	Registered Medical Practitioners	Colleges	Hospitals	Dispensaries
<i>Unani</i> <i>Tibb-e-Unani</i>	19,685* 50,000	33	177	958
<i>Siddha</i>	12,911	6	204	357
<i>Psa-Rigpa</i>				
<i>Ayurveda</i>	361,881	187	2189	14252

(Source: Ministry of Health, Department of Ayurveda, Unani, Siddha and Homeopathy, GoI)

Loss of medicinal plants causes loss of access to affordable and immediate medical treatment and disappearance of folk medical traditions. This cultural loss has been undervalued consistently worldwide. Much of the knowledge of the medicinal uses of plants lies with oral traditions. These are either unrecorded or documented poorly. There are already valid apprehensions that vast amounts of folk medical knowledge may have been lost, just like undiscovered plant species.

Unavailability of medicinal plants compels the poor to spend increasing amounts of money on treatment of common ailments. Human sickness is largely to do with common ailments. Recurrent expenditure for these ailments further impoverishes the poor. In the case of more serious diseases, it is the accessing of health care (rather than the medical costs) that becomes a heavy burden on the rural poor and has been identified as a major reason for people remaining in poverty.

Extinction of medicinal plant species robs future generations of new medicines and novel discoveries of uses of known medicinal species. For example, a recent discovery has shown that the fruit of *Terminalia chebula* can protect people from damage caused by nuclear radiation (Down To Earth, 2004).

## Conclusion

To sustain livelihoods and health security it is absolutely necessary that a) medicinal plants in the wild are conserved; b) those on red lists are able to recover and be taken off the red-lists; and c) the flow of raw drug produce and associated benefits from them are made more sustainable and equitable within a time bound framework.

The Global Strategy for Plant Conservation (with targets for achievement by 2010) is an excellent guiding document for countries to emulate (Global Strategy for Plant Conservation, 2002). However, in light of the above discussion and looking at the trends in markets, trade and policy, it is obvious that the chances for medicinal plants in their habitats continue to diminish. Particularly worrying is the eventuality that medicinal plants will become cash crops instead of remaining as NTFPs. A tragic fallout of this (which is already underway) will be the disappearance of the myriad localised, folk health traditions the world has known and on which it has survived. Poorer tribal-forest people will be marginalised even more and affordable health care further removed for millions. Under these constraints, is there light at the end of the tunnel?

Yes, there is. We have, amongst us, several small but highly successful examples some of which will find mention in the revised WHO/IUCN/WWF/TRAFFIC Guidelines on the Conservation of Medicinal Plants that are being finalised currently. Much of what should be done is known but needs co-ordinated action. Within the framework of an ecosystem approach, clear and practicable strategies for conservation of medicinal plants that hinge on livelihood generation and access to health care for the poor must become the drivers for policy change and effective action.

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# Rainforests for Health

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## Background

Tropical rainforests are the world's richest type of ecosystem, whose biological diversity is unsurpassed. As we all know, the estimated total of 10-15 million species on earth is an important source for new medicines, but pathogens - mainly viruses - are also widely present in undisturbed forests. These microbes may not constitute a human threat as humans are not their prime host and the vector (usually an insect) lives in the higher layers of the forest. In undisturbed forests, contact with a potential human victim is avoided, but as soon as the preferred non-human host has been made to disappear or the stratification of the forest is disrupted, a disease can break out among humans (Van der Kaay, 1998). Over the past decades, newly emerging infectious diseases have been attributable to ecosystem disruptions (Weinhold, 2004). Garrett (1994) reviews, in her book *The Coming Plague*, these emerging diseases, and suggests the importance of deforestation in bringing some pathogens in closer contact with human populations. The intrinsic link between ecosystem health and human disease (especially vector-mediated disease) has been further discussed in a number of publications (Cassis, 1998; Chivian, 2001; Epstein, 1995; Forget & Lebel, 2001; Haines et al., 2000; McMichael, 1997; Nielsen, 2001; VanLeeuwen et al., 1999; Waltner-Toews, 2001). These authors have noted that ecosystem health is influenced heavily by human activities and that, conversely, human health depends on proper ecosystem functioning.

Among the emerging and re-emerging diseases attributed to ecological disruption are diseases caused by arboviruses (viruses borne by arthropods), zoonoses (diseases transmitted by animals to humans, such as hantaviruses) and infections that appear to transcend simple transmission categories, e.g. viruses that were once zoonotic, but 'transformed' to become direct anthroponoses (diseases transmitted directly from human to human). For example, SARS (Severe Acute Respiratory Virus) and HIV (Human Immunodeficiency Virus) are such transformed viruses. A number of direct anthroponoses (such as measles, polio, and chlamydia), may also reflect ecological disruption, as in the case of transmission of cholera (Tauxe et al., 1994).

Most of the destruction of the tropical rainforests has occurred in the last forty years to make way for agriculture, human settlement, and logging, as a source of hard cash for the governments involved. These revenues, however, disregard the negative consequences of deforestation, such as the introduction of the 'diseases of deforestation.'

## Re-emerging and emerging diseases

Re-emerging infectious diseases are infections that were known to exist, but had fallen to such low levels that they were no longer considered a local public health problem. They can reappear, however, in epidemic proportions. Classic examples are malaria and yellow fever. During the construction of the Panama Canal in the 1880s, continuous outbreaks of yellow fever and malaria killed somewhere between 10,000 – 20,000 workers. The ultimate cause of these outbreaks was more complex, however, involving disruptions to both environment and society, mediated by a range of political and economic drivers.

Re-emergence and emergence of infectious diseases are the result of interaction between a growing world population of humans, intensified international travel, human behaviour and increased exposure of human beings to vectors of disease, e.g. during deforestation activities.

### Malaria

Destruction of the tropical rainforests led to a huge increase of the malaria mosquito *Anopheles darlingi* in several Amazonian states. Deforestation coincided with an influx of transmigrants, some of whom were infected with the most dangerous malaria parasite, *Plasmodium falciparum*, which causes cerebral malaria. These events caused a 76% increase of malaria in Brazil over a 15-year period. For the local Yanomami Indians, the resulting epidemic of malignant (tropical) malaria has had a disastrous effect, wiping out entire communities. Malaria transmission may have also increased in deforested areas of Africa because the most efficient local mosquito, a member of the Anopheles family, prefers to breed in fresh water and open sunlit pools caused by bulldozer tracks. In contrast, deforestation in Thailand has reduced the breeding sites of the major local vector, *Anopheles dirus*, which prefers dense forest and shaded pools. However, another mosquito (*Anopheles balabacensis*) grew in importance there to take over transmission in disrupted forest areas (Van der Kaay, 1998).

### Leishmaniasis

Leishmaniasis is a disease that results in significant human mortality and morbidity caused by a unicellular parasite and occurs as two different disease entities, visceral and muco-cutaneous Leishmaniasis. The former is deadly, with high prevalence in non-forest areas, such as Sudan, whereas the latter is non-lethal and mainly occurs in forests of Latin America.

In Central and South America this so-called sylvatic Leishmaniasis can result in infections of the skin and mucosae of settlers and all of those who employ or explore the forest. Natural hosts include animals like anteaters and rodents. When a forest-niche is entered or disturbed by man, the vector, a sand fly of the genus *Lutzomia*, can turn to the intruder. Well-known is chiclero's ulcer among men who collect 'chicle' (chewing gum) from Sapodilla trees; they spend up to six months in the forest for this. In Surinam this infection is known as 'bos yaws', which is nowadays seen in people involved in deforestation activities.

## Yellow fever

The yellow fever virus is generated and transmitted by *Aedes* mosquitoes, which feed on Colobus monkeys, all the way up in the canopy. Humans run a small risk of becoming infected and contracting sylvatic or jungle yellow fever, which therefore only yields incidental casualties. However, when natural niches are disturbed by deforestation, chances for human infection increase.

In Africa, outside the rainforest, other monkeys such as *Cercopithecus*, after being infected within the forest, initiate another terrestrial cycle. While raiding farms for food, they infect a second mosquito (*Aedes symponi*), which, in turn, transmits the infection to humans. Humans bring the virus home and infect an urban variety of *Aedes aegypti*. The latter is responsible for human-human transmission and can start an urban epidemic with high mortality rates.

Monkeys rarely die from yellow fever as they usually produce effective immunity. With their transient viraemia (i.e., the presence of viruses in their blood) they cannot be the fundamental reservoir of yellow fever, but they play a role as an amplifier of the virus. The true reservoir is the susceptible *Aedes* species that remains infected throughout life and transmits the virus to its offspring.

Yellow fever does not occur in Asia.

## Leptospirosis (Well's disease)

Recently, travellers on a jungle trip became infected by crossing surface water contaminated with leptospire. This can also happen during jungle rafting or crossing flooded areas. Floods, as may result from deforestation, force the wild rodent population (vectors of this disease) - including infected individuals - to leave their natural habitat for survival and thus infect floodwater. In such disaster areas, the local population can become infected when they are forced to cross inundated areas.

## HIV

Emerging infections - newly identified and previously unknown infectious diseases - are rapidly increasing in number, incidence and geographical range, and do cause major or minor public health problems. These include HIV and Ebola. Both emerging and re-emerging diseases are not specific for or limited to the tropical rainforest but HIV-1, the most important one today, most probably is.

The current worldwide AIDS epidemic is less than thirty years old, but its history is much older. AIDS is the unfortunate by-product of a virus's survival need. We must remember that the underlying evolutionary requirement for survival of any virus is efficient spread. The three known AIDS viruses are all retroviruses of the lentivirus family, all descended from harmless SIVs (the primate equivalent to HIV). Two of them, HIV-0 and HIV-2, remain fairly confined to their original African ecological niches, most likely because they had little opportunity to move. In contrast, the virus that became HIV-1 jumped from its original host and found foothold in humans. As HIV, it adapted rapidly and lethally to humans (Goudsmit, 1997).

Looking back, we can see that instability of the environment was a major factor in the rise of today's AIDS epidemic. Changes caused largely by humans occurred in the primate populations that originally sustained the SIV ancestor of HIV-1. Apparently, the virus circulated almost exclusively among non-human primates. However, as humans decimated these hosts through destruction of their habitats, they offered the virus an abundant alternative: themselves. The virus made use of the opportunity and now depends on us for survival. Human interference continues and grows with the human population. Our intrusion on more and more primate habitats, especially the rainforest communities, has convinced some scientists that primates could vanish from the wild by the end of the twenty-first century. What will happen to their retroviruses? They will not simply vanish too. Most of the retroviruses will accept the opportunity to jump to new hosts, most probably the human population. To survive and spread, they will adapt and cause disease.

## Ebola

Ebola Zaire was the first recorded occurrence of the Ebola virus in humans. So far, Ebola Zaire is the most lethal of the Ebola strains with a fatality rate between 80 - 90 %. It was isolated after the Zaire outbreak in 1976. In Sudan, an outbreak occurred roughly the same time that the Ebola Zaire outbreak took place. The Sudan variation has a fatality rate of between 50 – 60 %. Another strain, Ebola Reston, was identified and named after a batch of monkeys shipped to an experimental lab in Reston, Virginia in the United States. This batch of monkeys arrived from the Philippines indicated that there was an Asian strain of the virus. The Ebola Tai virus, identified in 1995, killed several chimpanzees; but the only known human infection was the non-fatal infection of a Swiss researcher in the Ivory Coast.

## Other emerging diseases

The Marburg filovirus is not considered to be an Ebola strain but, however, very closely resembles the Ebola virus and also causes severe haemorrhagic fever. This virus was discovered in Marburg, Germany, in 1967, when a worker at the Behring works vaccine factory, who fed monkeys housed for research and washed their cages, broke out with the virus. In an advanced, developed country like Germany where the medical care system is excellent, the fatality rate was 25%, compared to 5% for a highly lethal virus like yellow fever.

Other well-known haemorrhagic fevers are the Lassa fever, first noticed in the 1960s after an outbreak in Nigeria, and spread by rodents - the natural host - and the Rift Valley fever, mainly found in sub-Saharan Africa, and spread by mosquitoes.

Congo-Crimean haemorrhagic fever, found in many parts of Africa, the Middle East and even warmer parts of the former Soviet Union, is spread by ticks.

## Monkeypox

Among the best-documented examples of deforestation are outbreaks of monkeypox in Zaire and hantaviruses in the Americas. The clearance and replacement of rainforests, with less complex habitats have encouraged a massive proliferation of small animals (e.g., rodents and squirrels)



that act as vectors for monkeypox and hantaviruses (Glass et al., 2000; Khodakevich et al., 1988). Ecosystem interventions that were suggested were supposed to limit the destruction of forest and prevent the infringement of human communities on the habitats of virus-carrying mammals.

Outbreaks of a pox-like disease among captive monkeys have been described since the 1960s. This was followed by reports from Central and West Africa on human infections by the monkeypox virus, including several deaths. Supposedly, the monkeypox virus resides in the canopy, possibly with squirrels as natural hosts. In the late 1970s and early 1980s case reports on human monkeypox increased steadily, with most cases occurring in the rainforest regions of the Republic of the Congo (formerly Zaire). The patients, often children, can have high fever and generalized skin eruptions suggestive of smallpox. From laboratory investigations in 1988, it has been concluded that rainforest-pox virus was not close enough structurally to the smallpox virus to pose a threat to human populations. Moreover, it spreads so inefficiently from human to human that epidemics were considered highly improbable. Yet, an outbreak in 1996 in the Republic of the Congo registered 71 patients, including six deaths, in 13 villages. The route of transmission to human is not yet established; human-human infection with secondary cases among humans may occur.

## Discussion

In recent years, there have been a number of public health problems that have arisen in North America and Europe associated with tropical diseases that originate in rainforests. Among these are: AIDS, Ebola, West Nile Virus and monkeypox. Of these, AIDS is the only disease that has so far proven to be a serious, endemic (wide spread and permanent), and pandemic threat. The others are serious and potentially fatal illnesses, but they have not so far occurred in anything but isolated cases. However, the West Nile Virus, appeared in the New York area in the fall of 1999, and spread rapidly. Dozens of cases were treated, and a number of people died. The virus was controlled, but it was an illustration of how quickly a disease can appear, spread and become, if not an epidemic, then a serious threat to public health.

People have always caught diseases from wildlife, but logging and increased mobility have added a new dimension. In the case of SARS, business travellers carried the disease from one continent to another. Sometimes it is the animals themselves who do the travelling. In the case of the recent U.S. monkeypox outbreak, exotic pets made the trip. In 2003, a shipment of 800 small mammals arrived in Texas from the West African nation of Ghana. They included nine different species, including rope squirrels, tree squirrels, Gambian giant rats, brushtail porcupines, dormice, and striped mice. On investigation, it was found that monkeypox had already spread widely through these animals.

In the undisturbed tropical forest, predators and their prey, parasites and their hosts and competitors live in a delicate equilibrium. Degradation of the forest not only brings people in closer contact with pathogens of the canopy, but also becomes a human threat when insects and other prime hosts of microbes proliferate to become pest when their predators disappear.

## Conclusion

Tropical forest degradation can be the cause of re-emerging infections, but probably much more important for the future is the emergence of unknown infections. Viruses in damaged ecosystems come under extreme pressure to survive. As people enter the forest and clear it, viruses (carried by rodents, insects and ticks) are compelled to leave their niches and infect humans. This is why epidemiologists recently made rainforest conservation an extremely important issue for their science (Van der Kaay, 1998).

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## Threats to medicinal species



Photo credit: Chris Shepherd

Tiger (*Panthera tigris*) bone

# Threats to Medicinal Plant Species - an African Perspective

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## Introduction

Traditional medicine is an important healthcare system in Africa, with 20-30% of the population depending almost entirely on traditional medicine and almost a similar proportion using both allopathic and traditional medicine to varying degrees. Of the 40,000 or so flowering plants found in the continent, an estimated 15-25% are used in traditional medicine.

This reliance on traditional medicine can be attributed to a number of factors, most importantly, relatively good accessibility, local availability, affordability and existence of local knowledge and expertise among local communities. In contrast, allopathic, modern healthcare - with its high costs - is still beyond the reach of most rural populations. In addition, there is a low proportion of allopathic doctors per unit population and clinics are also few and far between, which should be viewed against the extremely poor transportation system in Africa. In the Machakos district of Kenya, the ratio of doctor to patient is 1:7142, while the ratio of Traditional Health Practitioner (THP) to patient was 1:378 (Marshall, 1998). In Uganda, the ratio of THPs to population was estimated as 1:200 and 1:400, while the ratio of allopathic doctors to the population was 1:20,000 (WHO, 2002). Western medicine has had an effect mainly on people living in areas where infrastructure is good, especially urban areas. But even in such areas, affordability is a major issue and therefore, medicinal plants are important to low-income groups.

The heavy burden already placed on the population and on government resources by diseases such as malaria has now been worsened by the HIV/AIDS pandemic. This weakens further the affordability of allopathic healthcare. The net effect is an overall decline in the standard of living and an increased dependence on local medicinal plants for healthcare.

Poverty in sub-Saharan Africa remains a serious issue, as this is the only region where the annual growth of GDP per capita has been declining between 1975 and 1999. (Maxwell et al, 2001). This is compounded by diminishing revenues and reduction in international aid. Therefore, the traditional medical healthcare system is a necessity. The industry now supports a huge number of people and is the only source of livelihood for traditional healers, harvesters, vendors and exporters.

Besides providing healthcare, medicinal plants are important sources of nutrition. They are used in soups, tonics, as appetizers, energy boosters, in teas, flavourings, in aromatherapy and as chewing sticks (Maundu, 1999; Okafor, 1989)

## Threats to medicinal plants in Africa

In spite of their important role in healthcare and a source of livelihood, medicinal plants in Africa are faced with ever-increasing threats. These resources are diminishing at an alarming rate, mainly as a result unsustainable use and destruction of habitats. This, in turn, is endangering the entire traditional healthcare system and hence, the lives and livelihoods of a large African population. Africa trades in a wide range of medicinal plants (Appendix I). The vast majority of these plants are harvested directly from the wild through unsustainable and uncontrolled harvesting. In a report by TRAFFIC, Marshall identified 102 medicinal plant species of priority for conservation and management action (Marshall, 1998). Unsustainable use has exerted excess pressure on several commercialized species, threatening their genetic and species diversity and affecting the ecological stability of the habitats in which they are found.

Unsustainability in the use of medicinal plants can be attributed to the following

1. *A High population growth rate:* This creates increased demand for herbal medicine that also results in several other issues (see below). High population growth often leads to urbanization. Urban centres tend to provide ready markets for the resources including medicinal plants.
2. *Competing land uses of natural vegetation to other forms of land use such as agriculture:* Crop production is progressively replacing natural vegetation where most medicinal plants are found. Other competing land uses include forestry, urbanization and related infrastructure. As an example, *Monanthonotaxis capea* (Annonaceae), which was harvested formerly for its aromatic leaves and traded from Cote d'Ivoire to Ghana, is now extinct in the wild after its last remaining habitat in a forest reserve was declassified and cleared for agriculture.
3. *Environmental degradation:* This includes habitat destruction, with attendant loss of species and reduction in intraspecific diversity. *Pericopsis elata* in Cote d'Ivoire and *Pericopsis angolensis* in Zambia and Malawi have both been affected by logging for timber. Habitat destruction as a result of logging and expansion of farms, as well as unsustainable harvesting of non-timber forest products such as rattans and medicinal plants were identified as key

threats to over 60% of Nigeria's endangered plant and animal species which are found within the forests of south west part of the country. Habitat destruction appears to be the most important of all the factors above and any measure to conserve and sustainably use medicinal plants should address this. This is linked closely to high population growth and pressure on resources. This effect is, therefore, more pronounced in highly populated areas and areas near urban centres.

4. *Loss of local knowledge:* Local knowledge on the use of the species is declining and has been already lost in some communities. This loss is typical of communities living near urban centres. With local knowledge gone, communities have little reason to conserve species.
5. *Increasing commercialisation of traditional medicine:* Traditional healers are no longer the only harvesters of plants. Traders supply both local (mainly urban) and international markets. Commercial gatherers of medicinal plant material, whether for national or international trade, are poor and their main aim is not resource management but earning money.
6. *Increasing demand in the local and world market:* This leads to more extraction of medicine from wild stocks. Though there is limited information and data on local, regional and international markets of many plants, the demand of the international market is steadily growing, placing the more important medicinal plants at higher risk. *Griffonia simplicifolia* in West Africa has been affected by commercial harvesting for export for the production of drugs in Europe.

It is clear, although data are lacking, that the demand in the international market keeps increasing. Increasing scarcity of popular species is followed by increased prices, which in turn, results in greater incentives to harvest remaining stocks. The quantities of material collected from the wild are, therefore, forcibly high and because of this, harvesting can be very destructive.

7. *Lack of appropriate policies and legislation/ or failure to enforce them:* Many governments lack specific policies for the conservation of medicinal plants and therefore, enforcing sustainable harvesting or monitoring the status of the resource becomes difficult. In 1995, *Prunus africana* was placed on Appendix II of CITES in 1995 but East African governments still do not have laws and mechanisms



Photo credit: Patrick Maundu

Young tree of *Prunus africana*



*Aloe secundiflora*

Photo credit: Patrick Maundu

to prosecute illegal exporters. Likewise, aloes have been placed under CITES protection but there is no mechanism in the East African countries to incorporate these decisions into their legal frameworks. Kenya has, in addition, a presidential ban, which is also not incorporated within the laws of the country. This lack of legislature, coupled with the lack of a coordinating institution gives exporters a leeway to export threatened species.

8. *Poverty and high unemployment rate:* Per capita incomes for most African countries have been falling. Unemployment has led to non-professionals (quacks) turning to herbal medicine harvest, sale and even treatment. Many people in Africa therefore derive income from collection of/and trading in medicinal plants. Labour for harvesting and supply is extremely low, hence, profits - especially for exported material - is high. This, in turn, is creating more demand and destruction. A survey conducted in South Africa indicated that as many as 4,000 tones of plant materials from the wild, harvested from 700 medicinal plants species, were traded in a year in Kwazulu Natal Province in South Africa, which led to the extinction of Wild ginger (*Siphonochilus aethiopicus*) and Pepper-bark tree (*Warburgia salutaris*) outside protected areas (Mander, 1997). Between 20,000 and 30,000, people derived income by trading in medicinal plants. In Kenya and Uganda, unemployed youths harvest the roots of *Mondia whitei* from forests to sell them in urban centres. The plant is now rare as a result.
9. *Low prices of medicinal plants:* Prices for medicinal plants exported for the pharmaceutical industry are low and do not provide an incentive or sufficient returns to grow the plants. One may also argue that high prices would deplete the resource even faster. A system incorporating *in situ* and *ex situ* conservation is therefore necessary.
10. *Invasive species: Alien invasive species are posing a threat to the indigenous biodiversity of East and Southern African countries.* The invasive, poisonous and obnoxious weed, *Lantana camara* and *Tithonia diversifolia* have replaced most of the natural vegetation in Nyanza Province of Kenya and large parts of Southern African Development Community (SADC) states. *L. camara* has threatened the ecology of the Victoria Falls, a UNESCO Heritage site shared by Zambia and Zimbabwe.

11. *Unsustainable methods of harvesting:* Ring-barking and other

down whole plants are destructive and unsustainable, but are common methods with commercial harvesters who harvest without consideration for sustainability, *Warburgia ugandensis* often falls victim to complete ring barking in Kenya.

12. *Undue pressure on specific preferred species:* Although a great number of medicinal plants are known to be used by the local people, a few well-known and preferred species are used preferentially. They are used in most treatments, usually in a mixture of other species. Examples include *Warburgia salutaris* in Southern Africa, *Trichilia emetica* in Western Kenya and *Rhamnus prinoides* among the Maasai people.

13. *Slow plant growth:* The majority of tropical African medicinal tree species are slow-growing hard woods, which take extremely long to mature or recover once growth is interrupted. Trees and particularly, slow-growing species are most vulnerable. *Prunus africana* and *Pausinystalia yohimbe* are harvested for drug manufacture and are slow-growing. Farmers are reluctant to grow slow-growing trees for medicinal purposes due to the time taken to obtain returns from their investment. This is exacerbated where land tenure is not secure, as is the case in many African countries.



Photo credit: Patrick Maundu

Debarking: an unsustainable method of harvesting

## Some key effects of threats

### Local or global extinction

The effect of all the above threats is pushing species to become rare and finally, causing local extinction. For example, *Siphonochilus natalensis* (*S. aethiopicus*), an endemic species, has disappeared from its only known locality in Natal before 1911, because of trade between Lesotho and Natal (South Africa) (Medley-Wood & Evans, 1998). Although total extinction is uncommon, it remains a possibility for species with a limited distribution.

### Narrowing of the genetic pool

The greatest impact - on intraspecific genetic diversity - is unseen. This declines as species become eradicated in different habitats. This genetic diversity may be reflected in differentiation of chemotypes within the gene pool. A good example is *Catha edulis* (*Chat*) in Kenya. Although the species occurs in many highland parts of Kenya, only types around the Meru region (near Mt. Kenya) are preferred.

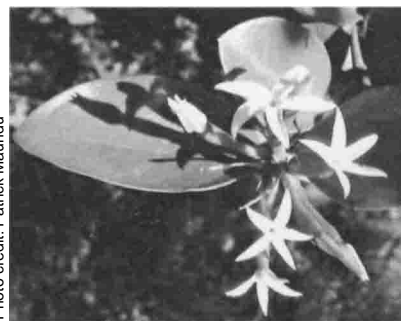


Photo credit: Patrick Maundu

*Carissa spinarum*. now locally extinct



### *Weakening regeneration potential*

Over-harvesting, particularly of seeds, can reduce the regeneration potential of a species. According to Juma (1989) 27.6 tonnes of plant material was collected by the National Cancer Institute USA (NCI) from a conservation area in the Shimba Hills (Kenya), for screening purposes as a potential treatment for pancreatic cancer. This adversely affected the regeneration potential of the species. When additional material was required four years after the first harvesting in 1972, regeneration was so poor that collectors struggled to obtain the additional material needed. In many of the cases, that involved collection of huge quantities of a single species or its seeds, environmental impact assessment studies are not carried out to determine sustainable harvesting levels. Exported plants with potential for weakening regeneration include: (a) *Griffonia simplicifolia* - 76-81 tonnes of seed exported each year (in the 80s) to Germany from Ghana (Abbiw, 1990). In Cote d'Ivoire, it is reported that vines of *Griffonia simplicifolia* and trees of *Voacanga africana* and *Voacanga thouarsii* are collected merely to collect fruits, (b) *Voacanga africana* seed 584 tonnes; *Prunus africana* bark (220 tonnes), *Pausinystalia yohimbe* bark (15 tonnes) exported for medicinal purposes to France. (United Republic of Cameroon, 1989). It is also reported that a Swiss pharmaceutical company requested eight tonnes of seeds of a rare species, *Voacanga grandiflora* and were willing to pay a high price. Such a supply would have left no seeds for regeneration in the following year, should the harvest have occurred.

### *Wiping out medicinal plants near urban areas*

The problem of exploitation has escalated in regions with large urban areas and high levels of urbanization, such as the Gulf of Guinea and Natal and Johannesburg areas in South Africa. Before 1898, local extermination of *Mondia whitei* had been recorded in the Durban area of South Africa due to collection of its roots. This occurred despite a traditional seasonal restriction on harvesting this species. By 1938, all that could be found of *Warburgia salutaris* in Natal and Zululand was 'poor coppices, every year cut right down to the bottom' (Gerstner, 1938).



*Mondia whitei*

Photo credit: Patrick Maundu

## Specific examples of over-exploited species

### 1. Aloes

Aloes (Aloaceae) are succulent plants, found commonly in arid areas. They are among the most important groups of medicinal (human and veterinary) plants in Africa. Traditionally, harvesting was sustainable as only a few leaves are sufficient for the occasional household use. They are currently among the most threatened groups of plants in Africa. Because the passion for *Aloe vera* used extensively in the cosmetics industry affected most parts of the continent only a few years ago, aloes have experienced an even greater threat from collectors. Whole plants are easy to collect due to their shallow roots, low height and soft texture. Many herbalists are now collecting these and planting them in their own herbal gardens. They are competing with local manufacturers of Aloe products and those collecting for export.

In South Africa, *Aloe ferox* (Cape/Bitter Aloe) is an important laxative. The larger part of the annual production is exported, but substantial quantities are marketed and used locally. Marshall (1998) indicated that *Aloe sinkatana* has been depleted in the wild in Sudan for its leaves which are valued in the treatment of skin diseases, constipation, fever and inflamed colon. Kenyan aloes, particularly *Aloe secundiflora* (the commonest aloe in Kenya), *A. turkanensis* and *A. scabrifolia* are being collected increasingly from the wild and marketed locally and even exported. This is in spite of a long-standing presidential ban whose enforcement has been difficult for authorities. All aloes, with the exception of *A. vera*, have been placed under CITES protection.

### 2. *Warburgia salutaris* and *W. ugandensis*

*Warburgia* is one of the most popular medicinal plants of Africa. Both the East African *Warburgia ugandensis* and the Southern Africa *W. salutaris* are valued as a source of medicine for fever and respiratory diseases. These species have been identified as a priority for management and propagation wherever they occur. *W. ugandensis* has been almost exterminated (due to ring barking and urban expansion) around Nairobi city in Kenya where it used to grow extensively, with the consequence that two peri-urban towns were named after it.

### 3. *Prunus africana*

Among the medicinal plants threatened by overexploitation in tropical Africa is *Prunus africana* whose bark is harvested and exported mainly to Europe to manufacture drugs for prostrate cancers - benign prostatic hyperplasia (BPH). Demand in the 90s led to whole forests being stripped of bark or trees felled.

Overexploitation particularly in Cameroon (the leading exporter), Equatorial Guinea, SW Nigeria, Kenya, Madagascar and Uganda has pushed the population of this species to uneconomical levels. The tree became subject to international trade controls under CITES in February 1995, being placed under Appendix II, where controlled trade with permit is allowed. However, recent studies show that exports of dried bark halved between 1997 and 2000 and some exporters (main exporter, Plantecam) had to close their extraction factories in Cameroon. The market has virtually collapsed due to dependence on wild sources that no longer exist.

In order to produce this species sustainably, the World Agroforestry Centre (ICRAF) has been working with farmers to grow *Prunus africana* to increase their incomes through sustainable harvesting of its bark. This involves growing and collectively exporting the bark to natural remedy producers. The bark of *Prunus* can be harvested sustainably by removing the lower part of two opposite quarters or panels of the trunk, then allowing eight years for regeneration before harvesting the other two quarters. ICRAF estimates that when harvested sustainably, each tree can provide 10-20 USD and up to 200 USD if a mature tree is stripped of bark.

The tree can be harvested at the age of 12-15 years but may take shorter if produced through marcotting.

### 4. Chewing stick harvesting

A number of chewing sticks are harvested from the wild throughout Africa. A popular species is *Garcinia afzelii*, now considered threatened by this trade (Assi, 1988). Okafor (1989) reported that the roots and stems of *Randia acuminata* chewing sticks were collected in forests within three km of villages, but that the distance was increasing due to depletion. Among the 27 species used in Ghana, high impact was seen in seven species whose stems and roots were used. In the rest, the impact was less due to use of twigs instead (Assi, 1988b). Impact on those source species, which are cut down or up-rooted to supply urban demand, is, therefore, high. A similar case is found with *Mondia whitei* in East Africa. The plant was common in Central and Western provinces of Kenya but it is now almost limited to Kakamega forest, a protected forest reserve. The plant has been uprooted in most of the other areas for its root, which is chewed for various reasons including good luck, good breath and as medicine.

## Mitigation

1. *Identifying species that need priority attention:* There is need to identify species that are endangered or likely to become endangered in each region and initiate programmes to mitigate the threats. The categories of medicinal plant species that are most vulnerable to over-exploitation can be identified by combining the insights of herbal medicine gatherers with knowledge on plant biology and distribution (Cunningham, 1990).
2. *Prioritising conservation areas:* Prioritising large areas for conservation should take into account two main factors: The importance of the biodiversity of each region and rapidity of urbanization or economic change. Problems of resource management of medicinal plants exist in densely populated and rapidly urbanizing regions and it is here that reaching a balance between human needs and medicinal plant resources is most urgent. Urban centres provide markets for traditional medicine but also accelerate change in land use in the neighbouring districts. Africa has some of the world's most important centres for biodiversity conservation due to a high degree of endemism. The Eastern Arc and Coastal Forests of East Africa constitute one of the 25 global hotspots (the highest in endemism in terms of unit area). The Albertine Rift Forests in Uganda-Congo-Burundi-Rwanda borders, the Cape region, *inter alia* are habitats surrounded by poor and ever-expanding populations that depend on medicinal plants from these areas, not only for medicine but also for income.



Photo credit: Patrick Maundu

Clearing *Nauclea latifolia* to make way for crops.

3. *Riding on existing strengths:* In Natal (South Africa) it appears that restrictions placed by traditional community leaders and enforced by headmen and traditional community police officers have reduced commercial exploitation of local traditional medicinal plant resources. There is need to strengthen cultural practices that ensure sustainable management. With cultural change, increased entry into the cash economy and rising unemployment however, these controls are breaking down. (Cunningham et al, 1993). In South Africa, where the taboo against gathering of traditional medicines by menstruating women was widespread in the past, urban herbalists now no longer place importance on this when buying plants from urban markets.

4. *Capitalising on current goodwill, momentum and interest to review policies and legislation:* The sustainable use of medicinal plants has, in the past, not received adequate attention by governments. This is partly because their potential in ensuring healthcare has not been recognised fully resulting in lack of appropriate national policies and legal frameworks and insufficient financial support for research and development. The declaration of the Decade (2001-2010) for African Traditional Medicine by the Summit of the organisation of African Unity (OAU, now African Union) recognised the important role TM continues to play in African societies and the need for African governments to acknowledge and build upon the traditional knowledge and plant resource base in order to make the goal of health for all easier to achieve by mobilising and more effectively using these resources (OAU,2001). As a result, many governments are now putting efforts to mainstream TM in health care. In East Africa, the Network on Medicinal Plants and Traditional Medicine was launched in 2003. Among its main objectives is to strengthen collaborative activities and to share information on medicinal plants (IDRC 2003). Other initiatives include the Conserve Africa Foundation (CAF). Among its programme goals is the identification and documentation of medicinal plants considered as threatened or of high priority to local communities.

5. *Re-examining current policies and legal frameworks.* With regard to policy and legal frameworks, there is need for a general assessment of existing policies and legislation relating to medicinal plants and natural resources with specific focuses on access, ownership, protection of community rights, conservation, in order that any flaws in current policies and legislation are addressed.

6. *Intensifying research and providing up-to-date data for decision-making.* Very few research activities have been carried out to address the conservation and sustainable use of medicinal plant genetic resources (their geographical distribution, ecological requirements, reproductive biology, seed storage and germination, sustainable management, etc.). Governments should ensure that there is continuous and up-to-date data on the status of the regular medicinal plants, especially those found in markets.



Photo credit: Patrick Maundu

Medicinal plants in Lome, Togo

7. *Supporting cultivation/domestication and sustainable harvesting:* Cultivation as an alternative to over-exploitation of scarce traditional medicinal plants has not been successful in Africa due to: (i) lack of support for production and dissemination of key species for cultivation by the state - mainly as a result of inadequate policies and legal frameworks; (ii) low prices paid for traditional medicinal plants by herbal medicine traders and urban herbalists. (This is in spite of high transport costs due to poor infrastructure, search time and the long-distance.) (iii) Many good medicinal plants are trees that take a long time to mature. It is, therefore, cheaper for harvesters to harvest from the wild. If cultivation is to be a success as an alternative supply to improve the self-sufficiency of TMPs and take harvesting pressure off wild stocks, then plants have to be produced cheaply and in large quantity in order to compete favourably with material obtained from the wild. Cultivation in urban areas, especially for herbaceous plants, needs to be encouraged.
8. *Enhancing cooperation and networking:* There is need for increased collaboration with and within traditional healers in order that ideas are exchanged. Better cooperation and coordination between local communities, local researchers, national governments, and international bodies are needed to design and implement sustainable *in-situ* and *ex-situ* conservation strategies (IDRC, 2003).
9. *Creating awareness:* There is need for awareness among harvesters and importers on threats posed by their actions and the need for sustainable harvesting.

## Conclusions

Medicinal plants are an important source of healthcare and livelihood for a large proportion of the human population in Africa. However, many medicinal plants are endangered as a result of unsustainable harvesting, and loss of habitats. Accompanying the loss of medicinal species is the loss of associated indigenous knowledge. Poverty, lack of the right policies and legislations and lack of the initiative to enforce existing policies and laws, are the main contributing factors for this endangerment.

With increasing population pressure, demands on the individual species and other resources in the environment is increasing. Cases of medicinal plants that have been or are being exploited to extinction in certain areas are becoming common.

Research on medicinal plants in Africa has been lagging behind and hence there, have not been sufficient data on many of the species on which sound decisions can be based. Correcting the flaws in existing policies and legislations has, therefore, been difficult. Likewise, monitoring and follow-up in cases of perceived overexploitation are rare. Some long-standing proposals for sustaining the industry include encouraging domestication, providing incentives for sustainable harvesting and monitoring and strict law enforcement. All these require a closer look, as well as a review of existing policies and legal instruments.

In the past, many African governments have ignored the important role traditional medicine plays in primary healthcare and livelihoods. Governments have underrated the threats facing specific species as well as on the industry as a whole. However, there is a re-awakening that has resulted from a number of factors and initiatives. Firstly, the popularity of complementary/alternative medicine has increased in many western countries and this increased opportunities for improving rural livelihoods in Africa. Secondly, the high cost of western medicine coupled with an ever diminishing purchasing power of many people and governments in Africa has placed modern medicine out of reach for most people, especially those living in rural areas. Thirdly, recognising these trends, a number of initiatives have been started by international organisations and donor agencies including WHO, IDRC, AU, IUCN which involve the governments in initiatives aimed at the sustainable use of medicinal plants. The momentum is building up, not only for medicinal plants but also for neglected food resources such as leafy vegetables. The time is ripe to rectify past mistakes.

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## Appendix I Key Commercialised Species

Species and region	Family	Comments and main source country
West Africa		
<i>Afromosia elata</i>	Apocynaceae.	Also heavily logged for timber. Côte d'Ivoire
<i>Cola acuminata</i>	Sterculiaceae	
<i>Cola nitida</i>	Sterculiaceae	
<i>Curcuma</i> (tema badur)	Zingiberaceae	
<i>Diospyros tricolor</i>	Ebenaceae	A source of naphthoquinones; Côte d'Ivoire
<i>Epinetrum (Albertisia) undulatum</i>	Menispermaceae	Cote d'Ivoire
<i>Garcinia afzelii</i>	Clusiaceae	Chewing sticks in Ghana, Côte d'Ivoire and Nigeria. Vulnerable
<i>Garclnia epunctata</i>	Clusiaceae	Côte d'Ivoire, Ghana and Nigeria
<i>Garcinia kola</i>	Clusiaceae	Chewing sticks (Ake Assi, 1988). Côte d'Ivoire, Ghana, and Nigeria
<i>Garcinia mannii</i>	Clusiaceae	Overexploited chewing stick plant with antibacterial properties. Nigeria, Cameroon
<i>Gnetum africanum</i>	Gnetaceae	Also a leafy vegetable. Cameroon. Nigeria
<i>Griffonia simplicifolia</i>	Fabaceae	
<i>Haplormosia monophylla</i>	Fabaceae	Côte d'Ivoire
<i>Loesenera kalantha</i>	Fabaceae	The genus Loesenera endemic to Guineo-Congolian region) Côte d'Ivoire
<i>Monanthes capea</i>	Annonaceae	Aromatic leaves. Extinct in the wild Côte d'Ivoire
<i>Okoubaka aubrevillei</i>	Santalaceae (Oknemataceae)	Used symbolically to ward off evil spirits. Endemic genus to Guineo-Congolian region. Vulnerable. Côte d'Ivoire. Côte d'Ivoire, Ghana and Nigeria
<i>Pausinystalia johimbe</i>	Rubiaceae	Bark harvesting in Cameroon
<i>Prunus africana</i>	Rosaceae	Cameroon, SE Nigeria, E. Guinea
<i>Rhigiocarya peltata</i>	Menispermaceae	Côte d'Ivoire
<i>Strophanthus barteri</i>	Apocynaceae	Côte d'Ivoire
<i>Strophanthus thollonii</i>	Apocynaceae	Côte d'Ivoire
<i>Voacanga africana</i>	Apocynaceae	
<i>Voacanga grandifolia</i>	Apocynaceae	Seeds are used
<i>Voacanga thuorsii</i>	Apocynaceae	
Eastern Africa		
<i>Aloe secundiflora</i>	Aloaceae	
<i>Aloe</i> spp.	Aloaceae	Kenya, Uganda, Tanzania
<i>Carissa edulis</i>	Apocynaceae	
<i>Catha edulis</i>	Celastraceae	Kenya, Ethiopia
<i>Maytenus senegalensis</i>	Celastraceae	



## Appendix I continued

Species and region	Family	Comments and main source country
East Africa		
<i>Mondia whitei</i> roots	Asclepiadaceae	Kenya, Uganda
<i>Myrsine africana</i>	Myrsinaceae	
<i>Ocimum kilimandcharicum</i>	Lamiaceae	
<i>Ocimum</i> spp.		
<i>Prunus africana</i>	Rosaceae	Kenya, Uganda
<i>Rhamnus prinoides</i>	Rhamnaceae	
<i>Rhamnus staddo</i>	Rhamnaceae	
<i>Rhoicissus tridentata</i>	Vitaceae	
<i>Rothea myricoides</i>	Verbenaceae	
<i>Pappea capensis</i>	Sapindaceae	
<i>Senna didymobotrya</i>	Fabaceae	
<i>Strychnos henningsii</i>	Loganiaceae	
<i>Trichilia emetica</i>	Meliaceae	Western Kenya Kenya, Tanzania
<i>Warburgia ugandensi</i>	Canellaceae	
<i>Ximenia americana</i>	Olacaceae	
<i>Zanthoxylum chalybeum</i>	Rutaceae	
<i>Zanthoxylum usambarense</i>	Rutaceae	
Southern Africa and Madagascar		
<i>Alepidea amatymbica</i>	Apiaceae	Used for coughs and colds. Swaziland, Zimbabwe, South Africa. Very limited distribution in Zimbabwe (a few localities in the eastern Highlands). Population declining.
<i>Aloe ferox</i>	Aloaceae	
<i>Asclepias cucullata</i> (Rooibos)	Asclepiadaceae	South Africa
<i>Aspalathus linearis</i>	Fabaceae	Used as tea. Now of world importance. South Africa
<i>Baillonera toxisperma</i>	Sapotaceae	
<i>Begonia homonymma</i>	Begoniceae	South Africa
<i>Bersama tysoniana</i>	Meliantaceae	South Africa
<i>Boweia volubilis</i>	Liliaceae	South Africa
<i>Cassia abbreviata</i>	Fabaceae	South Africa
<i>Catharan thus roseus</i>	Apocynaceae	Madagascar
<i>Centella asiatica</i>	Apiaceae	
<i>Dianthus zeyheri</i>	Illecebraceae	South Africa
<i>Dioscorea sylvatica</i>	Dioscoreaceae	South Africa, Malawi
<i>Drosera madagascariensis</i>	Droseraceae	

## Appendix I continued

Species and region	Family	Comments and main source country
Southern Africa and Madagascar		
<i>Erythrophleum lasianthum</i>	Fabaceae.	South Africa
<i>Erythrophleum suaveolens</i>	Fabaceae	Malawi
<i>Faurea macnaughtonii</i>	Proteaceae	South Africa
<i>Harpagophytum procumbens</i> (Devil's claw)	Pedaliacea	South Africa
<i>Haworthia limifolia</i>	Aloaceae	South Africa, Swaziland
<i>Hypoxis hemerocallidea</i> (African potato)	Hypoxidaceae	South Africa
<i>Mondia whitei</i>	Asclepiadaceae	Roots are used.South Africa
<i>Pausinystalia johimbe</i>	Rubiaceae	
<i>Phyllanthus engleri</i>	Euphorbiaceae	Zimbabwe
<i>Phytolacca dodecandra</i>	Phytolaccaceae	Has molluscicidal properties. Extraction of essential oils.Integrated bilharzia (schistosomiasis) control. Scaling up production of saponin from berries. Zambia
<i>Pimpinella caffra</i>	Apiaceae	South Africa
<i>Plectranthus grillatus</i>	Lamiaceae	South Africa
<i>Prunus africana</i>	Rosaceae	South Africa
<i>Pterocarpus angolensis</i>	Fabaceae	Roots used to treat diarrhoea and abdominal pains. Species has declined around Lusaka due to demand. Zambia
<i>Rauvolfia confertiflora</i>	Apocynaceae	
<i>Rauvolfia vomitoria</i>	Apocynaceae	
<i>Siphonochilus aethiopicus</i> ( <i>S.natalensis</i> )	Zingiberaceae	Used for coughs and colds. Has disappeared from known localities outside Malolotja Nature Reserve in Swaziland.Swaziland. South Africa
<i>Warburgia salutaris</i>	Canellaceae	Bark is used a wide range of ailments. Now most expensive traditional medicine in Zimbabwe. Endangered. South Africa

## Appendix II Centres of endemism in Africa

The seven centres of endemism in Africa, with numbers of seed plants, and the percentage of these endemic to each unit (adapted from MacKinnon and MacKinnon) (Cunningham 2000)

Biogeographic unit	Area (1,000 km <sup>2</sup> )	Plants No. of species	% endemic
Guineo-Congolian	2,815	8,000	80
Zambesian	3,939	8,500	54
Sudanian	3,565	2,750	33
Somali-Masai	1,990	2,500	50
Cape	90	8,500	80
Karoo-Namib	629	3,500	50
Afro-montane	647	3,000	75



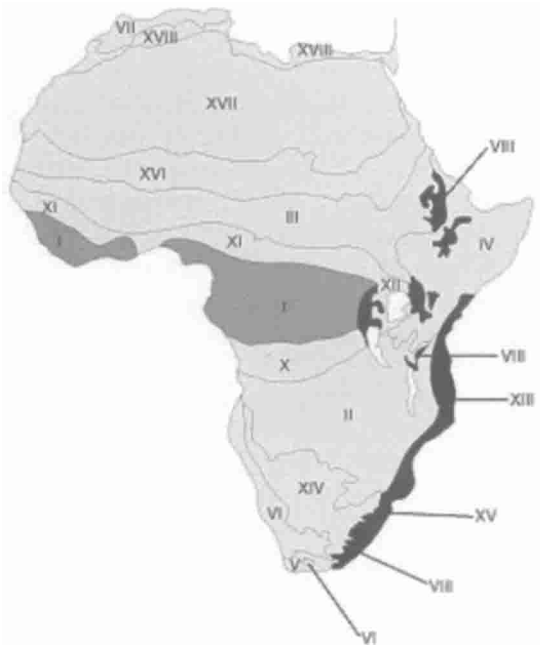
Photo credit: Patrick Maundu

Destructive harvesting

Distribution of major urban centres  
in sub-Saharan Africa (after Udo, 1982).



Main African phytochoria (after White, 1983).  
High conservation priority areas are in dark grey. (Cunningham 1990)



- I. Guineo-Congolian regional centre of endemism.
- II. Zambezian regional centre of endemism.
- III. Sudanian regional centre of endemism.
- IV. Somalia-Masai regional centre of endemism.
- V. Cape regional centre of endemism.
- VI. Karoo-Namib regional centre of endemism.
- VII. Mediterranean regional centre of endemism.
- VIII. Afromontane archipelago-like centre of endemism (including IX. Afroalpine archipelago-like region of extreme floristic impoverishment, not shown separately).
- X. Guinea-Congolia/Zambezia regional transition zone.
- XI. Guinea-Congolia/Sudania regional transition zone.
- XII. Lake Victoria regional mosaic.
- XIII. Zanzibar-Inhambane regional mosaic.
- XIV. Kalahari-Highveld regional transition zone.
- XV. Tongaland-Pondoland regional mosaic.
- XVI. Sahel regional transition zone.
- XVII. Sahara regional transition zone.
- XVIII. Mediterranean/Sahara regional transition zone.

# The Use of Marine Organisms in Traditional and Allopathic Medicine

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## Introduction

Wild marine organisms are used in the discovery and development of traditional and allopathic medical treatments. This use has, arguably, grown larger with increasing economic prosperity, population growth, technological development, and through the agents of globalisation such as migration, trade and communication. Natural marine systems already face a combination of pressures including habitat loss, pollution, introduced species, climate change and over-harvesting. To meet conservation aims and maintain the health and economic benefits of those who rely on the exploitation of these species it is critical to ensure sustainable use.

## Traditional, Complementary and Alternative Medicine (TM/CAM)

Traditional medicine, or complementary and alternative medicine (TM/CAM) is important to the health care of millions of people worldwide. (WHO, 2002). TM/CAM comes in at least 125 recognised forms, including the codified systems of traditional Chinese medicine (TCM), *Ayurveda*, *Unani* and the unwritten 'folk' medicines of the Americas, sub-Saharan Africa and the Asia-Pacific region (WHO, 2002). The World Health Organization recognises TM/CAM as valid forms of health care, defined as the 'diverse health practices, approaches, knowledge and beliefs incorporating plant, animal and/or mineral-based medicines, spiritual therapies, manual techniques and exercises, applied singularly or in combination to maintain well-being, as well as to treat, diagnose, or prevent illness' (WHO, 2002: pp 27). Given their function as a cure and/or prevention, TM/CAM treatments can be found anywhere along the gradient of medicine to tonic and food. Auspicious or luxury foods can often have medicinal value, such as sea cucumbers (Holothuridae) and shark fin, but are consumed predominantly as food items (Clarke, 2002) and as such, will not be covered here.

There is considerable uncertainty about the identity and number of marine species used in TM/CAM, particularly given that many of those listed in pharmacopoeia are used infrequently, if at all. As an index, however, Perry (2000) has estimated that approximately 394 species (representing 11 phyla) were being collected globally for their medicinal value (see Figure 1). The majority of these were consumed in Asia (see Figure 2), representing the practices of TCM, *Hanyak*, *Kanpo*, *Ayurveda*, *Unani*, *Jamu* and other folk medicines. Perry saw this figure as an absolute global minimum and identified several areas absent from the analysis such as the Middle East and North Africa (Perry, 2000). A second study noted 628 marine species in a survey of Chinese *material*

*medica* (Zeng, 1995), although a survey of prescription and pre-packaged medicine in Hong Kong (a global entrepot for TCM materials) and Guangzhou identified a total of only 26 marine medicinal materials from about 48 species (Kwan, unpublished data). Other research has reported nine marine medicinals used in the region containing Israel, Palestine and parts of Jordan, Syria and Lebanon (Lev, 2003), and approximately 20 marine species in Brazil (Begossi, 1992; Begossi *et al.*, 1995; Costa-Neto, 1999), compared to a previous total of nine for all of South America (Perry, 2000). Even where data do exist, taxonomic resolution can be quite coarse (e.g. Class or Phyla) and may represent multiple morphologically similar species, resulting in underestimates and/or misidentification. For example 'seaweed' is a commonly listed marine medicinal, but up to 14 species of algae are used within *Ayurvedic* medicine in southern India (Lipton, 2000).

Relatively little is known about the status of many marine medicinal populations or indeed the size and biological significance of the TM/CAM component of mortality. One study (Perry, unpublished data) identified 27 marine medicinals on the IUCN Red List of Threatened Species (three Critically Endangered, five Endangered, 14 Vulnerable, six Lower Risk, four Data Deficient) and 23 species that were listed on either Appendix I or II of the Convention of International Trade in Endangered Species (CITES). The 'higher' vertebrates were well represented with six marine turtles, the dugong (*Dugong dugon*) and the sperm whale (*Physeter macrocephalus*). At present, all 13 seahorse species (genus *Hippocampus*) identified in TM/CAM trade (Lourie, *et al.*, 2004) are included on the IUCN Red List (six vulnerable and seven data deficient) and CITES Appendix II (IUCN, 2003; CITES, 2004). In 1977, the Totuava (*Totoaba macdonaldi*), a large fish belonging to the croaker family Sciaenidae, was banned from international trade under Appendix I of CITES (IUCN, 2003). The stock was depleted grossly by a combination of a trade for their swim bladders (for use in a tonic soup) and later fishing for meat, as well as disruption to critical breeding habitat (Cisneros-Mata, *et al.*, 1995; CITES, 2004; [www.bajadestinations.com](http://www.bajadestinations.com); Sadovy & Cheung, 2003). The demand for swim bladders has apparently caused the virtual disappearance of another large croaker, the Chinese bahaba (*Bahaba taipingensis*) and in 1988, it was listed as a Grade II State Protected Species in the Peoples Republic of China (PRC) (Sadovy & Cheung, 2003). These declines have occurred despite the high fecundity of both species, a trait considered by some to confer resilience to overexploitation and therefore useful 'as [part of] a screening procedure to identify species at particular risk' (Powles *et al.*, 2000: pp 673).

Assessing the status of many of the marine medicinal species can be problematic. A large number of medicinal species are sourced from small-scale fisheries where there are few catch or fisheries independent data. Distribution and consumption is often local and not monitored. Trade and/or fisheries production data may, however, exist (e.g. national Customs databases, or FAO Yearbook Fisheries Statistics) for the more 'significant' medicinal species (with respect to volume and value), although this is often for the tonic foods such as sea cucumbers and shark fin. It is, therefore, possible to identify the major source and consumer areas and the temporal trends in traded volume and value (see Figure 3). However, temporal patterns in trade data may not be driven by biological factors and can even obscure existing biological signals.

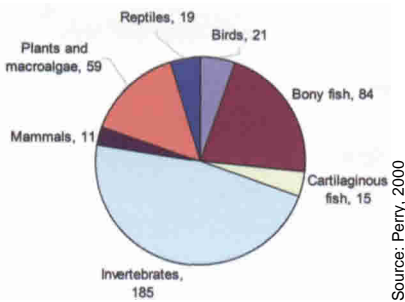
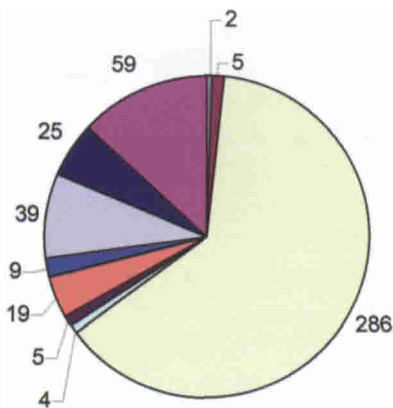


Figure 1 Marine Medicinals by broad taxonomy

Source: Perry, 2000

For example, the reduction of seahorse imports into Taiwan from 1992 to 1999 of nearly 50% (Figure 3) may be due in part to a reduction in demand following the regional economic collapse of that period. Conversely, the expansion into new fishing grounds can maintain overall supply to TM markets but mask the serial depletion of existing medicinal fisheries (Bruckner, et al., 2003). The most useful data for assessing status is at a biologically meaningful resolution and will often require independent survey work. Research carried out into numerous seahorse species identified qualitative and/or quantitative downward trends catch and trade per unit effort, which were instrumental in establishing these species in various categories on the IUCN Red List of Threatened Species (IUCN, 2003; Vincent, 1996) and CITES Appendix II (CITES, 2004). In 1996, 32 countries were reported to be involved in the trade of seahorses comprising 45 tonnes (Vincent, 1996). More recent surveys and trade analysis have indicated that at least 77 countries are now involved with global landings estimated conservatively at 54 tonnes (19 million individuals) (Vincent & Perry, unpublished data). The major exporters identified were Thailand, Philippines, India and Vietnam. Trade data have indicated that 22 tonnes of Pipefishes (e.g. *Solegnathus* spp.) are imported annually into China and Singapore. (Vincent & Perry, unpublished data)

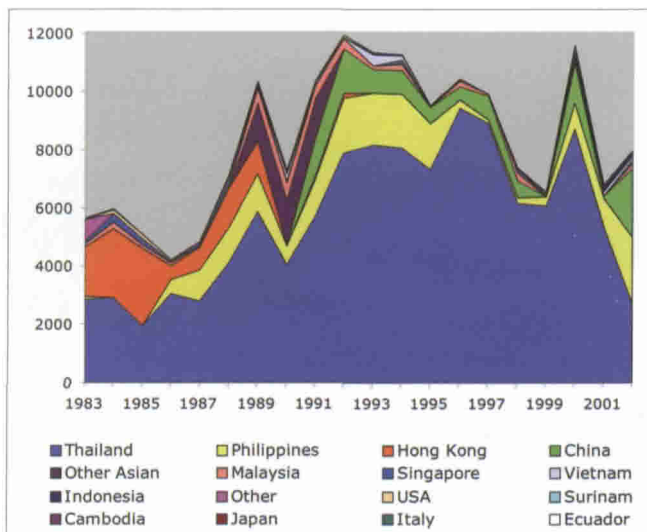


Source: Perry, 2000

Effective assessment of the status and resilience of exploited populations should be made at the point of extraction, in the framework of international agreements. Some countries do have the legislative framework and institutional capacity to assess the status of marine medicinals and if necessary, to regulate (or prohibit) extraction and implement recovery plans. For many small-scale fisheries, a lack of resources usually means that it is not possible to assess stocks in a conventional (and data-intensive) manner. Instead, sustainable extraction may best be achieved by utilising management strategies that are more suited to the data-poor and dispersed nature of these fisheries (Johannes, 1998; Parma et al., 2003). Dialogue and collaboration with user groups such as traditional medicine merchant associations, has sought to reduce pressure on threatened marine medicinal species through the use of alternatives and aquaculture where possible and appropriate. At an international level, CITES is facilitating an increased co-operation in regulating the trade of commercially important marine medicinal species (CITES, 2004). The convention allows for a ban on the trade of species threatened with extinction (Appendix I) and the monitored trade of Appendix II & III listed species, providing it is not detrimental to wild populations.

Figure 2 Marine medicinals by geographic zone  
 Note: Totals for Figure 2 are greater than 394 as some species are used in more than one region

Figure 3. Seahorse imports into Taiwan 1983 - 2002



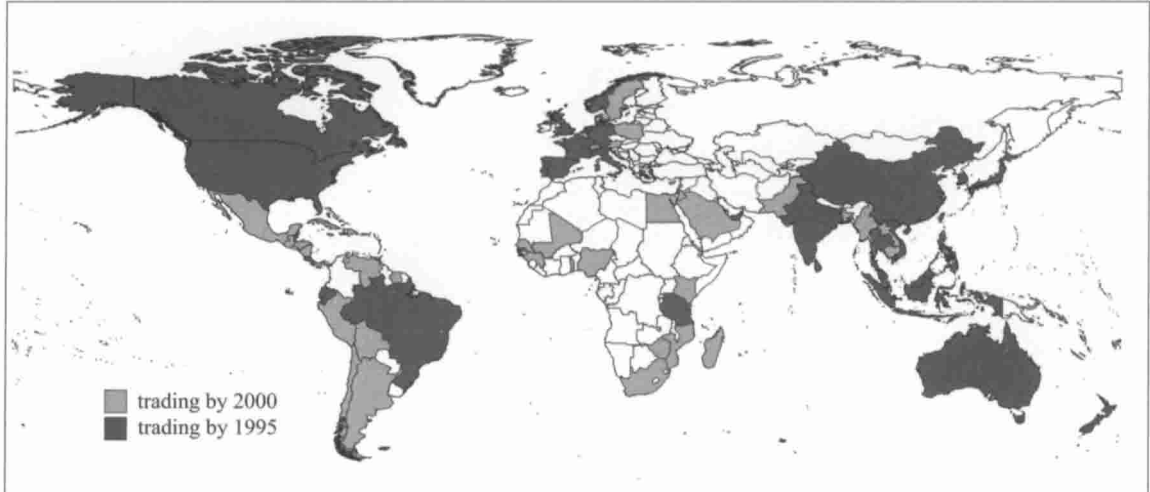
The practice of TM/CAM around the world is expanding, and arguably, so is use of marine medicinals. Populations in countries where TM/CAM is traditionally popular are increasing. Migration, trade and communication have aided the global spread of TM/CAM, from the influence of the Chinese diaspora throughout southern Asia (on practices such as *Hanyak*, *Kanpo* and *Jamu*) to the increased popularity of CAM in developed countries (WHO, 2002). Historical trade routes have expanded, providing access to new sources of supply (see Figure 4) and new technologies have allowed greater access to, and removal of, marine species. Economic growth in major TM/CAM countries has increased disposable income and therefore the demand for medicinal items (Vincent et al., 2005)

## Allopathic Medicine

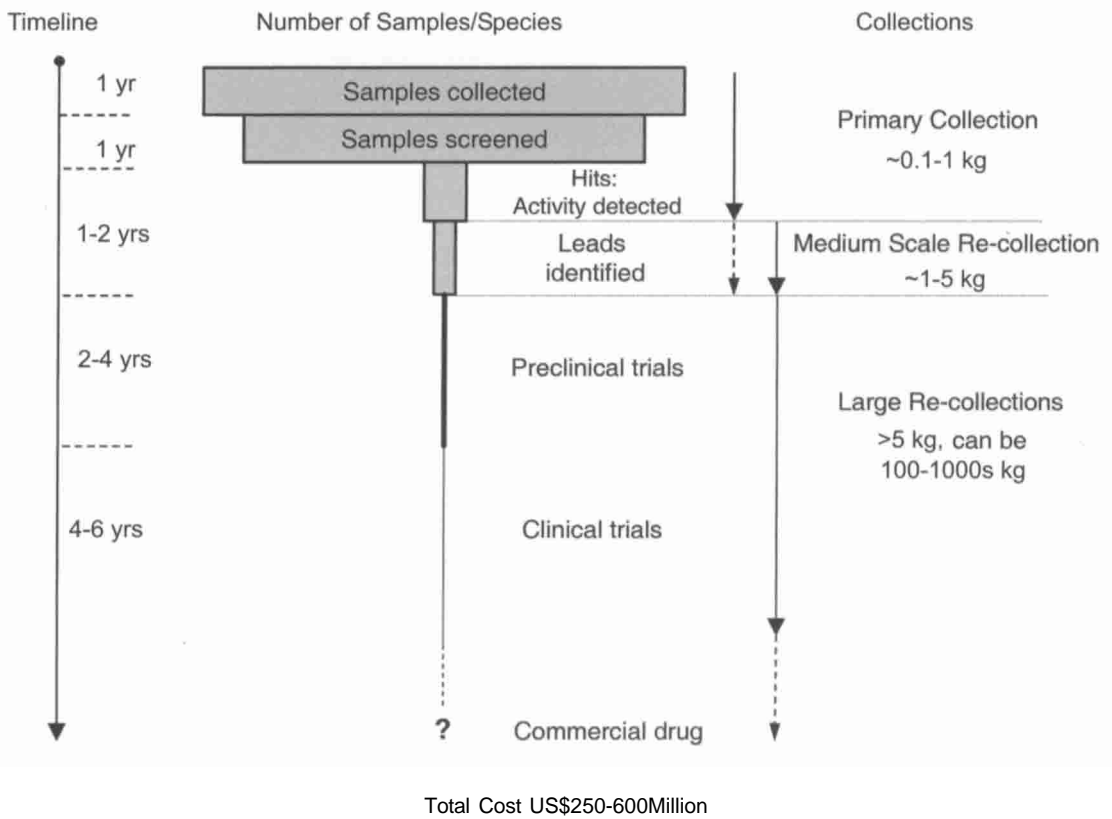
Marine organisms are collected for the discovery and development of pharmaceutical drugs used in allopathic medicine (also known as western medicine, evidence-based medicine, biomedicine). Extracts from collected organisms are tested for their effectiveness against particular disease targets in a series of automated screens (Cordell, 2000). If 'active', the compound responsible is isolated and its molecular structure determined. Secondary testing is done on efficacy before the decision is made to subject the compound to preclinical and possibly clinical trials. Very few compounds succeed in becoming commercial products, the process can take 10-15 years (or longer) and can cost hundreds of millions of dollars (Kuhlmann, 1997; Munro et al., 1999) (see Figure 5). Whilst tens (if not hundreds) of thousands of marine species have likely been sampled, only about 20 marine compounds are currently in clinical trials. Removals of marine organisms to supply this process can be broken into two types: primary collections and secondary or re-collections. Primary collections are typically broad and speculative in order to maximise the possibility of discovering bioactive compounds during screening (Cragg, 1998; Munro et al., 1999), whereas secondary re-collections are focused on supplying a particular 'bioactive' species of interest to later tests during drug development.



Figure 4. Countries participating in seahorse trade



(Source: Vincent et al., 2005)



Primary collection sample sizes are relatively small and do not appear to pose a considerable risk to marine populations. The size of primary collections samples has declined significantly over the last thirty years because of advances in technology, such as miniaturisation, better computing and automated screening. (Hooper et al., 1998, Quinn et al., 2002). In 1974, the Roche Research Institute of Marine Pharmacology (RRIMP) required 10kg (wet weight samples) to screen, isolate and determine structure (Hooper et al., 1998, Quinn et al., 2002), whereas today some researchers claim to only need 100g (Hooper et al., 1998) with screening possible on amounts as small as 20-40g or single specimens (Cronin, personal communication), although other collectors cite 0.5 to 1kg samples as being common (Faulkner, 2000). Soft-bodied, sessile invertebrates appear to be targeted disproportionately, as it is believed they have a greater probability of containing bioactive secondary metabolites that are used in ecological interactions such as competition for space, and protection from fouling and predation (Harper et al., 2001). (See Figure 6). However, this bias may also reflect the relative ease at which these taxa can be collected by hand on SCUBA from popular collection habitats such as coral reefs (Newman, personal communication). (See Figure 7 overleaf the for global distribution of collections as reported in the literature.) Primary collection programmes generally operate haphazardly, maximising the taxonomic diversity of the collection within a limited time frame (Munro et al., 1999). It would seem unlikely that a primary collector would encounter a viable population so small and then be able to remove a significant proportion of it with one sample.

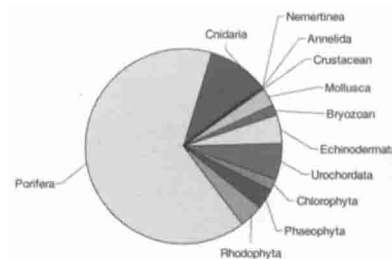


Figure 6. Taxa collected by marine bioprospectors (units are number of species)

Secondary collections can be larger than primary collections and may be more of a conservation concern for the taxa targeted (Benkendorff, 2002; Garson, 1997). The size of re-collections can vary for a number of reasons, such as the natural concentration of the compound to organism mass ( $\sim 10^{-4}$  to  $10^{-6}$  but can be as low as  $10^{-9}$ ), the type and scope of tests/trials, the dosage required, and the availability of alternatives.

If synthesis of these often complex molecules is not economically viable, then it is possible that bulk supply for further development may have to come from wild harvests (Munro et al., 1999; Pomponi, 1999). In 1988, 13 metric tonnes of the bryozoan *Bugula neritina* were collected in southern California by the pharmaceutical company Bristol-Myers Squibb and Program Resources Inc, yielding 18g of Bryostatin 1 for use in preclinical and clinical trials (Cragg, 1998). Arizona State University have made similar 'large' collections of *B. neritina* weighing 500kg, 1000kg and 1000kg, in 1980, 1981 (Pettit et al., 1987) and 1986 (Pettit et al., 1996) respectively. Others include 166kg (Pettit et al., 1988) and 450kg re-collections of the marine worm *Cephalodiscus gilchristi* and

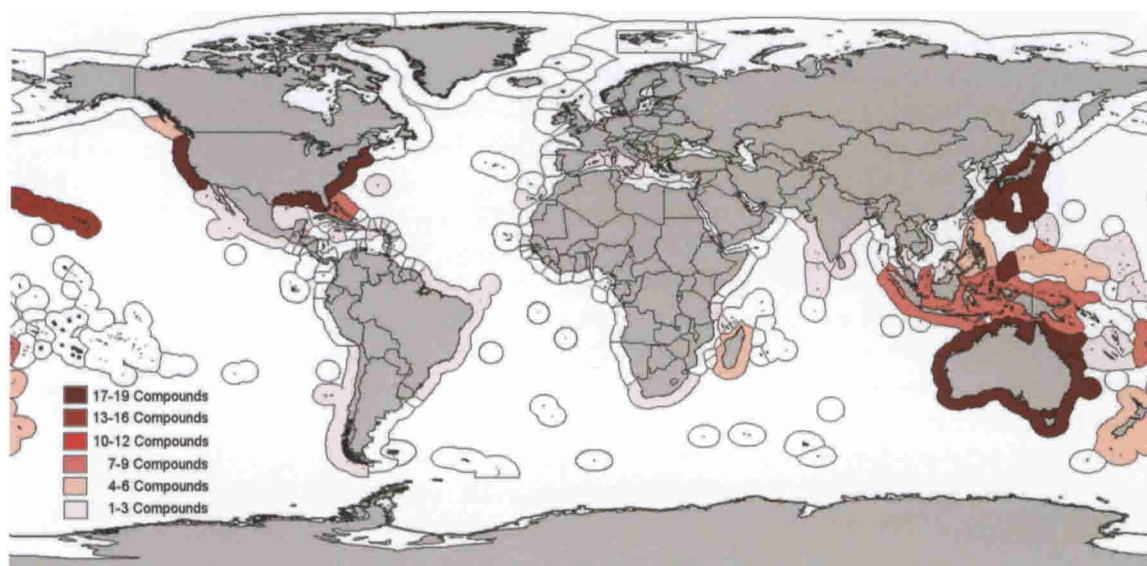


Figure 7. Global distribution of novel marine compounds

one tonne of the sea hare, *Dolabella auricularia* in 1982 (Garson, 1997). Sponges have also been targeted: 350 kg of *Cribrichalina* spp. (Pettit et al., 2000) and 400kg of *Spongia* spp. were collected from the Maldives in the late 1980's (Pettit et al., 1993) and 500kg of *Hyrtios erecta* (Pettit, et al., 1994) in 1994. A 480kg collection of the Palaun sponge *Axinella* spp. (Pettit et al., 1994) was made in 1985. Conservation concerns have been raised about the effects of these bioprospecting collections on marine organisms (Benkendorff, 2002; Chivian, et al., 2003; Garson, 1997). The most common is that large collection may significantly reduce local populations, decrease genetic diversity and cause genetic drift (Benkendorff, 2002). In terrestrial systems bioprospecting has directly caused the decline of plant species, such as the Brazilian *Pilocarpus* spp., used to produce pilocarpine (Pinheiro, 1997). Impacts are likely to be more pronounced if the organism is rare, has a restricted distribution (Chivian et al., 2003) or the collection is focused on a particular population. Collections may be geographically narrow due for logistical reasons or because of the possible variation in bioactivity across the distribution of a species (Mendola, 2003; Munro et al., 1999).

It is difficult to assess the extent and level of threat posed by bioprospecting. To an independent observer these too, are data-poor fisheries. The protection of intellectual property is considered key to the development of Pharmaceuticals and we found collection data often inaccessible because of commercial confidentiality. Extensive collecting has taken place; for example, the Spanish pharmaceutical company PharmaMar has a library containing approximately 39,000 samples of marine macroorganisms (Rouhi, 2003) and US National Cancer Institute (NCI) has processed 18,000 marine extracts between 1975 and 1982 (NCI, 2004) and collected 10,000 samples of marine invertebrates and algae since 1986 (NCI, 2004a). It has been claimed that the historically larger secondary collections are 'technologically less likely' in current times (Hooper et al., 1998). We were unable to verify (or falsify) this when examining for temporal trends in the problematic and sparse collection data reported in the natural products' literature. A recent workshop reported

that there was no evidence to suggest that bioprospecting was any more damaging to the marine environment than other scientific collections (Green, 2003). The lack of data makes it impossible to assert that bioprospecting is sustainable; however, it may be instructive to compare it to other forms of marine extraction, such as demersal trawling. A conservative estimate of bioprospecting collections in Australia over the last 30 years would be approximately 20,000 samples (Green, 2003, Hooper et al., 1998; Quinn et al., 2002) of macroorganisms, which might correspond to ~40 metric tonnes of predominantly primary samples (with fairly limited re-collecting). During a trawling experiment in the Great Barrier Reef inter-reefal lagoon, 38 tonnes of similar soft-bodied benthic organisms were removed from just 12 trawls (of 2.7 x 1.2 km)(Pitcher, et al., 2000). Results of the experiment estimated that commercial trawling may have depleted fauna susceptible to trawl removal (e.g. sponges) by ~55% over the entire area open to trawling, potentially changing the composition of communities and shifting them toward less vulnerable taxa.

The sustainable use of marine resources by bioprospectors can be achieved with self-regulation by industry and the development of effective institutions and legislation to govern access to marine genetic resources. Environmental best practice by collectors would involve adopting collection protocols or guidelines, making timely and precautionary assessments of economic and ecological viability and the development of alternative supply strategies. At present, synthesis is the most viable form of alternative supply. Indeed, a study of all new small molecule entities produced between 1981 and 2001 found that 61% were related to or derived from natural products (terrestrial and marine) but only 6% relied upon natural product for supply (Newman et al., 2003) and that many of these are from cultured sources, not wild harvest. With respect to management by source nations, it has been suggested that a tiered system may be the best approach to regulating bioprospecting collections (Voumard, 2000). Given the lack on information available for many marine taxa and the speculative nature of primary collections it is virtually impossible to assess a priori the potential impacts on, or conservation status of, all species that may be collected. As small samples are generally collected, it was proposed that mandatory collection protocols would provide an appropriate and sufficient form of management (Voumard, 2000). These could include restrictions on allowable collection methods, areas, taxa, maximum sample weights/numbers and on the qualifications of collectors. For larger, species-specific secondary collections, there should be the possibility of a formal environmental impact assessment. Given the variability in re-collection sizes and biological understanding of marine taxa, the need for EIAs should be assessed on a case-by-case basis.

Marine biotechnology has been growing rapidly for the last fifty years (Munro et al., 1999). Advances in technology (e.g. SCUBA) and natural products chemistry have allowed researchers to access more marine species and study their chemical composition (Munro et al., 1999). From the isolation of the antiviral Acyclovir (Ara-A) and anticancer Cytarabine (Ara-C) from the Caribbean sponge, *Cryptotehya cryta* in the 1950's, the number of novel marine compounds has risen to over 14,000 (Proksch et al., 2003). However during the 1990's some Pharmaceuticals de-emphasized their natural products research in favour of new methods for generating novel compounds for screening (Rouhi, 2003) such as combinatorial chemistry. This may have been enhanced by the perceived growing difficulty (and expense) of gaining access to the genetic resources of other nations and securing adequate intellectual property rights (FAO, 2003). There has been suggestion of a revival

in marine pharmacology as complex natural compounds increasingly serve as a platform to be 'optimised' by combinatorial techniques (Rouhi, 2003). Various national and international initiatives have been proposed to develop marine biotechnology research and its commercial applications, as many believe the industry has yet to achieve its full potential (Anon., 2001; Ministry of Economic Development, 2002; Anon., 2002; Zilinskas & Lundin, 1993).

## Conclusion

There is an increasing recognition by policy makers around the world that if we are to manage marine resources effectively, we need to take into account all removals from the ecosystems that support them (FAO, 2003; Pikitch et al., 2004). An awareness exists of the need to address problems of illegal and unreported fishing (Bray, 2000), discarding and destructive gears, (FAO, 1996; FAO, 1997) and there is also a growing scrutiny of the non-food use of the marine environment, such as the collection for souvenirs (Bruckner, 2001; Grey et al, 2005), the aquarium trade (Wabnitz et al., 2003) and medicines. Fisheries for medicinal species are characterised (to a degree) by a lack of biological and fisheries data, yet have been shown to threaten some wild populations (Vincent, 1996) and are important to the health and livelihood of many people. To attain sustainable use it is important that we develop our understanding in order to achieve more appropriate and effective management.

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Photo credit: Rebecca Ng

Dried seahorses Hong Kong wholesaler



# An introduction to the trade in wild species used for medicinal purposes

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## Introduction

It is currently estimated that the global human population is 6.1 billion and this is projected to increase to 7.5 billion by 2020 (UNPP, 2004). According to the World Health Organization, 80% of this population depends on traditional medicine as a source of primary health care (WHO, IUCN & WWF, 1993) and this percentage is concentrated in Asia, Africa, Central and South America (TRAFFIC, 1998). China and India - two of the most populous countries in the world - are in Asia, and these countries, with already dense human populations, are projected to have the high population growth rates in the next few years (UNPP, 2004).

In addition, in recent years, many people in developed countries have also turned to sources of alternative medicines instead of allopathic medicines. For example, from 1990-2000 the percentage of persons using herbal medicines in the US increased from 2.5 to 37% (WWF, 2004).

Whether medical practice is traditional, alternative or allopathic medicine, products and raw materials that are used are obtained largely from natural resources i.e., their source is biodiversity of animal and plant origin. A large number of species are so used: over 50,000 species of plants, globally; over 5000 species of plants and animals in traditional Chinese medicine (TCM), 2000 species of plants in ayurvedha, and over 14,000 species in herbal preparations (IUCN, this workshop, Synthesis paper). This demand for natural medical products has driven the trade in medicinal species and, according to UNCTAD, currently, there are more than a hundred countries engaging in the trade in medicinal species.

This increased demand coupled with an ever-burgeoning human population is resulting in a spiralling increase in the supply of medicinal species.

## Current status of trade in medicinal species

Obtaining data on the trade in animals and plants for medicinal purpose and its impacts on biodiversity is difficult because a) trade may take place without proper documentation and data are simply lacking in most areas; b) the only data available are from reported import and export regulated by customs authorities and CITES information, which do not reflect domestic trade that may be considerable in extent; c) for threatened species trade is often illegal and therefore there is great secrecy surrounding trade and reliable information is difficult to obtain.

Table 1 provides a snapshot of the trade in medicinal plants for the top ten exporting countries for the period of 1993-1998. During this time period, about 360 thousand metric tonnes of medicinal plants, valued at more than a thousand million US dollars, were exported from 112 countries. It should be noted that the top ten countries shown in Table 1 collectively share three quarters of the reported global export in medicinal plants, with China as the single largest exporter of medicinal plants, exporting on average almost 150 thousand metric tonnes per annum and having a 42% share of the global export.

**Table 1. Quantity of exported medicinal plants and their trade value, by country**

Country of export	Quantity per annum (tonnes)	Value in thousand million USD
China	149,556	323,587
India	30,590	48,989
Germany	15,304	72,934
USA	13,076	113,585
Chile	12,278	32,871
Egypt	11,988	14,027
Bulgaria	10,807	17,277
Singapore	9,930	62,880
Mexico	9,585	10,586
Pakistan	7,271	4,685
Other countries	87,949	365,337
<i>Total</i>	<i>358,334</i>	<i>1,066,760</i>

(Source: UNCTAD database)

In contrast, Table 2 provides a snapshot of the trade in medicinal plants for the top ten importing countries for the period of 1993-1998. Here again, it should be noted that the top ten countries shown in Table 2 collectively share about 80% of the reported global import in medicinal plants, with Hong Kong as the single largest importer of medicinal plants.

**Table 2. Quantity of imported medicinal plants and their trade value, by country**

Country of import	Quantity per annum (tonnes)	Value in thousand million USD
Hong Kong	70,220	298,660
Japan	62,559	146,566
USA	56,890	140,829
Germany	47,762	116,916
R O Korea	36,463	54,065
France	21,715	49,775
China	13,643	45,211
Pakistan	11,931	11,912
Italy	11,838	43,366
Spain	9,340	28,210
Other Countries	85,397	329,428
<i>Total</i>	<i>427,757</i>	<i>1,264,937</i>

(Source: UNCTAD database)

## CITES listed medicinal species

A significant portion of these medicinal species is harvested from the wild. Increased demand invariably results in unsustainable harvest and, in some cases, destructive collection methods with the consequence that many medicinal species are threatened with extinction.

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), an international agreement between Governments, 'aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival.' Species are listed on different appendices depending on prohibition or regulation of trade: for example, trade of species listed in Appendix I is prohibited, while trade of species listed on Appendix II is regulated. Presented in Table 3 are the CITES listing and conservation status of some heavily traded species.

Table 3. Legal and threat status of some heavily traded species

Species	Red List category	CITES listing
Kingdom Plantae		
American Ginseng ( <i>Panax quinquefolius</i> )	Not listed but considered 'extinct, vulnerable and rare' in many parts of the USA and Canada.	Appendix II
Asian Ginseng ( <i>Panax ginseng</i> )	Not assessed by the IUCN Red List. Classified as 'endangered' by Chinese Angiosperm Red List	Appendix II
Golden Haired Dog Fern ( <i>Cibotium barometz</i> )	Not listed	Appendix II
Selected species of Orchids ( <i>Bletilla striata</i> , <i>Dendrobium spp.</i> , <i>Gastrodia elata</i> )	<i>Bletilla striata</i> not listed. 3 spp. of <i>Dendrobium</i> Critically Endangered 8 spp. of <i>Dendrobium</i> Endangered 1 sp. of <i>Dendrobium</i> Vulnerable <i>Gastrodia elata</i> Vulnerable	Appendix II
Desert-living Cistanche ( <i>Herba cistanche</i> )	Not listed. Classified as 'endangered' by Chinese Angiosperm Red List	Appendix II
<i>Saussurea costus</i>	Endangered in India	Appendix I
Agarwood ( <i>Aquilaria malaccensis</i> )	Vulnerable	Appendix II

Table 3. continued

Species	Red List category	CITES listing
Kingdom Animalae		
Tiger ( <i>Panthera tigris</i> )	Endangered	Appendix I
Rhinoceros	<i>Diceros bicornis</i> : Critically endangered <i>Ceratotherium simum</i> : Near Threatened <i>Dicerorhinus sumatrensis</i> : Critically endangered <i>Rhinoceros sondaicus</i> : Critically endangered <i>Rhinoceros unicornis</i> : Endangered	Appendix I  Appendix I & II with quotas Appendix I  Appendix I  Appendix I
Bears	Sun Bear ( <i>Helarctos malayanus</i> ): Data deficient; Sloth Bear ( <i>Melursus ursinus</i> ): Vulnerable; Spectacled Bear ( <i>Tremarctos ornatus</i> ): Vulnerable; Asiatic Black Bear ( <i>Ursus thibetanus</i> ): Vulnerable.	Appendix I: <i>Helarctos malayanus</i> , <i>Melursus ursinus</i> , <i>Tremarctos ornatus</i> , <i>Ursus arctos</i> (populations of Bhutan, China, Mexico, Mongolia) <i>Ursus arctos isabellinus</i> , <i>Ursus thibetanus</i> All other Ursids are listed Appendix II
Giant Panda ( <i>Ailuropoda melanoleuca</i> )	Endangered	Appendix I
Lesser Panda <i>Ailurus fulgens</i> , Musk deer ( <i>Moschus moschiferus</i> )	Endangered  Vulnerable	Appendix I  Appendix I: <i>Moschus</i> spp. in Afghanistan, Bhutan, India, Myanmar, Nepal & Pakistan  <i>Moschus</i> spp. other than those included in Appendix I are on Appendix II, without quotas.

In the following section, I discuss, in detail, seven of the above species.

## Wild ginseng (*Panax ginseng*)

Discovered some millennia ago in the mountains of Manchuria, China, this species has been valued highly for its powers of rejuvenation. It is likely the most valued species in TCM, and has recently become the third highest ranked in herbal products sales in the US (TRAFFIC, 1998).

In ancient times, the root of wild ginseng root was a gift that was offered only to the Emperor or to someone powerful and rich. Demand in China and Korea created a sizeable market. Originally found in China, North and South Korea, and the Russian Federation, Ginseng is now extinct in Korea and China. While there may be scattered populations in North Korea, it is likely that the only biological viable populations remaining are in Russia. Given its medicinal value, *Panax ginseng* has long been cultivated in China and South Korea and its cultivation is now a multi-million dollar business in both countries. However, wild ginseng roots are sold for higher prices in the retail markets - sometimes ten thousand times more per unit value than its cultivated counterparts.



Ginseng products in TCM

Photo credit: Samuel Lee

In the case of *Panax ginseng*, there appear to be minimal linkages between *ex-situ* cultivation and *in-situ* conservation. Although cultivation of *Panax ginseng* has become a multi-million dollar business, wild stocks are still threatened with extinction.

## American ginseng (*Panax quinquefolius*)

In 1716, a Jesuit priest working among native Americans in Canada saw the resemblance of a herb growing in Canadian hardwood forest to that of a herb highly valued in China for medicinal use. He looked for it and discovered it, beginning an extensive trade in its export from Canada to China. For the years in which records of ginseng exports were kept in the 1770s, an average of about 63,500 kg was exported each year.

Before long, the herb was discovered in the eastern US and exported from there too. However, by the end of the nineteenth century, over-harvesting and destruction of hardwood forests had led to the near extinction of this species in North America (Lewis & Zenger, 1982). Since then, it has been extensively cultivated and in 1995, 704,130 kg of cultivated ginseng root, valued at 44,905,434 USD, was exported from the U.S (Pumphrey, 1996).

Although it has been exported to Asia for many centuries, it is not until 2000 that this species was written into the official pharmacopoeia in China.

## Desert-living Cistanche (*Cistanche deserticola*)

This is a parasitic plant that is found mainly in the deserts of north western China and Mongolia (CITES, 2002). It is parasitic on the roots of *Haloxylon ammodendron*. The dried stem of the Desert-living Cistanche is used in TCM to treat a variety of ailments. This popular species is in great demand, and 400-550 tonnes were traded nationally and 120 tonnes internationally in 1995. Hence, it is now being over-harvested and is listed in China as a threatened species (CITES, 2002). In addition, its host species is eaten by camels and is also a favoured firewood for local people (CITES, 2002). This host species is also considered threatened as a result of over-exploitation and over-grazing (CITES, 2002).

In addition, collection of this plant is destructive as it is parasitic on the roots of *Haloxylon* and hence the entire host plants are often uprooted for collection, with the result that the surrounding area is disturbed, contributing to sand storms and desertification in China.

The Desert-living Cistanche is used mainly in traditional Chinese, Japanese and Korean medicines. However, it is not an irreplaceable ingredient in those medicinal systems. The medicinal communities in those countries can manage, albeit with some inconvenience, without this species.

But the collection and trade in this plant is closely linked with poverty. The north-western part of China is the poorest region of the country. Collection of Desert Cistanches can increase family income considerably in a country where the GDP per capita is only 4020 USD (UNDP, 2001).

This species requires a specific environment and a specific host plant in order to grow. In this case, there is significant challenge to have the supply-demand balanced because this species will need to be cultivated at a commercial scale to satisfy the demand.



Photocredit: TRAFFIC East Asia

*Cistanche deserticola*

## Scythian Lamb/ Golden Haired Dog Fern (*Cibotium barometz*)

This is a tree fern that is found in natural forests throughout China, Japan and through continental India and Southeast Asia, including the Philippines and Indonesia, as well as in Papua New Guinea (CITES, 2004).

The rhizomes of this species are covered with long golden hairs, hence its common name. These rhizomes are popular in TCM and in Korea and used to treat a wide variety of ailments. They are traded internationally for this purpose with China and Vietnam as the highest global exporters - with more than 90 tonnes per annum exported from China and 200 tonnes from Vietnam (Caldwell, 2001)

It is reported that wild populations have declined significantly in the last 25 years due to habitat destruction and over-harvesting (Qin & Dong, 2003). Although this is a good candidate for ex-situ conservation, no cultivation is yet reported on a commercial scale (WWF, 2004).

Managing harvesting of wild collections at sustainable levels and better trade control at borders appear to be the most viable option for this species.

Bears: Asiatic Black Bear (*Ursus thibetanus*), Brown Bear (*Ursus arctos*), Malayan Sun Bear (*Helarctos malayanus*) Sloth Bear (*Melursus ursinus*)

All seven species of bear extant in the world today are under severe threat from human activities. In Asia, the Black Bear, Brown Bear, Malayan Sun Bear and Sloth Bear are impacted severely by habitat loss.

In addition, all the Asian bears are threatened seriously by wildlife trade (Lee, 2000). Trade in all Asian species is banned internationally under CITES.

A reporter for TRAFFIC states that for traditional Chinese medicinal practitioners, bears are 'a walking drugstore' and that many body parts, including fat, meat, blood, brain and spinal cord, have been used for thousands of years (Servheen, 1999). However, the most valuable body part for medicinal purposes is a bear's gallbladder (except for the Giant Panda's), is unique among other mammalian gallbladders as the bile it produces contains Ursodeoxycholic Acid or UDCA. UDCA is used to treat a wide variety of serious ailments from cancer to liver cirrhosis.



Photo credit: <http://www.dba.go.th>

Rhizome of *Cibotium barometz*

Currently, UDCA synthesised from cow bile is used in allopathic medicine to dissolve gallstones (TRAFFIC, 1995).

Of the annual global consumption of bear bile, more than half is used by China, Japan and South Korea (about 100 tonnes). In 1996, it was reported that China housed 481 of bear farms where bile was extracted from an estimated 10,000 captive bears (Severn, 1999). TRAFFIC (1995) reports that in a five-year period, one farmed bear can produce the bile equivalent of gall bladders from 220 wild bears. In China, farmed bile is reportedly sold at 9 USD per gram; in Russia illegally obtained gall bladders were sold for 500 USD per gall bladder, and in South Korea, 210 USD per gram (TRAFFIC, 1995).

Breeding bears in captivity and milking them for their bile is seen by the TCM communities as a means of ensuring a steady supply of UDCA to markets in Asia. However, there is a continuing and vigorous debate about the efficacy of bear farming as a means of bear conservation because there are some continuing concerns as listed below.

- The legality of the founder animals is often questioned.
- The conservation status of the bears in the countries of origin - often in Asia - is often endangered.
- The level of compliance with the existing domestic requirements, if any, set by the relevant authorities on breeding endangered species in captivity remains unclear;
- The impact on the remaining wild populations within Asia and beyond remains unknown.
- The impact on the illegal bear gall bladder trade remains un-investigated.

An international symposium held in 2000 on the Trade in Bear Parts, recommended significant reduction in the use of bear bile to a level that would meet only urgent and serious health care needs as an interim measure (Lee, 2000).



Photo credit: TRAFFIC East Asia

Bear gall bladder



## Musk Deer (*Moschus moschiferus*)

Depending on which taxonomist is consulted, there are between four and six or more species of musk deer, whose geographic range extends over most of mainland Asia and Eastern Russia. Musk Deer are small ungulates who are restricted to forested mountainous habitats at high altitudes. Secretions produced by special glands (pods) situated in the posterior abdomen of male musk deer have been used for many thousands of years in perfumes and in traditional medicine in China and neighbouring countries (TRAFFIC, 2002).

Musk is used currently in as many as 400 Chinese and Korean traditional medicines to treat ailments of the circulatory, respiratory and nervous systems (TRAFFIC, 2002). The demand for musk from China alone is between 500-1000 kg per annum needing extraction from pods of more than 100,000 male musk deer (TRAFFIC, 2002). In Russia, 400-500 kg of raw musk were traded illegally between 1999 and 2000, needing extraction from 17,000-20,000 stags (Homes, 2004).



Musk pods

Photo credit: Susan Earle

As recently as 2003, TRAFFIC reported that musk products were available in all TCM shops in New York City and in 50% of the TCM shops in San Francisco, indicating a steep increase in availability in countries outside their natural range.

Although today's perfume industry uses mostly synthetic musk, some countries such as France imported some 100 kg of musk during the period of 1980-1995 (TRAFFIC, 2002).

Musk may be worth many times as much weight for weight than gold and is worth 2-3 USD per gram at poacher level, and worth 12 USD per gram at retail markets in Hong Kong, meaning that musk from a single pod can be sold for 70 USD - a fortune for a single 'catch' for villagers in Asia and Russia (TRAFFIC, 2002)

Although musk can be extracted from live animals, it is not easy to do so in wild animals. Because the high selling price of musk provides a strong incentive, poaching of this species is still rampant, notwithstanding the fact that the Siberian Musk Deer (found in the Russian far east) is considered vulnerable and the other species near threatened in the IUCN Red List. For every male that is captured, three to five females are killed (Holmes, 2004).

It is estimated that a total of 60,000 musk deer could be poached each year in Russia and that musk deer populations have dropped by 50% in Russian and as much as 75% to 90% in some parts of Russia. In Mongolia at least 12,000 animals were reported killed between 1996 and 2001; while in Nepal, 500-600 snares per km have been observed (Holmes, 2004).

To ease the pressure on wild populations, China, established the first musk deer farms in the 1950s. Since then, a number of breeding facilities have been established in several provinces in China. However, breeding musk deer in captivity and collecting musk from their pods on a regular basis is difficult and the supply from such farms is inadequate: all musk deer farms in China collectively produce about 6 kg each year, whereas the domestic demand in China alone is estimated at around 1000 kg per annum (Wu & Parry-Jones 2001).

Anti-poaching patrols, cross-border protection, enhancing law enforcement and monitoring international trade are the options available for this heavily-traded and declining species.

### Seahorses (*Hippocampus spp.*)

In the past decade, international trade in seahorses has increased tenfold, with an estimated total global consumption of more than 70 metric tonnes (at least 25 million seahorses) in one year - 2001 (Project Seahorse, 2004).

As many 77 countries in the world - if not more - are engaged in trading seahorses (See Hunt, this volume, for a distribution map). The largest exporters are Thailand, Vietnam, India and the Philippines while the largest importers are China, Hong Kong, and Taiwan.

The majority of this trade is for TCM (seahorses are used to treat a variety of ailments from respiratory diseases to sexual dysfunctions) as well as in traditional medicine in Indonesia and the Philippines (Project Seahorse, 2004)

Good quality dried seahorse can be sold in Hong Kong for as much as 550 USD for about half a kg and poorer quality dried seahorse at about 200 USD for the same quantity.

Seahorses are monogamous and have a long period of parental care. They have small home ranges and do not move very far. Hence, removal easily disrupts their breeding biology and recruitment and re-colonization of depleted areas is difficult. Further, growth patterns and behaviour of juveniles, existing global wild stocks are unknown. In addition, taxonomic and geographical delineations are not clear. Hence, the long term effects and impacts of removing so many million seahorses is yet unknown. However, fishermen engaged in the capture of seahorses are already reporting a marked decline in catches. Samples surveys from five countries have revealed a 50% decline in the last five years and a 70% drop in the Philippines from 1985-1995 (Project Seahorse, 2004).



Photo credit: K Markey

*Hippocampus comes* is among the popular seahorse species used by practitioners of traditional medicine in Asia.

The current trade, sourced from the wild is already showing signs of unsustainable harvesting. (Although there have been some attempts to breed seahorses in captivity in several countries, too many unknown parameters such as control of disease make ex-situ conservation extremely difficult.)

In the past, using seahorses in TCM and manufacturing over-the-counter drugs containing seahorses occurred only in the coastal regions of China. However, in the past decades, planned- economy has gradually switched to market-economy, which has contributed to an open trade for traditional medicine, better provision of infrastructure across the country, and less trade restrictions on imports and exports. Marine medicinal species such as seahorses are now available in almost every corner of China, even in land-locked provinces.

In this case, factors beyond the supply-demand equation have played an important role in the trade. For these species, it is the external trade environment that has facilitated enormously the trade and is not merely driven by demand alone.

## Conclusions

Given that cultivation and breeding species in captivity is not necessarily a panacea, managing species in the wild and maintaining their genetic variability is important. Data on wild stocks of heavily traded medicinal species - populations estimates, age structures of populations, basic reproductive and behavioural biology - are woefully lacking. Such information is critical for informed adaptive species management.

For many species over-exploited for their medicinal properties, a wide range of stakeholders along the trade chain - from collector and middlemen to traders and end-users - must be engaged in conservation activities and mobilized to review their roles in conserving or sustainably managing species.

In the future, awareness and committed actions from professionals from a wide range of expertise, including officials responsible for health care policies, TCM educators and students, are also crucial; not only for the conservation of species but also for the health of humankind.

What is patently apparent is that there is no single formula as a universally applicable prescription for the conservation of medicinal species important in trade. For each species, in each locality, conservation biologists will have to work in concert with many other professionals and stakeholders to think laterally and to formulate innovative methods that not only safeguard species but also ensure that livelihoods and traditional culture are sustained.

## Acknowledgements

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Confiscated rhino horn

Photo credit: TRAFFIC East Asia

# Conservation of Medicinal Species: Detection



Confiscated rhino horn

Photo credit: Samuel Lee

# Bear Detection Kits: A Forensic System for Controlling Illegal Trade in Bear Parts and Derivatives

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## Background

The illegal trade in wildlife often involves products that are not readily recognisable as originating from protected species. This reflects a worldwide demand for the parts (e.g. meat and viscera) and derivatives (e.g. musk and bile) of wildlife for consumption and use in traditional medicines. Reliable species identification of commercial wildlife products is, therefore, of central importance in wildlife law enforcement and conservation.

Numerous techniques are available currently for determining the species identity of wildlife products. DNA profiling can be used to categorically identify species (Bai et al., 2003; Singh et al., 2004), but is relatively cost and time expensive, requires considerable expertise and can be unsuitable for analysing processed and degraded products (see Wetton et al., 2002). The genetic profile of species determines the amino acid sequence of proteins, and many methods of species identification are now based on analysis of species-specific protein signatures (e.g. Espinoza et al., 1993; Hagey et al., 1993; Hollemeyer, 2003). These can provide a more rapid and economical alternative to DNA profiling that in some cases is more suitable for analysing animal derivatives, and degraded wildlife products (Stelling & van der Peijl, 2001). However, like DNA profiling, most methods of protein analysis are laboratory-based and require specialist training or equipment to perform. The intensity of trade in the products of many endangered species necessitates routine testing of wildlife products by enforcement and monitoring authorities. This calls for a reliable means of testing alleged wildlife products that is rapid, convenient, straightforward, economical, and hence suitable for routine use.

All populations of the seven species of bear are listed on Appendix I or II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). However, continued demand for bear bile parts and derivatives in traditional and patented Asian medicines has led to illegal exploitation of many populations of bears (See Miththapala, this volume). Bear gall and bile medicines are prescribed for a wide variety of conditions (Bensky & Gamble, 1986) and have been marketed recently in non-traditional products such as shampoos and wines. A recent investigation by the World Society for the Protection of Animals (WSPA, 2002) found significant volumes of alleged bear bile products in traditional medicine shops in East and Southeast Asia, Australia, Canada, the US and Europe. In addition to widespread illegal poaching of bears for their gall

bladders, wild bears are live-caught to supply Asia's bear farms (Mills, 1992) where their bile is extracted daily and exported illegally (WSPA, 2002). It is believed that continued illegal trade in bear parts and derivatives may cause declines of wild bears that could lead to the extirpation of certain populations and even species (CITES Resolution Conf. 10.8 [Rev. Cop12]).

Legislation protecting bears is often difficult to enforce due to challenges encountered in identifying bear parts and derivatives in commercial products and the presence of fraudulent bear bile products in trade. This paper reports the ongoing development of a new forensic tool for on-the-spot identification of bear products. The bear detection kits will be field-based, highly reliable, rapid, straightforward to use and low cost. It is hoped that they will help to control the illegal trade in bear parts and derivatives by assisting enforcement authorities in seizing illegal bear products and initiating prosecutions.

## Description

The test will be based on a solid-phase immunoassay method of protein detection. The immunoassay chemistries will be incorporated in an existing kit used currently for food testing. This kit consists of a test device, a test comb and a mixing tube containing a protein extraction buffer. The kit components are designed to be small, lightweight and durable and will be delivered in a sealed foil wrapper.

## Specifications

- Fully validated forensic test that will help to seize illegal bear products and initiate prosecutions.
- Single test for all of the seven bear species: Asiatic black, American black, Malayan sun, sloth, spectacled, polar and brown.
- Likely to detect traces of bear protein in blood, skin, gall bladder and manufactured bile medicines.
- Suitable for use in the field; requires no special training.
- Takes approximately three minutes to perform, with a result available after five minutes.
- Minimum shelf life of 18 months at room temperature; doubled if stored refrigerated.
- Low cost.

## Performing the test

The kit is designed to be very straightforward to use. Performing the test will require four simple steps (Figures 1a-d) and take approximately three minutes. First, a small portion of the test sample is added to the mixing tube containing an extraction buffer. The tube is shaken for one minute to release the protein. The lid is then removed and the test comb inserted into the tube. Once full, the test comb is removed from the mixing tube, inserted into the test device and clicked into place.

## Test results

A result will be available within five minutes. The test will incorporate a control indicating that the test has been performed correctly but that no bear protein is present, i.e. a negative result. This is shown by the presence of lines at positions 2 and 3 on the test device (Figure 2a). A positive result will be indicated by blue lines at positions 1, 2 and 3 (Figure 2b).

## Methodology

The kits will use an immunoassay method of protein analysis that is based on *in vitro* capture of antigens by isolated specific antibodies. This is a standard, highly sensitive technique that is used for a wide range of commercial applications (Gosling & Basso, 1994). Examples are home pregnancy tests (e.g. Butler et al., 2001), tests for traces of dangerous allergens in processed and manufactured foods (e.g. Drs et al., 2004) and venom detection tests to determine the appropriate antivenom treatment for snakebite victims (e.g. Dong et al., 2003). In wildlife monitoring, immunoassays have been used previously for the identification of commercially important marine species (Hartman, 1999; Lopata et al., 2002; Asensio et al., 2003).

The test will use polyclonal antibodies (Immunoglobulin Gs) specific to the albumins of seven bear species. Albumin was identified as an appropriate antigen as it is present in the majority of animal tissues and derivatives and is thought to be homologous between most bear species (Seal et al., 1970). The test will identify bear products by binding bear albumin (in the test comb) to blue latex microspheres coated with anti-bear antibodies (in the test device). Complexes of bear antigen, antibody and microsphere form once the device is loaded, and are forced by capillary action past three discrete columns fixed to a nitrocellulose layer within the device. These correspond to positions 1, 2 and 3 on the test device and contain immobilised antibodies or antigens to bind the antigen complexes, which are visualised as blue lines.

Following development, the kit will be validated fully by at least two independent laboratories. This will identify the upper and lower limits of detection (i.e. the levels of bear protein required to initiate a response) and the range of tissues, derivatives and manufactured products suitable for testing. A comprehensive evaluation of cross-reactivities with a range of other species will also be carried out to ensure that false positives do not lead to inaccurate species identification.

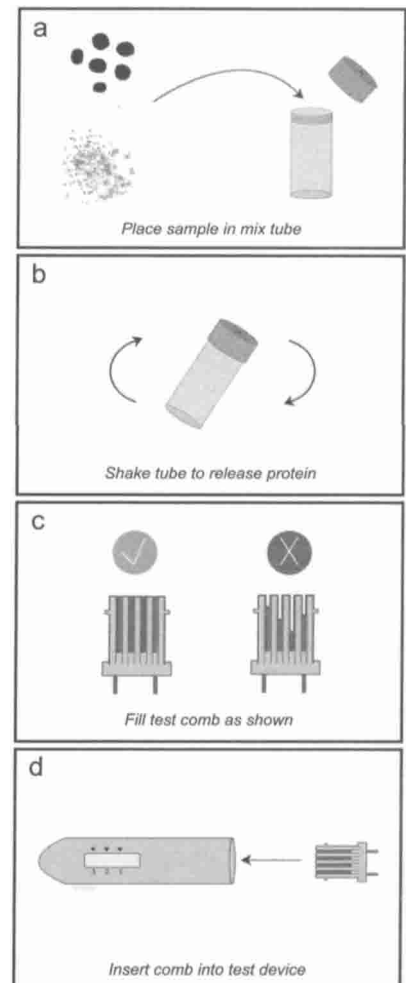


Figure 1 Four-step procedure for performing the test.

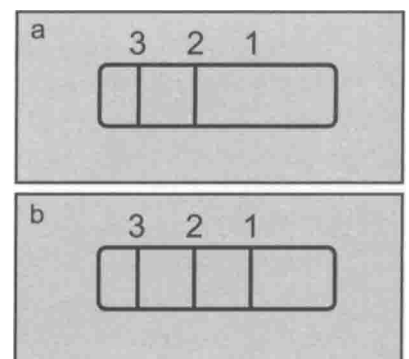


Figure 2 Test results (a = negative; b = positive).



## Anticipated outcomes

The overall aim of this work is to produce a forensic test for bear parts and derivatives that is certified to be highly reliable, sensitive to trace and manufactured products, suitable for field use, straightforward, rapid and low cost. We anticipate that the bear detection kits will assist enforcement authorities in seizing illegal bear products and initiating prosecutions. Following trials in two or three countries in 2005, it is hoped that the kits will be widely implemented in the many regions where bear products are traded illegally.

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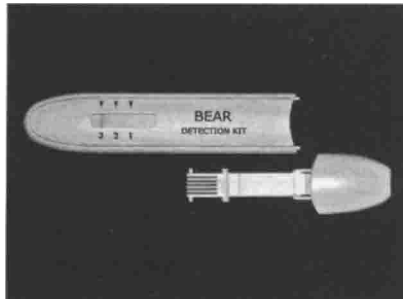


Photo credit: Kate Sanders

Bear detection kit

# Conservation of medicinal species: Sustainable use



Photo credit: Patrick Maundu

African medicine women

# Community-driven Medicinal Plants Conservation: Wise Practices from South Asia

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## The medicinal and aromatic plants (MAP) sub-sector in south Asia

In South Asia, medicinal and aromatic plants (MAPs) are an essential part of traditional health care systems. Among local and indigenous peoples, medicinal plants evoke spontaneous and enthused interest as well as value to meet their health, livelihoods, and cultural and spiritual needs. However, modernists, especially those with backgrounds in western education, such as allopathic doctors and basic scientists, usually react with scepticism and uninformed criticism to the concept and practice of a traditional medicine system (TMS). Nevertheless, in recent years, MAPs have been recognised widely as a source of significant livelihood value, especially to the rural poor, as they provide cash income, local medicines and supplementary food and nutrition. These plants also provide economic incentives to promote and sustain participatory conservation of plants and their ecosystems to forest dependent communities. The wild collection and cultivation of MAPs can enhance forest-based livelihoods especially to the primitive and indigenous communities, landless poor and marginalised farmers. Poor people in different parts of south Asia, especially in the Himalayas, central Indian and Sri Lankan highlands and coastal belts of Indian subcontinent draw as high as 30 to 50% of their livelihoods from MAPs and other non timber forest products (NTFPs) (Karki, 2002; Belcher, 1998). The gathering and cultivation of MAPs provide critical sources of cash income to many rural families, to enhance their livelihood security. Singh (2002) reported that the total income from sales of MAP and NTFPs from forests in Madhya Pradesh, India was around 2,000 USD /year, which is significant from the point of local living conditions. In the northern mountains of Nepal up to 50% of the household income is derived from harvest and sale of high value NTFPs such as Indian spikenard (*Valevianajatumansi*), gentian (*Picrorhiza spp.*), *Yartsagumba* (*Cordyceps sinensis*) and *Chiraita* (*Swertia chirata*) (karki, 2000). The government also benefits from MAP collection in Meghalaya, a single district provides around 100,000 USD /year of revenue from the sale of about 3000 tons of bay leaf products (Karki et al., 2003; Tiwari, 2003).

Hills and mountains, especially the Himalayas, are a treasure-trove of medicinal plants biodiversity and associated indigenous and traditional knowledge wealth. South Asia's *Ayurvedic* system is believed widely to have originated in the Himalayas, 5000 years ago, where medicinal plants

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Medicinal plants are often used to describe plants with medicinal, aromatic and dye properties and therefore, in this paper they are also referred as MAPs and MADPs.

are still found in abundance. Other common TMS such as *Unani*, Tibetan and *Siddha* evolved subsequently. MAPs are linked inextricably to the region's rich natural biodiversity because some of the most biodiversity-rich pockets of MAPs are found in the two globally recognised 'hot-spots' of eastern Himalayas and western Ghats of the Indian subcontinent. It is estimated that more than 1000 MAP species found commonly in the hills and mountainous regions of south Asia provide a significant amount of employment opportunities - 35 million person days in India alone - to the people engaged in gathering and selling of MAPs and NTFPs (GOI, 2001). Traditional and indigenous knowledge and practices about MAPs are fast weakening and in many cases, vanishing altogether. While attempts have been made both at policy and project levels to revamp this sector, the efforts remain coordinated poorly and funded inadequately, lacking clear direction, necessary institutional and human resources and required research-based information, knowledge, technologies and practices.



Providing traditional medicines to villagers

Photo credit: Madhav Kariki

## Evolution of multi-stakeholder fora in the MAP sector

In 1994/95, the International Development Research Centre (IDRC), Canada initiated its support to medicinal plants research in south Asia by funding projects on keystone commodities such as *Neem* (*Azadirachta indica*) in India and extended gradually and diversified its approach in other countries. Initial research focused on generating basic information and knowledge such as species distribution, ethno-botanical practices, domestication/cultivation technologies and value addition methods through primary processing and marketing. A series of stakeholder consultations and priority setting workshops and seminars organised by multi-stakeholder network yielded common codes of conduct in research, networking mechanisms and culture, regional and national prioritisation of species, multi-level and multi-partner partnerships among government organisations (GOs), non-governmental organisations (NGOs), community-based organisations (CBOs), the private sector and regional sharing of experience and practices between researchers and development practitioners. These intensive activities helped create a number of successful pilot projects, multi-stakeholder forums, policy champions and wise practices.

## Evolution of regional and national networks

Today, governments, NGOs, CBOs, donor partners such as IDRC, United Nations Development Programs (UNDP), Global Environment Fund (GEF), Ford Foundation (FF), International Fund for Agriculture Development (IFAD), Swiss Development Corporation (SDC), Danish International Development Agency (DANIDA) and Canadian International Development Agency (CIDA) are supporting a large number

of projects and activities that are responding to local conservation and livelihood needs, promoting gender and social equity, building information networks and dealing with national and global policies and processes. These programmes and projects within each community and/or country incorporated the strategy of creating scientific and technological societies by building individual and institutional capacity, networks and centres of excellence. The emphasis of the programme has been on process-based research that incorporates gender and social analysis, livelihood-oriented policy outcomes and those projects that have potential to benefit the rural poor and indigenous communities. Policy influence in the areas of biodiversity conservation, sustainable livelihoods and improved primary health using MAP/NTFP resources, as a model is the priority of a number of governments and donors like IDRC, FF, SDC and IFAD. The partners are also working closely with national governments, especially policy makers, in effecting institutional reforms and change targeting archaic rules, overlapping legal and administrative instruments and bureaucratic layers in decision-making processes. Launching by IFAD, SDC and others of a series of livelihood enhancing and poverty reduction projects in the Himalayas from Pakistan to Bhutan can be cited as an example.

## Local conservation efforts and results

There is widespread concern among local people and the conservation and development community, including governments, about the manner and pace in which unregulated and unsustainable wild collection of high value medicinal plants from fragile hills, mountains and coastal areas is continuing in the region. Partly in response to such concerns, there are increased efforts by local communities, CBOs, NGOs, government agencies, research institutions and donor-led initiatives such as Medicinal and Aromatic Plants Program in Asia (MAPPA) to promote an integrated conservation and cultivation, including sustainable harvesting related projects and programmes in the region by employing participatory action research (PAR) and community-based approaches. Local inhabitants, especially wild collectors in some of the projects, have already started cultivating a number of MAP species such as *Aconitum heterophyllum*, *Allium humile*, *Swertia chirata*, *Picrorhiza kurrooa*, *Saussurea costus* on terraced slopes, degraded waste and range lands and in home gardens (SHER, 2003; Makhuri, 2003). Species that have multiple values such as food, medicine, spices and condiments, as well as good marketing potential, are found to be preferred by the growers. However, there is still a lack of effective coordination among different agencies and the efforts made to date suffer from lack of systematic planning and policy support. There is also a lack of standards and protocols to produce quality products that are able to access high-end markets. In fact, marketing challenges, especially international markets, have not been comprehended fully and strategies defined. Growing organic and certified products, complying with the WHO-prescribed good practices is expected to ease both marketing challenges and illegal harvesting.

## Existing gaps, issues and challenges

Unfortunately, the sustainability of the MAP sub-sector is threatened constantly and challenged by multitudes of environmental, socio-economic, technical, institutional and marketing problems. Some descriptions follow.

## Lack of economic gains to the poor

The continuous erosion in the livelihoods of poor and indigenous people, traditionally dependent on the MAP/NTFP collection and sale, is a major social concern. The natural resources needed for sustaining the local income requires effective conservation and management in order to ensure that the livelihoods are enhanced and sustained. Continuous inequity in access and benefit sharing is an important issue in the MAP sub-sector due to the opaque and secret nature of prevailing market chain. Resource access is about power; effective balance of power in natural resource management is needed in order to ensure that poor people can sustainably exercise their rights to common resources such as MAPs. Ensuring the sustainability of these resource management skills and policies can reduce rural poverty, and vulnerability of people dependent on natural resources.

## Threat assessment of MAP species

Threat assessment has emerged clearly as one of the most important activities in conservation planning and management. Experiences of different methodologies of threat assessment such as the exercises of Conservation, Assessment Management and Planning (CAMP) and Rapid Vulnerability Assessment (RVA) have been gathered and shared. Threat assessments carried out by different stakeholder groups - such as the *Amchis* (Traditional Tibetan doctors) of Nepal, taxonomists and foresters in India and multi-disciplinary groups in Nepal - have been documented and disseminated (Yildiz et al, 2003; Bhattarai & Karki, 2002). Capacity building and training of human resources at all levels for a practical threat assessment and management planning have been stressed as important factors in achieving long-term conservation of MAPs. Exchange of information on threat assessment methods and outputs across regions will also contribute to this process (Yildiz et al., 2003).

## Resource tenure: how to tilt the balance?

Resource tenure remains an important issue for medicinal plant conservation. The importance of secure land and tree tenure has been highlighted amply by the work of partners working in different parts of South Asia, especially in the uplands and fragile ecosystems (Subedi, 2003). It has been experienced that it is relatively easy to establish secure tenure in individual or a community-owned land and possibly trees (managed and planted) growing in private lands. Because MAP/NTFPs represent a range of mostly wild and semi-domesticated species of plants, which come under various national and international regulatory domains, there is still a perception among farmers that giving secure tenure will endanger the resource endowment. In communal management regimes such as those that community forestry, members have, in general, been able to access wild MAP/NTFPs quite freely. However, uninterrupted tenure and enforceable property rights are not feasible in protected areas except perhaps adequately compensating the community to protect their resources from outsiders through socio-economic and development projects.

## Best practice for livelihoods development

Based on the experiential learning gathered so far, the action agenda for medicinal plants conservation and sustainable development in the uplands can be summed up as follows on the next page.

- **Influencing policy and institutional reforms**

We need to institute national, provincial and local level policy reforms by putting medicinal plants on the development agenda of governments, agriculture/rural development banks, and other related agencies as a part of an integrated agro-ecosystem management. We will require enabling policies and institutions that provide incentives to specialised groups and enterprising individuals to develop the activities sustainably and manage medicinal plant resources, which are, invariably, community-based resources with their equitable and meaningful participation in all stages from production to marketing activities. Various resource user groups, self-help groups and MAP growers' fora can be federated and their capacity built to strengthen their bargaining power in the market chain.

- **Outreach and networking practices**

We should concentrate on learning from other commodities in developing production-to-consumption and marketing models in MAPs/NTFPs sector. Local, national, regional and international level supply chains can bring together individuals, groups and organisations to discuss problems and their solutions in a more cost effective manner and to exchange valuable information. Researchers, development workers and local communities have an immense repository of knowledge, networks of which can be used in the identification of priority species both for conservation and development. NGOs and GOs who are willing to be the agents of change and facilitators of a community-based development process, and who will want to promote the medicinal plants-based solutions in livelihood development areas should first re-orient their mindsets believing that local resources like MAPs can play a significant role. In south Asia especially, they may be the basis of empowering women and indigenous communities to build safety nets and resiliency in food security.

- **Technology transfer and information sharing**

There is a need to use scientific knowledge and modern technology to achieve local level value-additions to the TMS derived from MAPs. Information and communication networks for transfer of technical expertise and streamlining of the existing supply system of MAP raw materials are priority areas. The emerging opportunities afforded by internet technologies provide enormous opportunities for quick and cost-effective access of the market and dissemination of price information, of which the small-scale producers and manufacturers of MAPs can take advantage. Use of electronic communications including the Internet can be encouraged to become up-to-date on information regarding markets, price and products.

## **Supply chain management: a bottom-up marketing approach**

Marketing and value-addition have become the key issues in the MAP sub-sector. At a micro level, semi processing of raw materials at or in the vicinity of the cultivation/collection points would ensure better returns to the primary collectors and growers, and has the potential to generate wage employment for women and marginalised families as well (Nagpal, 2003). Possible avenues follow overleaf.



- Cleaning and grading to enhance the price, as well as the quality of the raw material. Cleaning involves washing and drying or simply removing mud and other impurities. Even these simple steps have been ignored largely so far, due to lack of awareness of higher prices that could accrue.
- Grading involves separating the different quality classes and can also enhance greatly the price received. Value addition/semi processing are processes that include drying, grading, packaging, labelling, powdering, making aqueous extracts, boiling, distilling and cooking. Most of these are carried out in sequence and are best done logistically in a central place. However, care needs to be taken to ensure that there is adequate traceability to ascertain the quality of the material being processed. From a practical perspective, even seemingly simple activities like drying and cleaning in hygienic conditions are difficult in most rural areas. Ensuring availability of basic storage facilities, therefore, becomes an important element of such an activity. This will also ensure that raw material does not need to be sold on-the-spot, often the root cause of low realisation at the base of the value chain, where there is no option but to accept price(s) quoted by the trader, because material cannot be taken back or stored in the hope of better prices at a later stage.
- The domestic markets are obvious focus areas given their size, ease of access, and ready acceptance of TMS by local populace. In particular, rural areas suffer from lack of low cost healthcare solutions for basic illnesses such as fever, pain, cold and cough, and represent good markets for herbal remedies. Community-based enterprises such as Gram Muligai Co. Ltd. (GMCL) in India and *Gorkha Ayurved* in Nepal can develop a distribution channel for such low cost medicines in rural areas and boost the domestic markets (Raju, 2003; Subedi, 2000). This can be done through an effective raw material sourcing mechanism on the one hand, with distribution through agencies and organisations, which already have a base in the rural markets on the other.
- In terms of global markets, it would probably be appropriate to focus on high potential; premium international markets from the initial stages itself, because these will be the ultimate test of acceptance from the quality, traceability and sustainability perspectives. Once acceptance is obtained in these markets, then entry into other markets should not pose much of a problem. The European markets (specifically Germany, UK, France and Italy) are areas where detailed field research and identification of potential customers, products as well as strategic partners could be carried out. Herbal teas could be assessed seriously as a product for launch in the US markets as well.

## Building south Asian brands

Building a brand image for any MADP-related product from the region, be it in raw, processed, semi finished or finished forms, or in services such health-tourism, will be critical to the long-term success of any sustained MAP initiative. To this end, an integrated approach that cross cuts individual producing companies or groups is of utmost importance. Some of the strategies, which have higher chance of success in this regard are listed on the next page.

- While individual community-based enterprises or business-oriented co-operatives or societies in different parts of the region can establish and coordinate MAP activities such as capacity building and scientific cultivation/collection/harvesting practices, it is recommended that an apex body, at the national level - such as the National Medicinal Plants Boards (NMPB) of India, producing company or group, self-reliant cooperatives, federations of CBOs such as Federation of Community Forest Users in Nepal (FECOFUN) - be set up with the specific mandate of brand-building, marketing, developing and sustaining strategic tie-ups etc. This apex body would be responsible for developing strategic connections such as long-term trade linkages between communities and buyers, participating in international herbal fairs to promote south Asian brands, organising conferences on MAPs etc. This will help build economies of scale, optimise cost, and also enhance the bargaining power of small units such as forest user groups when consolidated together as a producer of MAPs.
- An apex body such as the NMPB in India and National NTFP Development Committee (NNDC) in Nepal will be needed to perform the role of a nodal agency interacting *inter alia* with Chambers of Commerce; industry associations; government agencies such as the Ministries of Forests and Environment; agricultural, commerce and banking institutions such as export/import banks and agricultural banks. All such activities will help spread the message regarding the commercial and livelihood potentials of south Asian MAPs/NTFPs within regional and global markets.
- The apex body such as the NMPB could also promote a south Asian e-commerce initiative, keeping in view the increasing popularity of the Internet as a medium for purchase of MAPs and related products. It would also be relevant to consider promoting specific products as brands by themselves and laying the foundation for a long-term sustainable export initiative. A good example of such an initiative is the manner in which Ginseng, as a product, has been promoted in the world market by Korea and China. (Today, a wide variety of products using Ginseng as a base is available in the market.) In south Asia, products such as Psyllium husk (*Plantago* sp.), Senna (*Cassia augustifolia*), Yartsagumba (*Cordyceps sinensis*), Small Indian Ipecac (*Gymnema sylvestris*) and Thyme-leaved gratiola (*Bacopa monnieri*) - which already have a great deal of market acceptance, and for which the south Asian region already is a major resource base - could be possible candidates for such an initiative. Likewise, Aloe vera is another product which finds wide acceptance in the nutrition and healthcare, as well as cosmetics industries and which could be well worth a serious assessment from the MAP commodity perspective.
- Different types of herbal teas, while a brand by themselves, can also be an integral part of the overall South Asian MAP brand-building exercise. This is a relatively small, yet fast growing, premium market today. Herbal teas from herbs cultivated organically in the Himalayan belt - in Bhutan, Nepal, Uttaranchal, North East and Himachal - would have some inherent advantages. The 'exotic' association with the area, the wide acceptance of teas from the Indian sub-continent, the strong sales pitch of teas from herbs grown organically with pure snow fed water from the Himalayan ranges. Important markets for herbal teas are Germany and France in the EU, and the US. Focus on these locations for a more in-depth market study would be a good idea.

- The objective of any regional initiative should be to build and publicise such 'pockets of excellence' - real life success stories of profitable individual enterprises in different parts of the region, to build upon the success of these pockets, creating a momentum that will ultimately realise the overall objectives or the vision for the initiative.

## Conclusions and recommendations

The policies, programmes and strategies for developing a vibrant, sustainable and remunerative community-based MAP sector should be based on the foundation of people-centred, livelihood-focused and biodiversity-enriching principles. The vision has to be based on long-term goal of providing equitable access, fair share of benefits and conservation through sustainable use to the local people.

Underlying principles of conservation and development programme development should be:

- Assignment of roles and responsibility to different stakeholders in a manner commensurate with the demand of their services, institutional capacity and track record of performance in the past projects;
- Monitoring and evaluation of the performance of agencies to be based on monitoring actions and activities of various stakeholders in a time bound manner and on evidence-based and verifiable progress markers and outcomes; focussing as much on process as on methodology to achieve the policy objectives;
- Defining and monitoring actions and activities of various stakeholders in a time defined manner;
- Evaluation of the outcomes and relevance of any policy reform in MAP sector based on tangible improvement in rural livelihoods and improved quality of biodiversity because the MAP policies and their proper implementation are most critical to the poor and local community. There are no simple and easy answers in complex policy debates and discussions. But the ultimate actions of i) the people whose livelihood is dependent on these resources, ii) the community forest users and joint forest management committee members who have undertaken the responsibility of protecting both the forests and livelihoods on behalf of their community; and iii) the district and state level government officials in policy and institutional arenas will have to understand the nature and extent of problems and their possible long-term solutions.

Transferable lessons for other South Asian partners include:

1. Strong leadership in the context of a multidisciplinary team with representation of both genders and the local community has been a key factor in the success of the majority of the projects.
2. By ensuring that community members possess a shared commitment to meeting project as well programme goals by building rapport with each community and establishing a long-term commitment to the mutual exchange of information, the MAP related activities
3. Building with strategic partnerships with relevant CBOs, GOs, NGO's, INGOs, private sectors and key individuals to identify research needs and develop new programmes in order to remain responsive, despite a limited resources.

4. Creating an obvious incentive to conserve and sustainably use medicinal plants by demonstrating the potential of traditional health practice to provide culturally appropriate and accessible health care, and alternative sources of household income.
5. Developing proper certification systems and ensuring practice of sustainable harvesting, international quality and standards and organic properties.
6. Educating consumers on this issue so that they choose products with sustainable harvesting and organic/ecological cultivation labels.
7. Linking the management and conservation of MAPs and other NTFPs with the commercial development of these resources.
8. Moving beyond demonstration/pilot projects towards comprehensive conservation, use, benefit-sharing and sustained human health.

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# Biodiversity from the Centre of the World: Medicinal Plant Conservation through Sustainable Use: the Case of the Natural Ingredients Sector of Biotrade Initiative of Ecuador

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## Introduction

The Biotrade Initiative (BI) was established in Ecuador in January 2002, with the subscription of a formal agreement between the United Nations Commission on Trade and Development (UNCTAD), the Ministry of the Environment of Ecuador, the Corporation of Export and Investment Promotion (CORPEI) (as the national focal point) and EcoCiencia (as the technical partner within the national focal point). The mission of BI is to promote biodiversity conservation and the reduction of poverty through the sustainable use of these resources.

It is important to note that BI implemented its strategy not as a sole executor but as a coordinator of a network of actors involved in such mission. Organisations such as Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), local universities, Centro Nacional de Acuicultura e Investigaciones (CENAIM), Canadian Government supported NGOs, the Dutch Embassy in Ecuador, Charities Aiid Foundation (CAF), Fundación Natura, CENAIM, Fundación Chankuap, Fundación Rescate Jambelí, Organization of American States (OAS) and *Jambi Kiwa*, are some the donors or partners of the several projects that have been implemented.

Since its initiation, BI has implemented pilot projects throughout the country in sectors such as the mariculture of scallops, the production of alpaca fibres, the extraction of essential oils from Amazonian plants and the sustainable use of wetlands. Since 2003, BI has adopted the strategy of supporting not only products but also sectors or whole value chains.

Today, BI is working to support the natural ingredients for cosmetics and Pharmaceuticals sector (NICP), natural ingredients for the food industry, the bird watching sector and value chain.

Besides these value chains, BI has offered help to specific programmes such as the New Ventures Investment Forum of the World Resources Institute, with support of CAF, UNCTAD and other actors. Also, in the spirit of project contests, BI partnered with Regional Fund of Appropriate Technologies for the Sustainable Management of Natural Resources (FOMRENA), a project founded by GTZ to support five new projects fulfilling both the Biotrade and FOMRENA's criteria.

Basic aspects of the Bi's work are the Biotrade principles and criteria. These set of tools serve to differentiate a simple use of biodiversity project from what we call a 'biotrade project.' These set of analytical and prospective tools are in continuous improvement because the local and regional biotrade offices make changes as new projects are implemented.

## The natural ingredients for cosmetics and Pharmaceuticals sector NICP

So far, the NICP is the star sector for BI in Ecuador. The idea has always been to support sectors within a multidimensional approach. In this sense, the strategy has been not to depend on one supporting project to strengthen the value chain but instead with the integration of several supporting projects shooting at the same common target. For example, the NICP receives support from:

### Biotrade Facilitation Programme (BTFP)

This is a programme led by UNCTAD's Biotrade office with financial or technical assistance from the State Secretariat for Economic Affairs (SECO), Directorate-General for International Cooperation (DGIS), Centre for the Promotion of Imports from developing countries (CBI), Swiss Import Promotion Program (SIPPO), International Trade Corporation (ITC), among others. As shown in Annex 2, BTFP finances specific activities such as good conservation practices and new product development. It is important to note that during the strategic planning stage of the NICP, a key issue identified was that local companies must develop new products from local biodiversity in order to target speciality niches in international markets. The BTFP is also financing market studies.

### Dutch Embassy Project

As it has been explained, the idea is to provide support to the different stages of the value chain. In this sense, the NICP sector has actors at different levels of development and with different approaches to their development. There are those born as projects from NGOs that are migrating recently to a more business-like structure, there are those as networks of small producers integrated as cooperatives or shared ownership companies and there are those as conventional family owned small and medium sized companies. Consolidated corporations are not the focus of our work but are considered for partnerships in order to secure markets with strategic alliances. These types of partnerships have been explored in business to business meetings with encouraging success.

Table 1 Services as a function of the stage of development

	1	2	3	4	5	6
Stage:	Idea	In operation pre-commercial	Local Commerce	Starting Associations and alliances	Pre export	Export success
Types of services required	Business plan. Feasibility studies. Market studies.	Business consulting Support services. Cost accounting Technical and process transfer.	GAPs, GMPs, GCPs, Business support services. Strategic Planning Marketing and commercial quality improvement.	Organisational consulting, legal, network formation, associations and strategic alliances. Logistics, strategies to consolidate value chain formation. Increase volumes. Financing for growth. Sustainability issues. Local B2Bs and trade fairs.	Market studies. International partners. B2Bs international trade fair participations. International trade training, export training. Quality and packaging. Legal compliance improvement for export.	Trade fair participation. Product value added, market diversification and customer Integration. Strategic alliances. Value chain improvement and strategic linking.

The funds from the Dutch Embassy project are being channelled to provide capacity building to the projects and business ventures at a lower stage of development (see Figure 1) but not at the idea level. Although some support has also been given to more structured small companies, the main focus is to structure the network of community-based ventures and their capacity building (levels 2-5). Several meetings have been financed to encourage cooperation and integration of the network now named *Mashi Numi* (a fusion of *quicha* and *shuar* names meaning 'friends of the forest'). Capacity building activities have included, among others, good agricultural, conservation and manufacturing practices workshops, organic certification, legal advice for formal legal structuring as network, sanitary registry technical support, commercial strategy consulting, packaging and web page for commercial promotion.

### CORPEI-CBI Export Development Programme

CORPEI, prior to the participation of BI, has been working with the support of the Dutch Centre for Import Promotion (CBI) that promotes imports into the European Union. Typical CBI Export Development Programmes (EDPs) provide technical assistance with an assigned expert consultant; commercial assistance and information systems, trade fair participation preparation and co-financing and participation in an periodic export training seminar (EXPROs).

### Organization of American States (OAS)

CORPEI helped one of the institutions, *Jambi Kiwa*, to obtain direct financing from the OAS. This funding covered not only services but also the purchase of machinery for their new processing plant opened in 2004.

## *Mashi Numi*: the main focus of the work for the development of the NICP Sector

*Mashi Numi* is a network of 14 community-based organisations/companies producing natural ingredients and medicinal plants. The network started to work together during 2003 and a more formal legal structure is expected to be in place by the end of 2004. Members are estimated at 2500 people from the Coastal, Amazon and Andes regions of Ecuador and are in general from indigenous and local populations. Their consolidated offer includes approximately 150 plant species both native and exotic to Ecuador. *Mashi Numi* promotes a philosophy of:

- Endorsement of local knowledge and use of plants;
- Conservation and good environmental practices;
- Sustainable production and supply chain;
- Organic production and good collection practices; and
- Benefit sharing along value chain.

These organisations operate in 100 ha of domesticated plant fields, collect from 650 ha of Andean forests and 80,000 ha of tropical forests. Today, they can process more than 200 tonnes of plants per year. Related to the network, we have established links with several processing and commercialisation companies as part of the sector value chain.

## General Objective

A network of suppliers of medicinal and aromatic plants and spices who promote sustainable use of natural resources, with high quality standards, under international specifications and that provide a direct benefit to local communities.

## Specific Objectives

- To consolidate the network and position it at local and international markets;
- To improve quality and management at the stages of collection, agricultural, process and logistics. Good conservation and environmental practices must be ensured throughout the process;
- To build capacity in technical, associative, social, environmental, process, administrative, managerial and research aspects at the local level;
- To generate adequate tools for new funding that will guarantee the network's development and management (sustainability); and
- To access markets for current products and for new developed products.



Photo credit: Giovanni Ginatta Higgins

A member of Jambi Kiwa, a community-based organisation



## Members

The following are current members of *Mashi Numi* network:

Name of organisation	Type	Members	web link	Region
Asociación de productos de Plantas Medicinales de Chimborazo "JAMBI KIWA"	Commercial Association	400 families	<a href="http://www.jambikiwa.com">www.jambikiwa.com</a>	Sierra
Asociación de expendedores de plantas medicinales Carabotija	Commercial Association	18	N/A	Sierra
CEDEIN /Huertos Eden	Commercial Association	450 families	<a href="http://www.huertoseden.com">www.huertoseden.com</a>	Sierra
Fundacion Chankuap – recursos para el futuro	NGO	400 families	<a href="http://www.chankuap.com">www.chankuap.com</a>	Oriente
Escuelas Radiofónicas Populares del Ecuador	NGO	450 families	<a href="http://www.erpe.org.ec">www.erpe.org.ec</a>	Sierra
Nueva América - Jambi Sacha	Commercial Association	27		Sierra
Fundación Familia Salesiana Salinas	NGO	18 families	<a href="http://www.salinerito.com">www.salinerito.com</a>	Sierra
San José de las Palmas	Commercial Association	40 families	N/A	Sierra

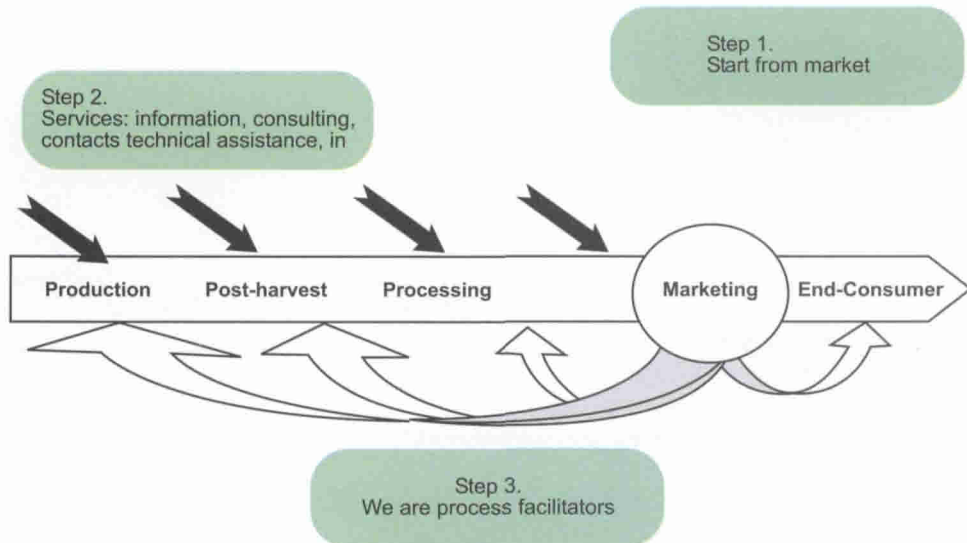
The following are private companies included in the value chain analysis work and that have established ties with the network: Agroalegre, AgroTrading, Sisacuma, Amazon Aroma, Compañia Ecuatoriana del Te, LAFIP, Lapronag, Master Plant, Natusil, Renase.

Santa María de Milán	Commercial Association	7	N/A	Sierra
Asociación Agroartesanal de Productores de plantas secas medicinales del Ecuador	Commercial Association	300	N/A	Sierra
Nunkui	NGO	26	N/A	Amazonia
Nueva Semilla	Commercial Association	15	N/A	Sierra
Promoción Humana	NGO	34	N/A	Sierra
Loma Alta	Commercial Association	30	N/A	Coast

## The history of the support process

Using the methodology of the BTFP and ITC to analyse sectors as strategic links among their members (value chain analysis), the key issue is to start with a market perspective in order to assure sustainability:

Figure 1. Services must be market driven and are offered for the different stages of the value chain.

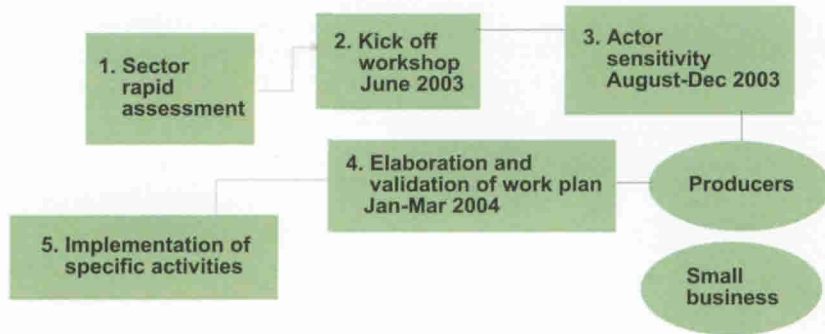


For CORPEI and BI, this process has been a learning experience and we have developed and improved support services along the way (Figure 1). The history is summarised as follows:

Initial assessments were carried out during 2003 and the work plan and implementation phase began in 2004. The first year was the key to integrate actors, to create an environment of trust and to make the group define their own mission, goals and work plan. The second year (2004), was a year of validation and implementation. The process stages in order of implementation were:

1. Identification of relevant actors (including producers, universities, service providers, donors);
2. SWOT analysis with relevant actors;
3. Meetings to create awareness, integration among actors, consolidate criteria and strategy of the network;
4. Defining strategic plan, annual operative plan and build consensus among actors;
5. Defining the network's temporary structure and government;
7. Monthly meetings of the network with assistance of CORPEI (temporarily); and
8. Planning and evaluation/validation meetings with network's members.

Figure 2 History of the work done by Biotrade- CORPEI with the sector



## Action lines and activities

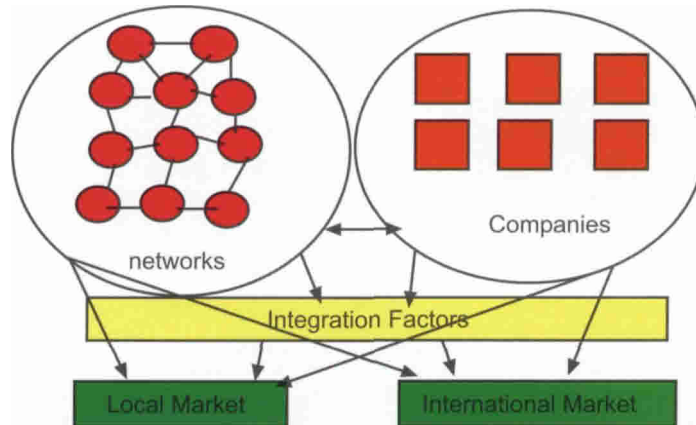
Some of the typical activities along this process have been:

- Commercial (local and export) promotion. This includes trade fair participation, creation of a web page, printed promotional materials, business-to-business meetings.
- Market studies and commercial strategy definition.
- Technical assistance at all levels:
  - a. Operations: procedures and manuals for exports.
  - b. Quality improvement assistance and workshops.
  - c. Sanitary registry and laboratory assistance.
  - d. Good environmental, agricultural and manufacturing practices, workshops.
- Links along the value chain: organised meetings between the network and local processors and exporters. Advice on commercial agreements and alliances.
- Trust-building meetings and organisational structure support.

## Results

- Relative trust built among network members, knowledge of the supply and demand of each member.
- Approximation among network members and more structured commercial businesses, breaking down of old stereotypes and distrust between community based producers and formal businesses.
- Sales and production increase in a relatively short period of time.
- Two joint marketing/commercial agreements signed and under implementation.
- Organisations trained in GAPs, GMPs and GCPs.
- Organisations trained in sales techniques, marketing, cost accounting, negotiation and other managerial capacities.
- Six environmental and wise use plans developed for six companies and sector organisations.
- Sector strategy designed and validated by network members (and under implementation).
- Web page launched.
- Organised marketing information per company and promotional printed material.
- Participation in trade Fair Latinpharma Rio de Janeiro Brazil 2004.
- Draft legal arrangements formulated for network formal constitution.
- *Jambi Kiwa* inaugurated new processing plant with partial support from the integrated project.

Figure 3 Format for sector integration A succesful network: Integration



## Conclusions

- Organising networks of small producers requires a long process of preparation so that a sense of ownership and trust is established.
- It is possible and necessary to use a 'value chain analysis' approach to structure the sector, starting with a market-oriented direction.
- With proper coordination, it is possible to deliver services from a variety of actors to the network in order to generate conditions and internal capacities for both local and export markets.
- Associativity and integration are necessary to achieve commercial volumes and quality. It is possible, with the appropriate structure and trust building methods, to link the social sector (micro-enterprises) with the more formal business sector.
- Conservation practices can and should be incorporated into the standards of these projects as part of the delivered services and as a condition for participation.
- New product development is necessary but is longer and a more capital-intensive process and the initial phase must be based on existing products for a shorter term.
- It is important to link conservation with sustainable use. Sustainable use should always be tied to very concrete social and economic incentives. Even at a very slow pace, community participants must see the potential brightness of the future ahead.
- Local leadership is also vital. Most of the remaining network members have enthusiastic, positive, hard-working leaders supporting and ensuring follow up of the process.
- Our role as impartial facilitators has been vital in critical moments.
- Pre-conditions and showing clear rules (such as sustainability compliance rules) from the start has been key to show consistency and ensure the actors were willing to play along the intended framework. Surprises would have broken gained trust.

## Acknowledgements

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- UNCTAD Biotrade's lead role in the region to keep up the Biotrade Initiative.
- CECI
- EcoCiencia for their partnership at the Biotrade Initiative
- The Ministry of the Environment of Ecuador for their continuous support.
- *Mashi Numi* and all its members, specially *Jambi Kiwa*.

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Ecuador's Biotrade Initiative: [www.biocomercioecuador.org](http://www.biocomercioecuador.org)

Web page for promotion of Ecuador's medicinal plants and herbs network: [www.hierbasdelecuador.com](http://www.hierbasdelecuador.com)

Fundación CENAIM: [www.cenaim.espol.edu.ec](http://www.cenaim.espol.edu.ec)

Fundación Chankuap: [www.chankuap.com](http://www.chankuap.com)

Internacional Trade Center: [www.intracen.org](http://www.intracen.org)

Ministerio del Ambiente del Ecuador: [www.ambiente.gov.ec](http://www.ambiente.gov.ec)

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Proyecto FOMRENA GTZ: [www.gtz.de](http://www.gtz.de)

SIPPO: [www.sippo.ch](http://www.sippo.ch)

UNCTADs Biotrade Office : [www.biotrade.org](http://www.biotrade.org)



Photo credit: C ORPEI

Fundacion Salinas' store for its products

## Annex 1: Sample list of products from Mashi Numi

Type of product	Product	Scientific name
Herbal teas		
Mixtures	Tisana Andina	Mixtures
	Horchata	Mixtures
	Fórmula adelgazante	Mixtures
	Fórmula diurética	Mixtures
	Fórmula expectorante	Mixtures
	Fórmula desparasitante	Mixtures
	Fórmula hígado	Mixtures
	Fórmula bilis	Mixtures
	Fórmula nervios	Mixtures
	Fórmula desinfectante	Mixtures
	<i>Guayusa</i> (Rainforest Holly), Lemon grass and <i>Ishipingo</i> (American Cinnamon)	<i>Ilex guayusa</i> , <i>Cymbopogon citratus</i> , <i>Ocotea quixos</i>
	<i>Ishipingo</i> and Lemon grass	<i>Ocotea quixos</i> , <i>Cymbopogon citratus</i>
	Lemon grass and Ginger	<i>Cymbopogon citratus</i> , <i>Zingiber officinale</i>
	<i>Ishipingo</i> , Lemon grass, Guayusa and Ginger	<i>Ilex guayusa</i> , <i>Cymbopogon citratus</i> , <i>Ocotea quixos</i> , <i>Zingiber officinale</i>
Individual teas	Bitter Orange leaf	<i>Citrus aurantium</i>
	Borage	<i>Borago officinalis</i>
	Chamomile	<i>Matricaria recutita</i>
	Common Lime	<i>Tilia europaea</i>
	<i>Cucharillo</i>	<i>Oreocallis grandiflora</i>
	Guayusa	<i>Ilex guayusa</i>
	Herb of grace	<i>Ruta graveolens</i>
	Least Mallow	<i>Malva parviflora</i>
	Lemon grass	<i>Cymbopogon citratus</i>
	<i>Mashua</i> (Nasturtium)	<i>Tropaeolum tuberosum</i>
	Nettle	<i>Urtica urens</i>
	Rosemary	<i>Rosmarinus officinalis</i>



Dried Chamomille flowers at Jambi Kiwas processing plant

Photo credit: Lorena Jaramillo G.,  
Biocomercio/CORPEI

Spices		
	<i>Annatto</i>	<i>Bixa orellana</i>
	Chilli	<i>Capsicum frutescens</i>
	Ginger	<i>Zingiber officinale</i>
	Turmeric	<i>Curcuma longo</i>
Essential Oils	Cypress	<i>Cupressus macrocarpa</i>
	Eucalyptus	<i>Eucaliptus globulus</i>
	Ginger	<i>Zingiber officinale</i>
	Lemon	<i>Citrus x limon</i>
	Lemon grass	<i>Cymbopogon citratus</i>
	Lime	<i>Citrus limonum</i>
	Orange	<i>Citrus aurantium</i>
	Pine	<i>Pinus radiata</i>
	Turmeric	<i>Curcuma longa</i>
	Diluted (in almond 10%)	
	Dragon's blood	<i>Croton lechleri</i>
	Ginger	<i>Zingiber officinales</i>
	<i>Hoja de Ispingo</i>	<i>Ocotea quixos</i>
	Lemon	<i>Citrus x limon</i>
	Lemon grass	<i>Cymbopogon citratus</i>
	Orange	<i>Citrus aurantium</i>
	Turmeric	<i>Curcuma longa</i>
	<i>Ungurahua</i> (Milpesos palm)	<i>Oenocarpus bataua</i>
Cosmetics	Ointment of Curabena (Divine nightshade, Seashore vervain and Rosemary)	<i>Solanumnigrescens, Verbena litoralis, Rosmarinus officinalis</i>
	Ointment of Curalipto	<i>Eucaliptus globulus</i>
	Ointment of Curapino	<i>Pinus radiata</i>
	Ointment of Curapres	<i>Cupressus macrocarpa</i>
	Shampoo Rosemary	<i>Rosmarinus officinalis</i>
	Bath soap Ispingo	<i>Ocotea quixos</i>

## Raw material

Product	Scientific name
Alfalfa	<i>Medicago sativa</i>
Aloe Vera	<i>Aloe barbadensis</i>
Ambrosia	<i>Ambrosia arborescens</i>
<i>Arquitecto</i>	<i>Lasiocephalus ovatus</i>
<i>Arrayan</i>	<i>Myrcianthes hallii</i>
Artichoke	<i>Cynara scolymus</i>
Avocado leaf	<i>Persea americana</i>
Balsam Apple ( <i>Achochilla</i> )	<i>Mormodica charantia</i>
Bitter orange leaf	<i>Citrus aurantium</i>
Black cherry ( <i>Capuli</i> ) leaf	<i>Prunus serotina</i>
<i>Borage</i>	<i>Borago officinalis</i>
Broad-leaved dock	<i>Rumex obtusifolius</i>
<i>Calaguala</i>	<i>Campyloneurum amphostenon</i>
Celery	<i>Apium graveolens</i>
Chamomile flower	<i>Matricaria recutita</i>
Common horsetail	<i>Equisetum bogotense</i>
Common lime	<i>Tilia europaea</i>
Common mint	<i>Mentha sativa</i>
Corn silk	<i>Zea mays</i>
Chilca	<i>Baccharis tricuneata</i>
<i>Chuquiragua</i>	<i>Chuquiraga jussieui</i>
Dandelion	<i>Taraxacum officinalis</i>
Dill	<i>Anethum graveolens</i>
Divine nightshade	<i>Solanum nigrescens</i>
Eucalyptus	<i>Eucaliptus globulus</i>
<i>Grana</i>	<i>Paspalum humboldtianum</i>
Herb of Grace	<i>Ruta graveolens</i>
Herb of Saint Mary (Purple foxglove)	<i>Digitalis purpurea</i>
Knotgrass	<i>Polygonum aviculare</i>
Least mallow	<i>Malva parviflora</i>
Lemon balm	<i>Melissa officinalis</i>
Lemon grass	<i>Cymbopogon citratus</i>
Lemon verbena	<i>Aloysia triphylla</i>
Love-lies-bleeding	<i>Amaranthus caudatus</i>
Mint	<i>Mentha viridis</i>
Nettle	<i>Urtica urens</i>
Oregano (leafs)	<i>Origanum vulgare</i>
Parsley	<i>Petroselinum sativum</i>
Peppermint	<i>Mentha piperita</i>



Product	Scientific name
Pepperina ( <i>Tipo</i> )	<i>Minthostachys mollis</i>
Peruvian walnut leaf	<i>Juglans neotropica</i>
Plantain	<i>Plantago major</i>
Pot marigold	<i>Calendula officinalis</i>
Rainforest holly ( <i>Guayusa</i> )	<i>Ilex guayusa</i>
Rosemary	<i>Rosmarinus officinalis</i>
Seashore vervain	<i>Verbena litoralis</i>
Spiked ( <i>Matico</i> ) pepper	<i>Piper angostifolium lam</i>
Sweet basil	<i>Ocimum basilium</i>
Thyme	<i>Thymus vulgaris</i>
Valerian	<i>Valerian officinalis</i>
Wild carrot leaf	<i>Daucus carota</i>
Wormseed	<i>Chenopodium ambrosioides</i>
Wormwood	<i>Artemisia absinthium</i>

#### Other raw materials

Product	Scientific name
Annatto	<i>Bixa orellana</i>
Chilli	<i>Capsicum frutescens</i>
Dragon's Blood	<i>Croton lechleri</i>
Ginger	<i>Zingiber officinalis</i>
Lemon grass	<i>Cymbopogon citratus</i>
Milpesos Palm ( <i>Ungurahua</i> ) oil	<i>Oenocarpus bataua</i>
Rainforest holly ( <i>Guayusa</i> )	<i>Ilex guayusa</i>



Photo credit: CORPEI

Ecuadorian value-added products derived from MAP

# Conservation of Medicinal Plants: Experiences from Sri Lanka

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## Introduction:

For millennia, plants and plant products have been used systematically by humankind for treating illnesses. In Sri Lanka, the traditional systems of medicine are known to have been practised for at least three thousand years. When last listed, 1,414 plant species (of a total of approximately 3,400 indigenous and naturalised species) were recorded as being used in *Ayurveda* in Sri Lanka (Anon, 1997). Approximately 200 species of medicinal plants (MPs) are used commonly, and of these, 50 are used heavily in *ayurvedic* and traditional health care systems (Anon.,1997). Nearly 80 medicinal plant species are now considered threatened (Anon., 1997). In addition to recognising their curative and therapeutic value, Sri Lankans use MPs in rituals, cultural activities and religious functions. Thus, medicinal plants play an important part in the daily lives of the Sri Lankan people.

About 35% of the Sri Lankan population is primarily dependent on *ayurveda* and traditional systems of health care, and there is a long history of traditional knowledge associated with plant use (Anon., 2000). In particular, rural populations depend heavily on these systems. In village societies, *ayurvedic* physicians and traditional medical practitioners are integral, and there is an interwoven relationship between communities and such practitioners. On most occasions, illnesses are treated free of charge, with practitioners often providing medicinal plant preparations as well. In rural areas, medicinal plants are collected primarily from forests and other natural (i.e. uncultivated) habitats. In the past, villagers collected only their requirements for treating illnesses, or healers harvested the minimum amounts required for the preparation of medicines. Thus, in the past, communities practised the concepts of sustainable use, with minimal damage to the habitats in which these precious plants were found.

The increased demand both for local medicinal use, as well as for export has placed a great strain on the natural populations of plants. Collectors of medicinal plants are now resorting to unsustainable exploitation, causing serious threat to the survival of some species. This overexploitation is exacerbated by the rapid depletion of natural habitats. Indeed, habitats in which these medicinal species are found are threatened too. For example, forest cover in Sri Lanka has declined from

84% of total land area in 1881, to 24% in 1992 (FPU, 1995; Legg & Jewell, 1995). During this period, the Sri Lankan population rose from 0.9 million to about 19.5 million. Forest degradation has occurred particularly rapidly in the biodiversity-rich, densely-populated wet zone of the island's southwest, where less than 10% of the original forest cover now remains, and 40% of primary forest cover was lost in the period between 1956-1983 (Gunatilleke & Gunatilleke 1991).

This emerging threat to natural populations of medicinal plants greatly concerned the Government of Sri Lanka, which realised that it had become essential not only to take swift action but also to put in place a plan for the long-term conservation of Sri Lankan medicinal plants.

## The Sri Lanka Conservation and Sustainable Use of Medicinal Plants project

In order to address the rapidly declining medicinal plants populations in Sri Lanka, and associated social and economic impacts, a project was launched in 1998 for the conservation of medicinal plants and for the promotion of their sustainable use. This project was supported by the Global Environment Facility (GEF). The project sought to secure the conservation of globally and nationally significant MP species and habitats through:

- (a) *In situ* conservation: through the establishment of five Medicinal Plant Conservation Areas (MPCAs) in different ecological zones of Sri Lanka as part of, or adjacent to, existing natural forests that are the home of some threatened MP species;
- (b) *Ex-situ* cultivation; through the promotion of nurseries and germplasm collections, cultivation in home gardens and plantations, and supporting propagation and agronomic research; and
- (c) Provision of information and institutional support, including the promotion of appropriate legal and policy environments.

An important element of the adopted strategic approach has been to define and demarcate MPCA reserves in biogeographically representative areas, and use these as centres for a wide range of activities that cover conservation, propagation, basic processing, ethnobotanical and ecological studies, awareness promotion, as well as extension and outreach programmes (Anon., 1997).

As threatened as some of the medicinal plants of Sri Lanka is the knowledge base on which traditional medicinal systems has been developed, because only a small portion of traditional knowledge and ethnobotanical information has been documented. The majority remains recorded in ancient, obscure *ola* (palm leaf) manuscripts scattered throughout the country or locked in the memory of elderly practitioners. In the past, as a practice, traditional practitioners passed on their knowledge to blood relatives. However, due to waning interest in younger generations, this system - known as the *gurukula* system of ancient teaching of traditional knowledge - is fast disappearing. This traditional knowledge not only addresses health care of individuals; it also addresses the traditional care and management of the natural resources surrounding the rural communities (Mahindapala, 2004a).

# The project interventions, results and discussion

## Medicinal Plant Conservation Areas (MPCAs)

A key activity of the Project was the demarcation of medicinal plant reserves, selected mainly on the basis of the known presence of important species (and where, despite regulatory restrictions, active collection of medicinal plants from the wild by local communities was ongoing), human pressure, and habitat destruction, in biogeographically representative areas and the use of these as centres for a wide range of activities. For this purpose, five MPCAs were established in Bibile and Ritigala (in the dry zone), Rajawake and Naula (in the intermediate zone) and Kanneliya (in the wet zone) (See Figure 1).

Each MCPA consists of (1) core forest lands managed for conservation (e.g. forest reserves, strict nature reserves, sanctuaries) or for timber extraction purposes, which is (2) surrounded by domestic land defined by the boundaries of about ten *Grama Niladhari Divisions* (GND)<sup>1</sup> abutting the core forest area. The GNDs themselves often include significant areas of natural vegetation, in addition to those occurring in core reserved lands. The extent of natural vegetation at respective MPCAs was estimated to range between 42.7-149.6 km<sup>2</sup> (Table 1).



Figure 1. Geographical location of MPCAs

Table 1: Extent of natural vegetation habitat at each MCPA

MCPA	Extent of natural vegetation (km <sup>2</sup> )
Bibile	114.6
Kanneliya	61.7
Naula	42.7
Rajawaka	65.2
Ritigala	149.6

Source: Adapted from Russell-Smith et al. (2004)

*In situ* conservation relies very heavily on the active involvement of the communities living around the core forest area for promoting conservation and sustainable use of medicinal plants. Each MCPA has a site consisting of a medicinal plant garden (which serves as a demonstration site), a medicinal plant-processing centre for the use of communities, an *ayurvedic* dispensary (which is expected to depend on preparations made by the communities), and an information centre.

<sup>1</sup>GND is an administrative unit and will contain several villages.

## Assessment of the potential of medicinal plants

Aside from the demand for medicinal plants for use in daily prescriptions for the preparation of decoctions (*kashayas*), there is a thriving *ayurvedic* drug production business in Sri Lanka. A survey carried out in 2000 showed that there were 104 *ayurvedic* drug production units in the country, using herbal materials valued at approximately 1,760,000 USD. Table 2 shows that only 68% of the national demand for medicinal plants is met currently by local supply (Abeywardena & Hettiaratchi 2001).

**Table 2 - The national demand for herbal material (in 2000)**

Source	Quantity (kg)	Value (SLRs)	%
Imports	1,509,201	125,091,177.96	32
Local supply	2,355,559	261,634,461.65	68
National Demand	3,864,760	386,725,639.61	100

Source: Abeywardena & Hettiaratchi (2001) Note: US\$1 approximately SLR 100

About 80% of locally supplied medicinal plants are collected from the wild. Of the 50 species most heavily used, 30 are collected primarily from forest habitats (IUCN, 1996). Such increasing local usage also reflects growing international demand. Indeed, in 1996, the world-wide trade in MPs was estimated at 1.3 billion USD (Lange & Schippmann, 1997).

Table 3 provides information on the ten largest imported herbal materials and their values. It should be noted that several of these species occur naturally, (e.g. *Phyllanthus*), or are cultivated easily.

**Table 3 The ten largest imported herbal materials (in 2000)**

Species	Source	Quantity (Kg)	Value (SL Rs)
<i>Solanum virginianum</i>	India	253,416	10,247,506.40
<i>Mollugo cerviana</i>	India	151,539	10,909,611.00
Zingiber officinale [dried]	Dubai/China	126,500	8,321,600.00
<i>Anethem graveolens</i>	Pakistan	83,341.60	2,518,364.00
<i>Cedrus deodara</i>	India	74,737.50	2,452,939.20
<i>Glycyrrhiza glabra</i>	Pakistan	55,609	1,878,654.40
<i>Phyllanthus emblica [dried]</i>	India	55,100	4,772,611.20
<i>Trachyspermum roxburghianum</i>	Pakistan/Dubai	53,222.20	3,202,500.00
<i>Withania somnifera</i>	India	42,347.10	2,840,449.60
<i>Piper longum</i>	India	42,163	20,084,158.80

Source: Abeywardena & Hettiaratchi (2001) Note: US\$1 approximately SLR 100

## Community participation and livelihood improvements

Each MPCA has about ten villages, and the communities in these villages were mobilised with concerted awareness programmes. They were organised into Village Project Management Committees (VPMCs), which were registered to enable independent operation, and were entrusted, after due training, to identify and implement activities, primarily for improving livelihoods, and, at the same time, conservation of medicinal plants. They were provided with medicinal plant processing facilities, as well as a drug manufacture unit, together with technical assistance and training.

The VPMCs are organised into an apex body, the Conservation Area Management Committee (CAMC), mandated to undertake activities common to the CAMC.

Although the communities living in the MPCAs are quite poor, they have now recognised the value of conservation (Samaranayake, 2003). Using Participatory Rural Appraisal (PRA) and Participatory Innovation Development (PID) techniques, they have developed micro-plans for the MPCAs, identifying a range of activities to achieve the objective of conservation and sustainable use of medicinal plants. For instance, in some MPCAs, the community felt that forest fires had to be reduced. Thus, fire belts were established with the cooperation of the Forest Department. Concomitantly, they undertook enrichment planting of the forest, using locally-found medicinal plant species. Some of the community members functioned as paraforesters in resource surveys and in ethnobotanical surveys. After five years, their level of understanding of conservation is relatively high. They have provided leadership for establishing school medicinal gardens, and have persuaded the Forest Department to enter into a memorandum of understanding with them on joint forest management, thereby taking the responsibility for forming forest vigilant committees and seeking sustainable harvesting of identified medicinal and other non timber forest products (NTFPs) from the forest.

At the beginning of the Project, almost all members participated actively in project activities. Later on, there was waning of interest. At the closing of the Project, active members ranged from about 50% to 75%. There are a number of reasons for this fluctuation, although 50% is a satisfactory level. To illustrate this aspect, pertinent information from Bibile MPCA is given in Table 4.

Parallel with conservation efforts, the VPMCs have embarked on a number of initiatives for livelihood improvement (Samaranayake, 2004). These include, amongst others, the following:

- *Ex-situ* cultivation of medicinal plants and their scientific processing are significant achievements. Links have been established with drug manufacturing facilities for the supply of raw materials and processed medicinal plants;
- Communities have taken advantage of the facilities to process vegetables during the season, and this will bring them additional income;
- Production of *ayurvedic* medicine;
- Bee-keeping;
- Supply of planting materials; and
- Over the years, the VPMCs have developed a revolving fund, which is now used for further enterprise development and for micro-credit.

Because of engaging in income-generating activities, the VPMCs have accrued funds. The current situation concerning the funds of the Bibile MPCA is presented in Table 4.

Table 4 Active Membership and Funds Collected (Bibile MOCA)

VPMC	No. of families	No. of Members	No. of active members	VPMC fund
Hamapola	215	119	70	142,116.00
Thotillakatiya	172	115	70	194,933.00
Pitakumbura	209	125	60	167,330.00
Nilgala	158	109	60	362,138.00
Bulupitiya	202	105	40	224,526.00
Urawala	82	61	30	77,308.00
Galgamuwa	182	73	35	53,215.00
Nilliyadda	125	97	45	67,745.00
Ratugala	82	50	50	165,480.00

Source: Dainis, (2004)

Note: US\$1 approximately SLR 100

A recent survey indicates that around 40% members of all the VPMCs have improved their livelihoods substantially because of project activities. For example, around 50 families of indigenous people in the Ratugala VPMC (of the Bibile MPCA), who were earlier dependant heavily on forest resources, have commenced paddy cultivation with project support and have, largely, improved their livelihood. The situation in some VPMCs is better than in others. Some VPMCs have converted their savings into a revolving fund, which is, in turn, used for further income-generation activities. This revolving fund has helped the VPMCs to keep the membership active. They have regularly held VPMC meetings maintaining over 50% attendance (Dainis, 2004).

## Plant inventory work

The Project undertook a resource inventory in the respective MPCAs to provide: (a) baseline assessment of the distributions, associated population structures and densities, and ecological requirements of medicinal plant species; and (b) an informed basis for ongoing *in-situ* conservation, management, and harvest sustainability of defined priority medicinal plant species.

The methodology comprised the following:

- (a) Quantitative assessment of medicinal plant populations and habitat features at 901 inventory plots, located using a strict hierarchical stratification;
- (b) Standard numerical classificatory procedures that defined major habitat types; and
- (c) Aerial estimates of habitats based on available fine-scale topographic mapping, augmented with refined mapping derived from Landsat TM imagery.

The fieldwork for the resource inventory was undertaken with the active participation of local communities ('para-foresters'), who were trained in the requisite techniques. During this inventory work, 1,400 medicinal plant species that occurred in conditions ranging from dense-canopied, relatively undisturbed tropical forest, to savanna were sampled; most vegetation was of secondary, reflecting ancient and varied histories of slash and burn cultivation, the burning of grassland/savanna

for pastoral purposes, and recent logging. For 23 priority medicinal plant woody species, derived population estimates and structures were described, and the potential for sustainable harvest from the wild, assessed.

The plant inventory work can be considered as a pioneering effort in Sri Lanka, that has provided invaluable data for conservation work (Russell-Smith et al., 2004). Simplified versions of the plant inventories were made available to the communities in order to raise awareness of their flora and biodiversity.

Associated with this study, the Project launched a pilot study to determine acceptable levels for sustainable harvesting of selected species. In view of the current pattern of collection of medicinal plants and the knowledge that some of the species are collected illegally, it was important to decide on permissible levels of harvesting. In this regard, data were collected for selected species: *Terminalia chebula*, *Phyllanthus emblica*, *Munronia pinnata*, *Coscinium fenestratum* and *Garcinia quesita*. These studies are essentially long-term, but during a short period of 18 months, the Project collected valuable information with regard to collection patterns, amounts collected, preliminary information on regeneration patterns in some species, and cases of destructive harvesting (Singhakumara, 2003). These studies are indicative of the need for long-term studies, and will provide much-needed information on harvesting levels for selected species. Such data would be essential prerequisites for implementing forest community management regimes.

## Agronomic aspects

Cultivation of medicinal plants at the community level, as well as at a commercial level, is hampered due to the paucity of nursery and agronomic information. As was seen in the preceding sections, there is a significant demand for medicinal plants, many of which could be grown in Sri Lanka. In addition, the home garden planting programme for these communities requires a significant volume of planting material. In order to address this issue, the Project launched a contract research programme to develop protocols for nursery management, supply of planting materials and to provide basic guidance on commercial cultivation.

This contract research programme was implemented through several 'centres of excellence', such as universities and applied research institutions. In addition, farming systems research and adaptive research trials were undertaken in farmers' fields to evaluate the community perceptions and acceptance of the technologies developed (Mahindapala, 2004b). This programme has been able to develop protocols for nursery propagation for 22 species of medicinal plants. In several species, significantly large areas were developed as nursery stocks. On many occasions, the researchers provided training to both farmers and *ayurvedic* practitioners. However, in some cases, the economic analyses of agronomic practices could have been improved to provide a better picture of costs and benefits. In order to encourage large scale planting, a system of 'outgrower' contract growing system was introduced and the produce was purchased centrally at prevailing market prices.

Using the information generated from the contract research programme, supplemented with other published information, the Project prepared two techno-guides. These techno-guides provide easy-to-follow steps on propagation, nursery establishment, and cultivation of the 23 species for which there are protocols now.



## Product Development and Marketing

A feature in the current scenario is that villagers collect medicinal plants for third parties, often middlemen, who then transport these to the main market in the capital, Colombo. As a result, the village collectors and producers receive a paltry income. In order to improve the income of the communities, action was taken to introduce a number of value-added products at each MPCA, giving consideration to the seasonal availability of raw materials, infrastructure facilities and quality assurance in product formulation and process control. The Project has contracted the Industrial Technology Institute of Sri Lanka (ITI) for regular technical support for product development and related trouble-shooting during processing and quality maintenance of the final products. This support will also be extended to other herbal and food-based products.

In close partnership with the communities, the Project identified the seasonal availability of medicinal and other plants. In this connection, the community organisations were educated on seasonal variation of raw materials, and were provided with technical skills and facilities for introduction of food material based technologies, herbal tea production (using *Cassia spp.* and *Aerva spp.*), herbal/fruit ready-to-serve drinks, and herbal shampoo using *Aloe vera* (Goonaratne, 2004).

Additionally, potential market links for the products were also identified. Already, several private companies have entered into agreements with the MPCA committees for the supply of various products. Interestingly, some of the private concerns are promoting organic farming methods for the committees in order to establish regular suppliers for organic foods and herbal material.

In furtherance of the support to the communities, good manufacturing practices were introduced for the processing units to produce *ayurveda* drugs of quality, suitable for marketing island-wide. Areas of special interest were:

- Adoption of quality control procedures (including hygiene and sanitary practices and the adoption of guidelines of the Sri Lanka Standards Institute; quality for raw materials should be based on known quality parameters; analysis of the final product for its quality);
- Improvement of process control during manufacturing (including standardisation of all procedures used in the manufacturing process of *ayurveda* drugs; storage procedure to be improved by the use of labelling of batches);
- Staff training on processing etc.
- Documentation of procedures (including preparing a manual of procedures for all products including the selection and storage of raw materials, detailed quality control, processing and packaging techniques, labelling procedures; data on cost of production for each process; and documentation of all purchases and sales);
- Legal aspects of commercial operations (including meeting environmental requirements for the removal of waste products; meeting sanitary requirements for the manufacturing of *ayurvedic* drugs as specified by the public health inspector; meeting legal requirements in labelling of *ayurveda* drugs etc.)

## Ethnobotanical information and traditional knowledge

The project identified the need for legislative and policy changes to address issues relating to the conservation of medicinal plants, regulation of harvesting, regulation of their import and export, safeguarding traditional knowledge and plant genetic resources. The Project was keen to support the review of existing legislation relating to the country's obligations to the Convention on Biological

Diversity (CBD). Areas of immediate concern were the access to genetic resources and safeguarding intellectual property rights. Essentially, therefore, the Project design identified supporting technical assistance and studies to review existing policies and legislation, and examining the feasibility of preparing laws for the protection of indigenous knowledge and the legal issues related to intellectual property rights as they relate to the use of medicinal plants.

The Project undertook an ethnobotanical survey in the MPCA areas. This survey was conducted in two phases.

Phase 1 was conducted by members of the 'ethnobotanical survey team' from state agencies working with the communities. This phase did not collect information of an IPR-sensitive nature (nor botanical voucher specimens), but focussed on the development of a sound understanding of the roles of medicinal plants and other forest products in the livelihoods of the communities surrounding the MPCAs.

Phase 2 began after the establishment of memoranda of understanding between the Project and the communities, and was conducted by a team in two villages in each MPCA. This phase would investigate knowledge and use of medicinal plant species and would involve collection of data as well as voucher specimens.

Further details on the ethnobotanical information are available in Milliken (1999, 2000).

Before undertaking these surveys, specific guidelines for the ethnobotanical survey, especially addressing issues relating to data to be collected during the surveys were formulated (Nanayakkara, 1999). These guidelines required that:

- the Commissioner of *Ayurveda*, on behalf of the Department of *Ayurveda* and the project director, should enter into an MOU in writing with the VPMCs acting on behalf of each village community, regarding confidentiality of information collected;
- access to the database on ethnobotany would be regulated;
- If the project collected voucher specimens for the purpose of the project activities, all such collections shall contain passport information enabling the repatriation of any benefits that may accrue due to such collection.

A vast body of very important information has been collected during the ethnobotanical survey. The findings have been shared with the communities, and further action will be forthcoming once proper legislation is in place.

The Project has also supported the formulation of legislation for safeguarding traditional knowledge on the use of medicinal plants. This legislation has undergone a thorough review, including public scrutiny, and is awaiting gazetting (Karunaratne, 2003).

In order to protect and continue traditional health practices, the local traditional healers have been provided with acolytes to understudy the traditional *gurukula* system of education. These acolytes have been selected from the communities, so that there is ownership amongst the communities to preserve traditional medicinal knowledge. Once their apprenticeship was completed, the acolytes were provided with short-term formal training in *ayurveda* to enable them to register themselves in the formal system of health care in Sri Lanka.

## Conclusion

The Project ceased operations in June 2004. The project activities, together with the assets have been handed over to the communities for management.

As community participation was a pivotal aspect in the project, micro-planning and associated elements were reviewed towards the end of the project (Fernando, 2005). The review noted the usefulness of micro-planning to mobilise the community to achieve project objectives at the local level. It highlighted the awareness imparted to the communities but commented on the need to regularly update the plans in the context of baseline data collection at the beginning of the year. Participatory planning, monitoring and evaluation were very useful in implementing activities under the micro-plans. This process also provided self-management tools for the communities. In spite of the emphasis placed, integration of micro-plans with other village development activities was weak to address issues of sustainability. Yet another matter of interest was that, in general, medicinal plants-based agricultural activities did not provide consistent incomes. The need to integrate them into the farming systems of the villages was important. The Project's sustainability in the light of the foregoing needs to be examined periodically, as community-based resource management is yet in its infancy in the country.

As income-generating initiatives that will also optimise medicinal plant and other herbal resources, manufacturing and value-added products were important introductions. The Project provided assistance to improve the MPCA processing units through an overall quality improvement and standardisation in the production of *ayun/edic* drugs. In addition, a number of value-added products were also recommended for production at each of the MPCAs, considering the seasonal availability of raw materials, infrastructure facilities and quality assurance in product formulation and process control. As a post-project operation, arrangements were made to continue technical assistance in these areas through the Industrial Technology Institute (ITI). Relevant staff were trained, but it is necessary that quality control parameters introduced are maintained, both in drug manufacture as well as in other processes. This work has shown the viability of the manufacture of both herbal and food-based formulations as income generating activities. Additionally, potential market links for the low-cost technologies introduced by ITI were also identified. The success of these ventures will depend primarily on the commitment shown by the MPCAs (Goonaratne, 2004).

The pertinent communities are confident of undertaking the responsibilities of project activities. In order to undertake effectively this work, the following exit plan was implemented:

- Training in management and finances, for community members;
- Providing a business plan;
- Institutional strengthening, to convert the CAMC into a company (under the Companies Ordinance), with membership from VPMCs;
- Conducting *ayurvedic* clinics;
- Continuing drug manufacturing and medicinal plant processing facilities; and
- Establishing linkages with private sector.

In order to continue the initiatives, empowerment and strengthening of community organisations have to be addressed on a regular basis. Capacity building of these organisations by way of training in financial accounting and management, exposure to ventures elsewhere and vocational training are some of the priority areas. Inculcating good governance practices and demonstration of transparency in their day-to-day work were found to be important. Introduction of a participatory monitoring and evaluation system for self-assessment of the activities was found to be an important element in enhancing the self-confidence of the communities (Samaranayake, 2004a).

The novel approach of attempting conservation with peoples' participation has shown much promise. The long-term sustainability of the venture requires well-established, independent, corruption-free community organisations, which are able to attract the support of other development agencies, and will provide a fillip to maintain traditional medicine in a sustainable footing as well.

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*Phyllanthus emblica*

Photo credit: (c) Gehan de S. Wijeyeratne

# Lessons Learned in Community Participation and Joint Forest Management: the Conservation and Sustainable Use of Medicinal Plants Project in Sri Lanka

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## Introduction

With the conclusion of the above project (described in detail in Mahindapala, this volume), it was necessary to reflect upon lessons that the implementing agency and other stakeholders could learn from this six year experience, in order to prepare better for practical initiatives of similar conservation or development projects in Sri Lanka.

With this purpose in view, my ten-month study focused on two aspects of the Project - Community Participation (CP) and Joint Forest Management (JFM) - as these two elements were considered to influence significantly the outcomes of the Project. Initially, in the US, I conducted a literature review of relevant topics (on CP and JFM in conservation projects in South Asia, as well as previous reports of the Project). During the second phase, I carried out fieldwork at the four Medicinal Plant Conservation Areas (MPCAs - see Mahindapala, this volume.), and consulted with experts and project staff in Colombo. Finally, back in the US, I analysed my qualitative data, consulted with academics and professionals, and made observations and recommendations detailed in this paper.

The three objectives of this study were:

- To examine the process of public participation at the community level;
- To understand various perspectives regarding JFM from the point of view of different stakeholders; and
- To combine the above and make recommendations in a broader context for developing other such initiatives for Sri Lanka.

1 hypothesised the following. a) There should be diverse views of the project from stakeholders but they would be all well-integrated in the project. b) The public participation regime at a local level is efficient and c) The experiences are abundant and helpful for developing such initiatives elsewhere in Sri Lanka.

I focused my study at a local level, where there were several types of stakeholders defined by their relationship to the Project:

- Those who had direct use of or who benefit from medicinal plants, such as collectors of medicinal plants, traders, traditional medicine practitioners, users of medicinal materials or products. Almost everyone in the Project sites belonged to this category of stakeholders, as it was very difficult to observe a family who did not possess any medicinal products or raw material.
- Those who affected the habitats of medicinal plants, such as collectors of NTFP, shifting cultivators, timber loggers. A significant portion of the members of the four communities could also be sorted into this category, although it was difficult to assess, as most of the activities were illegal.
- Those who implemented the Project, such as Conservation Area Management Committee (CAMC) staff administering the Project and local forest officials overseeing most of *ex-situ* conservation related activities.

I conducted rapid appraisals and semi-structured and unstructured interviews and analysed my qualitative data using textual and discourse analyses (Bernard, 2002).

I observed that there was variability in the success of the project in the four sites related to both community participation and JFM.

## Community participation (CP)

Factors that affected CP were a) Different opportunities for participation and b) Different willingness for participation:

### Different opportunities for participation

These related to the top-down decision-making mechanisms used for implementation and internal divisions that already existed in communities. These mechanisms retarded opportunities for every member of each community to participate actively.

### Different willingness for participation

These related to variation among MPCAs (their regional economies, dependencies on forests and internal bonding). This in turn, I believe, related to different characteristics in different communities.

### ○ Dependency on forests

This is a critical factor that determines the willingness of community members to participate in the Project. It is reasonable to assume that people who have a greater dependency on forests will be more involved in protecting forests as their income is derived from forests and forests sustain their daily life and health. This was observed in the MPCA of Bibile - a savannah grassland habitat in the Uva Province of the Intermediate zone (see Figure 1, Mahindapala, this volume, for location) - where more people depended on harvesting NTFPs other than medicinal species. In the other project sites, agriculture was a more prevalent form of income

generation, particularly in Kanneliya (a rainforest habitat in the Southern province of the wet zone) where smallholder tea plantations have been the source of income for a long time. Although this is important, it would be an over-simplification to say that it is the only contributing factor when more subtle local contexts are examined. I suggest that dependency on forests is the *outcome of the interactions of regional and local economic activities*.

Regional economics play a large role. The Project was clearly more successful in Bibile than in the other three sites. The lower Uva, where Bibile is situated, is an economically under-developed area (Baminiwatta, 2002), with fewer job opportunities. The majority of the population lives on subsistence agriculture (particularly shifting cultivation), which is heavily seasonal because of the extremely scarce precipitation during one part of the year. I argue that it is this difference in regional economies that have shaped Bibile to be a successful example of community involvement in the Project. Because jobs are scarce, the younger generation tends to stay in their hometown rather than work outside the area, contributing to stronger bonding within communities, as more young people participate in community and daily activities. This has resulted in strong community relationships that have formed a superior base from which the Project could perform.

In contrast, the other three MPCAs are different in terms of regional economic activities. The agricultural activities in Naula and Rajawaka are similar because both are located in intermediate zone (see Figure 1, Mahindapala, this volume, for location). The agricultural activities are seasonal, but during dry season environmental conditions are not as harsh as they are in Bibile, as a) there is more rain and b) there are regional irrigation channels, in addition to some locally deep wells. In addition to farming, most of the youth work also as hired labourers (in brick factories or garment factories) in nearby cities or towns. There is also a small portion of people who are involved in the tourism industry, as these two areas are close to important tourist destinations.

Kanneliya, the most affluent area, is noted by many project personnel to be the site where the Project has been least effective. It is famous for its tea industry, and the regional economics are superior to the other sites. Besides, Kanneliya is close to Galle, which is the fourth biggest city of Sri Lanka. Therefore, people have easy access to job opportunities outside of their community, besides their income from tea estates.

#### ○ Differentiation within an MPCA

Willingness to participate in the Project was also affected by differentiation within an MPCA. Two of the most crucial factors of this differentiation are accessibility to roads and water. In all four sites, villages closer to the main roads of the region had a higher percentage of membership in Village Project Management Committees (VPMCs). Easy accessibility to the main road provides nearby villages with more opportunities to obtain relevant information, to acquire implementing equipment and to distribute products. Moreover, roads also provide more opportunities for communities to meet, exchange ideas and to be involved in meetings or organized activities.



Water supply has been a tremendous concern for the Project, especially in the Naula, Rajawaka, and Bibiie MPCAs. The importance of water supply is not only the concern of members of VPMCs but also of non-members and many local forest officers. Water is not only essential for the propagation of medicinal plants, but also for agricultural activities benefiting local communities, which is one of main programmes provided by the Project. Water also plays an important role in processing medicinal material and producing products. The lack of water supplies means that benefits from the Project are reduced and therefore interest declines, unless this very basic problem is solved. Because of this, villages which are closer to irrigation canals or which own their agro-wells tend to be more active in the Project.

## Joint Forest Management (JFM)

In recent decades, there has been a call for JFM in the South Asian region and Sri Lanka is fully aware of this need. It has been suggested that JFM is a process 'where the owner (the government) as well as the users (the communities) manage the resources and share the costs as well as the benefits thereof (Seeland & Schmithusen, 2003, p. 132) Two other terms often used may be confused with JFM, which are 'Participatory Forest Management' (PFM) and 'Community Forest Management' (CFM). PFM refers to instances 'where the government takes initiatives, manages the resources and the community participates in various forms, most commonly as hired labour' (Seeland & Schmithusen, 2003, p. 132); while CFM refers to 'the . . . community tak[ing] the lead, manag[ing] the resource while the government is a passive supporter or observer.' Therefore, JFM is the intermediate stage between PFM and CFM, in terms of the level of involvement by state and community and the form of collaboration between them.

My observations indicate that the concept of JFM is probably not practised fully, and appears to be in the stage moving from PFM toward JFM, despite numerous activities of forest protection.

Obstacles that impeded JFM were the lack of trust and the lack of incentives.

### The lack of trust

Historically, the Forest Department has been a law-enforcing organisation that prevents illegal activities, with the result that the relationship between the forest authority and local people has not always been harmonious. There is now a shift in thinking to elicit cooperation from the community, which helps improve this relationship. However, my observations indicate that the lack of trust between the forest authorities and the communities (a two-way process) is still a significant problem that hampers the target of achieving JFM. Part of the reason for this lack of trust is that forest officers are assigned to a location only for a few years. Thus, there is little incentive or opportunity for them to understand local politics and become involved in the internal workings of a community. Moreover, they are the representatives of state power and they are mandated to implement policy made at a higher level, whether that policy is acceptable by local people or not. Overcoming this obstacle will require a) intensive training of staff b) awareness within the community and c) joint activities where interaction between the community and forest officers is enhanced.

## The lack of Incentives

Community members do not always fully realise the benefits of forest protection and therefore, there is no incentive for them to strive for conservation goals. From my observation, it appears that the community considers the benefit only in monetary terms; thus, they neglect the importance of forest services and the importance of a healthy forest in securing their environment.

Secondly, there are few professional or personal incentives for local forest officers to engage in joint forest management. In their professional lives, their goal is to protect the forests. Further, in their personal lives, their position between the local community and the Forest Department is also not an easy one to manage. Forest officers, therefore, do not have any incentive to engage in JFM.

## General lessons learned

- It is crucial to understand the primary concerns of local community (such as water shortage or transportation inconvenience).
- Local communities should have more opportunities to address their concerns to government and the implementing agency, and have a full access to the information/knowledge relevant to projects.
- It is important to identify and address the internal fractions of local communities and to make efforts to ensure social equity while implementing projects.
- Before the implementation of a conservation project, it is equally important to analyse the cultural factors, as well as biological ones of a local situation and to develop different initiatives based on different social contexts rather than only natural resource data.
- Full consultation with traditional social leaders and incorporation of the traditional community participation mechanism into the new processes is highly recommended when building a system with new types of social representatives and organisations such as VPMCs.
- Based on the primary understanding of local communities, the Forest Department should keep working on involving them into forest management, with ample opportunities provided and with good information dissemination. It is essential to note that the effort to do so is not only to address responsibilities on local communities, but also to ensure the benefit of them.
- When formulating policy it is equally important to listen to the opinions of local forest officers who are implementers on the ground as well as to local community members.
- It is essential for a local community to realise the importance of the forest conservation in terms of provisioning, regulating, support and cultural benefits.

## Conclusion

Many benefits have been gained by this Project, notably in the empowerment of local communities, but much needs to be done yet, on the ground, to move forest management from PFM to JFM. Strong efforts are also needed to shift the focus of communities from an orientation of monetary benefits only to the goal of conservation benefits.

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*Coscinium fenestratum*

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# Documentation of Indigenous Knowledge in the Nilgiri Hills of India

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## Introduction

Indigenous people of the Nilgiri Hill Range in Southern India have a rich heritage of traditional knowledge that has been used for centuries and is a major part of their daily lives and livelihoods. Their ethno-botanical knowledge, traditional arts and crafts and survival strategies all have been developed over centuries of adapting to local conditions. With modernisation and globalisation, there is a very real fear that these traditional systems could become lost. To address this fear, we have been carrying out a programme through which traditional (*adivasi*) knowledge is gathered, documented and disseminated.

Indigenous knowledge has two powerful advantages over outside knowledge: it has little or no cost and it is available readily (Kothari, 1995). Properly documented and used, traditional knowledge can be used, *inter alia*, for livelihood strategies and to provide health care options. This knowledge has been shared traditionally and communicated orally, by specific examples and through cultural interactions.

## The Setting

As the Western Ghats extend southwards, the Nilgiri Hills appear as a massive block of prehistoric rocks in the distance. The Nilgiri Biosphere Reserve stretches from Nagarhole Sanctuary in the north, to the Sathyamangalam division in the east, Wynad Sanctuary in the west and Silent Valley National Park to the south. The biosphere lies at the junction of three southern states of India - Kerala, Tamil Nadu and Karnataka. This range of hills supports moist, dry, evergreen and montane tropical forests. The Western Ghats, and the Nilgiris in particular, are rich repositories of biodiversity and harbours a diverse assembly of endemic faunal and floral species (Keystone, 2005).

## The People

The NBR has a large number of indigenous communities - *adivasis* - (estimated to be 21), most of them forest dwellers and hunter-gatherers (Keystone, 2005). These distinct ethnic groups have small populations and live in geographically distinct areas. Within these *adivasis* are traditional healers - *vaidyas* - who provide health care for the communities.

These *adivasis* are, predominantly, collectors of forest produce which they use to sustain their nutritional and economical needs, including shelter and medicines. As a consequence, they are dependent on forests for their survival.

## Documentation as a tool for preserving and promoting indigenous knowledge

### ○ Documentation of indigenous seed knowledge by building seed banks

*Adivasis* possess a vast repository of indigenous wealth with regard to forest species. Even amongst *adivasis* *vaidyas* and honey hunters are prime storehouses of knowledge. With the help of indigenous people, collection is ongoing of as many varieties of non-timber forest products (NTFPs) that may be of use to the people. Regular workshops are held and information gathered about the local name of the species, habit, appearance of the flower or the fruit, period of flowering, habitat, availability of the species in the locality, animals dependent on the species and finally, the uses of each species.

A seed bank has been created as a biodiversity centre, where this knowledge can be preserved. These banks serve to enhance the community's knowledge.

### ○ Publication of a *Kurumba* medicine book in their language

This activity was initiated because of the perceived need that tribal children have little access to ancestral customs as they are taught from state government syllabi. The publication of this book attempts to provide children and adults the opportunity to read and raise questions about traditional knowledge.

The main author and illustrator of this book were from the community, as were their helpers.

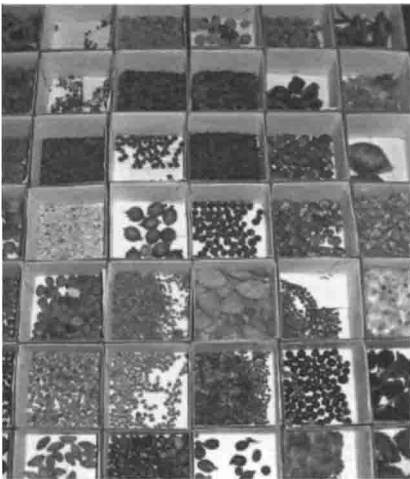


Photo credit: Keystone Foundation

Preserving Forest Seeds For Biodiversity Conservation

A unique feature of this publication is that the script is in Tamil language but the dialect is *Kurumba*. Similar attempts are now underway to publish similar documents in different *adivasi* dialects so that people from different communities benefit from these initiatives.

## ○ Mapping of ancestral domains to demarcate NTFP resource use

This exercise is currently ongoing to assess traditional domains of different sub groups of *adivasis*. Mapping also ensures that *adivasis* are not deprived of their traditional lands. In collaboration with the forest department, we have used *adivasi* knowledge and use of modern instruments such as Global Positioning Systems and Geographical Information Systems to demarcate accurately their lands and then present their cases to the Forest Department.

This effort blends traditional knowledge with modern technology.

## ○ Floral guide for the Nilgiris

An initiative to document the ethno-botanical knowledge of the *adivasis* is ongoing through a publication of a field guide to the plant species found in the hills. With 200 plus colour plates, the field guide aims to be a comprehensive guide to the flora of the Nilgiris through the eyes of the *adivasi*. Combining strict scientific discipline and *adivasi* knowledge, the guide includes botanical information such as habit, habitat and description along with indigenous information such as local name, special characteristics, cultural and economic significance. The book will be published this year.

## ○ Traditional Practices for NTFP harvest

*Adivasis* collect numerous NTFP species, which they use culturally and economically. Each step of harvest has evolved over several centuries and resource management is of paramount importance to them. As an activity in this project, we are documenting important parameters of resource management and assembling it in a publishable form.



A book on medicinal plants published in Kurumba

## Outcomes of the programme

Using documentation as tool for preserving and promoting indigenous knowledge is proving to be successful. Documentation has played the dual role of disseminating information externally as well as providing offering economic incentives to *adivasis* to preserve their traditional knowledge. We believe that documentation has, to some extent, reversed the loss of indigenous knowledge, in the following ways.

- *Adivasis* have found the establishment of biodiversity centres useful not only in terms of enhancing and consolidating their knowledge but also in arousing the lost sense of proprietorship that they had maintained traditionally with forests and their resources.
- The publication of the floral book is expected to serve as a field guide not only to researchers but also to the *adivasis* themselves in aiding them to enrich their knowledge through easy-to-use steps provided in the book.
- The mapping work using GIS and GPS technologies has yielded positive results. The maps have generated knowledge on depleting forestry resources and this has emboldened the communities to take remedial action by establishing nurseries of NTFP species. This, in turn, has decreased pressure on forest resources and has opened up new employment options in the form of growing commercially valuable NTFP species.
- The assessment work also highlighted the issue of minimal marketing avenues for NTFP products and the lack of interest in protecting forests. However, after setting up of value addition units and guaranteed marketing support, stability has been ensured to the people in terms of income generation.



Collecting *Phyllanthus emblica*

Photo credit: Keystone Foundation

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Photo credit: Keystone Foundation

Collecting Information through Participatory Monitoring



## The future of medicinal species



Photo credit: L.Jaramillo c., Biocomercio/CORPEI

Member of *Jambi Kiwa* at its processing plant

# Sustainable Wild Collection of Medicinal and Aromatic Plants: Practice Standards and Performance Criteria

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## Background

Medicinal and aromatic plants (MAP) have been an important resource for human health care from prehistoric times to the present day. According to WHO, the majority of the world's human population, especially in developing countries, depends on traditional medicine based on MAP (WHO, 2002). A recent survey of published medicinal floras conducted by members of the Medicinal Plant Specialist Group of the Species Survival Commission, the World Conservation Union (IUCN) suggests that 72,000 species of higher plants are used medicinally worldwide, approximately 17% of the world's higher plant flora. Relatively few MAP species are cultivated. The great majority is still provided by collection from the wild (Lange & Schippmann 1997; Srivastava et al., 1996; Xiao Pen-gen, 1991). This trend is likely to continue over the long term due to numerous factors: most medicinal plants are traded locally and regionally rather than internationally; the costs of domestication and cultivation are high; and land for cultivation of non-food crops is limited. Moreover, cultivation is not necessarily the most beneficial production system. Wild collection practices secure valuable income for many rural households, especially in developing countries, may provide incentives for conservation and sustainable use of forest and other important plant areas, and can be an important factor in the source countries' local economies (Schippmann et al., 2002).

However, over-harvesting of MAP, land conversion and habitat loss increasingly threaten a considerable portion of the world's MAP species and populations (*circa* 4,000 species). For these reasons, approaches to wild MAP collection that balance the needs of local, regional, and international markets with the need for conservation and sustainable use are needed urgently.

In recent years, a number of initiatives have been launched to achieve a better framework for the sustainable use of biological diversity, particularly the Convention on Biological Diversity (CBD; UNEP, 2001). Under the CBD, more specific guidance for the ecological, socio-economic, and equity basis for conservation and sustainable use of biodiversity has been articulated in the Ecosystem Approach (CBD V/6), the Bonn Guidelines on Access to Genetic Resources and Fair

and Equitable Sharing of the Benefits Arising out of their Utilization (CBD VI/24), the Global Strategy for Plant Conservation (CBD VI/9) and the Addis Ababa Principles and Guidelines for the Sustainable Use of Biodiversity (CBD VII/12).

## Preparing Guidelines

Recognizing the need to develop and introduce standards and criteria for wild collection of non-timber forest products (NTFP), several efforts have been made to consider the relevance and application of various models aimed at certification of sustainable wild collection. For example, standards and criteria for the ecological, social, and fair business practice elements of certification systems have been developed for application to NTFP by agricultural organisations and fair trade associations (see, for a summary and analysis: Shanley et al., 2002).

Specifically relevant to medicinal plants, the 1993 WHO/IUCN/WWF Guidelines on the Conservation of Medicinal Plants (WHO, IUCN & WWF 1993) and the 2004 WHO Guidelines on Good Agricultural and Collection Practices (GACP) for Medicinal Plants (WHO, 2003) provide general guidance and principles for the development of a global framework of practice standards and performance criteria for MAP. Of these documents, only the 1993 Guidelines directly address ecological and socio-economic/equity issues related to sustainable wild harvest, and these are now out of date. Currently WHO, IUCN, WWF and TRAFFIC are working together to revise these Guidelines through an international consultation process and with the intent to incorporate broader guidance and principles related to sustainable use of biological diversity, access and benefit sharing, and fair business practices. Publication of these revised and updated Guidelines is envisaged for this year.

## Need for a subset of Standards and Criteria

Existing principles and guidelines for conservation and sustainable use of medicinal plants primarily address the national and international political level, but only indirectly provide the medicinal plant industry and other stakeholders, including collectors, with specific guidance on sustainable sourcing practices. For example, the revised WHO/IUCN/WWF/TRAFFIC Guidelines on the Conservation of Medicinal Plants will provide general principles addressed primarily to governments and other political stakeholders, NGOs, IGOs and businesses world-wide. These guidelines call for the development of concrete practice standards and performance criteria for the conservation and sustainable use of medicinal plants as a practical interface between the general principles set out in the Guidelines, and management plans that must be developed for particular species and specific situations.

Other existing guidelines for the sustainable collection of non-timber forest products provide useful models for MAP: models for NTFP that may be particularly useful for MAP include the certification system of the Forest Stewardship Council (FSC), the International Federation of Organic Agricultural Movements (IFOAM), and Fairtrade Labelling Organisations International (FLO). Other models that may be considered include natural resource co-management agreements with indigenous communities, and access and benefit sharing arrangements between genetic resource users and providers.

Nevertheless, these models do not cover the range of guidance needed for MAP on topics such as access and benefit sharing, participatory management practices, and quality control. The proposed work will build on these existing principles, guidelines, and standards, but will expand and extend these to provide relevant standards and criteria for the sustainable wild collection of MAP. These will benefit forest managers, industry, and local collectors by providing reputable standards of practice for sustainable wild collection against which local performance can be tested with criteria relevant to MAP.

## Initiative by WWF, IUCN and BfN

The initiative 'Development of an International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants' ISSC-MAP) by WWF Germany, IUCN Canada and the IUCN Medicinal Plant Specialist Group (MPSG), and BfN has provided a draft framework of practice standards and performance criteria for the sustainable wild collection of MAPs. These are applicable to the wide array of geographic, ecological, cultural, economic and trade conditions in which MAP are found. The draft framework has built existing standards, particularly those relevant to non-timber forest products.

Testing the draft framework has been carried out in model projects carried out by other agencies, using a framework to be developed by WWF-Germany and an international Advisory Group. An iterative evaluation of the relevance of the draft standards and criteria to these model projects has been incorporated into the process and has ensured that the draft will be adapted constantly to feedback from projects and stakeholder consultations.

The drafting and consultation process has involved the expert members of the MPSG and a wide range of relevant stakeholders. The formation of a technical Advisory Group, accompanied this process. Also, a network of conferences and workshops have been used to present the draft work stages to the relevant audiences and collect their feedback. These events have included the World Conservation Forum of the 3rd IUCN World Conservation Congress in Bangkok in November 2004, the International Botanical Congress in Vienna 2005 and others.

The draft framework has undergone several widely consultative reviews.

The process will provide widely relevant, workable and tested principles, criteria, indicators, and associated guidance by the end of 2006. Funding for the process is secured through 2006. Strategies for implementation of the standard in several model applications are currently being developed.

Additional information about this project is available on the project website: [www.floraweb.de/map-pro](http://www.floraweb.de/map-pro), and on the website of the IUCN-SSC Medicinal Plant Specialist Group: <http://mpsg.org>.

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Photo credit: Dama Leaman

Harvesting anti-malarial bark *Aglaia dookoo* in Indonesia

# Sustainable Conservation of Medicinal Plant Species: Experience from the Kumaon Himalayas

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There is a rich history of use of medicinal plants in the Central Himalayas. However, in recent decades, deforestation of the area and over-exploitation of medicinal species for external markets have caused many species to become extinct e.g. *inter alia*, *Aconitum heterophyllum*, *Berberis aristata*, *Gloriosa superba*, *Nardostachys jatamansi*, *Saussurea costus* and *Swertia chirata*. Many more are threatened with extinction. This over-exploitation has occurred concurrently with the growing alienation of poor, small and marginal farmers from their land; growing demand for medicinal and aromatic plants; and the lack of awareness amongst the local communities regarding the harvesting, processing and marketing strategy. These changes have occurred as a result of government policies, as well as socio-economic circumstances created by modernisation and dominance of a market economy.

The Institute of Himalayan Environmental Research and Education (INHERE), an NGO, is working with mountain communities to reverse this situation in the district of Almora in the state of Uttarakhand in India, a part of the Central Himalayas.

INHERE sees the conservation of medicinal species as being linked to food security; sustainable livelihoods; low cost and accessible community based health care; augmentation of biodiversity and environmental conservation.

Hence all these strands are interlinked in the community-based programme of INHERE for the conservation of medicinal plants.

INHERE believes that cultivation is the key to conservation. The harvesting of any medicinal plants from any zone in the Himalayas needs to be linked to conservation. Hence, INHERE is involving local community members in the cultivation of medicinal plants. This cultivation is kept as natural as possible, through methods of organic cultivation and placed within the natural biodiversity of the region.

Medicinal species chosen for cultivation - for example, *Aconitum ferox*, *Asparagus racemosus*, *Carum carvi*, *Picrorhiza kurroa*, *Saussurea costus*, *Swertia chirata*, and *Tinospora cordifolia* - were prioritised based on a combination of high demand and high value. Priority was given to

medicinal plants used in substantial quantities in medicinal formulations and used widely for health care. Medicinal plants that command a high value in the market and are more susceptible to over-exploitation were also given priority.

Two types of medicinal crops are promoted by INHERE: short duration crops (up to 18 months) and long duration crops comprising mainly of trees such as *Cinnamomum tamala*, *Emblica officinalis*, *Mucuna pruriens*, *Sapindus mukorossi*, *Terminalia belerica*, *Terminalia chebula*, and creepers, which yield a crop year after year after a much longer gestation period. A mix of short and long duration crops is promoted. Small quantities are grown by each farmer and volume is obtained by aggregation. This also spreads out income obtained among a large group of farmers and secures the individual grower against market fluctuations in the price of individual herbs.

INHERE is working to procure premium prices for farmers in order to encourage more cultivation and secure a sustainable livelihood to the grower. Premium prices are linked directly to the demand for medicinal plants, market value of medicinal plants, and quality of production. Organic certification is an assured certifiable management system with controls and traceability used in harmony with local environment conditions and land husbandry techniques such as soil-conservation measures, crop rotation and the application of agronomic, biological and manual methods instead of synthetic inputs. It ensures value additions such as packaging and labelling. INHERE is working on all these aspects to create a sustainable model. This sustainable model combines environment and biodiversity conservation in the Himalayas, sustainable community based livelihoods and community based healthcare.

Promotion of cultivation has been encouraged and sustained because INHERE has provided the following services and inputs to the farmers:

- Information on cultivation INHERE is promoting cultivation of nearly 28 species of medicine plants/herbs. Inhere is providing simple cultivation techniques and information on cultivation to small and marginal farmers in the project area such as a) natural habitat of a specific species, b) information on useable part, c) use in a specific disease, d) size and beds of nursery, e) preparation of land, f) size of pits for transplantation, g) use of compost, h) time of sowing, i) time of harvesting, j) harvesting and storage techniques and k) good quality planting material, seeds and cuttings.
- Short-duration training on cultivation, harvesting and post harvesting processes.
- Training to community members, especially women, on the use of herbs for healthcare including simple medicinal formulations for managing of common ailments and diseases of the area.
- Organic certification of medicinal plants. This organic certification is an independent third-party certification which ensures that environmental, ecological health and sustainability norms in agriculture are maintained. This also applies to cultivation of the medicinal plants. In organic cultivation, measures have to be taken for maintenance of soil health. Use of chemicals in any form whether as fertiliser, pesticide or growth promoter is not permitted, and no chemicals may be used in post harvest preservation. In this process of organic certification, the certifying agency carries out an inspection to ensure these safeguards have been met and then issues a certificate.
- Processing and branding of medicinal herbs.
- Buy-back from farmers and linkage with wider market opportunities and where possible, fair trade market.
- Cultivation and conservation incentives through local addition to value and scaling up the value chain.

# A Methodological Template for Participatory Planning and Designing for Sustainable Harvesting of Medicinal plants

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## Background

The World Health Organization estimates that 80% of the population of the developing world uses traditional medicines as the source of the primary health care (WHO, IUCN & WFF, 1993). In the past, the collection of medicinal species that provide traditional medicines were collected at subsistence levels from the wild, but in the last two decades, increases in the use of alternative medicines as well as a burgeoning human population, have increased the demand on these species changing them from being subsistence entities to commodities of commerce (TRAFFIC, 2002). This change has increased greatly pressures on this natural resource and the upsurge in demand has catapulted these biological entities in to a greater threat arena, increasing their vulnerability to extinction. This situation necessarily demands the development of efficient management systems for their conservation.

Medicinal plants are important resources for rural and tribal people in India, as their livelihood depends on them. People living in and around forests collect medicinal plants to meet their subsidiary income and use them in traditional medicine. Relatively few medicinal species are cultivated and the great majority still collected from the wild (Lange & Schippmann 1997; Srivastava et al. 1996; Xiao Pei-gen, 1991). In India it is estimated that more than 1000 species of medicinal plants are under various degrees of threat from, *inter alia* human interference, habitat fragmentation, overexploitation, unsustainable harvest, illegal trade (Kinhal & Murthy, 2002). More than 60% of this threat is a result of due to over-exploitation and destructive harvesting.

There is an immense traditional and indigenous knowledge with local people about medicinal plant species, including about best practices and methods for their sustainable harvest. Within this context, with assistance from the Forestry Research Programme of the Department for International Development (DFID), UK we, the Foundation for Revitalisation of Local Health Traditions (FRLHT) and the Environmental Change Institute of the Oxford University worked together with a third partner, Forest Action (in Nepal) to design jointly and test a methodology that would enable communities to monitor medicinal plant populations in a rigorous way, and to experiment with



alternative management systems to explore whether harvesting could be done more sustainably. We started from the viewpoint that it is essential both to recognise local conditions, including local knowledge and to develop a process that provides reliable information. Consequently, we sought to develop a hybrid between standard scientific methods for forestry research and the growing experience in participatory research (Lawrence 2000; Pound et al. 2003). The aim was to provide a template based on rigorous scientific method that allows for repeatability of the *results* given the right conditions, or repeatability of the *method* in different conditions. For such a template to be viable, three prerequisites are required: a) Communities must harvest the product whilst maintaining a viable population; b) This viable population is supported by a healthy ecosystem; c) The community has the tools to assess the viability of the population and health of the ecosystem.

This chapter focuses on the experience of the project in India. We believe that this exercise, which has taken place for the last three years in India, empowered communities to manage their resources in a more sustainable manner, in turn stabilising community resource dependence and economy. At the time of writing, the quantitative results from the communities' experiments were still being analysed, and our focus here is on the process, institutions and organisational relations that were needed to make the participatory process work. Updates on the project outputs and experience, as well as examples from Nepal, can be found at [http://www.eci.ox.ac.uk/humaneco/he\\_sustainableharvesting.html](http://www.eci.ox.ac.uk/humaneco/he_sustainableharvesting.html).

The main objectives of our project, in reaching the overall goal of developing a methodology to produce transparent, reliable information for NTFP management, were to

- Understand context: to assess who the stakeholders were, and what factors influenced change in quantity and quality of selected medicinal plants;
- Conduct rigorous participatory experiments based on clearly formulated hypotheses and indicators;
- Institutionalise results through a transparent and participatory assessment of both methods and findings, and their incorporation into management plans; and
- Analyse wider implications for adaptive collaborative management and participatory environmental governance.

## Design and development of methodology

The documentation of community knowledge, implementation of experimental methods, merger of two knowledge bases (scientific and traditional) and monitoring adaptive management is essential in a cyclic form in this template to ensure that management was truly adaptive.

The practice of sustainability at local level calls for active participation of all the stakeholders so that knowledge, skills, needs and interests of all the individuals are taken in to account.

The participatory steps essential in designing and developing a participatory methodology are:

- Documentation and application of indigenous knowledge about selected medicinal plants and about potential and possible interventions for their sustainability.
- Devising mechanisms to merge both scientific and indigenous knowledge systems and to develop a management methodology for sustainable harvest of medicinal plants. This methodology needs to be adaptive, so that changes can be effected as needs arise.
- Implementation of the adaptive management methodology
- Monitoring the implementation of this methodology.

When designing the above, it is also essential that the following sub-designs be also incorporated into the design: Local Participation, Implementation, Capacity building, Participatory tools, Dissemination and Assimilation.

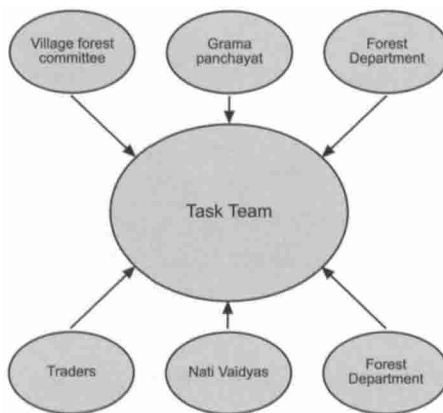
### Local Participation:

The design for Local Participation is very crucial, as all other designs depended on this: any weakness at this level of planning will affect the effectiveness of all other designs. The basic principle in this sub design is that it should be inclusive, non-discriminatory, equitable and gender sensitive. It is also essential that any inclusion should be voluntary: only those interested stakeholders who wish to be part of the process should be included.

For local participation to be effective, the concepts of Group-Think and Team-Think were also extremely relevant. Group-Think is a concept where collective action dominates over individual wishes. This necessarily strengthens the participatory decision-making process, as the concerns of all stakeholders are voiced.

The concept of Team-Think realises that eliciting participation of the entire village is not feasible due to constraints of space, time, availability, interests etc. Thus, a few representatives are elected for effective implementation. In this way, ideas generated in the Group-Think level are translated in the field by way of Team-Think. Team members are selected through community workshops, with a clear scope for adding new members to enrich the team with special skills, when required. Such a team is called a Task Team (TT) and there could be as many TTs as required for different specific tasks at the village level (Fig 1).

Figure 1. Constitution of Task Team



The different roles for the TT are:

- To provide opportunity to representatives of all stakeholders to participate in the process;
- To facilitate application of local and scientific knowledge to the study; and
- To build the local capacity to implement the study outcomes for the benefit of resource and the community.

The listing of all stakeholders and eliciting their participation is crucial for setting up an efficient TT. The second step is to establish a common goal for the TT that binds them together for the task ahead. (They all need to be interested in conservation of medicinal plants, and sustainable harvesting of the forest products). The steps in the formation of TT are listed in Box I.

#### Box I: Steps in formation of TT and its responsibility

A new participatory institution is established at village level by ensuring gender and equity and multi-stakeholder participation. The basic steps in the formation of TT are:

- Calling for a general meeting of JFMC; ensuring representation of all stakeholders.
- Facilitating identification of representatives from each stakeholder group, based on knowledge and skills of individual person.
- Discussing matters with members of all the stakeholder groups.  
opting stakeholder representatives.
- Seeking acceptance from the general body to select those representatives.
- Obtaining concurrence of the chosen individuals to participate.  
formation of TT and its responsibility.

## Implementation

The design of local participation results in effective Group-Think and Team-Think for planning and developing the methodology. This is the stage at which local people need to be motivated for the action and they need an effective design of implementation, to mobilise them into action and to derive expected results over a period. The essential step under the participatory process is to build viable community institutions at village level, which are responsible for accounting of resources - the medicinal species in question - followed by developing a (conservation) strategy for adaptive management of these resources.

Different institutions from grass root to various other levels involved in management of natural resources need to participate and accept their specific roles. The role played by the Forest Department is very vital, in the context of developing methodology for sustainable management of forests and adoption of such ideas into on-going projects. The forest officers at division, range and beat level play a supportive role in constituting the TT at JFMC, locating the areas and involving neighbouring villagers. The various institutions that should be involved and roles that should be performed are listed in Table 1.

Table 1. Institutional participation and its role

Intuition	Role
TT	Enumerating plots, keep records, field analysis, local dissemination.
JFMC	Requesting neighbouring JFMC members/ villagers to co-operate.
Forest Department	Facilitating the study, request contractors to regulate harvest by outsiders.
Self Help Groups	Promoting self-use for healthcare to offset commercial interests.
Nodal NGO	Guiding task team for data collection and disseminate study process and findings at the state and national level.

#### Memorandum of Understanding (MoU)

The different institutions participating need to have common understanding for the effective operation of study activities, and the terms and conditions are to be mutually agreed upon. In order to ensure transparency among various stakeholders at the village level (regarding objectives, design and development of methodology, monitoring data and preparing decisions of adaptive management) an MoU with clear roles, responsibilities and benefits to each of the participating institutions is signed.

This authorises the TT to conduct the study activities in a phased manner as agreed with the FRLHT. Some of the guidelines for the preparation of an effective and efficient MoU with local community were equity in participation, complete transparency and witness of all the stakeholders.

#### Capacity building and training

The participatory approach focuses on developing self-sustainable community institutions by empowering local people. Various capacity building and training programmes are designed and implemented for different stakeholders involved in the project, in order to reach people of different socio-economic and educational backgrounds.

Training is needed on participatory protocols to TT members through participatory rural appraisal. This includes development of social maps, status of medicinal plants, collection and marketing patterns as well as the local use of medicinal plants. This information helps to identify the status of the resource and to develop management strategies for sustainable extraction of such resources. Some of the methods that may be considered are: stakeholder analysis, group meetings, focus group discussions, semi-structured interviews, trend diagrams and participatory mapping

Through these protocols, it is necessary to find out traditional knowledge of identification of resources and the nature of extraction and also to place into the socio-economic context (tenure, market demand, infrastructure, policy etc) biological and resource management variables. It is important to know about these socio-economic factors so that the study tailors the protocols and methods developed to be useful to the target users.

- Training on Biometric protocol:  
Training inputs are given through posters, in biometric principles such as defining treatments and replications, randomisation, sampling, generation of hypotheses and indicators, determination of yield predictors, setting up of experimental plots (design, layout, location and delimitation of sample plots in the field) and enumeration of sample plots. This sets the stage for developing sampling protocols and treatments. The training is a two-way process where both the trainers (FRLHT team) and trainees (TT) learn from each other.
- Poster method of training:  
series of about 20 sequential posters detailing experimental methodology.

Posters serve not only as training tools but also to track project activities. They enable the local community to develop and implement the methodology and later serve as training tools for other communities.

- Community workshops:  
These are organised at frequent intervals to inform the larger group about progress of the study and to seek suggestions and larger application of sustainable harvest methodology. Participation of different stakeholders is ensured in order to have Group-Think decisions influence policy.



Photo credit: FRLHT, FRP, India

Harvesting, grading and weighing of *Ferronia limonia*

## Participatory tools

Development of participatory tools equips the local community to implement the study objectives in the field. This process considers traditional knowledge and skills for ease and effective application. It defines objectives, study locations and species to modify the biometric protocol for local application.

- (i) Setting objectives:  
The overall objective of the study is articulated.
- (ii) Selection of study locations:  
Criteria (geographical, ecological and socio-economic conditions) are developed for selection of study sites. Next study sites are selected.
- (iii) Selection of Species:  
This must be carried out through participatory discussion, informal community meetings held with different stakeholders such as members of Village Forest Committee, traditional healers, NTFP collectors and traders and Self Health Group (SHG) members.

The criteria used for selection of species are:

- Species providing higher livelihood opportunity to communities, so that the community would take interest in the wise management of these resources.
- Species harvested for different parts.
- Species currently harvested actively with a likely increase in trade demand, so that these can be harvested sustainably before they succumb to enhanced pressure.
- Species that cannot be cultivated and must be only collected from the wild, which necessitates that their stock and productivity maintained for posterity.
- Species representing various habits, with preference to trees, as trees require long time for recovery from harvest impacts.
- Endemic species as local population would represent the global population and the status of such species demands immediate attention for recovery

(iv) Development of a research agenda

Developing research agenda for participatory approach is crucial, as this needs integration of both participatory and biometric protocols. Requirements that need to be considered while designing the research methods are

- To determine changes in the focal species' population over time.
- To determine the effect of harvesting on the focal species' population.
- To determine maximum sustainable harvest rate and method.



Photo credit: Anna Lawrence

Harvesting Terminalia chebula

In order to operationalise the research agenda, nine key steps are followed:

1 Delimit and stratify the experimental area:

Maps of the forest area are developed and the area for the study demarcated by adopting stratification. Using the community knowledge the forest is divided into different strata, based on forest types and local knowledge related to presence of focal species.

2 Developing experimental treatments:

The development of treatments considers current methods of harvest as one of the treatments (to test whether such practices were affecting the resource status) and the other treatment is a harvest method and regime developed by combining the best practices in traditional knowledge with scientific knowledge.

3 Conducting preliminary sampling:

Our study adopted 18 metre radius circular plots, for this centre point was fixed randomly. Replication of such sampling plots is maintained for each treatment to ensure consistence in the experimentation. In each plot number and size of individuals of the focal species should be enumerated.

Training field workers in sampling and enumeration: TT members are trained to create random sample locations, locate sample points, delimit sample plots, count the number of individual plants within each plot, and measure plants. Setting up experimental plots:

Plots are randomly located across strata and these are marked for long-term monitoring. Treatment is allocated randomly and buffer zones maintained between plots to avoid the influences of one plot over other.

Developing plant yield indicators:

Quality and yield data collection depend upon the plant part used. The indicators considered to measure specific part/s extracted are given below.

Resource	Quality variable	Predictors
Whole plant	Biomass.	Plant size (height, diameter)
Leaves	Leaf number or leaf number in a subset of branches.	Plant size, canopy cover
Buds	Bud number or subset.	Plant size
Flowers, inflorescences	Inflorescence number or subset.	Plant size.
Fruits/seeds	Fruit number, quality or subset.	Plant size.
Bark/wood	Length/girth of useable plant parts.	Plant size.
Roots/rhizomes	Mass of below ground parts.	Size of above ground parts.
Resins/exudates	Yield of product per time period.	Plant size and health.



members learning biometric applications

Photo credit: FRLHT, FRP, India

Enumeration of experimental plots:

Different data (such as edaphic data, rainfall and climate, plant data including girth, height, canopy cover and number of braches needed), are recorded in each plot. The status of germination and regeneration are also monitored.

Monitoring harvest:

In the long-term, harvesting produce from each plot as per the treatment designed is the most important activity. Later the number and weight of the produce collected are recorded. In the control, plot the yield is estimated.

Data analyses and preparation of adaptive management plan: All data collected are analysed and relationships among environmental data, tree data with harvest across the treatments are established to prepare decisions for best harvesting method for adaptive management in the region.

## Dissemination

Dissemination programmes are needed to inform concerned people about the methodology, progress and achievements and more importantly, to seek means to update processes. Several innovative dissemination programmes are designed and implemented for different stakeholders. Interpersonal and group/mass communication programmes are developed for local communities.

### Interpersonal communication:

These programme are intended to provide specific and in-depth information for stakeholders directly involved in the study. A series of leaflets developed in vernacular languages are produced to communicate the study ideas to the local community and other stakeholders. Letters to each household in the village are a unique means of informing all households under study jurisdiction about progress of the study. Suggestions from local community are sought by provision of a self-addressed and stamped replyletter.

### Group and mass communication:

This mandates for development of group communication interventions for spreading the participatory approach across the study area. Some of these programmes designed for wider dissemination are:

- Exhibitions conducted during special occasions in the local area during which TT members display study posters and educate the public about wise practices to follow.
- Community and Children march is an effective way to reach out the people at their doorsteps. The TT members and school children march in villages to create awareness and provide information on sustainable management of resources in the village.
- A series of community meetings are conducted at a community level for general acceptance of the methods developed in the study, to communicate study ideas to various stakeholders in the village and outside the village to create micro level environment.

The Forest Department and other stakeholders are kept informed through series of meetings such as of Project Liaison Committee (PCL), Research Advisory Committee (RAG) and workshops (national and state).

## Mainstreaming/integration

The development of methodology for sustainable harvesting can happen only through assimilation of good practices into management plans. At the micro level, local people have to practise wise methods during the collection of resources and at macro level, policy formulation should aim to develop marketing system that sustains the interest of the local people dependant on the resources for livelihood.



Photo credit: FRLHT, FRP, India

Micro plan preparation



Photo credit: FRLHT, FRP, India

Community to community training



Developing the Community Communication System: A novel Community-to-Community Training programme (CTCT) is developed for training of local communities by already trained community members. This provides for the horizontal spread of study ideas across communities (who have similar attitudes, socio-economic and education status and other inter personal features) and across resources.

At the micro level through a micro plan approach: Under the JFM programme, village community institution is initiated and micro plans are prepared for management of forests. Micro plans are village management plans prepared for five years, which describe resources in the village and plans for sustainable management of resources through community participation. The study process and outputs became part of the micro plan and the methods developed in the study guided the sustainable harvesting of resources.

At macro level through a working plan approach: The Forest Department prepares a working plan (ten year duration) for management of forests at the division level and assess the resource potential and provide guidelines for resource management. The study has adopted strategies for reaching the forest officers at various levels to incorporate study processes in the preparation of working plan.

Policy brief: Policy formulation at state and central level needs to be influenced by the study methods and outputs. For this various dissemination programmes are planned: national and state level workshops for information about the study and its significant participatory achievements.

## Implications of the participatory approach

The impact of the participatory experimentation in both the study sites was positive and significant in building appropriate community institutions and motivating local community towards the conservation and management of natural resources. The implications indicate that application of participatory approach is the best way for managing natural resources across different ecosystems. The participatory methodology described in previous sections culminated in the following:

- Empowering Community institutions to design and develop participatory methodology through a Task Team approach.
- Developing a participatory and biometric protocol.
- Disseminating capacity building programmes for the local community.
- Managing indicators for long-term monitoring through participatory and scientific approach.
- Establishing a decision-making process for development of adaptive management plans both at Micro and Marco level though micro planning and working plan approaches.

The overall design of such a process must deliver a community-oriented methodology, which caters to a) Increased awareness of the JFMC and the Forest Department local staff, b) Strengthening of monitoring, management, feedback system with co-ordination among all the stakeholders, c) Security of future stock and yield, d) Increase in cash income of the gatherers for good quality produce and timely harvest and also help generate savings for health and livelihood security d) Methods evaluated by relevant stakeholders and recommendations made for management plans, and e) Internalisation of the method in to management systems such as Micro plans and Working Plans.

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# Gender Mainstreaming in Medicinal Species Conservation: a Case Study from the Hills of Uttarakhand in India

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## Introduction

The province of Uttarakhand in India is rich in medicinal plant diversity. Of the total geographical area in Uttarakhand, approximately 65% is forested and contains many species of medicinal plants (Anon., 2005). These medicinal species are an integral part of the traditional health care system of this hill province. Remote, disadvantaged hill communities are largely dependent on herbal wealth for medicine, nutritious food and livelihoods. The rural poor, especially small farm owners and landless households, collect these medicinal species for their cash income.

Of the total medicinal plants coming to the market, less than 10% is from cultivated sources (Sharma, 2002). Most of the natural habitats from which medicinal plants are sourced are at great risk due to ruthless exploitation. In addition, most of medicinal plant collectors are not aware of scientific and sustainable collection practices. Very often, collectors are only interested in extracting as much as possible from existing resources to obtain more short-term income.

Under the prevailing circumstances, individual producers and collectors receive very little compensation for the produce they collect and harvest. There is little awareness regarding the market chain, income potential, and the regulatory and policy framework. Those involved in the market chain are typically very secretive because much of the trade in medicinal plants is illegal and competitive. The regulatory and policy framework for licensing is bureaucratic, complex, prolonged and generally beyond the scope and understanding of most mountain village farmers. As a result, collectors resign themselves to collect produce for middlemen and agents for traders in large regional markets. Typically, middlemen recruit cheap hired labour from outside the area, so very few local people are actually employed in the harvest and therefore receive little economic benefit from the natural resources in their forests. In the process of collection, men play the role of local agent or middleman in this trade of medicinal plants, while women and children actually do the hard work of collection from remote areas, head loading and semi processing the raw material (Pacholi, 2004).

Gender mainstreaming would ensure the participation of women in all aspects of cultivation of medicinal species, and this is crucial for the conservation of these species. Once trained and knowledgeable about the process, women can join men in bringing (rich) economic benefits to their area in the field of medicinal cultivation and conservation as well as reap the benefits of their hard work. However, for this, a consistent effort in gender mainstreaming is required. It is long tradition in the hills of having a patriarchal family system, where there is more control over resources by men than women. But in case of the forest resources, it is reverse. Women comprise over 48% of the total population of the project area (910 women per 1000 men) and play a very important role in managing agriculture as well as gathering fuel and fodder, in addition to managing the household. Though they are the key players in the collection and head loading and semi processing of the medicinal plants, their role is still not recognised by the traders or the market players. Also, when women handle the sale of the collected produce, there are fair chances of being cheated by middlemen. Men always getting more money for the same quality of produce than women do in the same area (CBED, 2003). Women work quietly and remain in the background of all production activities. Their contribution is usually overlooked and forgotten. It is important to bring the women to the forefront of conservation activities and medicinal species cultivation is a good area to do so. It has been seen in all developmental efforts that wherever women's roles have been mainstreamed into the activities, the efforts of economic development have yielded better results. The role of women role is central in conservation, management and use of biodiversity and this critical aspect must be understood and used by conservationists.

## The Community Based Economic Development (CBED) project

The Community Based Economic Development (CBED) Project is a project operating in two hill districts of Uttaranchal, namely Pithoragarh and Champawat, working with seven local NGO partners, and extending over 300 villages. The CBED Project aims at improving the social and economic well-being of poor households in Uttaranchal. The project has used sub-sector analysis in the promotion of Uttaranchal's niche market areas, specifically for selected off-season vegetables (e.g. French beans, capsicum, peas, ginger) and medicinal and aromatic plants (e.g. *Asparagus racemosus* and *Cinnamomum tamala* (Indian Bay-leaf)). Small-scale farmers worked together with the project to build their understanding and experience in collective commercial marketing. In tandem with production and marketing activities, savings self-help groups have federated to form Savings and Credit Cooperatives, in each of the project cluster areas. Efforts are on going to strengthen these organisations, with a focus on promoting equity and inclusion through support to timesaving activities for women and participatory activities such as Gender Theatre and the project's Integrated Economic Literacy component.

### Quity, in the Pithoragarh district of the CBED Project

In August 2003, a farmer's group made up of villagers from the Quity area in the Pithoragarh District of Uttaranchal, India, was one of the first to register as a cooperative under the State's new Self Reliant Cooperatives Act. The Nanda Devi Agro-forestry Service Cooperative Limited (AFSC) is a very active and progressive organisation. In slightly more than a year of existence, this cooperative mobilised a membership of over 196 women and 84 men. In September 2003, they

were awarded the 'Best Cooperative' award by the CBED Project, for their successes in mobilising an impressive membership, promoting gender awareness and sensitivity, pro-activity of the Board of Directors and initiatives taken regarding business operations, and record keeping. Presently, they are successfully offering farm input procurement services to their members and are even making farm equipment available on a rental basis to members (Ordinarily, this would be too costly for an individual producer to purchase). It is now necessary for the AFSC to extend member services into marketing so that producers could get fair price and remain motivated for conservation.

The forests in the Quity area are rich in non-timber forest products (NTFPs), of which medicinal plants are a subset. Indian Bay-leaf, in particular, is abundant both as a cultivated species and growing wild in the forest. Due to its abundance and market potential, Indian Bay-leaf is one of the sub sectors promoted by the CBED project. Because of CBED project interventions (such as provision of NTFP market information, sustainable harvesting, market studies and information along with facilitation of policy framework), the Quity AFSC decided there was an opportunity to organise producers and offer marketing services relating to NTFPs.

While preparing the produce for market, cooperative members discovered quality problems relating to poor harvest, and post harvest practices, despite previous technical training. They also detected a traditional system of cheating, which involves mixing stones and fresh uncured leaves with the produce to increase weight. These problems were remedied quickly when they identified that the offending collectors had not participated in the technical training. These members were given the training and the AFSC instituted a quality control program by marking each bag of produce with the collector's name before the grading began, thereby discouraging cheating. The training and quality control initiative resolved the problems and resulted in increased quality of the produce.

## Lessons Learned

The only way a woman farmer can participate in Indian Bay-leaf cultivation in her own name is with a letter of agreement from her husband who is typically the registered landowner<sup>1</sup>. To enforce these rights they must go through the courts, which, of course, rarely happens., because land ownership invariably lies with the men in the society. While the project has promoted the concept of husbands giving their wives a letter of agreement, in reality this has not occurred as much as it should. Although most women do not perceive this as a major issue, it is a real problem for widows who are precluded from participation due to this constraint.

It appears that the best way to manage these constraints towards a long term resolution is through indirect intervention by mobilising the AFSCs, raising their awareness of these issues and promoting open dialogue between appropriate bureaucrats and elected government officials. Generally, AFSCs and their boards are gender balanced. There is potential for increasing number of women in marketing committees (which is less than 50 % at present). Involving more and more women in training and member education programs is essentially useful in bay leaf cultivation. The Quity

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<sup>1</sup>Generally, spousal and patriarchal lands are not registered in women's names, notwithstanding their rights. To enforce these rights they must go through the courts, which, of course, rarely happens.

AFSC has already demonstrated that they are capable of managing issues on their own. With a little awareness raising and coaching, it is certain that, in time, they will increase the percentage of women in committees.

Notwithstanding these constraints, this excellent marketing experience exposed the AFSC to a broad range of limitations from policy and regulatory framework to unethical practices. In the process of confronting and managing these obstacles, the Nanda Devi Agro-forestry Service Cooperative (AFSC) Limited discovered new capacities, enthusiasm and motivation.

## Impact of CBED Intervention

The members of cooperatives have benefited from increased savings, access to lending, improved agricultural technologies, reduced women's workload, and increased sustainable production of profitable products and improved collective marketing of everything from medicinal plants to fruits and vegetables. This has helped to identify production pockets among the traders in regional and national markets. In this process, the Cooperative has mobilised a share capital of over 1,200 USD and have a business turnover of 3,500 USD per year through collective marketing for its members. Small farm producers are now quite aware about the price of their commodities. At the beginning of the project, the scene was different. Farmers either accepted the set rate by licensed middlemen or they did not collect/cultivate the produce. Now with the collective power in the form of Self Reliant Agro Forestry Service Cooperatives (AFSC), they are able to secure the (ownership) right to sell the produce to regional traders, thereby cutting out the middlemen and improving their profit margin.

To make women aware of the market chain and trade system of medicinal plants, local, regional and national level, medicinal plant market surveys were organised by the CBED project with a gender-balanced team of cooperative leaders. This has helped women members of the Cooperative break the myth that marketing is for men only. The team realised that they could better negotiate their produce in a gender-balanced group, because it was observed that men overlooked small price variations, whereas women did not accept this and were ready to take their produce to other traders and collection agents.

Because of the awareness created by the CBED project regarding the medicinal plant market chain, price information system, and income potential for area farmers, the Self Reliant Cooperatives are now ready to tackle the first and most complex constraint (which is a basic requirement) of obtaining a license for transfer of the produce. In this way, cooperatives are involved in the process of medicinal plant cultivation and collective marketing.

AFSCs gave fair prices to its members, and minimised losses and deductions that resulted because of the usual practice of cheating by middleman from their members. As a result, women members felt confident to bring their produce to the AFSCs and are enthusiastic with the price they received which was higher than ever before. Before intervention from the Cooperative, the bay leaf price was Rs. 7 per kg (0.155 USD per kg) whereas Cooperative pays Rs. 12 per kg (0.265 USD per kg)

to its members. In addition, male members of the family permitted women to deliver the produce to the AFSCs, because they felt that negotiation was possible and cheating by middlemen was not.

The Community Based Economic Development project (CBED) has focused strongly on women's participation in training, awareness, crop production, quality control, post harvest management and marketing of the produce.

As a crosscutting theme, women's involvement in the agriculture and medicinal plant species cultivation and marketing is presented in Table 1.

Table 1: Women's involvement in activities

Activity	Total participants	% of women participants
Cooperative membership	9724	50
Medicinal plant producers	2681	57
Cooperative members involved in marketing of medicinal and agriculture produce (cumulative)	7300	30
Cooperative members involved in savings and credit services	3200	72

(Original data from CBED Project, CECI 2005)



Model farmers in baralu

Photo credit: CBED

It is evident from Table 1 that women are more active in saving and credit services, playing a responsible role for their households. In contrast, their role is limited to 30% in cash receiving opportunities such as marketing vegetable and NTFPs. Thus, despite their main role in cash crop production, women are dependent on men for their cash needs. The impact of the interventions is categorised below:

#### o Empowerment:

National and micro-level studies in India, Sri Lanka and Nepal have highlighted the contribution of women to the national income (Anon, 2000). Women's work is concentrated mainly in farm activities, which are generally invisible in terms of cash income. Economic value is attributed to farm outputs and women receive little recognition for their work. The credit of income goes to men who bring produce to the market and receive money. During cooperative interventions, women are encouraged to sell their produce and be equipped with market information and quality aspects of the produce. This has built their capacity of bargaining with collection agents/middlemen. Increased revenue from this marketing activity has added to the financial power, financial management and confidence among men and women in the family.

### ○ Decision-making for conservation:

The collection, semi-processing from cultivated sources nearby and selling at local level is realised as an easy activity by women. Increased revenue through cooperative interventions forced them to increase medicinal plants population in and around their farmland. Large-scale cultivation of *C. tamala* has proven this. Complete lopping, cutting of thick branches for fuel, annual leaf collection, and using leaves as leaf litter has been reduced to the large extent. Women and men are now intervening by helping other family members to protect this valuable species. Traditionally in medicinal plant sector, women have performed the role of labour while men are decision makers, who decide what to plant, how to market the produce and how to sell it. This division creates a gap in the community. Capacity building and increasing role of women as cooperative leaders has narrowed this gap.

### ○ Environmental awareness:

Although producers are well aware of environmental degradation, they do not practise conservation. Because of increasing pressure on the environment - such as extraction of fuel wood, fodder and medicinal plants in the surrounds of the village, women, most affected by this increasing pressure, have begun to raise their concerns at cooperative board meetings.

## Gender mainstreaming, a sure way of medicinal species conservation

The case studies from the CBED project listed above indicate clearly the importance of mainstreaming gender into production activities. In CBED, gender is a crosscutting component of the project, i.e. it is integrated fully into all the project components. The CBED gender strategy objective is to empower women by addressing both their practical and strategic needs, with a focus on the capacity of Community Based Organisations (CBOs). In the process of cultivation, over 57 % women members are involved. Similarly, the cooperative board is gender balanced and women are taking decisions for promoting the cultivation of bay leaf in their farmlands.

The CBED project has achieved great success in this area because of its integrated gender approach in all project activities, right from the grass root to top management levels of the project. It requires each person in the project to think critically and act according to this gender strategy.

Throughout south East Asia, several efforts are underway to mainstream women in conservation programs. In Nepal, female-headed households are growing in number, women are increasingly supporting their households where rural economy has declined, and social conflicts are escalating. Women in Nepal are involved in medicinal plant collection and primary processing (Regmi. 2000.). Similarly, in Sri Lanka, women and children play an important role in collection and conservation of spices and medicinal plants, mostly achieved by integrating a gender balanced development approach (Pacholi 2004). Repeated emphasis on women's empowerment and raising their awareness on environment concerns, could lead women to contribute significantly to the conservation of medicinal plants.



## Recommendations

The following recommendations are made in order to ensure the success of gender mainstreaming in the cultivation and conservation of medicinal species

- Women must be empowered by addressing both their practical and strategic needs.
- All programmes must ensure equal participation of women and men in production activities. This must be monitored and evaluated on a regular basis. Gender disaggregated data must be collected and analysed at regular intervals and in all documentation.
- Women must receive equitable socio-economic benefits from participation in the programme.
- The programme should be able to address the long-term strategic interests of the women beneficiaries and improve their position in the family and the community.
- The programme must conduct awareness programmes to build the understanding of gender issues between men and women and create awareness of the need and role of women in medicinal plants cultivation and the resulting benefits to the entire community.
- The institutional capacity of development stakeholder organisations (including CBOs) must be built to address gender equity issues in development initiatives.
- Women must be included in all policy and decision making platforms.

This will result in:

- An improvement in the self-confidence, self-esteem of women and their ability to interact with the environment.
- An increase in awareness on gender issues in both women and men.
- The most urgent practical and economic needs of women being addressed.
- An improvement in the access to economic opportunities and resources such as credit, technology and markets by women.
- An increase the political and decision-making power of women within the community.
- The conservation and production of medicinal species as well as other cultivation in the area.
- Economically self-reliant women and men in the community.

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# The Future of Medicinal Biodiversity

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## Introduction

The papers collected in this book have demonstrated how important biodiversity is for human health. Emerging diseases resulting from the destruction and fragmentation of tropical forests and other ecosystems (for example, Ebola), wildlife-human disease linkages (for example, Lyme disease), the many known and yet-undiscovered pharmaceutical products found in nature, the contribution of ecosystem services to human health, the increasing recognition of endocrine disruptors on both animal and human health, and the effects of climate change on ecosystems, all confirm the importance of biodiversity as a health-related issue (Ossofsky *et al*, 2005; Chivian, 2002).

Biodiversity can be both an ally and an enemy to our health. Bacteria and viruses can cause disease; large carnivores, poisonous creatures, and plants can kill us; conflict with small herbivores such as rats and large herbivores such as elephants can undermine our food production systems, thereby undermining our nutrition; and non-native species can cause economic or ecological damage. But even more, people also benefit in many other ways - aesthetically, spiritually and economically - from biodiversity. In concluding this book, we would like to coin a new term for a particular sub-set of biodiversity that supports human health and well-being: 'medicinal biodiversity.

Our understanding of medicinal biodiversity is based on species. Seventy two thousand plant species are used as medicines, of which 9,000 are threatened (see Preface, this volume); reviews of threats are presented by Miththapala (this volume), and Maundu *et al*. (this volume). In Europe, about 2,000 plants are used medicinally, of which about around 10% are endangered in at least one of the range countries (WWF, 2002). Sales of phytomedicinal products in Germany grew from 2.5 to 3.6 billion USD from 1993 to 1995 - an annual increase of 15%. Europe has about a 25% share in the world trade in medicinal and aromatic plants, but growing demand is putting increasing pressure on supplies of these species. The world trade in medicinal plants has increased by 85% since 1991, though the vast majority is within only about a dozen countries. On the other hand, about 80% of the world's population use remedies and drugs containing natural plant agents, many from within their own countries (WHO, IUCN & WWF 1993). The leading suppliers of medicinal plants are China, India, Chile, Egypt, Bulgaria, Albania, and Spain (WWF, 2002).

Beyond use of species in medicines, the world's fauna also provides essential models for research into human health (Chivian, this volume). Animals have unique physiologies that are providing valuable insights that could improve human health. For example, roundworms, poison dart frogs, chimpanzees, bears, and sharks are studied to seek treatments for diabetes, renal disease, osteoporosis, HIV/AIDS, cancer, obesity, neurological and immunological disorders, and many other maladies. As Chivian (this volume) reports, many species of actual or potential importance to human health are endangered: some species of bears are threatened by hunting for use in traditional medicines, chimpanzees are threatened by habitat loss and hunting, and some species of shark are threatened by accident bycatch, which is then used for shark fin soup and for shark cartilage (IUCN, 2005).



A poison dart frog

Photo credit: Jessie Cohen, Smithsonian Institution

While many of the papers have focused on the species level (at least partly because species are being harvested or otherwise used for medicinal purposes), other aspects of biodiversity are also important for human health. The benefits of biodiversity for human health occur also at genetic and ecosystem levels. Genetic diversity reflects the variation within a species, and it is highly likely that some populations of a species will have greater medicinal value than other populations. For example, many plants serve as 'bioaccumulators' of certain soil elements - such as heavy metals - that are found in high concentrations in some specific locations, and therefore, may have more pharmacological effects. Productive ecosystems are essential for human health, and indeed, make all life on earth possible. Ecosystems provide numerous services, including purification of air and water, mitigation of floods and droughts, recycling of pollutants and maintaining appropriate levels of gases in the atmosphere (MEA, 2003; McNeely, this volume). Finally, nature - as a source of inspiration for our culture - can be a source of mental as well as physical health.

## Environmental degradation and our health

Actions that we take today will threaten our health tomorrow and in the future. Environmental degradation from habitat loss, overexploitation and climate change will all have implications for human health. In addition, loss of traditional knowledge and practice related to biodiversity and medicines could have significant consequences in years to come.

Loss of intact habitat can translate directly into compromised health through loss of sources of clean water, clean air, and medicines. In addition, habitat degradation is often associated with increases in invasive species and disruption of ecosystems, which also have significant

implications for the spread of infectious diseases and the loss of important plants and animals that may have medicinal values. At the ecosystem level, evidence is accumulating that human impacts on natural ecosystems are exposing people to new health hazards (see, for example, van Wilgenberg, this volume; MEA, 2005a).

The introduction of new agricultural practices, or expansion of existing practices, can also increase epidemiological risks through changing ecological relationships. A particularly worrisome mechanism is genetic exchange between viruses infecting people and wild or domestic animals, with the two viruses picking up genes from each other, enabling the virus to produce a new outer coat and so evade the human immune system (Miller, 1989). This is the main mechanism by which influenza pandemics arise, often involving an influenza virus that infects humans and one that is carried by ducks, including wild ducks, and other species of birds. Many believe the recent outbreak of H5N1 avian influenza arose this way. As humans spread into more nesting areas of wild birds, opportunities for this genetic exchange are likely to increase, with global air travel enabling the virus to spread around the world, before its symptoms are expressed.

Animal populations that are displaced by habitat alteration can provide new habitats for pathogens or can carry their pathogens to new areas and new species. Because populations of humans or animals exposed to a new infectious organism tend to experience disease in an explosive manner rather than the sporadic and lower-level outbreaks of disease that characterise endemic infectious organisms, these 'invasive species' are likely to be especially dangerous. Thus, habitat fragmentation, already identified as a major threat to biodiversity, can also increase both human and wildlife susceptibility to introduced diseases (MEA, 2005b).

Some health concerns resulting from habitat degradation relate to specific biomes. Infectious diseases have often been associated with wetlands, leading to their modification as a public health measure. Other kinds of water resources development may increase the risk of disease. Four main diseases are commonly associated with water development projects - schistosomiasis, lymphatic filariasis, onchocerciasis and malaria - because of their wide distribution and serious symptoms. Many other diseases, such as cholera, dysentery, and encephalitis, are also linked to water. As demand for more water development projects increases and natural wetlands are modified to provide greater flows of economic benefits, an ecological approach has been recommended to wetlands management and health assessment (Zimmermann, 2001; MEA, 2005b). This will involve dealing with an entire landscape, addressing spatial boundaries, and ensuring that cross-boundary interactions are incorporated in planning decisions.



Deforestation of tropical rain forests

Photo credit: IUCN Sri Lanka

Tropical forests are not amenable to intervention for control of insect vectors, and it often is difficult to establish effective health care and surveillance systems to serve the needs of indigenous or migrant populations. Where health care systems do exist, they are likely to be less able to respond to ecosystem changes projected over the next few decades, especially if resources for public health continue to diminish. Thus, changes associated with diseases of the tropical forest and its interface, and the consequences of continuing forest loss to human and wildlife health, will be less predictable in the future. The impacts of deforestation and climate change are particularly potent combinations that create conditions conducive to the emergence and spread of disease. As the rate of change continues to accelerate, we should expect more uncertainty in the future. This implies that medicinal biodiversity is likely to be even more important in the future, to help rural people address the challenges of new diseases and living conditions.

Two parts of the tropical world that are especially vulnerable to habitat destruction are the Amazon Basin and the Congo Basin. These two regions are also especially notable as important wilderness areas and as centres for the emergence of new infectious diseases (see Box 1).

#### Box 1. Habitat loss and infectious disease in Brazil and Central Africa

Nearly 190 new species of viruses were identified in the Brazilian Amazon from 1954 to 1998. Vasconcelos *et al.* (2001) reviewed ecological and epidemiological data and reported that the kinds of environmental changes that lead to the loss of biodiversity -- such as deforestation, mining, dam and highway construction, human colonisation, and urbanisation - were associated with the emergence and/or re-emergence of relevant arboviruses, including some known pathogens for humans. For example, deforestation for agriculture leads to outbreaks of sylvatic yellow fever in Brazil.

Central Africa, including the Congo basin, is the home of Ebola, Marburg, HIV, and many other emerging infectious diseases that involve human-animal interactions (van Wilgenburg, this volume). The Marburg virus, which broke out in August 1967 in the German town of Marburg, infected 37 people, of whom nine died. But the virus was carried by monkeys from Uganda that were used for preparing polio vaccine and in other kinds of research. Diseases that affect humans can also have devastating impacts on wild populations of various primates, especially those that are most closely related to humans. Ebola has recently devastated chimpanzee and gorilla populations, possibly due to human changes in the forest habitat (Karesh and Reed, 2005).

In addition to habitat degradation, it is clear from earlier chapters that many medicinal species are under serious threat from over-exploitation. As a dramatic example, Nijman (2005) documents the decline of a species of monkey endemic to Borneo, Hose's langur (*Presbytis hosei*), in Indonesia's Kayan Mentarang National Park. This species is declining because of hunting for bezoar stones (visceral excretions found in langurs and used in traditional medicine). In 1998, a merchant guaranteed to purchase any bezoar stones, which sparked excessive hunting of the monkey to such an extent that within three years the hunting was no longer economically viable. Nijman's study 'demonstrates that, with increasing access to markets, hunting large vertebrates for medicinal purposes even for short periods only, can have a dramatic impact on population numbers. In such cases, habitat protection alone does not guarantee preservation, and more active protection of wildlife is required'. Hundreds of other langurs have been killed recently for the trade in bezoar stones. These species are often especially important biologically, as consumers of plants, distributors of seeds, and prey for other species. The fact that they produce a valuable medicinal product makes them far more vulnerable to human predation. It should come as no surprise that expanding demand for medicinal species means that future supplies are becoming increasingly threatened.

Finally, climate change is increasingly becoming a factor in human health. In general, previous chapters have indicated that declining biodiversity together with the impacts of climate change on habitat and biodiversity can decouple biological control systems that currently are limiting emergence and spread of biological pathogens, as well as reduce the supply of medicinal biodiversity. Many of the effects of climate change on human health are indirect, through the spread of disease vectors, changes in habitats, changes in food supply, increases in extreme weather patterns, and changes in water supply.

Climate change is likely to affect the ecology of many diseases and insect and arthropod disease transmitters (vectors) such as those responsible for malaria, dengue, schistosomiasis, yellow fever, onchocerciasis, lymphatic filariasis, leishmaniasis, and American and African trypanosomiasis. Increases in the incidence of viral tick-borne encephalitis in Sweden have already been linked to recent milder winters and the earlier arrival of spring. All known Rift Valley fever outbreaks in East Africa from 1950 to 1998, and probably earlier, followed periods of abnormally high rainfall (Linthicum et al., 1999). Colder, wetter, or drier years that lead to declining harvests of major food crops will also have a direct health effect (Fagan, 2000).

One essential element of the link between human health and biodiversity that has been slightly under-emphasised in this book is traditional knowledge. Indigenous peoples have identified virtually all of the medicinal species that are living within their territory, yet traditional knowledge may be even more seriously threatened than biodiversity. Of the world's approximately 6800 languages, at least half are spoken only by the elderly and are no longer being taught to the young; they are hence doomed to extinction (Harmon, 1995). Language is often a carrier of traditional knowledge, and many rural people remain dependent on traditional medicinal biodiversity. We therefore need stronger efforts to conserve the entire package of both medicinal biodiversity and cultural knowledge.

## What we can do today to prepare for the future

Looking at biodiversity through the lens of human health can help provide new perspectives on policy and practice of biodiversity conservation with a view to supporting human health. Demonstrating biodiversity's links to human health takes biodiversity out of the unique realm of ministries of environment and instead, puts conservation at the very centre of humanitarian concerns. Such links can help to influence public opinion in support of efforts to conserve genes, species and ecosystems.

### Improving biodiversity policy to promote human health

The policy options to support both biodiversity and human health that are suggested below derive from earlier chapters, augmented by other sources to suggest a comprehensive package of measures that would ensure the future of medicinal biodiversity. They are directed at multiple audiences, including international agencies, the private sector, and civil society organisations. These policy options also indicate how those concerned primarily with conserving biodiversity can make important contributions to human health, and how those concerned primarily with human health can contribute to conserving biodiversity. Particular attention is given to the developing countries where local ecosystem goods and services remain vital to the sustenance and well-being of many people, especially the rural poor.

Policies and practices that affect the status of global and local biodiversity almost inevitably have an effect on human health. Given the beneficial role of high levels of biodiversity within vertebrate communities in reducing the risk of disease, human activities that erode vertebrate species diversity must be considered carefully for their epidemiological impacts. In addition, it is important to establish, ideally as an extension of pre-existing national health information systems, an international monitoring programme on ecosystem disruptions and their effects on human health. Where such national health information systems do not exist, their creation needs to be encouraged through developing appropriate human resources, functioning infrastructure, effective inter-sectoral links, and the country's resources and capacity to deal with unexpected situations.

All policy should be based on a sound understanding of its potential systemic effects. This will require, for example, a much more comprehensive approach to impact assessments. Relevant decisions under multilateral environmental agreements related to biodiversity need to include details of how to use ecosystem functions to improve human health and medicinal biodiversity and contain information on how to implement these decisions at international and national levels. Health and biodiversity need to be addressed in development cooperation at international and national levels, applying the ecosystem approach to the resulting health programmes.

- Support and implement the CBD provisions on access to genetic resources, benefit-sharing and the knowledge of indigenous and local communities.

The Convention on Biological Diversity (CBD) was designed to promote the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources. To date, the negotiations have emphasised intellectual property rights, access and benefit sharing, and agricultural biotechnology. Medicinal species have received relatively little attention, though they remain a sub-theme in many of the discussions about genetic resources. Whether these discussions are effective in actually conserving medicinal species is quite another issue, and awaits further developments. The issue of access and benefit sharing remains a contentious topic for negotiation at meetings of the CBD, and the future of medicinal species may be affected significantly by negotiators sitting in distant conference rooms. It is perhaps worth noting that most of these negotiations are between governments, and the delivery of actual benefits to indigenous or rural peoples, who originally identified and used the medicinal biodiversity that is being discussed, is seldom considered at the domestic level.

#### Box 2: The CBD Conundrum

Article 15 of the CBD, on access to genetic resources, calls for Parties 'to create conditions to facilitate access to genetic resources for environmentally sound uses by other Contracting Parties and not to impose restrictions that run counter to the objectives of this convention.' But years of 'biopiracy' have led many countries to establish restrictive legislation that effectively prevents the export of any genes or species, even those that are designed solely for research. The pharmaceutical 'rainforest gold' promised Pearce and Puroshothaman (1993), even when brought down to more realistic terms by Mendelson and Balick (1995), gives governments an incentive to protect such resources against predatory prospectors. Ironically, this may be hampering the further development of at least some medicinal species and is certainly making international cooperation in biodiversity-based health research more difficult.

- Support and implement the CBD provisions on sustainable use of biodiversity, with special reference here to medicinal species.

In 1996, the first IUCN World Conservation Congress adopted a resolution on sustainable use, recognising that sustainable use was central to implementing major multilateral environmental agreements. Currently, the Union, in collaboration with the German Federal Agency for Nature Conservation (BfN), the World Wide Fund For Nature (WWF) and TRAFFIC is working towards establishing an International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP) (see Klingersten et al, this volume). Meanwhile, TRAFFIC is working towards strengthening sustainable development by developing indicators for sustainability.



- Encourage developing nations to produce legislation that takes full advantage of the flexibility offered by the Convention on Trade-related Intellectual Property Rights (TRIPs) developed under the World Trade Organization.

All countries need to be able to participate fully and equally in negotiations on intellectual property rights, and encouraged to develop their domestic systems of intellectual property rights. New approaches may be required to protect traditional knowledge, including through providing non-commercial public funding for development of new Pharmaceuticals. An optimal system might be one that has less restrictive permitting for initial research and screening purposes, followed by more restrictive permitting when a compound is patented and moves to clinical trials, with graduated milestone payments to source countries along the clinical trial pathway.

- Support and implement the provisions of other multilateral agreements that have implications for biodiversity and human health.

The Convention on International Trade in Endangered Species (CITES) covers medicinal species of both animals (e.g. rhinos and tigers) and plants (e.g. *Hoodia* sp.) (Miththapala, this volume). Regulation of trade in medicinal species has been part of CITES discussions for many years, with the most recent suite of decisions relating to medicinal plants (Decisions 13.50, 13.51, 13.52, and 13.53) providing clarifications for Parties engaging in trade of medicinal species.

Significant work has been carried out by IUCN (especially through its Medicinal Plant Specialist Group and the Species Programme), TRAFFIC and WWF liaising with WHO on the issue of preparing international guidelines for the conservation of medicinal species. In 1993, IUCN, the World Health Organization (WHO), and the World Wide Fund For Nature (WWF), prepared 'Guidelines on the Conservation of Medicinal Plants'. These are currently being revised, also in collaboration with TRAFFIC. Meanwhile, the WHO has established WHO Collaborating Centres for Traditional Medicine (WHO, 2005).

Climate change has numerous implications for both human health and biodiversity, and these need to be addressed together under the United Nations Framework Convention on Climate Change (UNFCCC), leading to a broadly-supported action plan for ensuring that human health and biodiversity issues are incorporated in all relevant activities that address the problem of climate change. To date, health issues have received inadequate attention by the Parties to the Climate Change Convention.

- Support the private health sector in mainstreaming biodiversity concerns in their activities.

In many countries, governments require risk assessment for all projects that may affect the environment. However, such environmental impact assessments typically give insufficient attention to either health or biodiversity. At a minimum, impact assessments should endeavour to protect sparsely inhabited ecosystems from further human impacts, until such time as a fuller understanding is available of the nature of the infectious agents in the system as evolved currently.

This awareness can be enhanced further through creating incentives for local communities to contribute to long-term conservation of medicinal resource populations through establishing legal responsibility and tenure over these resources.

## Improving biodiversity practice to promote human health

Fortunately, more institutions are recognising the importance of medicinal biodiversity, and are seeking ways to conserve these valuable resources

The 'ecosystem approach' that has been developed under the CBD is also being applied to human health (see, for example, Sabroza & Waltner-Toiws, 2001). This requires looking at the whole set of nested hierarchies, ranging from the individual to the village, nation, and globe. A change at any one scale may disrupt ecological and social systems of which they are part, leading to uncertain delivery of unexpected results from development interventions. This approach also suggests a sense of humility as we seek to address such problems.

- Integrate the conservation and sustainable use of medicinal biodiversity within both development and implementation of national biodiversity strategies and action plans.

Appropriate measures might include establishing a permit system for harvesting species from the wild, developing national-level databases to bring together information on the identity, distribution, demography and conservation status of medicinal plants and animals, and promoting the involvement of local communities and local government units in the organisation of such databases. Enhanced awareness among traditional medical practitioners and local communities of the problems caused by over-harvesting, poaching and the loss of traditional knowledge should also be an objective of such plans.

- Support the involvement of local communities in management of medicinal biodiversity.

This volume contains several papers describing the role of communities, and especially women, in collection and use of medicinal biodiversity (Singh & Pacholi, Wang, Karki, all this volume). As primary consumers, these groups should also be part of the management and decision-making systems relevant to sustainable use of this biodiversity.

- Ensure that medical research does not threaten the survival of any species.

Appropriate measures may include developing protocols for using fewer animals in research and using tissue cultures, computer models and other surrogates for whole organisms. Using animals for medical research also raises ethical concerns and some animal welfare organisations object strongly to any such use, especially when it involves suffering in the experimental animals. Sometimes these concerns have even led to violent confrontations between animal rights advocates and medical researchers.

- Improve means of mitigating potential impacts on medicinal biodiversity of development activities.

Agricultural development should incorporate means of mitigating disease risk by: avoiding overuse of antibiotics in livestock and poultry; preventing the close spatial associations between domesticated and wild animals to prevent transmission of infectious agents between them; reducing the potential of livestock and poultry as pathogen reservoirs in the local transmission of human vector-borne diseases; and avoiding natural habitat destruction and fragmentation that can increase disease risk.

Resource extraction projects (e.g., forestry, mining) and the development of human habitations in previously undisturbed habitats must consider the potential for significantly elevating disease risk. Risk can be increased by: the creation of new habitat for disease vectors (e.g., road-building and mosquitoes); changes in vector behaviour (e.g., switching to humans when alternative natural hosts become locally scarce); and the close juxtaposition of people with reservoirs and vectors of pathogens (e.g., settlements within zones of natural transmission among wildlife).

- Establish and effectively manage extensive systems of protected areas to cover all habitat types, especially in biodiversity hotspots, extensive areas of old-growth forests, and critical marine habitats (such as coral reefs).

The conservation of medicinal species needs to take place in ecosystems that are continuing to evolve and adapt to changing conditions. This implies a particularly important role for protected areas, where the main management objective is the conservation of biological diversity. Protected areas have much to contribute to the conservation of medicinal species, especially if they can build appropriate measures into their management plans (McNeely & Thorsell, 1991). Protected areas should recognise explicitly the specific medicinal plants and animals that they are protecting, identify their range and populations, and educate the public about their importance. They may also need to consider an element of research on these species, and perhaps even permit some limited harvesting as part of a planned bioprospecting effort.

#### Box 3: Medicinal plants and protected areas in Vietnam

On et al. (2001) described the development and application of a survey methodology that uses standard phytosociological techniques for the quantitative inventory of medicinal plants in BaVi National Park in northern Viet Nam. They sampled over 200 medicinal plant species, including 41 of the 44 economically important medicinal species found in the area. About half of the important medicinal plant species were vines and were concentrated in relatively intact late secondary closed forest habitats at higher elevations. The status of most important medicinal plant species was found to be rare or uncommon, and to exhibit scattered (as opposed to clumped) distributions. They discuss implications of the applied methodology and the assembled data for the inventory, conservation, and sustainable use of medicinal plants at local and broader regional scales. More such studies are required.

A national system of protected areas can serve as an essential antidote to habitat destruction, a major means of adapting to changes in climate, a means of maintaining ecosystem functions, and a mechanism for conserving medicinal species. Virtually all countries already have systems of protected areas, but these need to be expanded and managed more effectively if they are to make their optimal contribution to biodiversity and human health.

Management plans for the protected areas need to provide for the appropriate use of genetic resources important for human health. The protected areas can be funded by capturing the market value of the ecosystem services provided by the forests, coral reefs, wetlands and other habitats that are managed to maintain ecosystem integrity.

- Apply preventive and precautionary approaches in addressing issues related to invasive alien species.

Experience has shown that preventing invasions of potentially harmful species is more cost-effective than waiting until they have become established as a threat to biodiversity and human health. Sanitary, zoosanitary, and phytosanitary measures have been established, but need to be implemented more effectively. This will require that the assumptions of the World Trade Organization (WTO) on the application of these measures (the SPS Agreement) would need to be amended to place the ultimate legal burden on the proponent to show that a proposed import is safe. More broadly, the WTO should be working with the CBD and the WHO to address issues of invasive alien species that may be harmful to human health and biodiversity. At national levels, governments will need to coordinate activities of various agencies that are responsible for human health, animal health, plant health, transport, tourism, trade, protected areas, wildlife management, water supply and other relevant fields, and to develop an early warning system and rapid response capacity in each country.

- Provide mechanisms to support sustainable sourcing practices for consumers, including industry, to be encouraged to use, and to be able to identify in the market, sustainably sourced products. The IUCN/SSC Medicinal Plant Specialist Group is currently examining centres of medicinal plant diversity in the world. Regional projects have been established to support national and regional conservation strategies and capacity building within existing centres of medicinal plant diversity. The MPSG is also focusing on a global strategy to increase awareness among all stakeholders (inter alia, the medicinal plant industry, consumers, governments, and health and conservation policy makers) about highly threatened species of medicinal plants all over the world.

## Conclusions

The policy and management options presented here underline the essential point that human health depends ultimately on the health of other species and on the healthy functioning of ecosystems. This chapter suggests incentives to conserve species and habitats and should help to build the broad public support that is required to address the continuing and alarming loss of biodiversity at the global scale.

Different stakeholder groups have different interests in medicinal species. Those concerned with nature conservation are focused on habitat protection, sustainable collection from the wild, appropriate controls on trade, and so forth. Those with social interests seek acknowledgement of traditional knowledge, and reliable and sufficient income to enable harvesters and farmers to make a viable income. Those with primarily economic interests are concerned with quality standards, a prosperous trade, and a profitable processing industry leading to a lucrative trade. Managing these sometimes competing interests is a significant challenge for the future.

It is in our own interest to conserve medicinal biodiversity. We are seeing the emergence of increasing numbers of new infectious diseases, and history has indicated that at least some potential treatments to such diseases are likely to come from nature, if only we have the wisdom to conserve the full diversity of genetic resources so that they are available when they are needed.

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Climate change is altering the geographic range of disease vectors such as *Aedes aegypti*

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Dried *Dendrobium*



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## The World Conservation Union (IUCN)

Founded in 1948, IUCN -The World Conservation Union brings together States, government agencies, and a diverse range of non-governmental organizations in a unique partnership. As a Union of more than 1,000 members, IUCN seeks to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable. IUCN's six Commissions unite 10,000 volunteer experts from a range of disciplines. They assess the state of the world's natural resources and provide the Union with sound know-how and policy advice on conservation issues. IUCN's Headquarters is in Gland, Switzerland.

**IUCN's Vision is a just world that values and conserves nature. Our mission is to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable.**

<http://www.iucn.org>

## The World Conservation Union (IUCN) in Asia

The IUCN Asia region covers 23 countries, stretching from Pakistan in the West to Japan in the East, Indonesia in the South to Mongolia in the North. IUCN maintains offices in Bangladesh, Cambodia, China, Lao PDR, Nepal, Pakistan, Sri Lanka, Thailand and Vietnam. The Asia Regional Office is in Bangkok, Thailand.

IUCN's nine regional thematic programmes, known collectively as the Ecosystems and Livelihoods Group (ELG), are based in two clusters: one in Colombo, Sri Lanka (biodiversity, environmental economics, marine and coastal, species), and one in Bangkok, Thailand (environmental law, forests, mountains, protected areas, wetlands and water resources).

IUCN also runs a Regional Information Hub on coastal ecosystem management in a post-tsunami context out of its ELG cluster in Sri Lanka.

<http://www.iucn.org/places/asia>

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