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Management of Biodiversity and Land Use in Southern Peru

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Source: Mountain Research and Development, 25(3) : 287-289

Published By: International Mountain Society

URL: https://doi.org/10.1659/0276-4741(2005)025[0287:MOBALU]2.0.CO;2

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Mountain Partnership News

Creating New Opportunities for Networking in Mountain Research

This is the first of what will be periodic reports by the Mountain Partnership on the progress of its activities. MRD *is a member of the Mountain Partnership.*
— Ed.

The IYM2002 spirit of cooperation continues

Cooperation is one of the distinguishing characteristics of mountain societies; indeed, it has long been recognized that sharing information, pooling resources and working together is essential for long-term survival in these environments. This spirit of working together to bring about meaningful change in mountain environments underlay the International Year of Mountains (IYM) in 2002—a springboard for long-term collaborative research and action to enhance the well-being of mountain people and conserve mountain ecosystems. The Year recognized that it was essential to intensify the regional and global exchange of research results, methods and approaches, as well as to reinforce research partnerships across continents and mountain regions. In particular, the Year also underlined the importance of connecting research partnerships between north and south to increase the sharing of research results and findings and expose stakeholders to different situations, conditions and approaches.

But three years on, how is the international community working together to ensure mountain research results are generated, distributed and translated into concrete action across the world? Scientists, academics, researchers and development workers are increasingly coming together to achieve these goals through the Mountain Partnership.

The launch of the Mountain Partnership at the World Summit for Sustainable Development (WSSD, Johannesburg, 2002) was one of the most significant global events during the International Year of Mountains. Today, the Partnership is acting both as a tool and a framework in which to enhance long-term cooperation and commitment to sustainable mountain development, offering exciting new opportunities to exchange results, to network, to initiate new activities, and to strengthen existing ones. The area of mountain research is a priority in these collaborative efforts.

A force for change

We can do better and achieve more by working together than working alone. This is the core idea behind the Mountain Partnership—a purely voluntary alliance of interested countries and organizations committed to improving the lives of mountain people and protecting mountain environments around the world. By May 2005, a total of 117 members had joined the Mountain Partnership: 45 countries, 14 intergovernmental organizations and 58 major groups (civil society, NGOs and the private sector).

Members are addressing the challenges facing mountain regions by tapping the wealth and diversity of resources, knowledge, information and expertise, from and between one another, in order to stimulate concrete initiatives at all levels that will ensure improved quality of life and environments in the world's mountain regions. Indeed, it is the collaborative action known as the 'Partnership Initiatives' which drives the Mountain Partnership. By May 2005, members had identified and were actively engaged in developing seven thematic initiatives (on education, gender, policy and law, research, sustainable agriculture and rural development or SARD–M, sustainable livelihoods, and watershed management), as well as six regional initiatives (on the Andes, Central America and the Caribbean, Central Asia, East Africa, Europe, and the Hindu Kush–Himalaya).

The Partnership Initiatives are not intrinsically 'new'. Rather, they build on events, processes and concrete activities that took place or were started during the International Year of Mountains or before: for example, the SARD–M Initiative is driven by the outcomes of the global conference held in Adelboden, Switzerland, from 16–20 June 2002; the Gender Initiative is inspired by the findings of the Global Meeting "Celebrating Mountain Women", held in Thimphu, Bhutan, from 1–4 October 2002; and Watershed Management has emerged from an extended watershed management review process carried out between 2002 and 2003 by FAO, in collaboration with various partners worldwide.

Notably, the Research Initiative takes its lead from the various promising global research programs related to sustainable mountain development that were begun or strengthened within the framework of the International Year of Mountains (see Box). These include the IGBP–IHDP–GTOS Mountain Research Initiative, the UNU/CDE program on sustainable mountain development and the numerous programs adapted to incorporate mountain-specific elements in their research activities that were developed by UN organizations, CGIAR research centers and NGOs.

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Many of these groups and institutions are now members of the Mountain Partnership, and some are among the 40 members focusing joint efforts on the Mountain Partnership Research Initiative.

Bridging the communication gap

The Research Initiative of the Mountain Partnership is neither a new research program nor does it interfere with ongoing global mountain research projects. Instead, the Research Initiative recognizes that projects, policies and laws and other activities which support sustainable development in mountain areas have to be based on sound information and knowledge and that this is typically achieved by cooperation and information-sharing among partners. Much is known about the natural and social systems of mountain regions, but this information and knowledge tends to be fragmented among sources and themes and is not always well focused on sustainable development. Furthermore, there are important gaps in knowledge about key mountain issues that require greater attention by researchers. Although each of the existing mountain research programs links together many researchers from all over the world and the potential for collaboration is enormous, in reality there is often insufficient awareness, understanding and communication about ongoing programs and the link between them.

The mechanism of the Mountain Partnership helps bridge these gaps. It promises to create new opportunities for better coordination of ongoing research and a better focus for research priorities that address the needs of the members of the Mountain Partnership. More specifically, the Mountain Partnership Research Initiative provides a platform for communication among all ongoing global mountain

Some institutions implementing global mountain research programs

* members of the Mountain Partnership

Centre for Development and Environment (CDE)*
CDE, part of the University of Berne in Switzerland, is concerned with development and environmental problems of the South and East with special emphasis on the sustainable management of natural resources. CDE manages and edits the quarterly journal *Mountain Research and Development*. Together with the United Nations University, CDE is implementing a Global Mountain Partnership Programme (www.cde.unibe.ch/).

Food and Agriculture Organization of the United Nations (FAO)*
FAO is implementing a number of mountain research-related activities on themes such as the vulnerability of mountain people, watershed management, forests and water, nutrition, fisheries, pastures, policy and law (www.fao.org/).

International Centre for Integrated Mountain Development (ICIMOD)*
ICIMOD is a focal point for research, institutional strengthening, cooperation, and information sharing among the mountain areas of Asia, especially in the Hindu Kush–Himalayas. It operates through a partnership with member countries and partner institutions (www.icimod.org.np/index.htm).

International Scientific Committee on Research in the Alps (ISCAR)*
ISCAR represents the scientific community as the official observer of the Alpine Convention, promotes information exchange and facilitates networking and cooperation between alpine organizations and institutions (www.alpinestudies.ch/iscar/).

Mountain Research Initiative (MRI)*
MRI is a multidisciplinary scientific organization that addresses global change issues in mountain regions around the world through publications and events. MRI is working jointly with UNESCO and a consortium of partners, and is implementing the GLOCHAMORE project. MRI just published a report entitled *Global Change and Mountain Regions: An Overview of Current Knowledge*. The organization is developing a database as a central networking tool to connect people from research, government, NGOs and the private sector involved in the issue of global change in mountain regions. The database already comprises close to 3000 entries, featuring contact information and details on the participants' areas of expertise (mri.scnatweb.ch/content/view/40/44/).

United Nations Educational, Scientific and Cultural Organization (UNESCO)*
UNESCO promotes collaboration among nations through education, science, culture and communication. UNESCO is implementing a number of mountain-specific programs, particularly related to water, the linkages between man and the biosphere, and biosphere reserves (portal.unesco.org/en/ev.php-RL_ID=15006&URL_DO=DO_TOPIC&URL_SECTION=201.html).

Other members of the Mountain Partnership

International Potato Center (CIP)
CIP promotes scientific research and related activities on potato, sweet potato, other root and tuber crops, and on the improved management of natural resources in the Andes and other mountain areas. CIP is coordinating the Global Mountain Program of the CGIAR centers (www.cipotato.org/index2.asp).

United Nations University (UNU)
UNU is an international community of scholars, acting as a bridge between the UN and the international academic community, a think-tank for the UN system and a builder of capacities, particularly in developing countries. Over many years UNU has supported research in mountain areas. Jointly with the Centre for Development and Environment, UNU is currently implementing a Global Mountain Partnership Programme (www.unu.edu/).

World Conservation Union (IUCN)
IUCN's 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. IUCN has many projects which are implemented in mountain areas and has established a Mountain Task Force to assist the Union in streamlining the mountain-related activities throughout the organization (www.iucn.org/).

Other organizations and programs

Global Mountain Biodiversity Assessment (GMBA)
GMBA is a global network focusing on the mountain biodiversity research of DIVERSITAS, an international global change research program on biodiversity sciences (gmba.unibas.ch/index/index.htm).

International Union of Forestry Research Organizations (IUFRO)
IUFRO has a task force on "Forests in Sustainable Mountain Development". The objectives of this task force are to advise the Executive Board on current issues, initiatives and research needs as well as to provide a framework for developing and strengthening linkages (iufro-down.boku.ac.at/iufro/taskforce/hptffmd.htm).

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research programs and the individuals involved, in order to exchange information and experiences, to identify needs, and to create greater coherence, effectiveness and efficiency in common research and development efforts.

Some 40 members have already signed up to work together on the Research Initiative, which is led by the Mountain Research Initiative (MRI) and the Centre for Development and Environment (CDE), both of which have their headquarters in Berne, Switzerland. Members of the Research Initiative have agreed to focus on the wider dissemination of knowledge about existing mountain research programs, researchers, institutions and funding sources for use by researchers, donors and stakeholders, and to establish a consultative process that links donors, stakeholders and researchers around key mountain research issues, in order to increase funding opportunities.

Prior to the Second Global Meeting of the Mountain Partnership, or 'Cusco Conference' (Peru, 28–29 October 2004), leading members of the Research Initiative held a workshop for the first time to identify key issues and actions for the Initiative. The outputs of the workshop were further refined during the breakaway session dedicated to the Initiative at the Cusco Conference. Agreed next steps and activities in 2005 include: the development of a research community database that includes information on the topics noted above, as well as the development of research-issue assessments, which will focus on constraints that have limited research in the past and on opportunities for accelerating progress in the future.

The Mountain Partnership Secretariat, hosted by FAO and supported by the governments of Italy and Switzerland, is facilitating the process of building the Research Initiative—as it does with other thematic and geographic Initiatives in the Mountain Partnership. It connects members by organizing face-to-face meetings, by disseminating information and research results through e-mail distribution lists, a monthly newsletter and a dedicated Web site, and by maintaining a database on funding sources.

However, the Research Initiative is not being built in isolation from other Partnership activities. Recognizing that research is a cross-cutting issue in mountain development, the Secretariat is helping members of the Research Initiative forge links with other thematic and geographic Initiatives and assisting members in mainstreaming research concerns in all Partnership activities: by exposing members to effective models, good practices, and existing mechanisms, agreements and frameworks from other members that could be adapted to suit specific national and regional conditions.

In May 2005, for example, two meetings organized within the framework of the Mountain Partnership brought members face-to-face to share the findings of research on mountain biodiversity and transboundary cooperation and to network with others in order to maximize the impact of joint work now and in the future. Both meetings were held in Europe and discussed European-specific experiences, but both provided valuable lessons for potential adoption in other countries and mountainous regions of the world. The first meeting on legal instruments for transboundary cooperation for sustainable mountain development (FAO, Italy, 1 June 2005) focused on how transboundary areas could be protected and managed in partnership, using the experience of the "Espace Mont-Blanc." This group, consisting of 3 Mountain Partnership countries, Italy, France and Switzerland, has come together to manage the Mont Blanc area at the sub-national level. The second meeting explored the conservation of some of the most important mountain ecosystems in Europe and took place during the "Convention on Biological Diversity (CBD) Ad Hoc Open-Ended Working Group on Protected Areas" (Montecatini, Italy, 16 June 2005). The event, entitled "A Vision for Biodiversity in the Alps and Carpathians: the Implementation of the CBD Programme of Work on Protected Areas in the Conservation of Two Globally Important Mountain Ecoregions", celebrated the partnership between the Alps and Carpathians in pursuing ambitious and effective conservation strategies and explored priorities for the next steps for government agencies and NGOs in the region. The event was facilitated by UNEP and sponsored by WWF, with the support of the European Academy of Bolzano (EURAC)—all Mountain Partnership members—in collaboration with other key partners such as the Carpathian Ecoregion Initiative, Birdlife and the Alpine Network of Protected Areas.

For further information about the Mountain Partnership and its Initiatives, visit www.mountainpartnership.org. Subscribe to the monthly newsletter of the Mountain Partnership, 'Peak to Peak', by writing to info@mountainpartnership.org.

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Management of Biodiversity and Land Use in Southern Peru

ECOAN's Activities to Help Conserve *Polylepis* Woodlands

The ECOAN project

The Asociación Ecosistemas Andinos (ECOAN) was founded in 2000 in Cusco, Peru, to support the sustainable use of Andean ecosystems in Peru. The founders, local biologists from Cusco, had been working with the biodiversity associated with high-altitude woodlands since 1990. Recognising the need for effective conservation and sustainable use in the High Andes, they began a dialogue with institutions that might support these objectives. Early on, contacts were made with organisations that supported the idea of a scientific approach to biodiversity conservation, but acknowledged the wider social and economic issues. This was particularly effective with institutions concerned with bird conservation, because a number of vulnerable bird species rely directly on the conservation and sustainable use of their habitat: fragmented high-altitude woodlands of *Polylepis* (*queuña*) trees.

In partnership with American Bird Conservancy (ABC), ECOAN is now working to protect existing *Polylepis* forests, restore new woodlands, and conserve threatened bird species. Trees of the *Polylepis* genus grow at some of the highest altitudes in the world and are among the most threatened Neotropical vegetation types. Estimations by Jon Fjeldså and Michael Kessler (1996) are that *Polylepis* now covers around 10% of the potential cover in Bolivia and a mere 2–3% in Peru. Many rare, endemic, and threatened species are associated with remnant *Polylepis* woodlands.

These high-altitude zones (3500–4300 m) are inhabited by subsistence farmers with long traditions of living in these areas. They need *Polylepis* wood to keep warm at high altitudes, to cook their food, and to provide light. *Polylepis* is also ideal for making charcoal, and for construction, fencing, and tools. Therefore, *Polylepis* woodlands contribute to the immediate needs of local communities and are an important component of the local economy. But some forms of land use are destroying *Polylepis* woodlands. How much is known about *Polylepis* forests today? How can conservation of this vital ecosystem be promoted without excluding use of the resource?

Biodiversity research and land use management are the key elements of ECOAN's approach. Based on solid research and the involvement of communities, ECOAN has achieved increased awareness and stewardship. The ECOAN project includes villages and woodlands in the Cordilleras Vilcanota, Vilcabamba, and Apurimac (Figure 1). This region was identified by Fjeldså and Kessler (1996) as one of the three "top priority" areas for *Polylepis* conservation, and it contains six "vulnerable" *Polylepis* species according to the World Conservation Monitoring Centre (2003): *P. incana, P. microphylla, P. pauta, P. pepei, P. racemosa,* and *P. subsericans*.

Current status and biodiversity of *Polylepis* woodlands

Altogether, 15 species of *Polylepis* are classed as "vulnerable," and it is likely that many associated plants depend on the characteristic microclimate that the woodlands provide. Among the bird species that depend on *Polylepis*, seven are classed as endangered, five as vulnerable, and nine as near-threatened. *Polylepis* woodlands also provide good habitat for large emblematic mammals such as spectacled bears and pumas, as well as many poorly-studied small mammals. The status of other animal groups, such as invertebrates, is unknown.

The densely-packed, small leaves of *Polylepis* trees harvest occult precipitation from the frequent mists of the mountains (Troll 1959; Fjeldså 2002), providing an additional supply of water in rainless periods. The woodlands, with associated mosses, also regulate the flow of water and so reduce peak-flow and drought problems for local communities. The trees add organic matter to the soil and provide protection against erosion, stabilising the soil with its roots, and protecting the soil from heavy rainfall with its canopy.

According to several recent studies, wild potatoes, *ulluco,* and *oca* grow inside *Polylepis* woodlands, providing a genetic resource for improving cultivated varieties in the future (Fjeldså and Kessler 1996; Hijmans and Spooner 2001). Several plants from *Polylepis* woodlands have medicinal or tonic uses (e.g., Hensen 1991).

Controversy still remains as to the natural extent of *Polylepis* forest. Pollen records from Junín, Peru, suggest that the major destruction of the forest took place about 10,000 years ago, but it is still not clear whether this loss was mostly a consequence of climate changes or human activity (Hansen et al 1994). *Polylepis* woodlands are still being lost today, though in some areas forests are conserved (Byers 2000). A variety of land use practices has led to increased fragmentation and isolation of *Polylepis* woodlands, and

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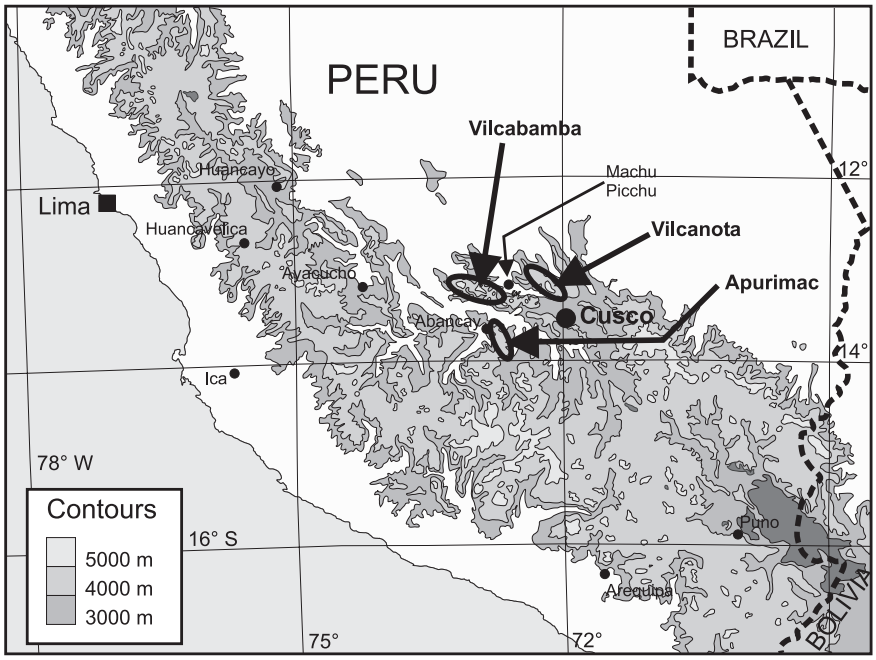
FIGURE 1 Location of the three areas covered by the ECOAN project in southern Peru. (Map by Paul M. Ramsay).



the deterioration of habitat quality within the remnant patches.

ECOAN's assessment of biodiversity and land use management

Patches of *Polylepis* are difficult to identify using current air photographs and satellite images. Therefore, exhaustive field reconnaissance was necessary and identified a total of 41 woodlands in the project area. A preliminary biodiversity inventory was made for each of these woodlands, along with basic cultural and social assessments of the neighbouring communities.

Detailed counts were also made for three threatened bird species that depend directly on *Polylepis* woodlands: *Cinclodes aricomae*, *Anairetes alpinus,* and *Leptasthenura xenothorax*. They revealed that numbers are very low, making these species extremely vulnerable to further habitat destruction. Given the limited information about most animals and plants in *Polylepis* woodlands, it is difficult to determine whether other species are similarly threatened.

Local people have little option but to collect *Polylepis* wood and alternatives must be provided if the loss of woodland is to be halted and reversed. A combination of long-term initiatives and temporary measures to buy time has been employed to save *Polylepis* woodlands in the region.

Developing alternatives

Agreements with local people lie at the heart of ECOAN's philosophy. Potential agreements are discussed, in Quechua, during traditional communal gatherings known as *rimanacuy*. Management agreements pay particular attention to the three most important causes of deforestation: burning of surrounding grasslands, grazing within the woodlands, and the cutting of wood. These agreements are policed by the communities themselves and, in return, there are a number of indirect benefits, supported by donor agencies, to improve quality of life.

Traditional clay stoves (*conchas*), which increase fuelwood efficiency, were reintroduced to highland communities and have halved the amount of wood needed, reducing the pressure to cut *Polylepis*. Several highland communities are working towards obtaining their own land titles: in 2004, Abra Malaga was the first community to realize this objective. Abandoned stone buildings have been converted into greenhouses to diversify agriculture and improve diet. Small supplies of medicines have also been donated to remote villages, and simple toys are given to the children of these communities, once a year, in return for good environmental behaviour when looking after livestock (eg no grassland fires, keeping animals out of the woodlands).

ECOAN also provides trees for planting: 60,000 trees of *Polylepis racemosa* have been planted to join up fragments of existing woodland, and more than 70% were still alive 2–4 years after planting. 36,000 transplants of *Eucalyptus globulus* have also been donated to provide fast-growing timber in community forests to buy time where wood is in extremely short supply and temporary measures are required while new *Polylepis* trees grow. A small-scale planting trial with native *Buddleja* has also taken place to provide fuelwood. In other places, where *Polylepis* woodlands are the only source of wood, eucalyptus wood from lower altitudes is provided for fuel.

The future of *Polylepis* woodlands in southern Peru

The people of these isolated mountain areas cannot survive without wood and their only source is *Polylepis*. A simple ban on its use would either be met with disdain or, if enforced, would result in the emigration of people from their ancestral lands. The only practical way forward is an integrated approach that recognises the needs of local communities. ECOAN has tried to combine a conservation message with the provision of genuine benefits to highland people. The destruction of *Polylepis* has been slowed in the project areas, but occasional problems continue. The communities themselves impose

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their own penalties for breaking the rules of the agreements, but independent monitoring is also needed. It provides feedback on how well the agreements are working, and permits data to be collected on the success of the various aspects of the project (biodiversity surveys, tree mortality and growth rates, etc).

In Inca times, *Polylepis* woodlands were strictly protected (Fjeldså 2002) and highland people in the project area practised large-scale agroforestry with *Alnus* (Chepstow-Lusty et al 1998). *Buddleja* was also used extensively (Gade 1999). At the same time, the Inca provided additional support for these people in the form of redistribution of wood and food (Gade 1999). ECOAN is reintroducing this approach in the Andes, combining woodland conservation with agroforestry and the provision of indirect support, in order to conserve biodiversity, ecosystem services, and highland culture.

A long-term aim is to encourage highland communities to establish voluntary community reserves, with sustainable management plans. Despite the threatened status of *Polylepis* woodlands, it is sometimes difficult to persuade some donor agencies to abandon their short-term perspectives and consider more effective strategies that might take decades to produce results. Nevertheless, some progress has been made and ECOAN will continue to work with local communities to conserve biodiversity in the extreme conditions of the Peruvian highlands.

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Life after Opium in the Hills of Thailand

This article uses a case study to describe the human ecological crisis among Thailand's former opium-producing hill-tribe minorities. Development projects in the country's northern highlands replaced opium with alternative cash crops and reduced opium production to a trickle during the final decades of the 20th century. When they were cultivating the illicit drug, Thailand's hill tribes were a focus of strong interest by the international news media and foreign governments. The spotlight on the hill tribes dimmed quickly after opium production virtually ended and the various replacement projects closed. Now, the news media will occasionally report in glowing terms about hill-tribe farmers' successful cultivation of opium replacement crops. Nevertheless, to an informed observer visiting a hill-tribe village, it is clear that the new "opium-free" economy is barely functioning in Thailand's northern highlands. Additionally, hidden largely from view are poverty-related social problems such as drug trafficking, heroin addiction, prostitution, and AIDS.

Mae Sa Valley case study

Some researchers criticize opium replacement projects and point to them as primary reasons for poverty in the hills. The critics identify a range of possible causal factors, such as ecological inadequacies of a new monoculture, inattention to social problems, or debt accrued from costly production inputs (eg fertilizers and pesticides). Indeed, if opium replacement could have averted poverty anywhere, it would have done so in the hill-tribe villages of the Mae Sa Valley. The valley is located about 30 kilometers north of the city of Chiang Mai, Thailand's second largest city and the northern region's center for tourism. Situated in the northeast section of the Inthanon Range, the valley is in the Mae Rim District of Chiang Mai Province. Two *tambons* (administrative subdistricts) make up the valley—Pong Yaeng Nai and

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Mae Raem. A curved line of elevation stretching from the rim of the Mae Sa watershed, where hill-tribe villages are situated, to where the Mae Sa stream empties into the Mae Ping River, represents the hill tribes' isolation from Thais living in the valley bottom and adjoining lowland. In addition to isolation, the amount of this curvature of elevation also symbolizes differences in living conditions among the hill tribes and lowland Thais. If living conditions were to improve enough in the more isolated villages, the curve would "flatten out." The hill tribes in the valley have received development assistance for about 30 years, a longer timeframe than any other group of hill-tribe villages in the country. Moreover, the valley enjoys a comparative advantage of location near lowland Thai markets, giving tribal people extraordinary opportunities for interaction with Thai lowlanders. The valley has also had access by road to lowland markets since 1974, including Chiang Mai, northern Thailand's largest economic center. What is more, at practically no cost to the farmers, the Thai government provides refrigerator truck transport of some hill-tribe crops from the valley to Bangkok, 650 kilometers distant. Despite these geographical and economic advantages, the Mae Sa Valley hill-tribe economy has been in a prolonged downward spiral. Household incomes reflect the magnitude of this decline; the average hill-tribe household income was 2.5 times greater than average income in northern Thailand in 1971, but it decreased to one-sixth the regional average in 2000.

Actually, the hill tribes' economic plight in northern Thailand probably has more to do with population pressure and environmental degradation than perceived failures of opium replacement programs. A closer examination of the hill-tribe ecology in Mae Sa Valley supports this argument. This study uses averages and percentages of population and land use to describe the causal linkage between population pressure, resource scarcity, and poverty in the Mae Sa Valley. Data for the early 1970s come from several primary sources. The Thailand government's Tribal Research Centre (now the Tribal Research Institute) conducted hill-tribe population censuses in the valley in 1971 and 1974. F.G.B. Keen gathered data there as well in 1971 and 1974. Keen's data are an exceptionally good find, as information is rare about early living conditions of former opium-producing villages. The 4 hill-tribe villages that he studied are Hmong villages that still exist today. The Hmong ethnic group makes up virtually the entire hill-tribe population of the Mae Sa Valley; therefore, one must assume that all former opium-growers in Thailand would adapt similarly to forces of change and opportunity costs. Data describing the present situation in the hills come from the Thai government and from the author's fieldwork in the Mae Sa Valley in 2002.

Pressures and responses

Hill-tribe population growth was widespread in northern Thailand, particularly from the late 1960s to the mid 1980s. The growth was due to immigration from Laos and Burma (now Myanmar) and a high natural increase (births minus deaths). Because of these two factors, the Mae Sa Valley's tribal population increased almost sixfold and outpaced the local Thai population by nearly 2:1 in 1971–2002. Compounding the pressure of a growing hill-tribe population was a large influx of Thais in the valley's bottomland and lower slopes. These immigrants were part of an inflow of migrants from lowland areas outside Mae Rim District; as a result, Mae Rim had the greatest increase in population density among all districts in Chiang Mai Province in 1970–2002, excluding the district in which the city of Chiang Mai is located. The valley's hill-tribe villages attempted to alleviate population pressure by expanding their cultivated land area. The land farmed increased by a factor of 3, but population density increased by nearly the same magnitude. Pressure on resources increased even more after the mid 1980s, when local forestry officials began enforcing a law against burning forestland and building hillside terraces for cultivation. Reforesting abandoned swiddens and declaring reforested land off limits to farmers also became part of forestry policy.

The hill tribes altered their farming methods in response to rising population pressures. Originally, they cultivated fields until soil fertility was depleted and then moved their villages to "pioneer" new areas. There was no intention of returning to previous sites. By the 1980s, the hill tribes had adopted conservative rotational swiddening under the guidance of crop replacement projects. This system allows a farmer to live in one place by burning less forest; the farmer clears a field in the forest, uses it for one or two years, and then clears another field nearby and so on. After a period of 7 to 10 years, plant growth returns fertility to the fallowed plot and the farmer cultivates it again. Less land is swidden land in the rotational system, as farmers use more land to grow capital-intensive crops (such as vegetables, root crops, beans, harvest fruits, and commercially cut flowers) in permanent fields (Figure 1). They must raise cash crops instead of traditional food crops in the permanent fields to pay for fertilizers and pesticides to assure sufficient crop yields. The villagers are usually able to pay for basic food staples, such as rice, from the profits. The new economy also diminishes the role of large livestock. The hill tribes used to raise cows and buffaloes to sell or barter; they also

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FIGURE 1 Hmong villagers in Nong Hoi washing recently harvested ginger. Ginger root was a traditional food collected in the forest; now it is a cash crop grown in permanent fields. (Photo by Richard A. Crooker)

rented buffaloes to paddy rice cultivators. They ate the pigs and used the horses for conveying crops from fields to village. When times were difficult, they would sell the animals for cash or use them to barter for badly needed supplies. The present economy almost totally excludes raising large livestock, as there is virtually no forestland available for grazing animals.

Prospects

After 30 years of development, the curve in living conditions between the Mae Sa Valley's hill tribes and lowland Thais has not flattened. The population of former opium-growers still has a pyramidal structure with a broad base of young, less productive people and gradually fewer people in the middle and old age groups. The total population has increased more than 5 times during this period. Despite the burgeoning growth in population, hill-tribe infant mortality is approximately twice that of lowland Thai infants. Common health problems among all age groups include diarrhea, colds, and flu. At the same time, lowland Thais are passing through a demographic transition to slower growth rates, smaller families, better health, and greater longevity.

In contrast to demography, the hill tribes' economy has undergone a revolution in land use from migratory shifting cultivation to permanent field agriculture. Nevertheless, ecological problems that were beginning to appear 30 years ago are now extreme. There is no longer new land to absorb the growing population. Swiddens, which farmers use mainly to supplement rice purchases, are tiny. Livestock husbandry has all but disappeared. What is more, there are no apparent safety valves to release the valley's ecological strain. Tourism is too competitive to be a solution; roads provide tourists with access to hundreds of other such villages. Hill-tribe people cannot compete with healthier and better-educated lowland Thais for off-farm employment. Lamentably, amphetamine and heroin trafficking, as well as AIDS, have moved stealthily into the valley as well. These latter problems drain income and other family resources and add to growing despair, nagging poverty, and loosening social bonds in villages.

There are some promising ongoing developments. The government is issuing more identity cards to enable hill-tribe people to travel more freely, have banking accounts, receive loans, own and sell property, attend secondary school, and use state-operated medical facilities. Three fourths of all couples of childbearing age use condoms now. Education is also improving, albeit at a slower rate than in Thai villages in the valley. Since the early 1970s, the ability to read and speak simple Thai has increased from 10% to 36%, and hill-tribe people are beginning to graduate from high school. Equally encouraging is the Thailand government's recent poli-

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cy of including villagers in forestry conservation decisions. This development emphasizes the need for more education, if minority villagers are to meet the challenges of social and economic integration.

Regional context

Thailand deserves credit for nearly 30 years of steadfast commitment to a policy of opium reduction in areas like the Mae Sa Valley. The hill-tribe people of the valley no longer grow opium to sell to local warlords or lowland drug traffickers. They live in permanent settlements, grow legitimate cash crops, and have a stake in participating in Thai society. Nevertheless, environmental deterioration threatens hill-tribe livelihoods and tribal people constitute the poorest socioeconomic strata in the valley. Even more distressing are the hundreds of former opium villages that do not share the location advantages that the Mae Sa Valley has. Villages that are closer to the Myanmar border are in the worst condition. Their economies depend heavily on smuggling drugs and other contraband from Myanmar to lowland Thai towns and cities. The availability of cheap drugs fosters crime, addiction, and police raids. AIDS is a greater concern there than in the Mae Sa Valley, as many more young hill-tribe women are leaving border villages to work as prostitutes in the lowlands and returning with the disease. The world must give more attention to the crisis of resource scarcity and hill-tribe poverty in Thailand, particularly since this crisis is in a historically volatile borderland region and affects international security.

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ACKNOWLEDGMENTS

The National Geographic Society Committee for Research and Exploration supported this research. Parts of this article are based on the author's in-depth study of environmental deterioration and security in northern Thailand (see reference). A special thank you goes to the Asia–Pacific Center for Strategic Studies' transnational and environmental security specialist, Christopher Jasparro, for his helpful editorial comments and suggestions.

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MRI Report on Mountain Climate Science Conference: MTNCLIM 2005, 1–4 March, Pray, Montana, USA

This MTNCLIM Conference was the first western mountain climate science conference modelled after the successful Pacific Climate (PACLIM) conference and sponsored by CIRMOUNT, the Consortium for Integrated Climate Research in Western Mountains—a working group of scientists from a range of agencies and universities, including the Mountain Research Institute (MRI). MTNCLIM aims to advance the sciences related to climate and its interaction with physical, ecological, and social systems of western North American mountains. Within this arena, MTNCLIM goals are to:

- Provide a biennial forum for presenting and encouraging current interdisciplinary research;
- Promote active integration of science into resource management applications;
- Advance the goals of CIRMOUNT through working groups, networking and co-hosting of meetings.

Highlights from the MRI perspective

Steve Gray of the USGS Desert Laboratory in Tucson, Arizona, gave an invited talk in which he linked perspectives derived from paleo-reconstructions of precipitation to both ecosystem dynamics and management of western resources. The paleo-record clearly shows that wet periods—and not droughts—are the anomalies of western climate. Beyond that, the pattern is far more complicated than a simple alternating of wet and dry periods. The record manifests a variety of frequencies, from inter-annual variation to multi-decadal regimes. Extended droughts result in extensive vegetation mortality. Subsequent wet years restart vegetation demography as well as launching colonization of new habitat. At larger scales, these disturbances may, like wildfire, create their own "weather," that is, generate endogenous novel dynamics. On an institutional level, regime shifts are often conflated with management (the debate regarding the management or, alternatively, climatic origins of fuel build up in western forests being a prime example). Furthermore, persistent regimes produce an ossification of management rules that leads to surprise and maladaptation when the next regime shift occurs.

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Indeed, a new CIRMOUNT work group has as its mission to explore the creation of an "up-to-date, spatially focused network of reconstructions to assist water resources managers in long term planning." This specific focus might be useful for at least a few of the Global Change in Mountain Regions (GLOCHAMORE) Mountain Biosphere Reserves (MBRs)—as it has not been included so far in GLOCHAMORE's research strategy—as well as in Central Asia, the subtropical Andes, and other arid mountain ranges.

Tom Whitham of Northern Arizona University in Flagstaff, Arizona, focused on community and evolutionary consequences of the extended drought in the Southwest, providing a much more nuanced view of vegetation response than the "shifting band" perspective. Tree mortality is the key consequence of the Southwest drought. As the tree species in question are keystone species, their mortality reverberates through the structure of plant, bird, mammal, and arthropod communities. The extensive mortality has evolutionary consequences both through population bottlenecks and, because mortality is recurrently site specific, the possibility of local genetic adaptation. Whitham emphasized that ecological interpretations are very likely to be fundamentally revised, and even reversed, once data sets have a duration sufficient to cover the full suite of selective forces. For instance, after nearly two decades of study he was ready to conclude that an insect-resistant morph of pinyon pine was bound to eventually dominate the population, only to find that insect-resistant morphs were three times as likely to die from drought, suggesting that the multiple disturbances of drought and insects maintained the polymorphism of the population. More information about these lines of research can be found on the DIREnet–Drought Impacts on Regional Ecosystems network website: www.mpcer.nau.edu/direnet.

For a variety of regions, MRI has focused on recruitment of woody vegetation into higher alpine areas. Whitham's work is a reminder that it is equally important to understand mortality at the lower edge of the mountain forest. While this may or may not be important in Europe, it is important in MBRs in semi-arid regions.

Alex Hall of UCLA gave a very intriguing talk on the use of a fine-grained (6-km grid cell) RCM (regional climate model) to investigate the impacts of southern California mountains on precipitation and wind events. He and his colleagues drove the model with observed boundary conditions from 1995 to the present, and found very high correlation with observed weather data. The model successfully predicted the circulation modes associated with extreme wet and dry conditions in southern California. The mountains themselves are implicated in the generation of offshore Santa Ana winds and in the pattern of precipitation across the basin. Along with another presenter, Ruby Leung of the Pacific Northwest National Laboratory, he argued convincingly that the creation of RCMs for key mountain regions is feasible and ought to be a main part of the GLOCHAMORE research strategy.

Many other papers and participants deserve mention: Sam Earman of the Desert Research Institute in Reno, Nevada and Mark Williams from University of Colorado at Boulder discussed isotope studies that showed the importance of snow melt to groundwater, and the subsequent importance of groundwater in runoff. Mitch Plummer's paper on the simulation of mountain glaciers gave the impression that he worked at the University of Zurich rather than the Idaho National Engineering and Environmental Lab. Pam Sousanes of Denali National Park explained the Natural Park Service (NPS) Climate Monitoring Program, which would have greatly pleased Bruno Messerli.

More information on the conference can be found at http://www.fs.fed.us/psw/mtnclim/

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