Mountain Forum Bulletin

In collaboration with the Mountain Research Initiative (MRI) and the Global Mountain Biodiversity Assessment (GMBA)

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Mountain Biodiversity: Lifeline for the Future

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Cover Photographs:*(clockwise from right)*
Farmer and professional maize breeder hand in hand, Guangxi, China. Photo: Ronnie Vernooy.
The Stirling Range – islands in the sky in surrounding agricultural landscape. Photo: Anne Cochrane.
Aglais urticae. A threatened species by global warming, Andorra. Photo: Montse Mases.
Snow leopard cub. Photo: Steve Tracy.

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The Mountain Forum Secretariat reserves the right to edit contributions for the sake of clarity and brevity.

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Message from the Mountain Forum Executive Secretary

Dear Readers,

It is with pleasure that I present to you this special edition of the Mountain Forum Bulletin, which focuses on Mountain Biodiversity. This is a central and binding theme in various parts of the world and was selected in 2008 by the Mountain Forum Board as one of the key thematic focus areas for the coming years.

This Bulletin is not only unique because of its extended size, but also because it has been produced in close partnership with the Global Mountain Biodiversity Assessment (GMBA) and the Mountain Research Initiative (MRI). Especial acknowledgement must go to Dr Eva Spehn and Claudia Drexler, who have dedicated a great deal of time and effort to furthering this process of collaboration. Together, Mountain Forum, GMBA, MRI and the regional nodes have worked in genuine partnership to mobilise expertise and experiences from the various networks and create workable synergies. GMBA anchored the thematic content whereas MRI aggregated resources and both insured the involvement of its wide research network. I am delighted that the collaboration made use of our complementary skills and resources, and that the final publication reflects this range of knowledge.

In this edition we have tried to address issues of biodiversity related to research, development and policy, and to bring experiences from the various regions to the footlight. This effort is meant to support discussions on Mountain Biodiversity. In 2010, the International Year of Biodiversity, the Conference of Parties on Biodiversity (COP-10) in Japan will pay special attention to Mountains.

This Bulletin also aims to facilitate the exchange of experiences and good practices at the regional, national and grassroots levels. Information and knowledge from the wider Mountain Forum community through the regional networks provides a solid base, bringing together all stakeholder groups. It is enriched and consolidated by the experiences and knowledge of specialised organisations and networks, such as the GMBA, MRI and the Mountain Invasion Research Network. The featured articles have benefited from review and feed-back from a team of experts, and herewith I would like to thank Dr Greg Greenwood of MRI, Dr Eva Spehn and Dr Katrin Rudmann-Maurer of GMBA, Prof. Martin Price of Perth University and Dr. Eklabya Sharma of ICIMOD for all their efforts.

The lead article sets the stage, sketching the situation and relevance of the topic to sustainable mountain development, whilst indicating actions required for the effective conservation and recovery of biodiversity. It is clear that a combination of measures will be needed at various levels. The featured articles cover all continents and a wide variety of topics, ranging from conflict and its impact to agricultural biodiversity; from butterflies to amphibians as indicators of biodiversity. Members of the Mountain Forum, GMBA and MRI have also contributed a range of practical experiences and initiatives: for example, on the preservation of the endangered Sierra Madre Sparrow in Mexico, the snow leopard in the Indian Himalaya and the caribou in the Canadian Rockies; on conservation of Mediterranean biodiversity in the tiny country of Andorra; on NASA on the Tibetan Plateau and food security in the Andes.

The list of useful resources included at the end of the Bulletin is intended to support networking and more direct exchanges of experiences. It points to key organisations, information resources as well as initiatives relevant for mountain biodiversity.

It is hoped that the process of information and knowledge sharing of the Mountain Forum community and partners will continue and lead to changes at all levels for the benefit of local mountain communities.

Wishing you happy reading,

Frans Neuman
Executive Secretary
Mountain Forum Secretariat

Your feedback is always welcome. Please send any comments or suggestions by email to bulletin@mtnforum.org or by post to the Mountain Forum Secretariat (for the full address see the back of the Bulletin).

Mountain Biodiversity – A Global Heritage

Eva M Spehn and Christian Körner

High biodiversity in high ecosystems

The world's mountains support approximately one quarter of terrestrial biological diversity, with nearly half of the world's biodiversity hotspots concentrated in mountains. Isolated mountains (such as Mount Kinabalu in Malaysia) are often rich in endemic species: plants and animals that occur nowhere else. In the alpine belt (the treeless life zone of mountains, ca. three percent of the global land-area), around four percent of the global number of flowering plant species (about 10,000 alpine species) are estimated to occur, which means that the alpine life zone is richer in plant species than would be expected from its area (Körner 2004). A biological inventory of the world's mountains does not yet exist, but data mining of existing archives of biodiversity offer new avenues to assess mountain biodiversity. The Global Biodiversity Information Facility (GBIF) established a data portal *www.gbif.org* that connects more than 174 million single species occurrence records from various data providers such as natural history museum collections. In cooperation with GBIF, the Global Mountain Biodiversity Assessment (GMBA) of DIVERSITAS is currently developing a thematic mountain portal, which will allow specific searches for primary biodiversity data in mountains.

Mountain areas have been affected by loss of diversity caused by human action, largely due to changes in land use and climate. Uphill expansion of agriculture and settlements, logging for timber and fuel wood and replacement by highland pastures are threatening mountain forests, which are among the most biologically diverse biota. Evergreen tropical cloud forests are the most fragile and most diminished part of mountain forests, but are very rich in endemic species (e.g. in Peru 30 percent of the 272 species of endemic mammals, birds and frogs are found in cloud forests). These harbour the wild relatives and sources of genetic diversity of important staple crops such as beans, potatoes and coffee. Global warming largely affects mountain biodiversity by reducing available land area for organisms adapted to the cold. Plant invasions into higher mountain areas may be promoted by climate warming. The pace of plant species moving uphill is quite high (e.g. a mean of 13 metres for all species in the Swiss Alps since 2001), increasing the total number of species in the upper belts in the short term, but outcompeting rare species or those adapted to the cold in the long term. With higher temperatures predicted, longer summers with a greater incidence of drought are expected in many mountain regions worldwide. Plant invasions into higher mountain areas may be promoted by climate warming.

Important role of mountain biodiversity for ecosystem services and human well-being

In steep terrain, more than anywhere else, ecosystem integrity and functioning depends on a structurally diverse plant cover. This functional diversity of species is nature's insurance against complete system failure, i.e. the loss of substrate on slopes in the case of mountains. At the same time, it secures other 'services' such as provision of medical plants, food and fodder, fibre and other montane forest products. It also ensures clean runoff water and offers attractive landscapes. The costs of replacing the services provided by mountain biodiversity are huge – both in economic, political, social and other terms.

The majority of the world's most precious gene pools (for agriculture and medicine) and traditional management practices are preserved in mountains. Several crops (maize, potatoes, barley, sorghum, tomatoes and apples) and a large proportion of domestic animals (sheep, goats, yaks, llama and alpaca) originated in mountains, whereas other crops found new homes in the mountains and evolved into many different varieties. However, mountain crops and breeds deserve greater attention as a genetic storehouse and buffer against increasing environmental pressure and to secure food of mountain people. Medicinal plants are one of the most valuable resources at high altitudes. For example, 1,748 species from the Indian Himalaya are used for local medicinal treatment or for trade involving the pharmaceutical industry. Roughly a third of them grow in the subalpine or alpine zone.

Managing mountain biodiversity

Managing mountain biodiversity has been recognised as a global responsibility in recent decades. Globally, protected areas have increased six to eight fold in the last 40 years, largely in

Cuenca Río Blanco Chingaza, Colombia. Photo: Klaus Schutze.

Introduction

Sangla-kanda pasture, Sangla Valley, Kinnaur, Himacha Pradesh, India. Photo: Uttam Lal.

mountain areas, and covered nine percent of all mountain areas in 1997 and 16 percent in 2003. On a global and regional scale, mountains are hot spots of biological richness because of the rapid altitudinal change of climatic conditions over a very short distance. This compression of life zones, each with its characteristic biological inventory, makes mountains so unique for conservation projects, and in fact, nearly a third of all conservation areas are in mountains (264 million ha. out of 785 million ha. in 2004, UNEP-WCMC).

While protected areas are essential, they alone cannot achieve biodiversity or cultural heritage conservation. Mountain places where people live and work require innovative approaches to conservation, engaging local people in the stewardship of the natural and cultural heritage. The Concept of UNESCO's Man and Biosphere reserves or conservation landscapes are tools to maintain high levels of biodiversity in combination with intensive, but diversified small-scale agriculture in densely populated mountain areas, where the establishment or extension of protected areas is not feasible. Participation of mountain populations at all stages is crucial in the sustainable management and use of biodiversity. Payment for environmental services (PES) is an innovative tool to compensate upland land users for the lack of on-site benefits, therefore enacting a much needed resource transfer to upland communities which are often socially and economically disadvantaged, compared to surrounding lowland areas (see IMD 2006).

Transboundary connectivity for mountain biota

Mountains can also have a corridor function for mountain biota, for instance connecting mesic temperate lowland regions, otherwise separated by hot or dry lowland climates, as is the case with the southern slopes of the Himalayas. Connectivity conservation corridors (and their associated transboundary protected areas) help conserve habitats and the opportunities for species to evolve, adapt and to move. Especially on a large scale, connectivity corridors provide additional opportunities for some species to survive in a world affected by climate change. Some of these large scale conservation corridors in mountains are underway in the Himalayas, Altai-Sayan, Australian Alps and Albertine Rift Valley in Africa (Worboys 2009).

Set of actions for mountain biodiversity

Managing mountain biodiversity with the aim of maintaining ecosystem integrity as a basis for the provision of crucial ecosystem services is a major challenge, requiring a global alliance of international organisations, national governments, civil society, the private sector, and most importantly, mountain populations as stewards and beneficiaries of biodiversity in mountains.

Research has several important roles to play. Inventorying and ensuring open access to existing biodiversity data are key tasks, as in some regions only a small fraction of mountain species are known to the global community. Ecosystem services linked to mountain biodiversity, such as the productivity of upland pastures, water supply, or erosion control, need to be demonstrated and quantified. Projections of how future climate change will impact mountain ecosystems and management scenarios need to be explored, in ways which serve both biodiversity conservation and human needs.

The Convention on Biological Diversity, signed by 150 governments worldwide, with its specific Programme of Work on Mountain Biodiversity, provides a set of actions addressing characteristics and problems that are specific to mountain ecosystems. The review of the Work Programme in 2010 and the International Year of Biodiversity in 2010 will provide opportunities to promote action for the sustainable management of mountain biodiversity at international, regional, national and community levels.

References

IMD (International Mountain Day) 2006: *Case studies on mountain biodiversity management from various mountain regions: www.fao.org/mnts/archive/2006/intl_mountain_case_en.asp*

Körner, C (2004) *Mountain biodiversity, its causes and function.* Ambio 7, Sp. Rep. 13, 11-17

UNEP-WCMC: *www.unep-wcmc.org*

Viviroli, D; Weingartner, R; Messerli, B (2003) *Assessing the Hydrological Significance of the World's Mountains.* In Mountain Research and Development, Vol. 23 (1):32-40, Tokyo and Berne.

Worboys, G L (2009) *IUCN WCPA Workshop report "Mountain Transboundary Protected Area and Connectivity Conservation 2008"*, ICIMOD, Kathmandu, Nepal. pp 47-64: *http://books.icimod.org/index.php/downloads/publication/588*

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Are Ethiopian Highlands Changing? Amphibians as Ecosystem Indicators

Simon Loader, Abebe Mengistu, Silvia Schwaller, David Gower, Peter Nagel, Abebe Getahun, Samy Saber and Roman Kassahun.

Mountain ecosystems have recently received considerable interest based on the understanding that climate change might have particularly serious, irreversible impacts on physical and biological systems in these habitats. Land use changes also continue to have a devastating impact on mountain habitats. Quantitative data is being gathered across the globe to measure changes and evaluate the most appropriate mitigating and adaptive strategies. For Africa, few quantitative studies exist whereby conclusions can be firmly established and this means that a fresh focus on the region is required. We outline a current project in Ethiopia that aims to establish a foundation for understanding changes to upland ecosystems using amphibians as indicators.

One of the most impressive landmarks on the planet is the African Rift Valley, stretching 6,000 kilometres from Mozambique in the south to Syria in the north. This rift also marks part of the area of the Eastern Afromontane global biodiversity hotspot (Mittermeier, et al. 2004). The region is a key centre of biodiversity and endemism in Africa. About 70 percent of African land exceeding 1,500 m.a.s.l. is found in Ethiopia, which is split into two main parts by the African Rift Valley. The Bale Mountains in the southeast have some of the largest areas of continuous Afroalpine and Afromontane forest habitats. Across the highlands in the south western part of Ethiopia remain the largest surviving patches of 'pristine' montane forest. Today it is estimated that only about four percent of the total 1.2 million square kilometres of Ethiopia is covered with forests. Habitat fragmentation by human activities has accelerated the loss of the natural forests (Taddese, 2001). This human influence will likely increase according to future population growth estimates.

Extreme and localised climatic conditions at altitudes exceeding 1,500 m.a.s.l. have led to the occurrence of different vegetation belts and a corresponding diversity in the flora and fauna. Endemic flagship species, such as the Ethiopian wolf *(Canis simensis)* and the Mountain Nyala *(Tragelaphus buxtoni)*, together with other remarkable mammal and bird species are found in the Ethiopian highlands, and are completely or partially restricted to these habitats. For many species, however, particularly 'lower' vertebrates and non-vertebrates, our understanding of biodiversity patterns is poor. This is worrying for several reasons, but chief among them is the absence of indicator species that might reveal complex, human-induced ecosystem changes and inform conservation management strategies. Detailed information is available only for larger flagship taxa, but their suitability as indicators of ecosystem health is questionable. For example, the Ethiopian wolf, although restricted to high elevations, ranges over relatively wide habitat types and is therefore likely

Figure 1: Gughe Mountains, Ethiopia, Gina River in Doshka Forest. Insert bottom left - endemic highland frog Leptopelis ragazzi. Insert top right - Degraded landscape around Dorze and Doshka Forest. Photo: S Loader.

to be less sensitive to smaller scale habitat disruptions. Other taxonomic groups might be better for investigating the impact of land use changes in these hotspots of biodiversity.

Amphibians are important components of species assemblages of many terrestrial ecosystems, often having a diverse number of species occupying a range of niches. Amphibians are often considered to be good habitat indicators, given their usually relatively narrow environmental tolerance. The limited tolerance of amphibians means that populations can rapidly change in response to ecosystem change (Stuart et al. 2004). Almost one-third of the world's ca. 6,000 amphibian species are threatened by extinction, with 168 species recently recorded to have gone extinct. Such recent and rapid declines, greater than for any other vertebrate group, are correlated with a number of factors (Stuart, et al. 2004). Among these factors, habitat change seems to be connected to many amphibian population declines.

The use of amphibians in conservation studies ranges from focusing on single species to whole assemblages being used as indicators 'measuring' broader changes (Stuart et al. 2004). Because patterns of their diversity strongly match areas identified as 'hotspots', amphibians seem to be important potential indicators of species and habitat diversity. For Ethiopian amphibians, however, we are hindered by a poor understanding of their diversity and distribution (Largen, 2001). Despite this, previous work has revealed a comparatively high diversity for Africa, particularly located in the mountain regions of Ethiopia. The paucity of detailed information on Ethiopian highland amphibian biology is particularly worrying given the amount of natural habitats that are increasingly being lost in Ethiopia (Taddese, 2001). These habitat losses pose a serious risk to amphibian species, which have highly restricted and fragmented habitat ranges. Understanding how habitat change is impacting amphibian communities, and by inference other taxonomic groups, requires basic data on the range of species.

We have initiated a project that aims to improve understanding of amphibian diversity and distribution. This will be achieved by using traditional taxonomic approaches, DNA assessment of populations, and GIS data. With these data we will be able to better understand the distribution of amphibian species in the highlands of Ethiopia and their taxonomic and conservation status. Eventually, this data will be utilised to address questions on how amphibian communities are responding to land use changes and predicted climate change. Preliminary evidence from our work conducted in the Bale mountains, a hotspot of amphibian diversity, suggests that there has been significant recent change to forest habitats. We are currently investigating the influence on the species endemic to Harenna forest in the Bale Mountains and how amphibian distribution and diversity has changed compared to historical records. Our work has also been extended over the rift to the south west forests of Ethiopia (Figure 1). The new data is being used to address the evolutionary history of the rift-mountains, and how the formation and changes in the rift have influenced organismal diversification.

Over the coming years, our work will map species units across the Ethiopian highlands in order to gain a better understanding of amphibian populations. We will utilise this information to assist in assessing conservation priorities across the rift-mountains. At specific sites we will also assess how land-use changes have impacted biological communities. Mitigation and adaptive strategies in the conservation of mountain ecosystems rely on quantitative data on physical and biological systems – our project aims to contribute towards this goal.

References

Largen, M J (2001) *Catalogue of the amphibians of Ethiopia, including a key for their identification*. Tropical Zoology 14:307-402.

Mittermeier, R A; Robles Gil, P; Hoffmann, M; Pilgrim, J; Brooks, T; Mittermeier, C G; Lamoreux, J; and da Fonseca, G A B (2004) *Hotspots Revisited*. Mexico: CEMEX.

Stuart, S N; et al. (2004) *Status and trends of amphibian declines and extinctions worldwide*. Science 306: 1783-1786.

Taddese, G (2001) *Land Degradation: A Challenge to Ethiopia*. Environmental Management 27: 815-824.

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PARADISE LOST? Conservation of Mount Marsabit Forest Ecosystem, Northern Kenya

Wario R. Adano

The mountain, the lowlands and the forest ecosystem

Marsabit Mountain rises from northern Kenya's vast low-lying arid region. During the dry season, the surrounding lowlands are expanses of desert-like environments, often dotted with patches of dry grass and leafless thorny shrubs. In the lowlands, temperatures are over 30 degrees Centigrade and the mean annual rainfall is hardly 300 millimetres. However, around the mountain, the temperature is always about 26 degrees Centigrade and the mean annual rainfall is about 800 millimetres. The mountain's lush vegetation and biodiversity-rich forest ecosystem is very different from the surrounding lowlands and is considered one of Kenya's most ecologically-sensitive biodiversity hotspots.

Over the millennia, the coolness of the mountain has created a small 'tropical cloud forest' on its misty peaks. The forest's

Buffalos at Sokorte Dika in Marsabit forest. Photo: R Eva.

The famous Lake Paradise (Sokorte Guda) during a 'normal' year. Photo: R Eva.

tall moss and lichen-laden trees trap moisture from the low clouds and the thick early morning mists to recharge underground aquifers and replenish the water sources within the mountain. The forest ecosystem both creates and protects the water; while two crater lakes (Sokorte Dika and Sokorte Guda) serve as small surface reservoirs: the porous mountain is an enormous invisible one.

Human settlement and conservation

Until colonial times, the mountain was used by pastoralists from the surrounding lowlands for grazing as a last resort in the dry season. In the early 20th century, the British established a small administrative post at the forest's edge on the north western slopes of the mountain. They strictly controlled settlement in the tiny town to a handful of traders and farmers who were encouraged to grow crops for the station.

At Independence in 1963, all such controls were lifted. By the 1970s, the mountain population had increased ten-fold since the 1950s. Most were former nomads from the lowlands who lost virtually all their herds to the severe droughts of the 1970s to the 1990s. The growing mountain population has created stiff competition for forest resources. The mountain ecosystem is becoming increasingly important for settling nomads, and the resources are simultaneously suffering from increasing pressure as a result.

From the 1930s, parts of Marsabit District (now about 69,000 kilometres^2) were accorded official protection by the colonial government. After Independence, part of the mountain was 'de-gazetted' to open it for settlement and by 1999, about nine percent of the total area had protected area status. This area, mostly 'the upper fertile levels' of the mountain, about three percent of the district's area, is governed by strict conservation rules where local people have restricted access and rights of usage. Their resentment towards these rules became a cause of general revolt against conservation programmes.

The economy of the ecosystem

The forest ecosystem supplies water to the ever-growing Marsabit town and enables people settled on the forest's periphery to practise rain-fed agriculture and use micro-irrigation to grow a few crops throughout the year. Most households on the mountain have permits to collect fuelwood. The lowland nomadic communities have had historical, dry-season claims to the ecosystem's resources.

The revenue generated from Kenya's protected areas is far too low to cover the costs of management. This is particularly true for Marsabit: the revenue is completely inadequate to share with the local communities or pay compensation for wildlife damage to crops and people. This is yet another reason why conservation efforts are poorly supported by the local people. The revenue obtained from the forest is, however, insignificant compared to the benefits of biodiversity, water supply, and support for rain-fed farming for the general public. Consequently, sensible conservation policies should resolve the conflicts between the conservation agencies and the local communities. The difference between these groups is that the former have a much broader set of environmental interests over and above the private interests of the local communities.

Paradise lost? The threats to the Marsabit ecosystem

Rainfall records show a consistent downward trend, the lowest amounts ever, and frequent droughts over the past four decades. This has been coupled with increasing human population, demand for arable land and use of forest resources. The result has intensified conflict between the local people and the conservation agencies over the use of ecosystem's resources. During the wet seasons, the elephants

Forest serves as a source of water for livestock during dry season. Photo: W Karen.

and buffalos have always moved out of the forest to their traditional dispersal areas. Now they trample crops and sometimes people. Fearless troops of baboons infest settled areas in Marsabit town, raiding fields and endangering children. Other wild animals also regularly attack livestock and local people retaliate. The wildlife damage understandably undermines local public support for wider conservation efforts. The ecosystem faces obvious threats that go beyond the borders of the protected areas.

The mountain's ecology has been under pressure in the past. The Sokorte Guda dried up three times in the 1930s and 1940s, while the water level in the Sokorte Dika dropped substantially. The colonial administration, alarmed particularly by the livestock grazing pressure, increased the size of the protected forest and piped water from within to the periphery where both livestock and people could use it without intruding on the forest. Given today's dense settlements around the protected areas, better management of the 'buffer zones' is the best option. Their on-going conversion to farm plots and the clearing of vegetation directly reduces the total forested area, decreasing the ecosystem's capacity to naturally trap moisture from clouds and mist. This means not only that Marsabit is faced with critical water shortages, but that rain-fed agriculture, on which all the many settled people rely and its biodiversity, is severely threatened.

What next?

This article has touched on the most obvious causes and effects of human settlement and climate change on Marsabit Mountain. There is much that we still do not understand about the delicately interwoven forest ecosystem. However, it is certain that, as the mountain population soars, so does demand for the use of forest resources. Conservation policies and policing and management practices should incorporate the 'buffer zones' and the local communities' needs for resources for their survival. Future tree planting to increase vegetation cover should consider trees which host moisture-trapping mosses and lichens. Improving the wellbeing of the ecosystem-dependent communities and promoting the wise use and management of protected areas must underline any successful conservation policy. If the pressures on the ecosystem go unabated, the small forest is in a serious danger and its roles at risk. This will also be the case for the rich biodiversity and the people who depend on the health of the Mount Marsabit ecosystem.

References

Adano, W R; Witsenburg, K (2008) *Pastoral sedentarisation, natural resource management and livelihood diversification in Marsabit District, Northern Kenya.* Wales: Mellen Press.

Emerton, L; Yemi Tessema (2000) *Economic constraints to the Management of Marine Protected areas: the case of Kisite Marine National Park and Mpunguti Marine National Reserve, Kenya.* IUCN-Nairobi.

Salvadori, C (2007) *Paradise Lost*. Swara magazine, July-September 2007.

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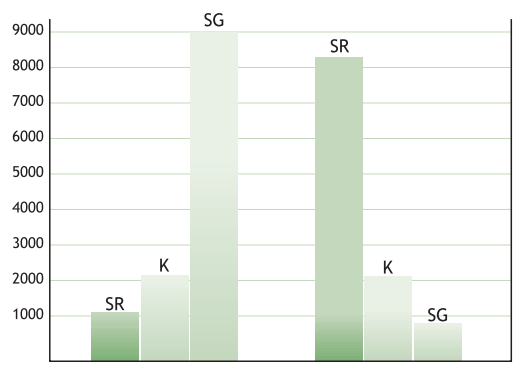
Responses to Threats and Impacts on the Outstanding Biodiversity Values of Low-Altitude Mountains in South Western Australia

Anne Cochrane, Sarah Barrett and John Watson

South western Australia is the most floristically rich region on the Australian continent and is one of the world's top biodiversity 'hotspots', with some 8,000 described vascular plants including numerous endemic and threatened species. The region contains a series of isolated mountain peaks in the Stirling Range National Park that are themselves biodiversity hotspots. Although small in absolute height (~1,095 metres maximum elevation), these small mountains are the highest points in the landscape for several thousand kilometres. However, they are truly 'Himalayan' in terms of their plant diversity with some 1,517 plant species and over 80 endemics, often with narrow distribution ranges on specific mountain peaks (Figure 1, Watson and Barrett 2004).

Figure 1
The Stirling Range - low in elevation but 'Himalayan' in plant diversity (Watson & Barrett, 2004)



Although located some 100 kilometres inland from the current day coastline, the Stirling Range peaks were once an isolated archipelago of islands in the Eocene marine incursion and they are now altitudinal islands of 'Gondwanan' habitat. Surveys have identified several Gondwanan relictual fauna species, particularly spiders and snails, which have close relationships with species found in other southern hemisphere areas including New Zealand and Madagascar.

The Stirling Range is surrounded by a highly modified agricultural landscape almost totally cleared of natural vegetation, and the peaks are therefore not only 'islands in the sky, but also islands of natural biodiversity in a surrounding terrestrial landscape (Figure 2). The biota of these peaks is also highly susceptible to a whole suite of threatening processes, including:

- plant pathogens, notably *Phytophthora cinnamomi;*
- inappropriate fire occurrence and its interaction with *Phytophthora cinnamomi;*
- climate change, in particular the impacts on fire behaviour, plant pathogens and plant regeneration from seed;
- recreation, in particular trampling, erosion and increased spread of plant pathogens on walkers' boots;
- feral animals, primarily European fox and European rabbit;
- isolation from other protected areas.

The range experiences a cool Mediterranean climate with cool to mild wet winters and warm to hot dry summers. Snow is rare and seldom lasts.

Current climate change scenarios indicate that south western Australia is developing longer drier spells of weather, a small regional temperature rise together with increased UV radiation and more frequent 'extreme' weather events. The predicted biotic response will be for species to 'migrate' further to the south west and to higher altitudes. Those species and communities around mountain summit areas have nowhere else to go, hence endemic montane plant species (some five of which are already Critically Endangered) and associated fauna habitat are likely to be heavily impacted by these changes.

Furthermore, these climatic changes have major ramifications for a number of the threatening processes listed above but in particular for unnatural fire regimes and plant disease (Watson, 2006). For example, any drying trend will dramatically increase the flammability of the vegetation and hence the wildfire threat, as well as generally compromising the effectiveness of wildfire suppression. Conversely, any increase in un-seasonal summer rainfall events, when soils are warm, inevitably causes a rapid flush in Phytophthora activity due to the resulting short term 'pseudo-tropical' soil conditions.

We briefly describe here some of the strategic planning, research and operational management responses being developed by the Department of Environment and Conservation (DEC) South Coast Region in the Stirling Range in an attempt to ameliorate threats to and improve the natural resilience of the natural biodiversity.

Strategic planning responses

A key strategy has been the development of a GIS model to identify those areas within the surrounding modified landscape that can maximise the retention and enhancement of vegetative connectivity at a regional scale. DEC has identified both local scale corridors of vegetation and 'stepping stone' or patchwork linkages to be established in the surrounding landscape that will improve connectivity to other un-cleared areas, including significant protected areas such as the Fitzgerald River National Park some 100 kilometres to the east. An early overview of this work is described in Watson and Wilkins (1999) with more detail in the subsequent macro-corridor report (Wilkins et al, 2006).

Figure 2. The Stirling Range – islands in the sky and in a surrounding agricultural landscape. Photo: Anne Cochrane.

Research responses

A major new initiative has been developed to study temperature thresholds required for seed germination of native plant species including a number of threatened species (Cochrane and Daws, in preparation). Seed germination and early seedling growth are the most sensitive stages in a plant's life cycle and perhaps the most vulnerable to climate warming. South western Australia has experienced climate variation in the past and its native species may have a broad tolerance to extreme climate conditions but there is uncertainty regarding their ability to persist under currently projected climate warming. We believe that predicted increases in temperature associated with climate change may limit recruitment of obligate seeding species in vulnerable environments.

In this research, we are using a bi-directional temperature gradient system to create germination temperature profiles and to determine sensitivity of early radicle growth to temperature (Figure 3). Preliminary results for ten Stirling Range species indicate that some (e. g., *Kunzea montana*) have physiological tolerance to a wide range of temperatures for germination despite their narrow range and mountain habitat. We have demonstrated a negative relationship between percent germination and increasing mean temperatures for

Andersonia echinocephala, *Calothamnus crassus* and *Sphenotoma drummondii*, but only the latter displayed an extreme sensitivity to high temperatures that may threaten its survival and persistence under climate warming. Little difference in germination temperature profiles existed for those species assessed from both mountain and coastal habitats (e.g. *Banksia brownii*).

This seed-based approach for identifying extinction risk will assist in prioritising species for operational management responses and for directing limited resources towards further investigations, as well as a useful addition for bio-climatic modeling per se.

Operational management responses

Threats to the biodiversity of the Stirling Range and our current threat abatement strategies were previously reviewed with a special focus on the critically endangered Eastern Stirling Range Montane Heath and Thicket Community (Watson and Barrett 2004). This community overlays a highly popular tourist destination on the summit plateau of Bluff Knoll (at 1,095 metres, the highest peak in south western Australia) and it also covers a popular two-day wilderness ridge walk from Bluff Knoll to Ellen's Peak (1,012 metres). The threats, management operations and recovery strategies for this community may also have relevance for other mountain protected areas where extremely high-value conservation sites must co-exist with major visitor destinations.

DEC South Coast Region strategies aim primarily to improve community level resilience by increasing and refining existing management actions, including aerial phosphate spraying with the fungicide phosphate for Phytophthora control, feral animal baiting (notably the European rabbit), and hygiene/access management strategies for recreational use. DEC is continuing to refine fire management and fire suppression capability, including the introduction of spotter aircraft during the summer fire risk season and, since 2004, fast attack aerial water bombers.

At the species level, in addition to the seed germination research referred to above, DEC has an active seed conservation program that acts as an 'insurance' against species loss in the wild, providing a source of material for future species recovery. For several critically endangered montane plants conservation seed orchards have been successfully established outside the national park in the hope that re-introduction to Phytophthora-free areas can occur in the future. Efforts are being made to develop tissue culture techniques also with the aim of developing Phytophthora-resistant strains of susceptible species for re-introduction to the wild.

Figure 3. Seed germination temperature threshold studies.
Photo: Millennium Seed Bank Project.

Summary

Low altitude mountains occurring within global biodiversity hotspots can assume 'Himalayan' proportions in terms of their biodiversity. They may also play a significant role in addressing climate change scenarios due to their accessibility and the concentration of various threatening processes into relatively small areas. Research into seed germination thresholds may be particularly valuable in helping to prioritise the focus for further research and adaptive operational management targeting threatened species and montane plant communities.

References

Barrett, S; Shearer, B L; Crane, C E; Cochrane, A (2008) *An extinction-risk assessment tool for flora threatened by Phytophthora cinnamomi*. Australian Journal of Botany, 56: 477-486.

Cochrane, A; Daws, M (in preparation): *Development of a seed-based approach for identifying flora at risk from climate warming*.

Watson, J; (2006) *Protecting the snowless wonderland: conserving biodiversity of low-altitude mountains in Southwestern Australia,* In Global Change in Mountain Regions, Price M F (ed) Sapiens Publishing Scotland.

Watson, J; Barrett, S (2004) *Small is Beautiful: Conserving the Nature of Low-Altitude Mountain Protected Areas in South Western Australia*. In *Managing Mountain Protected Areas: Challenges and Responses for the 21st Century*. Harmon, D; Worboys, G L (eds). Andromeda Editrice, Italy, IUCN 2004:340-345.

Watson, J; Wilkins, P J (1999) *The Western Australian South Coast Macro Corridor Project – A Bioregional Strategy for Nature Conservation*. Parks 1999;9: 7-16.

Wilkins, P; Gilfillan, S; Watson, J; Sanders, A (2006) *The Western Australian South Coast Macro Corridor Network* – A bioregional strategy for nature conservation Department of Environment and Conservation and South Coast Natural Resource Management Group, Albany, Western Australia, January 2006.

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Impacts of Armed Conflict on Mountain Biodiversity: Experiences from Nepal

Bishnu Raj Upreti

Nepal's armed conflict (1996-2006) has created enormous impact on biodiversity, the economy and society. This paper discusses only the impacts on biodiversity. The study was conducted in 2007 by using qualitative methods such as review of related documents, discussions with policy makers, practitioners and local people, and rapid field assessment in ten different districts.

Impacts on mountain biodiversity

The main negative impacts documented from the study were: a loss of unique habitats for wildlife within ecosystems once the vegetation for such specialised habitat were destroyed; loss of medicinal plant resources after the forests were used as battlefields; and severe disruption of conservation activities, leading to intensified unsustainable exploitation as law and order was broken down by the armed conflict.

National parks and wildlife reserves were one of the frequent targets of the insurgents, mainly because of being located in geographically isolated areas. There was engagement of the military in parks and reserves by insurgents. The rebels' interpretation of the park-people conflict was an outcome of restriction and denial of access of poor people to livelihood-based resources by park authorities, whilst there was a perception amongst the rebels that the parks and reserves were recreation centres for the royal family.

Forests, one of the main bases of biodiversity, became battlefields that ultimately led to biodiversity loss. Illegal hunting and trading of wildlife (e.g. five rhinos were killed in 2001 in Bardya National Park and musk deer were slaughtered by poachers in Langtang National Park) was rampant during the period of armed conflict, leading to a reduction of the composition and number of wildlife as well as habitat destruction.

Table 1: Number of attacks on biodiversity-related infrastructures

Year	Frequency of attack	Year	Frequency of attack
1996	10	2002	103
1997	15	2003	56
1998	21	2004	99
1999	25	2005	35
2000	22	2006	7
2001	26		

Source: Compiled from newspapers, reports and other sources

The Nepal Army, originally deployed for the protection of national parks and wildlife resources, was mobilised for counter-insurgency operations. This resulted in a lack of security protection in the parks, leading to increased activities of smugglers, poachers and hunters (Yonzon, 2004; Upreti, 2004).

Poaching of Himalayan black bears for their bile and musk deer for their aromatic musk pods in Manaslu Conservation Area (MCA) sharply increased after the eruption of armed conflict. Illegal collection of expensive herbs such as *panch aunl, e nirmasi, yarshagumba* and *ban-lasun* was frequent.

Explosion of landmines on 22 November 2004 killed five staff at the Parsa Wildlife Reserve. Consequently the Reserve suspended patrolling. Illegal logging and poaching (in particular of the golden monitor lizard, *suna gohoro, Varanus flavescens*) became frequent. A total of 89 rhinos were killed between 1997 and 2006 in Chitwan National Park (CNP) alone (Shakya and Chitrakar, 2006:140).

Table 2: Wildlife causalities 1996 -2006

Species	Total Killed 1996-2006		
	Conflict causalities	Natural deaths	Total
Rhino	128	128	256
Tiger	7	33	40
Hog Deer	1	13	14
Wild Buffalo	1	10	11
Red Panda	0	3	3
Monitor Lizard	2	0	2
Musk Deer	5	15	20
Swamp Deer	1	1	2
Cheetal (Chital)	21	25	46
Elephant	4	17	21
Sambar	0	7	7
Leopard	1	27	28
Leopard Cat	0	4	4
Jharal	0	13	13
Barking Deer	0	6	6
Turtle	0	2	2
Python	0	6	6
Wild Boar	0	3	3
Gharial Crocodile	1	3	4
Blackbuck Antelope	0	7	7
Peacock	0	2	2
Bear	0	2	2

Source: Upreti (2007).

Table 2 shows that several important wildlife species were destroyed during the time of armed conflict. The total value of damaged property belonging to the Ministry of Forest and Soil Conservation was estimated to be NRs 354.5 million *(Upreti, 2007)*.

During this time, 35,608 hectares of community forests in 48 places across 38 districts were taken by the army; many of them declared as 'military training areas; irresponsible exploitation of expensive medical herbs such as Yarsagumba *(Cordyceps sinensis)*, Chiraito *(Swertia Chiraita)*, Jatamasi *(Nardostachys grandiflora)*, Kutki *(Picrorhiza scrophulariiflora)*, Bikhama *(Aconitum palmatum)*, padamchal *(Rheum emodi)*, Panchaunle *(Galearis stracheyi)*, Sunpati *(Rhododendron anthopogon)*, Sughandhawal *(Valerina wallichii)*, was rampant once rebel forces imposed taxes on transactions of forest products in their zones of influence (Upreti, 2007; Shakya and Chitrakar 2006).

Out of seven main and 21 sub-cantonments, 75 percent are located in forested areas and many of them are within high priority environmental sites. An impact study of UNDP at PLA (People's Liberation Army) camps highlighted that PLA energy needs were almost exclusively dependant on firewood extraction that caused deforestation in many areas. An estimated firewood requirement for the combatants residing in the 28 cantonments came to approximately 2,100,000 tons of fuel wood each month. The study report stated, "In the case of the Kailali cantonments, PLA cadres are housed in close proximity to a mere 1.5 kilometres of forest cover that facilitates the migration and genetic dispersal of critically-endangered species like the Royal Bengal Tiger. Without key areas like this, scientists estimate that tigers in Nepal will be genetically extinct in just ten years" (Dinerstein et al 2006).

Conclusions

Mountain biodiversity has been negatively affected and even severely threatened by the decade long armed conflict. Therefore, immediate, short and long term restoration plans are urgently needed. Hence, regular conflict risk assessment has to be one of the fundamental components in any future strategy of protection and conservation of biodiversity in Nepal. Such analysis provides a powerful understanding of conflict impacts on biodiversity in conflict and post-conflict situations and assists in devising appropriate response strategies and options.

References

Dinerstein, E; Louckes, C; Heydlauff, E; Wikramanayake, E; Bryja, G; Forrest, J; Ginsberg, S; Klenzendorf, S; Leimgruber, P; O'Brien, T; Sanderson, E; Seidensticker, J; Songer, M (2006) *Setting Priorities for the Conservation and Recovery of Wild Tigers: 2005 – 2015*. A User's Guide. Washington, DC: WWF

Shakya, M M; Chitrakar, A (2006) *Cost of Conflict on Nepal's Conservation Efforts*. Kathmandu: WWG.

Upreti, B R (2007) *Quick Impact Assessment of the Armed Conflict on Environment and Biodiversity in Nepal*. Kathmandu: World Wildlife Fund.

Upreti, B R (2004) *The Price of Neglect: From Resource Conflict to the Maoists Insurgency in the Himalayan Kingdom*. Kathmandu, Brikuti Academic Publications.

Yonzon, P (2004) *Threats to Nepal's protected areas*. Parks 14 (1): 35-39.

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Conservation of Agrobiodiversity through Traditionally Cultivating 'Barahnaja' in the Garhwal Himalaya, India

Vishwambhar Prasad Sati

India's Garhwal Himalaya is an agrobiodiversity hotspot. The traditional system of cultivating 'Barahnaja' (literally, '12 seeds') together in cropped land is a centuries-old practice: a cropping pattern involving 12 or more food crops grown in 'synergetic' combinations (Singh and Tulachan, 2002). This is practiced under a 'Sar system' of crop rotation that characterises the cropping pattern together with a vertical distribution of crops – in valley regions, mid-altitudes and highlands – and supports the maintenance of agrobiodiversity. Three quarters of the people in the region depend on this system for their livelihoods. The traditional agricultural systems are the reservoirs of many crops and cultivars, most of which are still little known to mainstream societies and are better adapted than modern agricultural systems to environmental and social conditions (Altieri, 1995; Ramakrishnan and Saxena, 1996). Recently changes in the cropping pattern have taken place as 'Barahnaja' has decreased, particularly in the mid-slopes and low-lying areas.

The traditional Barahnaja system and agro-biodiversity

'Barahnaja' is an advanced system of traditional rain-fed hill farming with sophisticated intercropping. Mandua (finger millet), ramdana/chua (amaranthus), rajma (common kidney beans), ogal (buckwheat), urad (black gram), moong (green gram), naurangi (mix of pulses), gahath (horse gram), bhat (soybean), lobiya (French beans) kheera (cucumber), bhang (cannabis) and other crops are grown together in a mix which is finely balanced to optimise productivity, maintenance of soil fertility, conservation of crop diversity and is geared towards meeting diverse household requirements. These central Himalayan farmers grow about 100 varieties of paddy (rice), 170 varieties of kidney beans, eight varieties of wheat, four varieties of barley and about a dozen varieties of pulses and oil seeds each year (Zardhari, 2000). Farmers spend almost nothing on inputs, since seeds, organic fertiliser and pest control are virtually free. Whenever they see that conditions are suitable, they start planting. Table 1 shows the ecological sub-regions and agrobiodiversity in the Garhwal region. Crops are grown from 300 to 3,600 metres. Wheat, rice, mandua, and jhangora are the common crops in the three ecological zones, with wheat generally having the highest productivity. Various pulses are grown in the intercropping system during the two harvest seasons: early winter after the rainy season (millet); and midsummer before the hot dry season (barley and wheat). Dry and

Ecological sub-region	Altitude (m)	Agro-biodiversity
Lower Dun, Terai	300-600	Wheat, rice, and sugarcane
Upper Dun,Bhabar, Lower Shivaliks	600-1,200	Wheat, rice, mandua, jhangora, chaulai and maize
Middle Garhwal-Kumaon	1,200-1,800	Wheat, rice mandua, jhangora "cheena" (*Panicum miliaceum*), potato and barley
Upper Garhwal-Kumaon	1,800-2,400	Wheat, barley, potato, chaulai, cheena, phaphra" (*Fagopyum tataricum*)
Cold Zone	2,400-3,600	SUMMER- wheat, barley, potato, phaphra, chaulai, "kauni", "ogal", kodo" (*Fagopyum esculentum*), "uva" (*Hoycleum himalayanse*)

Table 1: Ecological sub-regions and agro-biodiversity. Source: Adapted from Sati (2005)

wet rice, taro, pumpkins, beans, corn, ginger, chili, cucumbers, leafy vegetables and tobacco are also grown. Potatoes have become an important cash crop, grown in areas unsuitable for other plants. 'Barahnaja' remains common in the upland areas (above 1,500 metres), but the mid-slopes and the low-lying river valleys have undergone tremendous changes in cropping patterns, as the cultivation of paddy, wheat and cash crops are recent trends, reducing agrobiodiversity.

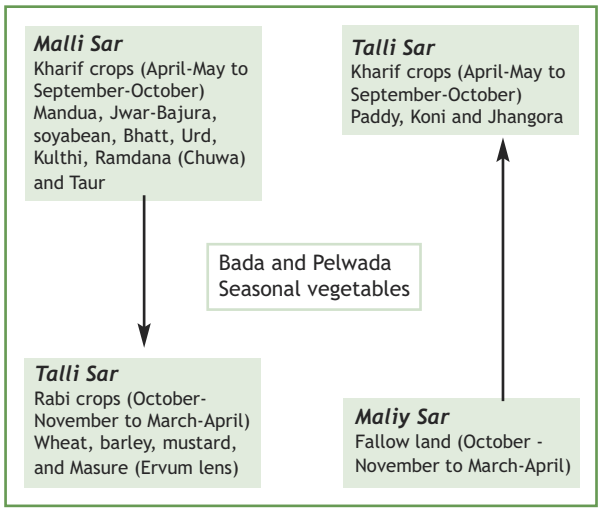

Figure 1: Malli and Talli Sars

Conserving 'Barahnaja' under the 'Sar System'

'Barahnaja' is conserved by the practice of crop rotation in the 'Sar system', in which agricultural land is divided into two parts: Talli and Malli Sar (Figure 1). The cropping pattern in the two sars is reversed every second year. Besides the Talli and Malli Sar, in and around the settlements, vegetables such as cucumber, pumpkin, potato, egg plant, lady's finger (okra), suchas garlic and maize are planted during the rainy season in fields known as Bada and Pelwara.

Sar system

The 'Sar system' gives a good yield and maintains agro-biodiversity. Each year the land is fallow for six months and the Sar is changed from year to year. The pattern of fallow land from October-November until March-April is a systematic method for conserving soil fertility. Figure 2 shows aspects of agrobiodiversity and the 'Sar system'.

While the highlands throughout the Garhwal Himalaya have a high agrobiodiversity, levels are far lower in the mid-altitudes and low-lying areas. The changes in cropping patterns seem more pronounced in these two vertical landscapes. A number of major trends have marginalised 'Barahnaja' and subsequently reduced agrobiodiversity: the low output from 'Barahnaja'; the significant cultivation of wheat, paddy and off-season vegetables; the high rate of population growth and literacy; and large-scale emigration. On the other hand, 'Barahnaja' is suitable in the region's agro-ecological conditions and is sustainable even in adverse climatic conditions such as drought. In 1987, when drought occurred across India, the Garhwal Himalaya enjoyed substantial production of subsistence crops. Keeping agro-ecology and suitability in view, these crops and their traditional farming system need to be conserved, along with cultivating cash crops, to maintain agro-biodiversity and food security in a balanced proportion.

References

Altieri, M A (1995) *Agro-ecology puts synergy to work to create self-sustaining agroecosystem,* Ceres FAO Review 154, Vol 27, pp 15-23.

Figure 2: Agro-biodiversity and Sar-system: [A] Traditional crops 'Barahnaja', [B] Paddy crop with pulses on the edge, [C] Wheat crop, and [D] Fallow land.
Photos: Vishwambhar Prasad Sati.

Ramakrishnan, P S; Saxena, K G (1996) Managing biodiversity for sustainable development in the Himalaya. In Ramakrishnan, P S; Purohit, A N; Saxena, K G; Rao, K S; Maikhuri, R K ed. (1996) *Conservation and Management of Biological Resources in Himalaya,* IBH, Oxford, pp 5–26.

Sati, V P (2004) *Systems of agricultural farming in the Uttaranchal Himalaya, India.* Journal of Mountain Science Vol 2 No 1 76-85 *www.imde.ac.cn/journal*

Singh, V; Tulachan, P M (2002) *Marginal farming in mountain areas,* Asian Agri-History, Vol 6, No 3, pp 269–280.

Zardhari, V (2000) *Barahnaja – twelve food grains: traditional mixed farming system'*, Leisa India, Vol 2, No 3, p 25.

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Biodiversity Conservation and Crop Improvement in a Fragile Agro-Ecosystem: Insights From Guangxi, China

Yiching Song, Zhang Shihuang with Ronnie Vernooy

Farming communities around the world are facing hardship in nurturing and developing crop and animal biodiversity. Their experimentation and innovation practices are under stress. In light of recent international developments concerning innovation, trade and intellectual property (rights), there is an urgent need to develop new policies and laws that recognise and support the key contributions of rural people in the sustainable use of biodiversity. The government of China acknowledges the importance of the sustainable use of biological resources. China, the most populated country with the lowest amount of arable land per capita in the world, has no choice but to keep food security and the sustainable use of biodiversity high on its agenda. One of the most important policy tasks is to create incentives and rewards that recognise and value promising and successful, collaborative efforts to achieve these goals. Our research in China's south-west mountainous areas confirms that farmers are key players in crop improvement and conservation and that farmer-researcher collaboration can produce added value that farmers or researchers alone could never realise. We illustrate these points with an example from the field.

Figure 1: Maize plot for seed production damaged by strong winds.
Photo: Ronnie Vernooy.

Guangxi: field laboratory for novel practices

The field example concerns a collaborative effort of the Center for Chinese Agricultural Policy (CCAP), national and provincial level plant breeders and local extension agents and farmers to improve maize production through a participatory innovation process. The working assumption of this initiative is that novel forms of collaboration among diverse social actors will lead to the creation of synergies required for the enhancement of sustainable crop development and in-situ/on-farm management of genetic resources (Figure 1). In this process, women and men farmers' research and management capacities to maintain agro-biodiversity in the specific Chinese context will be strengthened (Vernooy and Song 2004, Song and Vernooy, 2009).

The Chinese rural economy has experienced rapid growth since the adoption of a broad programme of rural economic reforms beginning in 1978. China is widely recognised for its achievements in reducing absolute poverty since then. Nevertheless, there are about 30 million people who still live under the absolute poverty line and they comprise the majority of the food insecure population. They mostly live in resource-constrained remote upland areas, which are agro-ecologically diverse, resource poor and risk-prone. Guangxi is one of those risk-prone mountainous regions and with an important ethnic population, the Zhuang. Our study focuses on two contrasting environmental and economic conditions of maize farming in this agro-ecological region that also covers parts of Guizhou and Yunnan provinces.

On steep mountain slopes and between rocks in a very limited number of flat fields, farmers plant maize in minute pockets of soil. Water is a serious problem due to calcareous rocks, while rains easily flood the land and wash away the crops. In these upland areas, there are no good roads and access to the market is reduced. Maize is produced for consumption as a traditional staple crop. There is still some diversity of maize landraces. For instance, waxy maize is considered to have originated from this area. Farmers work an average land size of less than 0.2 hectares. Although the poor have land use rights, in most cases the land itself is of such low quality that it is not possible to achieve subsistence levels of crop production. Some relatively better-off communities can be found in the valleys and flatter areas where maize is used mainly as pig feed. People here tend to be higher educated and their livelihood systems are more integrated in the market economy. Pigs are the main source of income for most villagers. Maize diversity has come under stress here. Since 2000, the planting area for hybrid maize varieties has been enlarged at a high speed and is now out-spacing the area planted with local varieties.

Figure 2: Waxy maize seeds drying. Photo: Ronnie Vernooy.

Research activities

Since 2000, the research team has been supporting farmers (many of them women) to carry out crop improvement experiments. We have also organised activities to strengthen their research and farm management skills; build linkages with extensionists, plant breeders and policy makers; set up farmer networks; and explore direct market involvement aimed at seed commercialisation. The research uses a participatory plant breeding methodology which facilitates close collaboration between researchers and farmers to bring about plant genetic improvements. Improvements can be made through a number of crossing techniques and/or through various variety selection processes. Trials in the Guangxi villages and on-station include both participatory plant breeding and participatory variety selection experiments. The trials build on farmers' own knowledge about crops and their environment and are "enriched" with formal plant breeders' expertise. Varieties tested include a large number of landraces, open-pollinated varieties, so-called waxy maize varieties (Figure 2) and varieties introduced from abroad (Song et al. 2006).

Some varieties have been locally improved through crossings and selections. Good potential exists to add value to these varieties through the marketing of seeds (Figure 3). Many (women) farmers are keen to explore these new economic avenues as a way to improve their households' livelihoods. However, given the particular features of these new varieties, farmers are facing several regulatory bottlenecks concerning recognition of the collaborative breeding efforts, stringent variety release procedures, non-existent certification, multiple requirements for seed production and marketing (as stipulated in the new Seed Law of 2000), and uncertain pricing (Vernooy, Song and Li 2007).

In most villages in Guangxi there is a local market once every three days. The vendors are mostly local farmers who have moved to doing off-farm work. Regular farmers go to the market to buy but not to sell produce. Direct exchange of goods does not usually happen at these markets; it might happen among neighbours or relatives. Since 2004, the research team has organised so-called Farmers' Seed Fairs which are integrated with the regular markets. These fairs were launched to encourage local people to share their seeds, knowledge, and planting experience. The Seed Fairs have become very popular and play an important function to help people value, collect and exchange local genetic resources and enhance local biodiversity. Seed Fairs have received some recognition and support from the government, but more could be done.

Challenges

Our research has made some progress in new crop variety breeding and landraces conservation and collection, but challenges have emerged. For instance, the first participatory plant breeding variety, named "New Mexico 1" (produced in 2002), is a collective achievement of farmers, breeders and extensionists in terms of efforts, knowledge and breeding materials and other inputs. Despite this collective nature of the innovation process, the variety can only be registered under a breeder or a formal breeding institution's name according to the existing new variety registration system, known as the "Protection Regulation for New Plant Varieties" and regulated by the Ministry of Agriculture since 1999. As such, it discourages farmer involvement in the innovation process.

Much remains yet to be done in China to create a more conducive enabling environment for collaborative efforts that promote the sustainable use of biodiversity. Farmers have a key role to play in crop improvement and conservation (including of medicinal plants), and farmer-researcher collaboration can produce added value that farmers or researchers alone could never realise. Acknowledging and institutionalising these two elements is important. In addition,

Farmer and professional maize breeder, hand in hand, Guangxi, China. Photo: Ronnie Vernooy.

there are other institutional issues to deal with. Farmers should be officially recognised as "co-authors" of new varieties. Plant breeders should be recognised and rewarded not only for the release of new varieties, but also for their contribution to the process leading to the final products.

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References

Song, Y; Zhang S; Huang K; Qin L; Pan, Q; Vernooy, R (2006) Participatory plant breeding in Guangxi, South-west China. In: Almekinders, C; Hardon, J (eds) *Bringing farmers back into breeding: experiences with participatory plant breeding and challenges for institutionalisation*. Wageningen: Agromisa. Agromisa Special 5, pp. 80-86.

Song, Y; Vernooy, R (eds) (2009) *Seeds and synergies: innovating rural development in China*. Ottawa: International Development Research Centre. In preparation.

Vernooy, R; Song, Y (2004) *New approaches to supporting the agricultural biodiversity important for sustainable rural livelihoods*. International Journal of Agricultural Sustainability, Volume 2, Number 1, pp. 55-66.

Vernooy, R; Song Y; Li, J (2007) *Local agricultural innovation in China: ensuring a fair share of rights and benefits for farming communities*. Asia Pacific Technical Monitor, Vol. 24 (2), March-April 2007, pp. 27-33.

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Intensified Sheep Grazing Decreases the Biodiversity of Alpine Grasslands in the Carpathians, Romania

Bruno Baur

In central and eastern Europe, alpine grasslands are unique habitats for a variety of plant and invertebrate species (Nagy et al. 2003). Seasonal pastoral activities have been practiced for many centuries on accessible areas of these natural grasslands. To increase grazing areas, semi-natural grasslands have been created in mountain areas below the tree-line by forest logging. Although vascular plant species richness of various natural and semi-natural grasslands in general increases under moderate grazing, effects of grazing on biodiversity vary considerably among ecosystems and among different taxa (Cremene et al. 2005; Baur et al. 2006). Moreover, patterns of biodiversity and their driving processes vary with spatial and temporal scale. Pasture management should be adjusted to the local conditions to identify and implement the best strategy of biodiversity conservation.

Threat to biodiversity

Alpine grasslands in the southern Carpathian mountains, Romania, harbour an extraordinarily high diversity of plants and invertebrates. Transhumant shepherding, the seasonal migration of sheep to suitable grazing grounds, is the traditional use of subalpine and alpine grasslands in the southern Carpathian mountains. Historical records document sheep grazing in the Bucegi mountains since the beginning of the sixteenth century. In these mountains, the sheep flocks have always been large, forcing the animals to graze also in adjacent forests, which were clearcut to extend the pastures in the 19th century (Coldea 2003). More recently, the size of the sheep flocks has increased further as a consequence of the altered socio-economic situation since 1989. Detrimental effects of overgrazing and trampling on plant diversity and vegetation structure, and eroded soils have been reported on the plateau of the Bucegi mountains. As a result, grazing pressure has increased on extensively used, adjacent steep mountain slopes. This is of particular concern as the southern Carpathians harbour a high number of endemic and relic plant and invertebrate species (Ioras 2003). Because of limited food resources, sheep are increasingly forced to graze on steep slopes, which were formerly not grazed by livestock and are considered as local biodiversity hotspots.

Species richness, abundance and number of endemic vascular plants and terrestrial gastropods on steep slopes that were either grazed by sheep or ungrazed by livestock in two areas of the southern Carpathians were examined (Baur et al. 2007). On calcareous soils in the Bucegi mountains, a total of 177 vascular plant and 19 gastropod species was recorded. Twelve plant species (6.8 percent) and three gastropod species (15.8 percent) were endemic to the Carpathians. Grazed sites had lower plant and gastropod species richness than ungrazed sites. Furthermore, grazed sites harboured fewer gastropod species endemic to the Carpathians than ungrazed sites. On acid soils in the Fagaras mountains, a total of 96 vascular plant and nine gastropod species was found. In this mountain area, however, grazed and ungrazed sites did not differ in species richness, abundance and number of endemic plant and gastropod species.

Implications for conservation and management

Our study shows that in the Bucegi mountains plant and gastropod diversity and abundance are significantly reduced by sheep grazing on formerly ungrazed, steep slopes (Baur et al. 2007). This is of particular concern because the plateau of the Bucegi mountains is already heavily overgrazed, which has resulted in the local extinction of numerous indigenous plant species (Coldea 2003). The grasslands investigated in our study belong to the last remaining refuges for several endemic and relic plant and gastropod species. If overgrazing by sheep should further extend into these particularly valuable grassland remnants, their diverse flora and fauna would be at risk. Thus, an appropriate management should aim to protect these last refuges on steep slopes from overgrazing. Most of these grasslands are part of the 13 nature reserves of the Bucegi Nature Park *(www.bucegipark.ro)*. The findings of our study indicate that there is an urgent need to implement the protective aims of the existing nature reserve. Furthermore, the restoration of overgrazed grasslands should be promoted. At present, the situation in the Fagaras mountains appears to be less critical, but should also be observed with attention.

Our study confirms the high biodiversity value of grasslands on steep slopes, not only for endemic and relic plant and gastropod species, but also for more widespread species in the Carpathian mountains. It also shows the detrimental effects of intensified sheep grazing on these so far unthreatened grasslands, which were only occasionally grazed by wildlife. Other taxonomic groups such as butterflies and moths may also suffer under the increasing grazing pressure.

References

Baur, B et al. (2006) *Effects of abandonment of subalpine hay meadows on plant and invertebrate diversity in Transylvania, Romania*. Biological Conservation, 132: 261–273

Baur, B et al. (2007) *Intensified grazing affects endemic plant and gastropod diversity in alpine grasslands of the Southern Carpathians, Romania*. Biologia, 62: 438–445

Coldea, G (2003) *The alpine flora and vegetation of the south-eastern Carpathians*, pp. 65–73 In: Nagy, L; Grabherr, G; Körner, C; Thompson, D B A (eds), Alpine Biodiversity in Europe, Springer, Berlin

Sheep grazing in the Fagaras mountains, Southern Carpathians, Romania. Photo: Bruno Baur.

Extensively grazed slopes of the Bucegi mountains, Southern Carpathians, Romania, harbour a high number of endemic and relic species. Photo: Bruno Baur.

Cremene, C et al. (2005) *Alterations of steppe-like grasslands in eastern Europe: a threat to regional biodiversity hotspots*. Conservation Biology, 19: 1606–1618

Ioras, F (2003) *Trends in Romanian biodiversity conservation policy*. Biodiversity and Conservation, 12: 9–23

Nagy, L et al. (eds) (2003) *Alpine Biodiversity in Europe*. Springer, Berlin, 477 pp.

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Main Threats to Mountain Biodiversity in Georgia

George Nakhutsrishvili, Maia Akhalkatsi and Otar Abdaladze

The Caucasus mountain system was formed ca. 28.5–23.8 million years ago as the result of a tectonic plate collision between the Arabian plate moving northward and the Eurasian plate. It is made up of two separate mountain systems: the Greater Caucasus mountain range lying north-west to east-southeast between the Black Sea and Caspian Sea; and the Lesser Caucasus Mountains, which run parallel to the greater range, at a distance averaging about 100 kilometres south. Georgian territory (69,700 kilometres^2) covers both mountain ranges between 40° and 47° latitude east, and 42° and 44° longitude north. Two thirds of the country is mountainous with an average height of 1,200 m.a.s.l., with highest peaks of Mount Shkhara (5,184 m.a.s.l.) at the Western Greater Caucasus and Mount Didi Abuli (3,301 m.a.s.l.) in the Lesser Caucasus.

Figure 1: Erosion and settlement. Photo: Maia Akhalkatsi.

The territory of modern-day Georgia has been continuously inhabited since the early Stone Age and affected by human communities for tens of thousands of years. On average, nearly half of the land in the region is already transformed by human activities. Nevertheless, several pristine areas remain in the hotspot, mostly in remote high-altitude areas and inaccessible gorges. About 12 percent of the original vegetation is considered pristine (National Biodiversity Action Plan, Georgia 2005). Most of the hotspot's intact ecosystems are concentrated in high mountain sites, while the plains and the foothills have suffered the most habitat loss. Therefore, urgent steps should be undertaken to protect remaining biodiversity in the area.

The two main problems threatening Georgia's mountain biodiversity in the modern age are anthropogenic impact and global climate change. Traditional agriculture in Georgia in the past was sustainable and did not seriously threaten biodiversity in Georgia. The main impact was generated in the Soviet period, when Georgian agriculture supplied by-products such as wine, vegetables, wool and cheese to Russia and other Soviet republics. This caused an increase in sheep and cattle herds up to several million heads on the relatively small territory of the country. While still shepherded in the traditional way, the herds became so large and rotations became too short, so that they threatened many high mountain pastures and caused soil erosion (Figure 1). This problem reduced after the disintegration of the USSR in the early 1990s, when Georgia became responsible mainly for production of agricultural products for its own market.

Nevertheless, the social and economic crises that have plagued the region since 1992 have caused other problems which nowadays are leading to habitat losses in the mountain areas in Georgia. Problems include the migration of population, especially youth, away from mountain regions, with abandonment of mountain settlements due to unemployment, bad roads, and the absence of communication and social comfort. There is a low quality of life for mountain people, as well as absence of factories for processing agricultural products and sellers' markets. There are natural threats to the population, roads and land in the form of avalanches, mountain torrents, landslides and floods. Lack of investment to improve disturbed slopes and the absence of sustainable management to improve life in the high mountain regions also causes problems. The lack of lowland winter pastures for sheep in the northern (Russian) foothills of the Great Caucasus has also led to a shift in the husbandry system away from sheep to heavier cattle, often not suitable for the steep and fragile slopes and adding to the risk of soil degradation and erosion.

It is necessary to improve the way of life of the local population and invest more funds in recovery projects for nature protection measures in mountain ecosystems. Progress in the mountain regions of the Caucasus might be reached by an improvement in the development of small power industries, fresh water supplies, use of mineral springs, production of ecologically clean products by local farmers, development of aesthetic resources and historical heritage for the development of mountain tourism, gastro-, agro-, ethno- and scientific-tourism, weekend tourism and development of hotel businesses. As a first step, detailed scientific investigations should be undertaken to develop an appropriate approach for a particular geographic region.

Figure 2: Overgrazed slope. Photo: Maia Akhalkatsi.

The central scientific focus should be on how fundamental processes in plant communities might alter, given current predictions for the response of alpine vegetation to global warming. Ongoing climatic changes cause lower-elevation habitats to expand into higher elevation zones, with alpine meadows and pastures often becoming encroached by shrubs and trees (Gottfried et al., 1998). Changes in climate also affect the depth of winter snowpack exposing sensitive taxa to harsh climate episodes. What is most important is treeline ecotone, representing the most sensitive ecosystem regulating mountain hydrology and the stability of mountain slopes with respect to soil erosion, avalanches and landslides. Sustainable life in mountains is largely dependent on slope stability (Figure 2). Vegetation plays a key role in stabilisation of soil on the steep slopes to avoid landslides and soil erosion (Körner, 2002). Heavy overgrazing, which took place in Georgia in the last century, caused massive destruction of many alpine meadows and pastures, impacting steep slopes in particular. To restore these disturbed areas, vegetation needs to recover. Special attention should be paid to the complex processes that determine structure and functionality of alpine ecosystems. Because of similarities in alpine regions globally, scientists from different countries should cooperate in order to compare studies from various alpine systems, share expertise and organise mutual activities. The expertise in different fields of a science gives good opportunities for the development of interdisciplinary research projects.

To develop the status of an effective methodology for the restoration of the environment and protection of mountain biodiversity, it is necessary to know biological indicators of degradation and to know which species are key to secure slopes. Once these species are identified, their future in a changing climate need to be assessed using the environmental envelope approach. It will thus be possible to rank species by both their slope protection function as well as their risk under climatic change scenarios. A joint project with the Institute of Botany in Basel, in the framework of the GMBA Research Agenda on Land Use Change and Mountain Biodiversity, is tackling these questions (funded by SCOPES-SNF, project 110670).

References

Gottfried, M; Pauli, H; Grabherr, G (1998) *Prediction of vegetation patterns at the limits of plant life: A new view of the alpine-nival ecotone*. AAAR, 30:207-221.

Körner, C; (2002) *Mountain biodiversity, its causes and function: an overview.* In: Körner, C: Spehn, E M (eds) Mountain biodiversity. A global assessment. Parthenon, New York, pp 3-20.

National Biodiversity Strategy and Action Plan - Georgia. 2005. Tbilisi, pp. 106.

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Recent Change of Alpine Vegetation and Plant Species Richness in the Swedish Scandes

Leif Kullman

This paper highlights results from monitoring studies in the southern Swedish Scandes, which are integrated into a long-term, regional network (Kullman 2001, 2004, 2006, 2007a,b, 2008, 2009; Kullman and Öberg 2009). Unfortunately, lack of funding meant that this unique observation programme had to be discontinued last year. This is regrettable, since it is increasingly evident that projections of future trajectories of the alpine and subalpine plant cover cannot entirely rely on manipulative field experiments and space-for-time substitute studies. Long-term observational time series, preferably in combination with paleoecological studies, are mandatory and invaluable for the purpose of ecological modeling.

Climate change

Since the early 20th century, summer and winter air temperatures have increased by 1.3-1.4 degrees Centigrade in the southern Swedish Scandes. Concomitantly, mountain glaciers have receded to their smallest extent and permafrost has ceased to exist. This implies a new climatic regime and a break of a millennia-scale trend of climate cooling and biological impoverishment.

Vegetation change

From a landscape ecological perspective, the most important change relating to recent climate change is treeline rise. The dominant tree species, viz. *Betula pubescens ssp. czerepanovii*, *Picea abies* and *Pinus sylvestris* have displayed regional-scale treeline rise by a common maximum of about 200 metres since around 1915. In most places, the upshifts are smaller, which relates to prevailing topoclimatic constraints. Initially, *Betula* advanced most rapidly, but during the past 30 years, *Pinus* has taken the lead. Obviously, *Betula* cannot take advantage of warming in the driest and most windy habitats. Tentatively, it appears from paleobotanical investigations in the same region that the new and higher treeline of *Pinus* is unsurpassed in a millennial-scale perspective.

A sapling of Epilobium angustifolium growing in thin morainic debris on glacier ice. This phenomenon has not been previously reported in Scandinavia. Photo: L. Kullman.

Anythyllis Vulneraria has recently spread about 700 metres higher than previously recorded in the southern Swedish Scandes. Photo: L. Kullman.

Another conspicuous consequence of the recent warming phase is the reduced frequency of late-lying snow patches in the high mountains. Despite increased precipitation, this has made the mountains drier and snow bed plant communities are being replaced by alpine grasslands and deciduous dwarf-shrub heaths *(Vaccinium myrtillus)*. To some extent compensatory, new snow bed and mire habitats are being continually shaped by the recession of glacier and semi-permanent snow patches. Alpine and subalpine mires are drying and are increasingly invaded by shrubs and trees. Lichen-dominated alpine grounds have shown tendencies towards increasing cover of dwarf-shrubs, such as *Empetrum hermaphroditum* and *Betula nana*. Overall, the mountains are taking on a lusher and greener face, which also implicates higher ecosystem productivity.

Increasing plant species richness

Studies revisiting sites based on historical plant distribution records from the early 1950s have demonstrated a substantial increase in alpine plant species richness. For example, resurveys of summit floras (vascular plants) on four high mountains have revealed raised species numbers by 58, 67, 88 and 156 percent, respectively, over the past 60 years or so. The rate of upshifts amounts to 35-45 metres per decade, which exceeds figures reported from analogous studies in other parts of the world. Saplings of tree species in particular have spread upslope by about 100 metres per decade, thereby reaching 500-700 metres above the treeline. In contrast to general expectations, no single species has disappeared from the summit floras during the survey period of substantial climate warming.

It is particularly evident from the studies summarised here that species have responded individualistically to climate warming. This upsets traditional views on community compositions, biogeographic delimitations systems and successional pathways.

Many of the altitudinally advancing species are traditionally considered as true forest species, rarely (if ever) observed above the coniferous treeline; for example *Anemone nemorosa, Anthyllis vulneraria, Chrysosplenium alternifolium. Polygala amarelle* and *Pteridium aquilinum*. It is quite remarkable and an unprecedented experience to find a forb like *Epilobium angustifolium* growing on ice cored moraines and even on debris-covered glacier ice .

The advent of a fundamentally new climatic regime over the past century is perhaps most striking in the establishment of young saplings of true thermophilic (nemoral) tree species such as *Quercus robur* and *Ulmus glabra* at the transition between subalpine forest and alpine tundra. These species have not been growing here since about 8,000-9,000 years ago.

The results briefly summarised above emphatically contest claims, based on inadequate field research, that intense grazing and trampling by semi-domestic reindeer has concealed attempts of vascular plants to migrate upslope and increase the alpine plant species richness.

The upslope advance of plant species may be facilitated by increased flowering and fruting, which has conspicuously occurred during the past decade or so.

Even if the changes accounted for here turn out to be ephemeral, the magnitude and pace of elevational rise clearly demonstrates that upper distributional limits of plant species do not necessarily lag behind the shifts of climatic isolines. Moreover, there is no conclusive and widespread evidence of retractions of the lower distribution limits of alpine plants, which seem to respond more sluggishly to altered climatic conditions than the upper limits. In fact, results obtained so far implies that the ranges of many species have actually increased in response to climate warming. This argues against the reiterated idea of pending mass extinction of mountain species in case of continued climate warming.

*Thermophilous Ulmus glabra has recently appeared at a site 300 metres higher than the few tree sized specimens which exist in the region.*Photo: L. Kullman.

References

Kullman, L (2002) *Rapid recent range-margin rise of tree and shrub species in the Swedish Scandes.* Journal of Ecology 90, 68-77.

Kullman, L (2004) *A face of global warming - "ice birches" and a changing alpine plant cover.* Geo-Öko 25, 181-202.

Kullman, L (2006) *Transformation of alpine and subalpine vegetation in a potentially warmer future, the Anthropocene era. Tentative projections based on long-term observations and paleovegetation records.* Current Trends in Ecology 1, 1-16.

Kullman, L (2007) *Long-term geobotanical observations of climate change impacts in the Scandes of West-Central Sweden.* Nordic Journal of Botany 24, 445-467.

Kullman, L (2007) *Modern climate change and shifting ecological states of the subalpine/alpine landscape in the Swedish Scandes.* Geo-Öko 28, 187-21.

Kullman, L (2008) *Thermophilic tree species reinvade subalpine Sweden- early responses to anomalous late Holocene climate warming.* Arctic, Antarctic, and Alpine Research 40, 104-110.

Kullman, L (2009) *High species turnover and decreasing species richness on mountain summits in Sweden: reindeer grazing overrides climate change ? Comment.* Arctic, Antarctic, and Alpine Research 4, 151.

Kullman, L; Öberg, L (2009) *Post-Little Ice tree line rise and climate* warming in the Swedish *Scandes - a landscape ecological perspective*. Journal of Ecology doi.10.1111/j.1365-2745.2009.01488.x

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Mountain Biodiversity, Genetic Resources and Cultures

Promila Kapoor-Vijay

Mountains cover 24 percent of the global land area and affect half the human population (Körner, 2002). They are home to rich biological diversity and genetic resources. However, our planet's ecological services are under threat. Urgent steps for the conservation and sustainable utilisation of mountain biodiversity are needed. It is of paramount importance to link human endeavour, cultures, traditional knowledge, not just for ecological concerns but to ensure the survival of humanity though sustainable use.

The mountain biota includes unique species that are adapted to extremes of temperature, soil water, disturbance to slopes and vulnerable environments. A vast number of plant species - Life Support Species (LSS: Kapoor, 1992; Kapoor, 2007) – are of socioeconomic and ecological value, as they ensure human survival in emergencies and in extreme environments. They are an integral part of native mountain cultures and communities and provide food, nutrition, primary health care, medicine and shelter. Central to maintaining the ecological integrity of the prevailing ecosystems, they provide ecological services which act as insurance against emergencies and hold the key to maintaining and preserving the ancient heritage of local traditions and cultures. Biological richness has an insurance value in times of crisis and serves as a buffer against system failure (Körner and Spehn, 2002). Traits in biodiversity in mountains adapted to extreme environments and which contribute to their ecological and biological uniqueness have been studied by scientists (Körner, 2003, 2009). More collaborative studies (e.g., Abbott 2008) are needed to build an inventory of the unique characteristics which enable LSS to survive and thrive in extreme mountain environments. More such efforts at local, regional and international levels would stimulate research to understand adaptations and the complex biology of species with high socio-economic and ecological values in the Himalayas, Andes and other mountain regions.

The current economic and financial 'world view' demands that monetary value be ascribed to biodiversity. This clear signal to estimate the value of the green matter of the mountains is still not fully recognised and the unique value of their cultures is not acknowledged. The erosion of cultures and languages in mountains is a warning that efforts to protect traditional knowledge should be encouraged and intensified. Mountain ecosystems are Nature's Bank for life (Kapoor, 2007) and underpin the ecosystems in which humanity, as we know it today, has evolved and flourished.

Mountain ecosystems represent dynamic living laboratories with rich traditional knowledge, often acting as a driver of biological diversity. While this knowledge needs to be protected and preserved, its sustainable use and conservation must also continue.

Mountain biodiversity and cultures are unique and invaluable as:

- They arise from millions of years of evolution that created the structure of mountains and isolated their indigenous communities;
- Mountain communities have attitudes and approaches to life that have evolved slowly by the assimilation of knowledge from people who moved to the mountains to escape the insecurities, persecution and turmoil of their native lands;
- Slow migration in the past due to very difficult physical access and the harsh environment led to the preservation of cultures in an undiluted form;
- Many areas have their cultures intact. They include ancient religious practices like the Mahayana Buddhism in Bhutan and the Vedic tradition of Hinduism in Uttarkhand. The land was fragile yet the microclimate was not disturbed, leading to the evolution and sustainability of biodiversity that included a wide variety of plants of very high medicinal, aromatic and nutritional value.

To ensure the continuity of biodiversity, cultures and traditions of mountains while providing food, nutrition, health and ecological security to mountain people in times of global climate change, the following recommendations are made with respect to traditional knowledge (TK) and conservation biology associated with biodiversity and genetic resources for action by the Convention on Biological Diversity (CBD) in 2010:

1 Definitions and terminology of TK need to carry within them embedded knowledge of the communities of people who live and create TK as a way of life. These definitions should draw on the ecological, social, philosophical, spiritual, cultural, scientific information and details attached to TK.

2 Equitable protection of TK should be based on its specific characteristics, i.e that its evolution in space and time is influenced by the social, spiritual and beliefs, and that it imparts a unique identity and integrity to the TK holders in a given community, culture, habitat and ecosystem.

3 Specific strategies should be developed and associated frameworks should be designed for equitable sharing of benefits of TK, including ecosystem services which enable local people and communities to thrive in their unique mountain environments.

4 Sustainable development and TK protection policy should allow valuation of TK in both measurable and non-measurable terms. For example, a gene identified from a plant species can bring economic benefit to the TK community from which it originates, when prior informed consent (PIC) has been obtained and a benefit-sharing agreement has been legally agreed. The non-measurable value of the species and its associated TK will be the conserved habitat, other associated plant, animal, microbial species, the nature of soil, water, location, people, their culture, spiritual and social traditions etc. which have maintained the ecosystem services.

5 Any TK protection policy should:

- Empower all people, especially women and the elderly who are often the TK holders;
- Promote equitable benefit sharing;
- Promote community development and legitimate trading activities. The CBD should develop such details in strategies which build and enhance trust and understanding, transparency among people who are the beneficiaries i.e. TK holders and with others, such as academics, scientists and commercial users of TK;
- Accommodate all approaches and build a harmonised system based on international principles and agreement;
- Create a structure of institutions and lay out processes for creation and flow of data, information and knowledge on TK and genetic resources;
- Encourage capacity building, awareness creation and advocacy for Conservation Biology programmes linked to

traditional knowledge while targeting mountain biodiversity genetic resources research. Geo-coded information is essential in the inventory and assessment of biodiversity through biological and ethnobotanical studies on LSS in the Himalayas, Central Asia, Andes, Alps and other mountain regions.

References

Abbott, R J (2008) *Overview. HIstory, Evolution and Future of Arctic and Alpine Flora. Proceedings of Scotland symposium June 2007*. Plant Ecology and Diversity, Vol.1 (2) pp 129 - 133

Kapoor-Vijay, P (1992) *Biological Diversity and Genetic resources: The programme of the Commonwealth science Council*. Commonwealth Secretariat, London

Kapoor-Vijay, P (2001) *Biodiversity, people's knowledge, and mountain community development: experiences, status, and visions beyond 2002*. In Proceedings of World Mountain Symposium, 30 September - 4 October 2001, Interlaken, Switzerland.

Kapoor-Vijay, P (2007) *ICIMOD's Mountain to Mountain Cooperation: Sustainable use of biodiversity including Genetic resources*. Himal-Andes Mountain Forum, Mountain Partnership and ICIMOD 2007 www.mtforum.org/rs/econfreports/Himalandes_biodiversity_econf_juje_2006.pdf

Körner, C; Spehn, E M (2002) *Mountain Biodiversity: A Global assessment*. Parthenon Publishing

Körner, C (2003) *Alpine Plant Life: Functional Plant ecology of High Mountain Ecosystems*. Springer Verlag Berlin Heidelberg, Germany

Körner, C (2009) *Mountain Biota and Climate*. In National Academy of Sciences,,Washington, USA "Symposium on Twenty First Century Ecosystems: Systemic Risk and the Public good", 11-12 February 2009

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Spread of Non-Native Plant Species into Mountains: Now is the Time to Act

Keith McDougall, Sylvia Haider, Tim Seipel, Christoph Kueffer and MIREN Consortium

Mountains are hotspots for biodiversity and of great importance to human societies. The worldwide placement of mountain areas in conservation reserves is recognition of their value. Managers have to remain vigilant to protect mountain ecosystems from future threats. One such threat is invasive, non-native plants. Invasive plants alter plant communities, affect grazing lands and homogenise the world's flora. Mountain areas have not been as intensely affected by plant invasions as low elevations because of harsh climatic conditions, isolation and limited human pressure. The relative resistance of mountain ecosystems to plant invasions may be transient, however, in light of ongoing global change (e.g. climate change, expansion of human pressures). Unique mountain flora, fauna and habitats may become increasingly susceptible to invasions.

Building a knowledge base for managing plant invasions in mountains

In 2005, the Mountain Invasion Research Network *(MIREN, www.miren.ethz.ch)* was launched to investigate the degree of plant invasion in mountain ecosystems, to understand the invasion process using elevational gradients as a model system, and to evaluate and communicate the future threat from plant invasions associated with global warming and changing land use patterns (Dietz et al. 2006). MIREN is associated with the Consortium for Integrated Climate Research in Western Mountains (CIRMOUNT), the Global Mountain Biodiversity Assessment (GMBA) and the Mountain Research Initiative (MRI). The MIREN core program comprises comparative research in six mountain regions (Pacific Northwest USA, Swiss Alps, Chilean Andes, Australian Alps, Hawaii, and the Canary Islands Spain), covering major climatic zones including island and continental systems (Figure 1). Beyond the core program, MIREN networks with researchers and managers in mountain regions worldwide. In an issue of 'Perspectives in Plant Ecology, Evolution and Systematics' on plant invasions into mountains (Vol 7, No 3), MIREN showed that non-native plants are present in mountain ecosystems around the world, but that the distribution patterns and impacts along elevation gradients differ between regions. In an upcoming article of 'Frontiers in Ecology and the Environment' (Pauchard et al. in press), we present a

Figure 1: Lupinus polyphyllus, a native of the Pacific Northwest of North America is a garden escapee a) in the mountains of Switzerland and b) in the abandoned gold mining village of Kiandra in the Australian Alps. Lupinus illustrates the future threat of invasions by amenity species to mountain areas. Photos: T. Seipel, S. Haider.

Figure 2: Unlike most non-native species in the Australian Alps, Hieracium aurantiacum (Orange Hawkweed) does not require disturbance for establishment in natural vegetation. It grows in a large range of habitats and has a reproductive advantage over native species by using vegetative spread, asexual seed production, seedling establishment and flowering over several months, with long distance wind dispersal of seeds. Photo: K. McDougall.

conceptual framework for understanding these differences and, more generally, plant invasion into mountains. Although factors determining plant invasions at high elevations are the same as in other ecosystems, the manner by which they influence the outcome of invasions differs in mountains because of the extreme conditions.

A database of non-native plants in mountains worldwide (McDougall et al., in preparation) contains almost 1,500 naturalised or invasive plant taxa. In a more detailed analysis of 13 mountain regions harbouring c. 1,000 taxa, more than half the taxa were recorded in only one region, suggesting that the total pool of potential invasive species is large. Adjoining lowland areas act as the main source of non-native plants, as indicated by the high degree of similarity between lowland and high elevation non-native floras in particular regions. The most widespread mountain plant invaders are species typical of native European pastures (e.g. *Dactylis glomerata, Rumex acetosella, Trifolium repens)*, which were probably introduced to many regions during the past few hundreds years in association with livestock grazing. Only a few of these (e.g. *Achillea millefolium, Holcus lanatus, Verbascum thapsus)* are regarded as threats to biodiversity where they occur. In contrast, woody species (e.g. *Acacia spp., Cytisus scoparius, Pinus spp., Salix spp., Ulex europaeus)*, which were often introduced for soil improvement or forestry, are widely regarded as problematic because they alter vegetation structure, soil chemistry and fire susceptibility. Further, taxa from the genera *Centaurea, Hieracium* and *Linaria* are of particular management concern in many regions. These species were introduced as amenity plantings in gardens. With the shift in many mountain regions from agriculture to tourism, the threat from ornamental plants such as these species is likely to grow.

A field survey of non-native plants along elevational gradients in the MIREN core areas corroborates these patterns. We found the highest number of non-native plants at the lowest elevations and the decline in the species richness gradient is remarkably consistent between regions. The species found at high elevation are generalist species that occur over large elevational ranges. It seems that most of the current mountain non-native flora was first introduced to lowland areas and later spread to higher elevations. It has been argued that this introduction pathway through lowland climates may act as a "filter" and reduce the risk of mountain invasions (Becker et al. 2005). If, however, mountain specialists are directly introduced from one mountain region to another one through the horticultural trade, the lowland filter will break down.

Towards a global, proactive strategy against the emerging risk of mountain plant invasions

Mountains are one of very few ecosystems not yet severely affected by plant invasions. This gives researchers and managers the unique opportunity to respond in time to this emerging threat. While prevention is the most cost-efficient management strategy, new non-native species are bound to arrive. Managers must therefore employ a range of strategies. Our results indicate that, in many mountain regions, a shift is taking place in land use from pastoral (e.g. range improvement and grazing of native pastures) to tourism activities. With this change, managers can expect a shift in the composition of their non-native plants and, in places, an increase in the threat posed by them. Non-native plants that came with grazing animals were mostly generalists that have relied on disturbance from humans and stock for their persistence and were not specifically adapted

to a mountain climate. Species arriving with tourist infrastructure, in contrast, have often been selected for their cold-hardiness. Many horticultural introductions are relatively recent (e.g. from the very species-rich mountain region of Yunnan in China; Mack and Sun 2002), and their potential to become invasive is not known. The safest approach for mountain managers is therefore to restrict the deliberate introduction of all novel non-native species to mountains.

An inventory of non-native plants is an important resource for managers of any biodiversity reserve and should be a priority for mountain areas, which face a growing threat from invasions. MIREN is developing an online database of mountain invasive plant species that will allow managers to evaluate the threat that such species may pose in their regions. It is also important to monitor populations of non-native plants as some will be benign or transient and some will be deleterious. Such a monitoring programme needs to include contingency plans for the event that a highly invasive non-native species is discovered. Eradication is possible only in a very early phase of an invasion and this is particularly true in the complex topography of mountains. In the Australian Alps, MIREN has worked with local land managers on the eradication of two Hieracium species (*H. aurantiacum and H. praealtum*) (Figure 2). Both species are thought to have been introduced through tourist infrastructure in recent decades (Williams and Holland 2007). They have spread rapidly, aggressively competing with natural vegetation, and, although only discovered in the last decade, are now the most costly non-native species being managed in the Alps and one of the greatest threats to these mountain ecosystems. In Australia, at least, the old notion that mountains are somehow resistant to serious plant invasions has been destroyed.

A comprehensive strategy against plant invasions may include more than prevention of novel introductions, monitoring and eradication. For instance, codes of conduct on cleaning clothes, tools and machines before entering natural areas may reduce the risk of spreading non-native species by visitors and managers of natural areas. More generally, awareness building and networking with stakeholders (e.g. the horticultural and tourism industries and the general public) are vital. In the European Alps, MIREN has begun collaboration with the Alpine Network of Protected Area *(www.alparc.org/)* and with the EU Alpine Space project ECONNECT on developing a comprehensive strategy for dealing with the risk of invasive plants. Experiences from this pilot project will later be tested and adapted in other mountain areas. MIREN welcomes inputs about best-practice approaches from managers who already have experience with managing invasive plants in mountains.

References

Becker, T; Dietz, H; Billeter, R; Buschmann, H; Edwards P J (2005) *Altitudinal distribution of alien plant species in the Swiss Alps. Perspectives in Plant Ecology Evolution and Systematics 7*, 173-183
Dietz, H; Kueffer, C; Parks, C G (2006) *MIREN: A new research network concerned with plant invasion into mountain areas.* Mountain Research and Development 26, 80-81.

Mack, R; Sun, W (2002) *Yunnan: a recipient and potential source of invasive plant species.* In: Proceedings of the 2002 Annual Meeting of the Ecological Society of America (ESA), Tucson AZ.

Pauchard, A; Kueffer, C; Dietz, H; Daehler, C C; Alexander, J; Edwards, P J; Arévalo, J R; Cavieres, L; Guisan, A; Haider, S; Jakobs, G; McDougall, K L; Millar, C I; Naylor, B J; Parks, C G; Rew, L J; Seipel, T (in press) Ain't no mountain high enough: Plant invasions reaching new elevations. Frontiers in Ecology and the Environment

Williams, N S G; Holland, K D (2007) The ecology and invasion history of hawkweeds (Hieracium species) in Australia. Plant Protection Quarterly 22, 76-80.

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Changes in Biodiversity Patterns in the High Andes - Understanding the Consequences and Seeking Adaptation to Global Change

Anton Seimon, Karina Yager, Tracie Seimon, Steve Schmidt, Alfredo Grau, Stephan Beck, Carolina García, Alfredo Tupayachi, Preston Sowell, Jerry Touval and Stephan Halloy

Over the past decade, a multinational group of investigators has been working in concert to observe, understand and develop adaptations to climate change and its impacts on species, habitats and people in the uppermost reaches of the biosphere at high alpine field sites along the central Andes of Peru, Bolivia and Argentina.

Global context

As infrared radiation is captured by greenhouse gases in the higher atmosphere, there is a faster rate of temperature increases at higher altitudes, with consequent destabilisation and changes in other high altitude climate parameters. Whole regions will develop entirely new (no-analog) climate suites, to which only certain more ruderal (opportunistic) species will be able to adapt. With the speed of change, plant and animal species may not be able to migrate fast enough. In addition to invasive exotics, disease advances are already being documented (Seimon et al., 2007; UNFCCC, 2007).

In the high Andes, changes in physical environments impinge on a complex and intricately interrelated mosaic of human land use and biodiversity with different degrees of impacts. The usual temporal variability of climate is superimposed in these landscapes on a fine grain spatial variability; cloud forest can give way to dry shrublands or grasslands within tens of metres.

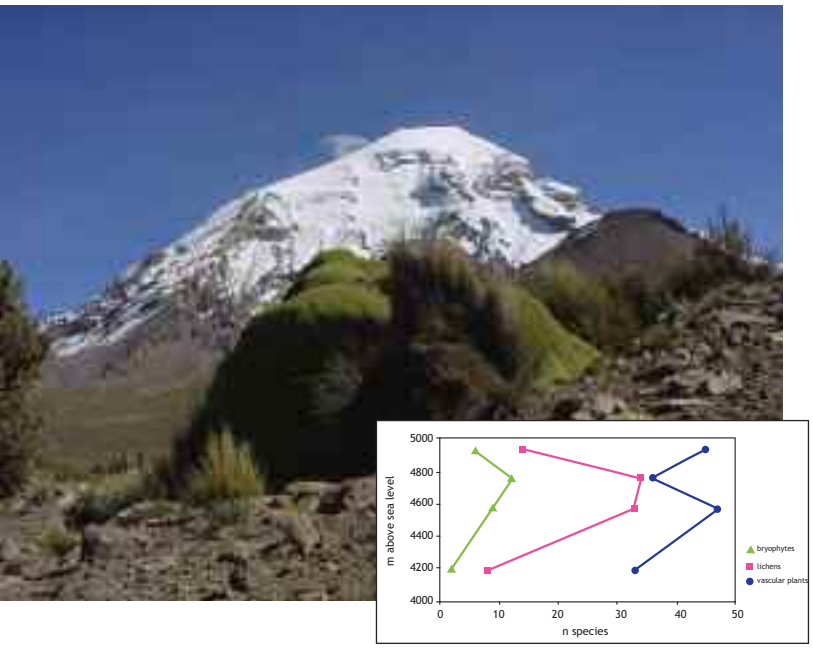

Figure 1: Species richness along an altitudinal gradient in Sajama volcano (background) national park, Bolivia. Photo: Stephan Halloy.

Gradients and patterns

Simplified concepts of altitudinal gradients help us to understand the gradual decrease in temperature and atmospheric pressure with altitude. Such concepts lead to the idea of creating altitudinal corridors to allow species to migrate to cooler altitudes as the climate warms. However, spatial heterogeneity means such gradients must be studied case by case and cannot be generalised. Cloud forest species faced with rising temperatures may not be able to climb into dry valleys separating them from new potentially similar climates. Climate patches may disappear entirely, leaving whole ecosystems cut off from suitable habitats. Given the complex and environmentally determined mosaic of habitats, even minor changes and shift of boundaries will have potentially large impacts on the persistence of ecological communities.

Satellite image analysis has permitted an understanding of coarse grained features of the Andean environment and change scenarios. Given our scant understanding of population biology and physiology of Andean plants (with some notable exceptions), we currently rely on modeling exercises to forecast potential movements and impacts. Although modeling provides novel and valuable insights into predicting species adaptation, there are major gaps in essential land-based verification.

Interdisciplinary research on the ground

Researchers from a wide range of disciplines are collaborating to fill in the gaps in ground-based data by exchanging information and designing research in alliance with local people. Here we describe briefly some aspects of interdisciplinary work that is providing exciting new avenues of research on adaptation to climate change along the central Andes. Research on adaptation to climate change along the central Andes includes analysis and interpretation of ice core data to peer into the past as well as working cooperation with indigenous communities to understand their perceptions of recent socio-ecological changes. Rates of deglaciation and microbial ecology of recently deglaciated and extremophile soils are being measured (Schmidt et al., 2008a; Schmidt et al., 2008b; Costello et al., 2009). Plant succession is also being monitored under variable year to year cycles (Yager et al., 2007), and the impact of change on standardised biodiversity monitoring sites (GLORIA network, *www.gloria.ac.at*) includes documenting the rising altitudinal limits of plants, vertebrates, invertebrates and human productive activities (agriculture and grazing) (Halloy et al., 2008).

Linking these research strands has provoked challenging new questions and has led to a broader awareness of the multiple relationships between various fields. For example, instead of merely documenting amphibians climbing to extreme elevations in deglaciating valleys, researchers have quantified and explained how this apparent expansion is simultaneously impacted by a rapid dieback due to a concurrent advance of the deadly chytrid fungus (Seimon et al., 2007). Likewise, GLORIA baseline studies have shown (Figure 1) unexpected diversity gradients in vascular plants, bryophytes and lichens, with hump-shaped curves (i.e. rise in diversity with altitude then decline) rather than gradual declines with altitude (Halloy et al., 2008). These trends may be linked with changes in microbial, invertebrate and vertebrate diversity. Importantly, these studies are bridging the gap between research and field application with local people (Figure 2). Adaptation action requires understanding the issues (research) and knowing what to do (technology); resources (material and energy, finance); and institutional support (community or government). Each of these dimensions raises a long list of additional interrelations, obstacles and opportunities.

The northern tropical Andes where páramos (wet grasslands) occur are more conical, leading to a gradual reduction of area available for species to colonise upwards. This phenomenon, observed in the Alps and other mountains, has been modeled following species-areas relationships. In contrast, the dry puna grasslands have developed over the large altiplano mountain plains with a more abrupt reduction of area available towards the small summits, entailing a much greater risk of species extinctions for puna species. Conversely, species living below the puna, unlike most mountains in the world, will have an abrupt increase in the area available to them, sometimes more than ten-fold, leading to a 'Noah's Arc' phenomenon where the altiplano could be managed as refuges for biota which is threatened by rising temperatures.

Figure 2: Workshops with local people in the Andes establish an open flow of information between scientists and indigenous people. Inset: booklet presenting the results of perception and adaptation workshops with local herders of Sajama, Bolivia, in a user-friendly and illustrated format (Ulloa and Yager, 2008). Photo: Stephan Halloy.

There are also considerable ethical issues regarding the impact of change and movements on humans and land use conflicts. Approaching these complex and interrelated issues from a wide range of different perspectives is a start to understanding and acting upon climate change adaptation.

References

Costello, E K; Halloy, S R P; Reed, S C; Sowell, P; Schmidt, S K (2009) *Fumarole-Supported Island of Biodiversity within a Hyperarid, High-Elevation Landscape on Socompa Volcano, Puna de Atacama, Andes.* Applied and Environmental Microbiology, 75: 735-747.

Halloy, S R P; *Yager, K; García, C; Beck, S (2008) South America: Climate Monitoring and Adaptation Integrated Across Regions and Disciplines.* In Settele, J. (ed.), *Atlas of Biodiversity Risks - from Europe to the globe, from stories to maps.* Sofia and Moscow: Pensoft (www.pensoftonline.net/alarm-atlas-info).

Schmidt, S K; Reed, S C; Nemergut, D R; Grandy, A S; Cleveland, C C; Weintraub, M; Hill, A; Costello, E K; Meyer, A F; Neff, J C; Martin, A M (2008a) *The earliest stages of ecosystem succession in high-elevation (5000 meters above sea level), recently deglaciated soils.* Proceedings of the Royal Society B-Biological Sciences, 275: 2793-2802.

Schmidt, S K; Sobieniak-Wiseman, L C; Kageyama, S A; Halloy, S R P; Schadt, C W (2008b) *Mycorrhizal and Dark-Septate Fungi in Plant Roots above 4270 Meters Elevation in the Andes and Rocky Mountains.* Arctic, Antarctic, and Alpine Research, 40: 576-583.

Seimon, T A; Seimon, A; Daszak, P; Halloy, S R P; Schloegel, L M; Aguilar, C A; Sowell, P; Hyatt, A D; Konecky, B; Simmons, J E (2007) *Upward range extension of Andean anurans and chytridiomycosis to extreme elevations in response to tropical deglaciation.* Global Change Biology, 13: 288-299.

Ulloa, D; Yager, K (2008) *El cambio climático: ¿cómo lo sentimos y qué proponemos para adaptarnos?* La Paz, Bolivia: *Conservación Internacional,* 28 pp.

UNFCCC (2007): *Climate Change: Impacts, vulnerabilities and adaptation in developing countries:* United Nations Framework Convention on Climate Change.

Yager, K; Resnikowski, H; Halloy, S R P (2007) *Pastoreo y variabilidad climática en el Parque Nacional Sajama, Bolivia,* II Congreso Latinoamericano de Parques Nacionales y otras Áreas Protegidas. Bariloche, Argentina, 14.

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Protection of the Cloud Forests and Their Biodiversity in the Coastal Cordillera of Venezuela

Winfried Meier

Avla National Park seen from the south east of Caracas (900-1,000 metres). The highest peak is about 2,600 metres. Photo: W. Meier.

The Coastal Cordillera of Venezuela stretches from east to west in a narrow band alongside the Caribbean Sea. The Cordillera principally consists of two mountain chains separated by high valleys, of which the best known is the Caracas valley. Generally the mountains are between 1,000 and 2,500 m.a.s.l. high. Moisture laden winds allow the growth of evergreen cloud forest islands within a mainly dryer vegetation. Additionally, more than half of the total precipitation may be caused by the cloud interception of the vegetation. Depending on the local conditions, cloud forests can be encountered between 600 and 2,200 m.a.s.l. The coastal mountains are among the most populated areas of the country.

The cloud forests of the Coastal Cordillera harbour an interesting mixture of plant species with different phytogeographical affinities (Andean, Caribbean, Amazonian and Guayanan elements). The mountain peaks with cloud forest are the major centres of endemism in northern Venezuela.

We are far from knowing all the species of this area, as the investigations of the author over the last years have shown. For instance the description of the tree species *Ampelozizyphus guaquirensis (Rhamnaceae)* showed that the genus was not monotypic but that the *liana A. amazonicus* of the coastal area of Venezuela has a sister species in the Coastal Cordillera (Meier and Berry 2008).

The Avila mountain region with the Avila national park, separated from the urban area of Caracas by a four-lane highway, is one of the floristically best known areas of Venezuela. In the "Flora del Avila" by Steyermark and Huber (1979) there are listed 1,892 vascular plant species. Approximately twenty years later, an additional 370 species have been registered, of which nearly 120

belong to (large and common) tree species and up to ten species are new to science (Meier 1998). Recent explorations have resulted in more than 250 additional species (Meier in preparation). It is possible that the area of this mountain range of approximately 100,000 hectares may harbour more than 3,000 different vascular plant species, nearly 20 percent of the total flora of Venezuela.

In the herbaria there are many botanical specimens from cloud forests still undescribed and there are even more to be discovered in the field. *Clusia* is a very important genus in the neotropics. It has many species, many of them still undescribed and forming dominant stands (especially at the forest/páramo border). In nearly all the herbaria most of the specimens are undetermined and a big part of the determined material is incorrectly identified. In many cases, the systematic revisions have not been transferred to the collections, thus there may be type material, a treasure, hidden within undetermined material. Many times the material is difficult to determine because of the inadequate conditions of the material, the dioecism of many species and the change of relevant taxonomic characteristics of specimens by the drying process. Another problem is that many herbaria are insufficiently staffed to be able to work on the taxonomic revisions to the specimens. Direct access to the internet and the availability of the relevant taxonomic literature in their libraries are often lacking, thus making effective work within the herbaria difficult. Furthermore, the floristic work is severely hampered by the absence of specialists in the relevant groups.

Cloud forests are the last frontier in the northern part of Venezuela. It is a difficult area to access because a lack of infrastructure such as roads, problems with the facilities and transport of the research institute and the inaccessibility during days or weeks in the rainy season. In many instances the main phenological periods of many important species are missed. In the planning and implementation of investigative projects, one has to allow time for failed expeditions because of bad weather conditions. Bureaucratic barriers (read permits) also make investigations difficult (permits by the environmental ministry, permits by the national park office, permits for regions with indigenous people, permits to enter private properties, CITES permits, etc.).

Clusia is a species probably new to science, from Avla National Park. Photo: W. Meier.

The precious cloud forest areas are threatened in different ways. The traditional practice of shifting slash and burn subsistence cultivation is still the predominant agricultural method. In some regions this practice is used for cash income near the bigger cities. A high percentage of the destruction is caused by people from outside the region. The cutting of the forest in order to create pasture land has increased dramatically in the last years, as has illegal logging, poaching, and collecting of ornamental plants such as orchids and bromeliads. Urbanisation and the construction of antennas and roads are other serious problems. In general in the Coastal Cordillera, the forests are not appropriate for sustainable agriculture and cattle raising because of the steep slopes, the acid soils and infertility. The best use is to preserve the forests as water reservoirs, thus indirectly protecting biodiversity. Huge areas are being destroyed without benefit for anyone due to deliberate or accidental fires and ignorance. Water will become a most precious good and Venezuela is lucky that the mountains still have forests that can capture the moisture. Without forested mountains, the northern part of Venezuela would be an arid land like many Caribbean islands without any pronounced elevations. Public and private campaigns should be created informing the people of all social strata, from farmers to policy decision makers, about the importance, beauty and fascination of the cloud forest ecosystems.

There are many areas of cloud forest protected within national parks and natural monuments, but there still remain many other areas under threat. The time during which extensive areas could be protected has passed. The biodiversity is now concentrated in relatively small areas, and therefore what is needed to protect this biodiversity are many small reserves and measures to protect these areas effectively.

There is an urgent need for a systematic investigation of the cloud forests of the coastal cordillera (distribution, species inventories) in order to prevent anonymous extinctions and anonymous loss of these ecosystems. More and financially attractive jobs for taxonomists and for experienced floristically orientated botanists should be created. Scholarships should promote interchanges with foreign institutions. Many relevant collections are housed in herbariums outside the host countries for historical reasons.

References

Meier, W; Berry, P E (2008) *Ampelozizyphus guaquirensis (Rhamnaceae), a new endemic tree species of the coastal Cordillera of Venezuela*. Brittonia 60 (2)pp 131-135.

Meier, W; (1998) *Flora und Vegetation des Avila -Nationalparks (Venezuela, Küstenkordillere), unter besonderer Berücksichtigung der Nebelwaldstufe*. Dissertationes Botanicae No. 296. Translation in Spanish in 2004: “Flora y vegetación del Parque Nacional El Avila (Venezuela/Cordillera de la Costa) con especial énfasis en los bosques nublados” in: http://freidok.ub.uni-freiburg.de/volltexte/1455.

Steyermark, J A; Huber, O (1979) *Flora del Avila. Madrid. INCAFO*.

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Transboundary Landscape Conservation in the Eastern Himalaya: Interview with Dr. Nakul Chettri

Samuel Thomas and Ujol Sherchan

Dr Nakul Chettri is Transboundary Landscape Management and Biodiversity Conservation Specialist with the International Centre for Integrated Mountain Development (ICIMOD). He has been overseeing the implementation of the MacArthur Foundation-funded landscape approach to biodiversity conservation through development of conservation corridors in the Kangchenjunga Landscape (western Bhutan, Darjeeling and Sikkim in India and eastern Nepal), and the Namdhapa-Hkakaborazi-Gaoligongshan Landscape (Arunachal Pradesh, India, Kachin state, Myanmar and Yunnan Province, China) since 2002.

Q: The Transboundary Biodiversity Management programme of ICIMOD, begun in 2003 in the Kangchenjunga Landscape, is now in its third phase. What milestones were achieved in Phase I and II, and what is your outlook for Phase III ?

Nakul: Though the actual field based activities on transboundary cooperation in the Kangchenjunga landscape started in 2003, the concept was discussed amongst the representatives from Nepal, India and China as early as 1997. ICIMOD facilitated discussion on the importance of the Kangchenjunga complex for biodiversity conservation in a workshop held in Kathmandu and made recommendations for addressing conservation issues. This was followed by a review of biodiversity of the complex that recommended the potential role of connectivity for better management of biodiversity in 2000. Then in 2003, ICIMOD initiated ground level activities for transboundary cooperation and now we are in the third phase of the initiative.

Phase 1 (2003-2005) was an inception phase when confidence building measures were taken. As milestones, we devised the strategy for reaching regional cooperation and initiated applied research to understand the value of biodiversity, conservation needs and livelihood options along with delineation of potential conservation corridors that are needed to make the landscape more resilient to all stresses and challenges. In addition, community-based participatory planning tools were used to address the socio-economic and socio-cultural aspects of conservation as well as to come up with comprehensive participatory corridor plans for each of the six identified conservation corridors in three countries (Nepal, India and Bhutan).

During the second phase (2005-2007), emphasis was placed on making the initiatives concrete and bringing policy dimensions to the forefront. Stronger partnership was developed with WWF-Nepal, The Mountain Institute and IUCN Nepal. A new dimension was added when the Kangchenjunga landscape was extended to a greater geographical coverage in the form of the Sacred Himalayan Landscape. This initiative resulted in development of a Sacred Himalayan Strategic Plan for Nepal for the period of 2006-2012. The most important milestone in this phase was the formulation of Regional Cooperation Framework to implement the Convention on Biological Diversity (CBD) in the Kanchenjunga landscape. The national corridor development plans address the individual corridor management issues whereas the regional framework brings together the common elements of the national conservation policies with reference to the Implementation Goal 2.3 of Mountain Biodiversity (COP VII/27) along with the other goals stipulated in the CBD. In addition, a draft "Regional Framework Strategy for Biodiversity Management in the Kangchenjunga Landscape" was prepared and discussed during a Regional Consolidation Workshop organized by ICIMOD and Nature Conservation Division (NCD) in Thimpu, Bhutan. This document, which is under review, emphasises cooperation for management of the Kangchenjunga landscape and development of corridors through national initiatives.

The ongoing third phase (2008-2011) is more of a consolidating phase for the landscape with a few new dimensions added to the Kanchenjunga landscape initiative such as climate change; perspectives on biodiversity conservation; valuation of biodiversity services; effectiveness of protected area in terms of governance and agro-biodiversity assessment. In addition, the experience from the Kangchenjunga landscape is being applied in the Bramhaputra-Salween Landscape considering three important protected areas of south west China (Gailogongshan Nature Preserve), north east India (Namdapha National Park) and Kachin state of Myanmar (Hkakaborazi National Park) for biodiversity management.

Q: While the Kanchenjunga Complex gets a lot of mainstream conservation attention, the Namdapha-Hkakaborazi-Gaoligongshan Landscape hardly gets any, although it is the largest contiguous expanse of natural forest in the Eastern Himalaya. How do the trans-boundary issues in this landscape compare with the K-complex? And what has been the level of cooperation (scientific and management) between the countries (China, Myanmar and India)?

Nakul: The Kangchenjunga complex has received more attention mainly due to its strategic location and the proactive roles of the countries sharing this complex and the active involvement of national and international organisations. The support from government agencies of these countries has added a new paradigm in that conservation initiatives have advanced from species-focussed to landscape level efforts.

The proposed Namdapha - Hkakaborazi - Gaoligongshan conservation complex was identified as an important transboundary complex in 1999 when ICIMOD organised a conservation dialogue between the representatives from China and Myanmar in Putao, Kachin state of Myanmar. The dialogue had underscored the need for regional cooperation in managing this complex.

The broad transboundary challenges in both complexes are similar. Weak enforcements and policing due to remoteness and inaccessibility, unregulated cross-border trade in high value medicinal and aromatic plants, poaching and illegal trading of animal parts are common. Poaching, illegal trading of animal parts, intensive slash and burn agriculture with decreased fallow periods and extensive commercial logging in parts of the Namdapha-Hkakaborazi-Gaoligongshan conservation complex have jeopardised this last frontier of biodiversity. People's dependency on the natural resources has been convoluted with higher level of poverty manifested by inaccessibility and insufficient developmental opportunities.

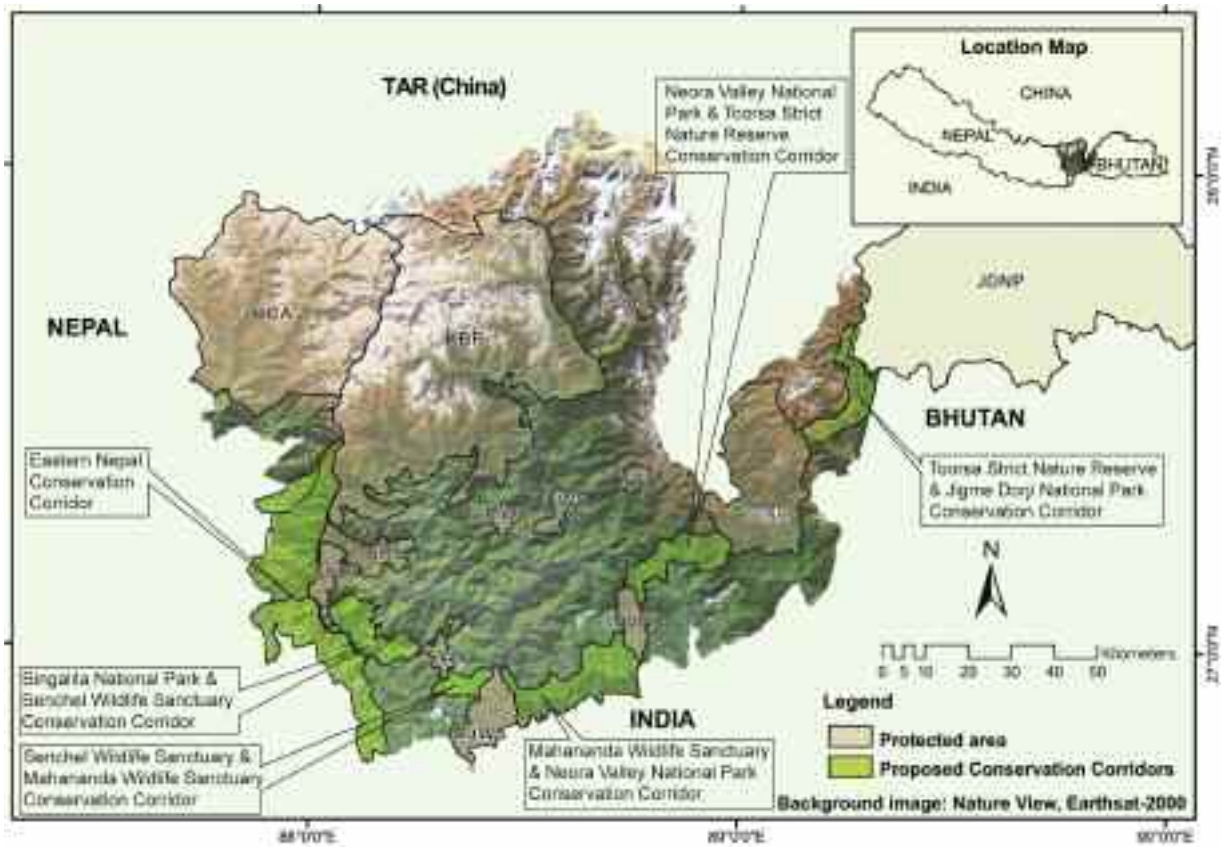

Figure of landscape approach in mapping biodiversity (source: ICIMOD).

Immediately after the 1999 dialogue, ICIMOD could not do much for the Namdapha-Hkakaborazi-Gaoligongshan conservation complex due to various reasons. However, after garnering experience in transboundary initiatives in the Kangchenjunga landscape, ICIMOD, in its present Medium Term Action Plan (MTAP 2008-2012), has envisaged expanding the landscape approach here. The dialogue with China and Myanmar and some preliminary work have already been initiated. To facilitate this process, ICIMOD, in collaboration with Kunming Institute of Botany, Chinese Academy of Sciences, has organised a 'Regional Experience Sharing Consultation on Landscape Approach to Biodiversity Conservation and Management in the Eastern Himalayas' during 24-28 May, 2009 in Tengchong County of Yunnan Province in China. The main purpose of the consultation is to impart understanding of the various landscape approaches piloted in the Hunder-Kush Himalayas (Bhutan, India and Nepal) and draw attention towards strengthening the Brahmaputra-Salween Conservation Landscape covering parts of India, Myanmar and China. As we are still in the process of taking things forward, commenting on the level of cooperation at this point of time may be too early.

Q: The eastern Himalayas is in some ways the last frontier for the rapidly growing economies of the region. So, there are huge plans for tapping the natural resources: dams, mines, logging, commercial cropping and so on. These plans have huge implications for conservation and sustainable growth of the region. How has the Programme been engaging with some of these issues ?

Nakul: Balancing conservation with development is one of the biggest challenges of this era. However, as signatories to the CBD, the Hindu-Kush Himalayan countries are committed to its three broad goals. The Conference of the Parties (COP) to the CBD adopted 'Mountain Biodiversity' as decision VII/27 at its 7th COP meeting in Kuala Lumpur in February 2004 where 14 overarching goals and 98 actions were prescribed as components of programme of work on mountain biodiversity. These goals and actions are guidelines for minimizing the adverse impacts of developmental activities. So far, the eastern Himalayan countries have set aside 15 percent of its geographical area under a protected areas network covering mostly wilderness areas of the region. This figure itself is significantly higher than the 2010 target (10 percent) of CBD. In addition, many of the eastern Himalayan countries and states have taken strides towards eco-friendly developmental activities. For instance, Sikkim has been declared as an eco-tourism destination and organic state. Bhutan has declared 60 percent of its territory to remain under forest cover at all times and continues to practice high value low volume tourism. Rigorous Environmental Impact Assessment for developmental activities and special development packages for mountainous states of India and Grain for Green initiatives in Yunnan, China are both examples of striking a balance between conservation and development.

Q: Doesn't what you say in a way just reinforce old stereotypes: technocratic solutions (or 'current' labels like 'organic') are good, traditional use is bad. For instance you mention slash and burn and people's dependence on forests

as challenges while remaining silent on mega projects like dam building or commercial agriculture in the region. The same state that claims to be 'organic' and an 'ecotourism destination' also made plans for 40 hydropower projects, many in biodiversity significant and sacred places. It has mass tourism in ecologically fragile areas. Similarly, Arunachal has plans for close to 100 small to large projects, all being built to feed the hunger of the heartland for power. There are plans to plant half a million hectares of rubber in NE India. Aren't these the real challenges?

Nakul: Let me reiterate here that conservation does not mean protection of resources only but also their sustainable utilisation. Nature has blessed us with diverse resources which are parts of the ecosystem, ecological processes and more importantly the food web that all organisms depend on. The century old principle of life such as 'struggle for existence' and 'the survival of the fittest' is still valid and can't be changed. In the modern era, there are more competitions among organisms for resources and unfortunately humans take the lion's share of them. Global communities are heading towards 'Sustainable Development' and 'Human Well-Being' but these will have to be realised with the resources we have on this planet. We can't borrow them from another planet. It is a fact that development and well-being can't be achieved by protection of resources only. We have to use the resources sustainably to fulfill demands.

Q: Climate change will likely change the floristic and vegetation composition of the K-complex and impact on the dynamics of wildlife movement, perhaps making the proposed conservation corridors redundant in the long term. Is this a concern? How does the programme mainstream climate change into its TBM strategy?

Nakul: The 4th Assessment Report issued by the Intergovernmental Panel on Climate Change (IPCC) in 2007 made a strong science-based appeal for actions to mitigate global climate change. It concluded that our planet is warming up. The eastern Himalayas will no doubt be hit hard by the changing climate. The K-complex has already witnessed changes in phenology, birds' migratory patterns and movement of some plant and insect species to higher altitudes.

Our recently completed report on 'Assessment of Climate Change Vulnerability of the Mountain Ecosystems of the Eastern Himalayas' revealed that the people living in the region are highly dependent on natural resources such as agriculture, forest, grassland and snow-capped mountains. Problems associated with modernisation like air pollution, land-use conversion, fragmentation, deforestation and land degradation have already crept into the region. The stress is exacerbated by an ever rising population and erosion of traditional knowledge and practices. The fragile ecosystems of the eastern Himalayas are, therefore, very vulnerable to emerging threats such as climate change.

Global communities are advocating protected areas, corridors and transboundary landscapes as a promising adaptive strategy to address emerging climate change challenges as they are the bastions of natural resources. The corridors also provide options for altitudinal and latitudinal migration for climate sensitive wildlife and vegetations. In addition, a well managed landscape also provides valuable environmental services for human well-being and enhances the resilience of ecosystems that are under various environmental stresses induced by climate change. ICIMOD has been advocating regional cooperation for developing transboundary landscapes with connectivity between the protected areas as adaptation strategies to climate change. So far, seven critical transboundary landscapes have been identified in terms of their conservation value and vulnerability to climate change. In addition, as a long term strategy, ICIMOD has embarked on introducing a "Transect Approach" for better understanding climate change science and its implications on mountain biodiversity. Interested readers can have more detailed information on this from the International Mountain Biodiversity Conference *(http:www.icimod.org/imbc)* held in Kathmandu in November 2008.

Q: 2010 is an International Year of Biological Diversity, when CBD-COP 10 and 2010 Biodiversity Targets will get heightened global attention. Considering that TBM programme has implemented CBD in the K-complex, what kind of message do you like to take to CBD-COP10 in Nagoya Japan in 2010 and what kind of outcomes would you like to see come out of this high-profile meeting?

Nakul: The CBD Secretariat and many global conservation organisations are engaged in reviewing the progress made so far on meeting the 2010 targets. To do so, CBD has devised indicators and has come up with a new format for 4th Report to be filled in by the Parties to get better understanding of the progress made. However, the Parties to CBD are facing numerous challenges in achieving the 2010 targets, mainly due to complexities in using the set indicators. Some of the indicators are inadequate and need further discussion. A majority of the Parties didn't comply with these indicators when reporting to the Secretariat of CBD and many of the developing countries have limitations in terms of human and financial resources to apply them. Even the simplest indicator of protected area coverage set by CBD COP VII (10 percent of terrestrial area under protected area network) has been contentious because the existing system of protected areas has not always been effectively managed, nor does it adequately represent all ecosystems, habitats and species important for conservation. Though the 'protected area coverage' and 'important land area protected' have been used as indicators which are essential and straightforward, they are not adequate to tell us whether we are 'achieving' the conservation objectives. This is true, as measuring the number and extent of protected areas provides only a one-dimensional indicator of political commitment to biodiversity conservation. It doesn't provide information on a key determinant for meeting global biodiversity targets: 'effectiveness' in conserving biodiversity. Though the COP 7 meeting in 2004 tried to address some of these challenges by devising time-bound targets for the Programme of Work on Protected Areas, we have yet to see its results in the forthcoming reports.

I am curious about the review work and its results, specially the effectiveness of the existing protected areas network that covers 12.5 percent of global terrestrial area in global conservation targets. In addition, I expect a rigorous discussion on the present indicators, their applicability and utility for future course of action.

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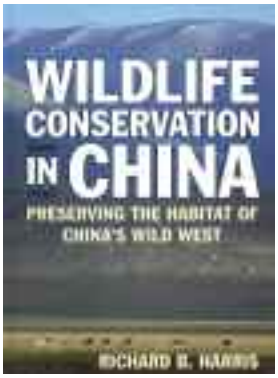
Wildlife Conservation in China: Preserving the Habitat of China's Wild West



Richard B Harris

M.E. Sharpe Inc. New York, USA. 2008.

Book review by Daniel J Miller

A number of biodiversity "hotspots" and globally important ecoregions are found in western China. With their highly distinctive species, ecological processes and evolutionary phenomena, these regions are some of the most important areas on earth for conserving biodiversity. For example, the Tibetan Plateau is one of the most ecologically diverse landscapes on earth. It also includes the most intact example of mountain rangelands in Asia with a relatively intact vertebrate fauna and is one of the largest remaining terrestrial wilderness regions left in the world. The area is home to numerous rare and endangered wildlife species such as the wild yak, Tibetan wild ass, or kiang, the migratory Tibetan antelope, or chiru, Tibetan argali and snow leopard.

Conserving these animals and their habitat is an important priority for the global conservation community. Tackling the biodiversity challenges on the Tibetan Plateau requires greatly increased scientific research and improved understanding of ecosystem processes. Critical examination of existing environmental conservation and economic development policies and programs is also required.

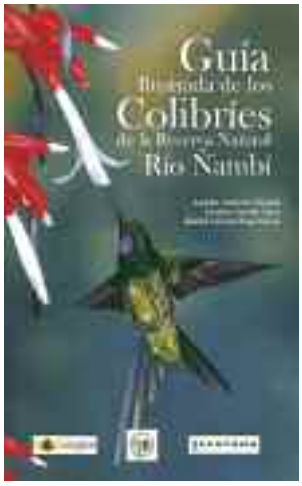
Richard Harris, in this ground-breaking book, provides a multidimensional analysis of biodiversity conservation issues in western China and presents well-grounded arguments for changing the current state of wildlife conservation and natural resource management practices. Harris, who has been working in China for over 20 years, has pulled together an amazing amount of information from both Western and Chinese sources. This data is complemented by his own insights on wildlife, rangelands, and conservation policies and programs in western China and the challenges the country faces in conserving wildlife and the habitats crucial for their survival.

Much of the information in the book is based on the author's fieldwork in various parts of the Tibetan Plateau and, therefore, anyone interested in Tibetan wildlife would find this book informative. This book is written by someone who has been there and understands Chinese culture as well. It is not just a report on wildlife in China. Rather it is a detailed analysis of the problems, an informed critique of current conservation strategies and efforts and provides a roadmap for the future.

The book should be read by anyone interested in China's environment and wildlife and especially those interested in biodiversity conservation on the Tibetan Plateau. The book would also be of interest to those concerned about broader rural development issues in western China. Even those who consider themselves an old 'China Hand' or 'Tibet Hand' would be wise to listen to what Richard Harris has to say.

"Illustrated Guide of the Humming birds of the Ñambi River Nature Reserve"

Aquiles Gutiérrez Zamora, Esteban Carrillo Chica & Sandra Rojas Nossa



Among the habitats of Colombian avifauna, recognised as the most diverse in the world with close to 1,830 species, the region of the Pacific Slope stands out: specifically the Coastal Foothills, an area which is characterised by its high degree of endemism. The Ñambi River Nature Reserve is situated in this region and South America. Amongst this vast scene of megadiversity, families such as those of the hummingbirds are especially relevant. On the reserve resides one of the most diverse and complex communities of hummingbirds on the planet, composed of 29 species, one-third of which are endemic and two thirds are globally threatened.

The guide presents the ecomorphological description of each one of the species, in the format of an information card where data is presented such as the common name in Spanish and English and the taxonomic identity. Information on the specimens is presented using five general parameters: identification, ethology, status and habitat, annual cycle and distribution. In addition, photographic records and full-color illustrations of the 29 species are included in the attempt to reach out not only to the scientific community, but to the public in general.

This field guide was created as part of the Ñambi River project: "Conservation and Alternatives of Development in the Pacific Rainforest in the South of Colombia", which was carried out by the FELCA Foundation and the ECOTONO Corporation with the support of the Environmental Action Fund.

References

Mazariegos, L (2001) *Hummingbirds of Colombia. Imprelibros.* Cali – Colombia.

Salaman, P (2001) *The Study of and Understorey of avifauna Community in an Andean Premontane Pluvial Forest*. Thesis submitted for the degree Doctor of Philosophy. Wolfson College, University of Oxford.

Global Mountain Biodiversity Assessment: The Mountain Biodiversity Research Network of DIVERSITAS

Eva Spehn

The Global Mountain Biodiversity Assessment (GMBA) is DIVERSITAS' oldest international cross-cutting research network, founded in Glion, Switzerland in 1999. GMBA aims to provide the scientific basis for conservation and sustainable use of mountain biodiversity by encouraging and synthesising the often hidden and fragmented results of research on high-elevation organismic diversity, its regional and global patterns and its causes and functions. A central paradigm is that functional insight and theory will only emerge from large-scale comparisons.

GMBA intends to increase the visibility of mountain biodiversity issues:

- through engaging scientists in developing research agendas on important mountain biodiversity themes, forming a research network to tackle focused scientific questions;
- promoting standardised methodologies;
- developing a global mountain biodiversity data portal;
- undertaking analysis, synthesis and integration of activities on particular mountain biodiversity themes;
- investigating policy implications of biodiversity science by engaging in dialogues with national and international policy instruments, such as the Convention on Biological Diversity.

The GMBA office coordinates a global network of researchers, holds a database on more than 800 mountain diversity experts and publishes news and research agendas in journals. The website *(www.gmba.unibas.ch)* is an important tool for informing and linking mountain biodiversity researchers and manages a list of news and events, which is updated regularly. An international Scientific Steering Committee (SSC) oversees GMBA activities and provides guidance to the programme as a whole for evaluation and endorsement of research projects in order to facilitate inter-/national funding. The GMBA office has been funded by the Swiss National Science Foundation since 2004 with a renewed grant until the end of 2010.

GMBA project on geo-referenced biodiversity data

In cooperation with the Global Biodiversity Information Facility (GBIF), GMBA encourages a global effort to mine biodiversity databases on mountain organisms, to build new biodiversity databases and to link them with geophysical databases, with the following activities;

- GMBA held two workshops on 'Geo-Referenced Biological Databases - a tool for understanding mountain biodiversity' in 2006 (Kazbegi, Georgia) and 2007 (Copenhagen), to show the value of openly accessible, interconnected electronic databases for scientific biodiversity research;
- A 'Research Agenda on Mountain Biodiversity Data Mining' shows exciting new research fields and questions that can only be answered using large biodiversity databases with geo-referenced data (Körner et al. 2007);
- A GMBA volume on 'Data mining for global trends in Mountain Biodiversity' (eds Spehn E M and Körner C) will be available with CRC press in September 2009;

Snow cock at kalapatthar and pumeru mountain. Photo: Suresh Maharjan.

- GMBA is developing a thematic data portal on mountain biodiversity with GBIF to facilitate searches for species occurrences in mountain regions, with the aim to quantify the regional/global patterns of mountain species distribution and biodiversity;
- In order to increase the amount and quality of geo-referenced data on mountain biodiversity provided online, GMBA encourages mountain biodiversity researchers to share their data within GBIF. We offer a DarwinCore schema specifically adapted for mountain datasets (mail to: gmba@unibas.ch).

Other projects in brief:

- GMBA aims to document the significance of biodiversity and land use for the hydrological catchment value (BioCATCH, Alpine Biodiversity and Catchment value in a land-use context) in the Pyrenees, European Alps, the Caucasus and the Himalayas, with individual field experiments using a common protocol;
- GMBA coordinated the authors of the mountain chapter of the Millennium Ecosystem Assessment and contributed to the chapter with a synthesis of global mountain biodiversity (Körner and Ohsawa 2005);
- GMBA is one of the key organisations in developing and implementing the Programme of Work on Mountains (UNEP/CBD/COP7/4) of the Convention on Biological Diversity (CBD) by synthesizing knowledge about the biological richness of the mountains of the world and changes caused by human influence.

References

Körner, C; Ohsawa, M (2005) *Mountain Systems. In Ecosystems and human well-being. Current state and trends: Findings of the condition and trends working group*. Ecosystems and Human Well-Being, Vol 1, pp 681-716. Island Press, Washington DC, USA

Körner, C; Donoghue, M; Fabbro, T; Häuser, C; Nogués-Bravo, D; Arroyo, M T K; Soberon, J; Speers, L; Spehn, E M; Sun, H; Tribsch, A; Tykarski, P; Zbinden, N (2007) *Creative use of mountain biodiversity databases: The Kazbegi research agenda of GMBA-DIVERSITAS. Mountain Research and Development* 27(3), 276-281.

Spehn, E M; Libermann, M; Körner, C (eds) (2006) *Land use change and mountain biodiversity*. CRC Press/Taylor and Francis, Boca Raton, USA

Spehn, E M; Körner, C (eds) in preparation *Data mining for global trends in mountain biodiversity*. CRC Press/Taylor and Francis, Boca Raton, USA

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Global Change in Mountain Regions: The Mountain Research Initiative

Claudia Drexler

View from Jungfraujoch shows an important part of the cryosphere of the European Alps. Photo: R. Ottersberg.

The Mountain Research Initiative (MRI) promotes and coordinates research on global change in mountain regions around the world. In its seven years of existence it has actively participated in the design of the international research agenda, as noted by the UN Secretary General in his address on Sustainable Development in Mountain Regions in August 2007. MRI's target is interdisciplinary and transdisciplinary research, but, on matters relating to biodiversity in mountain regions, MRI defers to its sister organisation, GMBA.

First milestones

The MRI began in 2001 as a joint project by the International Geosphere-Biosphere Programme (IGBP) and the International Human Dimensions Programme (IHDP).

"Global Change in Mountain Regions – An Overview of Current Knowledge" (Huber et al 2005) was MRI's first major product. This 700 page compendium provides an overview of what is known and what directions research should take in five research areas – paleoenvironmental changes, cryospheric changes, hydrological changes, ecological changes, and human dimensions.

Supported by the EU Framework Programme 6, the MRI and the University of Vienna coordinated the GLOCHAMORE (Global Change in Mountain Regions) project from 2003 to 2005. The GLOCHAMORE Research Strategy (Björnsen 2005) is an integrated and implementable research strategy to better understand the causes and consequences of global change. The Strategy is a consensus document developed through consultation with the international community of scientists and Biosphere Reserve managers at 5 workshops and one final conference.

Actions on a regional level: how to fill the scientific gaps?

In 2006 the MRI moved from strategy development to implementation through the initiation and support of regional networks of global change researchers. As MRI works through promotion and coordination, it induces research groups and individual scientists to fill the scientific gaps defined by the GLOCHAMORE strategy.

Thus, four program activities are at MRI's core:

1 MRI strives to enlist key scientists who, in their turn, promote inter- and transdisciplinary research through their funding agencies.

2 MRI supports the formation of new research partnerships and catalyses groups and individuals to develop project proposals to funding agencies.

3 MRI facilitates the development of peer-reviewed papers on key scientific issues. These contributions to the literature focus the community's attention on some of the most important issues in mountain regions.

4 MRI distributes relevant information to researchers on global change in mountains. By increasing the flow of information to these researchers, MRI seeks to create additional interaction and a more solid sense of community.

Scientific networks and their outputs

A large part of MRI's activities occurs through four regional networks: MRI Africa, MRI American Cordillera, MRI Europe, and MRI Carpathians, with plans to expand into Asia by 2010. Within these regional networks MRI attempts to catalyse research on global change. It does so principally through the development of new funding proposals, but also through the engagement of regional leaders and the development of regional-specific communication products such as websites, newsflashes, and database subsets.

The MRI in 2009 and 2010

During 2009-10, MRI intends to initiate:

Open funding proposals:

- Proposal for an International Scientific Seminar: Towards Sustainable Fine Resolution Hydro-Ecological Observatories in Southern African Mountains.
- Mountain Trip: Mountain Sustainability: Transforming Research into Practice (co-operation with 5 partners from Austria, Poland, France, Germany, and UK).

Peer-reviewed papers:

- Mountain Waters: Translation of Climate Change Scenarios into Water Resource Management Approaches (partner: Hydrology Group, University of Bern, Switzerland)
- Food Security: Climate Change Impacts on Food Security Issues, Their Causes and Potential Adaptation Measures in Mountain Regions in Developing Nations (partner: Centre for Development and Environment, University of Bern).

Workshops and conferences:

- MRI Workshop on Global Change in Mountain Regions, 18 April 2009, Vienna, Austria.
- Securing the Sustainable Provision of Ecosystem Services in the Alps and the Carpathians. Proposal Development Workshop, 9 June 2009, Bratislava, Slovakia (in collaboration with 6 European partners).
- Conference on Glacier Hazards, Permafrost Hazards and GLOFs in Mountain Areas (in collaboration with 3 European partners).
- Conference entitled "Perth 2010 - 5 years after Perth I" as a follow-up to the 2005 Open Science Conference "Global Change in Mountain Regions" (partner: Centre for Mountain Studies, Perth College).
- A "Forum Carpathicum" in September 2010, the first international and interdisciplinary meeting on global change topics in the Carpathians.

The history of MRI is a move from abstract ideas towards concrete activities. Whereas the compilation of the GLOCHAMORE Research Strategy was an intellectual challenge - defining and evaluating compelling global change research topics - the challenges now are much more human and entrepreneurial. How can we build active and growing communities, and how can we make sure that their members turn out the products that we need?

Small-scale agricultural structures in the hills of Rwanda. Photo: Bob Nakileza.

References:

Björnsen Gurung, A., ed. 2005. Global Change and Mountain Regions Research Strategy, Zürich

Huber, U., Bugmann, H., and Reasoner, M., eds. 2005. Global Change and Mountain Regions. An overview of current knowledge. Advances in Global Change Research, Springer

Weblinks:

http://mri.scnatweb.ch
http://mri.scnatweb.ch/networks/mri-africa/
http://mri.scnatweb.ch/networks/mri-american-cordillera/
http://mri.scnatweb.ch/networks/mri-europe/
http://mri.scnatweb.ch/networks/mri-carpathians/
http://mri.scnatweb.ch/projects/glochamore/

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Participants at the opening of IMBC. Photo: ICIMOD.

ICIMOD's International Conference and Workshops on Mountain Biodiversity

Bandana Shakya

The International Conference on Biodiversity Conservation and Management for Enhanced Ecosystem Services: Responding to the Challenges of Global Change was held from 16-18 November 2008 at the ICIMOD Headquarters in Khumalatar, Lalitpur. The Conference was accompanied by two pre-conference workshops on Mountain Transboundary Protected Areas (10-14 November 2008), Linking Geodata with Biodiversity Information (15-16 November 2008), and a post-conference workshop on a Research Strategy on Global Change in Mountain Biosphere Reserves (19 November 2008).

Professor Bruno Messerli giving key note speech at the inaugural session. Photo: ICIMOD.

ICIMOD brought together 12 global institutions and 75 experts and representatives from 20 countries involved in mountain biodiversity conservation and management to develop future alliances to jointly meet the emerging challenges of climate change in the mountains. Climate change, especially in the mountains, is expected to adversely affect mountain biodiversity and the lives and livelihoods of communities, not just living in the mountains but living downstream and beyond. The participants included representatives of global programmes, international and regional professionals, and representatives from government officials of the eight ICIMOD regional member countries. The conference allowed an open exchange of ideas and fruitful discussion on various thematic elements such as climate change and its implication for mountain biodiversity, biodiversity management for economic goods and ecosystem services, and institutionalising long term continuity in mountain research programmes.

The conference produced many concrete results including on the transect approach, the initiation of many bilateral agreements, and the production of a framework on transboundary protected areas. The transect approach on long term monitoring and research for representative HKH systems presented by ICIMOD was well received by the participants; the global programme also showed their enthusiasm and eagerness to support this initiative. Similarly, a framework for large scale ICIMODprotected areas and connectivity management was discussed; ICIMOD partners from China, Myanmar, and Pakistan

Imja Glacier in the 1950s. Photo: Erwin Schneider, Khumbu, Nepal, 1956 – 1961. Courtesy of the Association for Comparative Alpine Research, Munich (Archives of Alton Byers, The Mountain Institute)

Imja Glacier in the 2007. Photo: Alton Byers, Khumbu, Nepal, 2007, The Mountain Institute.

have already tried to customise the framework for strategic planning in two transboundary areas, namely: the Brahmaputra-Salween transboundary complex (Myanmar-China-India) and the Karakorum transboundary complex (Pakistan-China). ICIMOD and UNEP have agreed to initiate collaborative research and conservation actions in the Kailash Sacred Landscape. There was a unified opinion on creating GIS enabled biodiversity portals and information networks in the HKH. Discussions with GLOCHAMORE highlighted the commonalities in their and ICIMOD's strategies, and both agreed to further explore and pursue areas of common interest. UNESCO-MAB also indicated the likelihood of future partnerships with ICIMOD.

At time when the whole HKH region has been tagged as a 'white spot' in terms of long term climatic data representation and analysis, the conference was able to unify the voices from the region and around the world for their commitment in supporting the common cause of biodiversity conservation and management for enhanced ecosystem services by responding to the challenges of global change. The important message was that we need to join hands and direct our efforts to manage mountain biodiversity in the region together for the wellbeing of the people. Details of the conference can be found at *www.icimod.org/imbc* and the conference report at *www.icimod.org/?page=340*.

ICIMOD Photograph Exhibition: Himalaya – Changing Landscapes

Nonna Lamponen

The Himalaya – Changing Landscapes photograph exhibition resumed its European tour this spring. Our fourth exhibition was held in Bonn, Germany 1-12 June 2009 at the Robert-Schuman-Platz. Thereafter the exhibition will move to Switzerland later in the summer.

New photos have been added to the concept of Himalaya - Changing Landscapes. The repeat mountain panoramas and photos of the 1950s glacial research teams are accompanied by additional repeat photographs of landscapes from the middle hills of Nepal. New people photographs have also been added, as well as pictures of cultural and socioeconomic changes in the Himalayan region within the last few decades.

The exhibition aims to raise awareness of the impact of climate change, and the new challenges the mountain people are facing.

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Biodiversity and Climate Change Research Programme of the Snow and Mountain Research Centre of Andorra (CENMA)

Marta Doménech

Andorra is located in the heart of the Pyrenees, where the rocks are the oldest in the mountain chain. Although it is a small country, it has plenty of biodiversity. The flattest areas of the valley floors have traditionally been the areas where human occupation has been concentrated. It is where the majority of the population centres are, but it is also where we mainly find agriculture and in the wettest places, meadows. As a consequence of this, the river bank vegetation in Andorra has greatly diminished, especially fragments of river forests *(Fraxinus excelsior, Salix sp, etc)*. The low parts of the southern, sunny sides are the warmest slopes of the country and are the northern limit in the distribution area for some Mediterranean species. The vegetation that occupies the slopes between 1,800 and 2,200 metres are mainly mountain pine forests *(Pinus uncinata)*, a habitat which occupies 20 percent of the country. Over 2,200 metres there are clear alpine affinities. It is the domain of high mountain pastures, although we can find some scrub as a consequence of the reduction in stockbreeding. These pastures occupy approximately 25 percent of Andorra.

The Snow and Mountain Research Centre of Andorra (CENMA) is a centre that studies and researches different but connected mountain subjects (geology, nivology, biodiversity, climatology, etc.). We have a variety of studies and proposals in relation to climate change, global change and biodiversity. Below we explain some of the studies related to climate change and biodiversity.

One of the most important projects taken on at CENMA over the last two years has been the creation of an automatic weather station (AWS) network over Andorra, mainly at high elevations (1,600 - 2,700 metres). Variables such as temperature, precipitation, humidity, solar radiation, snow depth, snow and soil temperature, pressure, wind speed and direction are registered following the World Meteorological Organization recommendations as the "10 minutes resolution". Improving awareness about the Andorran climate and meteorology and the creation of a high quality climatological database for biotic studies are the main objectives that are considered by CENMA.

Climate variability through climatological series analysis is also studied at CENMA. Three long continuous series since the 1930´s are being homogenised and added to international databases (participation at the COST ES0601 European action and the WMO-MEDARE community, Esteban et al., 2008). Homogenised temperature and precipitation trends will be derived from these studies, one of the main steps for evaluating climate change in a certain region or country. Future work plans are related to the use of downscaling applications for deriving future climate scenarios over the Andorran area on the basis of GCM models.

Studies that are currently being conducted at CENMA related to biodiversity and global change are as follows:

Monitoring of butterflies in Andorra (Butterfly Monitoring Scheme)

This project is based on the methodology developed by Pollard and Yates (1993) and permits a precise recognition of changes in butterfly abundance by following itineraries to observe butterflies in their environment and later relate these observations to various environmental variables. The role of the butterfly as a biodiversity indicator is well-known for climate change in particular (Stefanescu et al., 2003; Parmesan et al., 1999). Butterfly abundance data is gathered over 30 weeks in seven locations in Andorra. Each location represents a microhabitat. By the end of the year, an abundance index per species is obtained which allows the population variations between years and over the year to be compared. This index is also used to determine environment preferences and possible variations due to the management carried out in the area of study. In general, the information obtained is very varied: fauna composition, phenological information, environmental preferences, population fluctuations, migrations, influence of the management of an area, introductions, colonisations and extinctions.

Aglais urticae. A threatened specie by global warming. This specie is one of the 156 that lives in Andorra. Photo: Montse Mases.

Study of changes in soil use in Andorra in 1948, 1972 and the present day

The evolution of Andorran soil cover over the last 50 years is being studied through aerial geo-referenced photos. Over recent years Andorra has experienced a dramatic change in soil use, passing from being a society nourished basically from the primary sector (stockbreeding and agriculture) to one almost exclusively dependent on the tertiary sector (tourism and commerce). These changes have a marked influence on the territory which needs to be evaluated.

Monitoring and studying of snowbeds in Andorra

In this study, snowbeds are regarded as a plant unit model for investigation on the consequences of climate change on high mountain vegetation. Snowbed species (called *chinophiles*) have narrow ecological niches and are highly vulnerable to environmental changes.

The development of snowbeds over the last 50 years is evaluated and a physical typology of these is produced. Tracking and monitoring stations for snowbeds are also set up through measuring meteorological data and monitoring vegetation. The main aim of these tracking stations is to study the relationship between the phenology of chinophila vegetation, the climate and other environmental variables. The monitoring of these variables will allow changes in the

composition and diversity of vegetation to be detected on an inter-annual basis and over the years. The processing of all the data in the long term will permit the adaptation of vegetation in these habitats to be assessed in the context of climatic change.

Study and monitoring of the production and diversity of fungus in experimental plots

An evaluation is made on the influence of climatic variables on the production or diversity of fungus carpophores in the forest habitats of Andorra close to an altitude of 2,000 metres.

References

Pollard, E; Yates, T J (1993) *Monitoring butterflies for ecology and conservation.* Chapman and Hall, London.

Esteban, P; Mases, M; Trapero, P (2008) *The Snow and Mountain Research Centre of Andorra (CENMA): Overview of the Andorran Meteorological Records.* Proceedings of the International Workshop on Rescue and Digitization of Climate Records in the Mediterranean Basis, MEDARE. WCDMP N°67, WMO-TD N°1432.

Parmesan, (1999) *Poleward shifts in geographical ranges of butterfly species associated with regional warming.* Nature. 399:579-583.

Stefanescu, C; Peñuelas, J; Filella, I (2003) *Effects of climatic change on the phenology of butterflies in the northwest Mediterranean basin.* Global Change Biology. 9:1494-1506.

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Climate Change and Biodiversity in the European Union Overseas Entities

Guilluame Prudent

Stretching from the Arctic to the South Pacific through the Atlantic, Amazonia, Antarctica and Indian Ocean, the 28 European Overseas Territories present both a remarkable and vulnerable biodiversity. Typically tropical islands, they are generally small in size with limited resources; they are often isolated and exposed to tropical cyclones and sea level rise.

These insular ecosystems are particularly rich, with significant endemism rates, but they are also extremely fragile and often highly deteriorated. Therefore, their resilience to new aggressions is limited. Furthermore, island economies strongly rely on the quality of their natural environment. Notably through tourism, fishing and subsistence farming, a degradation of their environment could deeply affect local communities. Mountain areas do not represent a significant proportion of these territories but some of them shelter unique and threatened biodiversity: sub-Alpine forests in French Polynesia (the only ones in the South Pacific region), high altitude rainforests and mountain forest on Reunion Island, laurel forests in Macaronesia, etc.

The range of environments, from polar to tropical, encompasses a wide range of exposure to climate change. Indeed, this project was the first attempt to capture the diversity of the seven Outermost Regions (OR) and 21 Overseas Countries and Territories (OCT) belonging to six European Union Member States.

The OR include: Guadeloupe and Martinique (France) in the Caribbean, French Guiana in South America and Reunion Island (France) in the Indian Ocean; the Azores, Madeira (Portugal) and the Canary Islands (Spain) in Macaronesia.

The OCT include: the Netherlands Antilles, Aruba (Netherlands), the Cayman Islands, the British Virgin Islands, Turks and Caicos, Bermuda, Anguilla and Montserrat (United Kingdom) in the Caribbean; Mayotte (France) and the Chagos Archipelago (United Kingdom) in the Indian Ocean; French Polynesia, New Caledonia, Wallis and Futuna (France) and Pitcairn (United Kingdom) in the south Pacific; Saint-Helena and dependencies (United Kingdom) in the south Atlantic; Greenland (Denmark), Saint-Pierre-and-Miquelon (France); the Falkland Islands (United Kingdom), the French Southern and Antarctic Territories (TAFF – France), South Georgia and the South Sandwich Islands (United Kingdom), and the British Antarctic Territory in the Polar Regions.

In 2007-2008, the International Union for the Conservation of Nature (IUCN) and the Observatoire National sur les Effets du Réchauffement Climatique (ONERC) prepared a report on the impacts of climate change in the European Overseas Entities. The territories were grouped into main regions: Caribbean, Macaronesia, Amazonia, South Atlantic, Indian Ocean, South Pacific and Polar Regions. The main characteristics and biodiversity of each OR and OCT were presented, as well as the key climate trends identified for these territories, the expected impacts and some ideas toward an adaptation process. An Editorial Board of 22 members was set up to help

Heard Coquille IPF. Photo: Guilluame Prudent.

the project team and authors to design and adjust the content and frame of the report, and more than 80 stakeholders and scientists reviewed the final work.

The resulting report was used as a background document for an international conference held at Reunion Island in July 2008. This conference was an official event of the French presidency of the European Union, aiming to raise awareness about climate change impacts in the European Overseas Territories and to develop a network to build a coordinate adaptive capacity for these territories.

The report "Climate Change and Biodiversity in the European Union Overseas Entities" is available online: *www.iucn.org /about/union/secretariat/offices/europe/resources/?1209/*

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Caribou of the Canadian Rockies: Understanding Environmental Change in the Context of Conservation and Evolution

Byron Weckworth

Global temperatures were increasing, massive sheets of ice at the higher latitudes were rapidly melting and receding, exposing tracts of bare soil that had lain covered for millennia. Ocean levels were rising, flooding and enveloping coastal terrestrial habitats. The Ice Age was coming to a close, and, during this period of dramatic climatic amelioration from a cold Earth to a warm one, the world's biodiversity was being shuffled about. Flora and fauna everywhere experienced the carnal influences of selection – either adapt to the changing climate, or perish.

In North America the last glacial maximum is known as the Wisconsinan. At its peak, two huge ice sheets, the Laurentide and Cordilleran, covered much of modern day Canada and the northern region of the contiguous United States. These massive glaciers effectively isolated the Beringian sub-continent and high arctic to the north from regions south of the ice. Wildlife populations that had been adjoining prior to glaciation became disjunct and isolated from one another, an evolutionary mechanism often leading to increased biodiversity. An icon of the northern latitudes, the caribou *(Rangifer tarandus)*, provides the perfect example. To the north, caribou adapted to the barren-ground tundra habitats and are now recognised as the subspecies *R. t. groenlandicus*. These barren-ground caribou persist in large herds and have the behavioural propensity for long-distance seasonal migrations. South of the glacial ice, caribou adapted to a much different habitat type in the forests, and are recognised as the sub-species *R. t. caribou*. These woodland caribou tend to be more spatially distributed, have smaller herds, and are sedentary, in contrast to their barren-ground brethren. As the glaciers fully receded, this intra-species diversity provided an adaptive advantage that allowed caribou to expand and prevail across most of Canada, while still retaining the barren-ground and woodland distinctions. However, today, across a landscape

Mountain caribou bull. Photo: Mark Bradley.

that is now heavily impacted by humans, the woodland subspecies is formally classified as threatened. As conservation efforts mount, a better understanding of caribou diversity is necessary in order to enact effective management strategies.

Evaluating and understanding caribou diversity

In the Canadian Rockies, caribou diversity becomes further complex. In the province of Alberta, a region dominated by natural resource extraction activities, woodland caribou are split into mountain and boreal ecotypes, based loosely upon their distribution and behaviours. The imprecision of the ecotype designations and their threatened status produced an environment ripe with urgency for scientific research to help clarify and guide policy and management directives. To that end, in early 2007 an interdisciplinary and multi-institution collective initiated the Canadian Rockies Woodland Caribou Project (CRWCP) to broadly determine causes for decline in woodland caribou of Alberta and British Columbia, with emphasis on declining populations in the Canadian Rockies. After only the first two years of the project, the CRWCP's first scientific publication (McDevitt et al. 2009) uncovered some amazing and unexpected results, the foremost of which is revealing a "hybrid swarm" of caribou in the Canadian Rockies of Alberta and British Columbia.

Caribou biologists had previously noted that some caribou in the Canadian Rockies had distinct summer and winter ranges. The spatial isolation of these ranges suggested some behavioural form of seasonal migration, a trait akin to barren-ground caribou, not the woodland subspecies. Through

telemetry and Geographic Information Systems methods, the CRWCP has been able to clarify and further describe these migratory behaviours. In the caribou analysed, some herds were either entirely migratory or entirely sedentary, while other herds are mixed, with different individuals exhibiting either behaviour. This brings us back to the "hybrid swarm", a unique group of individuals that result when two distinctive groups interbreed. As the Laurentide and Cordilleran ice sheets retreated around 14,000 years ago, the gap between them created a corridor, linking the previously isolated regions north and south of the glaciers. Geologic data indicate that this ice-free corridor was along the eastern slopes of the Canadian Rockies. Genetic information (McDevitt et al. 2009) suggests that the two caribou subspecies expanded into this newly available habitat and interbred extensively. The "swarm" of caribou created a group of hybrids that have DNA signatures showing mixed ancestry of both historic caribou subspecies. This mixed gene pool has resulted in a group of mountain caribou with characteristics unique from their historic parents. Individual analysis showed that mountain caribou with a barren-ground ancestry were more likely to be migratory. This correlation of genetic evolutionary history with contemporary spatial behavioural dynamics is rare. It is conceivable that the unique mixture of woodland and barren-ground ancestry has provided the genetic diversity, and hence flexibility, that has enabled caribou to persist in the variable and challenging landscape of the mountain ecosystem. The preservation of this genetic diversity is as imperative to caribou survival as is ensuring adequate numbers. This mixture contributes not only to the overall diversity of caribou, but also to the biodiversity of the Canadian Rockies.

But why are caribou populations in decline?

Widespread opinion blames increased wolf predation and loss of habitat for caribou declines. The increase in predation may be linked to human impacts on the landscape and changes to predator-prey dynamics. Industry activities related to natural resource extraction, such as timber and oil/gas, lead to an increase in artificial features such as roads, pipelines, seismic lines, clear cuts and oil/gas well pads. The presence of these features may lead to increased efficiency of wolf predation, resulting in increased predation on caribou. These changes to the landscape may also affect general primary prey productivity. If the human footprint on the landscape creates habitat types that favour moose, moose numbers may increase. Moose are a primary prey species of wolves: as moose numbers increase, so do wolf numbers. More wolves in the ecosystem might lead to an increase in incidental wolf-caribou predation events. Other primary prey species (e.g. elk and deer), the effect of habitat loss, changing industry practices and climate change further complicates this already multifaceted system.

Beginning to understand the evolutionary history of these caribou is an essential first step. Further research is necessary to detail landscape level patterns of genetic diversity and the influence of contemporary habitat change. Yet, clearly, in order to fully understand the plight of caribou and how best to change policy in order to save them, we must unravel the problems as they relate to the entire ecosystem and our role in it; this is where the Canadian Rockies Woodland Caribou Project (CRWCP) now extends its effort.

An unknown future

The planet is once again undergoing dramatic habitat and climatic alteration, with humans appearing as the catalyst for change. As the world's flora and fauna struggle to adapt, it remains to be seen how much will be lost. The situation for woodland caribou is dire. Science alone cannot resolve this calamity. Continued support among industry, government, and the public is necessary to ensure any possibility of success. Conservation efforts cannot flourish at the whim of economic booms, only to be forgotten when the economy fails. A consistent and resolute priority must be placed on understanding and resolving our environmental crisis. Alleviating our predicament requires more than action alone; success will not be measured by saving species or averting global warming, but rather by changing a global philosophy.

Reference

McDevitt, A D; Mariani, S; Hebblewhite, M; DeCesare, N J; Morgantini, L; Seip, D; Weckworth, B V; Musiani, M (2009) *Survival in the Rockies of an endangered hybrid swarm from diverged caribou (Rangifer tarandus) lineages*. Molecular Ecology, Vol 18(4). pp. 665-679.

Dimsdale Lake, British Columbia, in the heart of mountain caribou habitat. Photo: Byron Weckworth.

Migratory mountain caribou in summer range. Photo: Mark Bradley.

The Canadian Rockies Woodland Caribou Project (CRWCP) is led by Mark Hebblewhite of the University of Montana and Marco Musiani of the University of Calgary. Core funding is provided by the Petroleum Technology Alliance of Canada in association with the Canadian Association of Petroleum Producers.

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Thoughts on the Food Crisis in the Andes

Judith Kuan Cubillas

In August 2008, CONDESAN, as a co-sponsor with the Secretary General of the Andean Community's office, the Andean Initiative of Alliance for the Mountains, FAO, and Swiss Agency for Development and Cooperation (COSUDE), held an online conference: "The Food Crisis: Challenges and Opportunities in the Andes".

This article presents some relevant notes and thoughts regarding the conclusions and recommendations from the conference. In this conference the concept of "food crisis" meant not only the 'increase in food prices' but also 'food safety and nutrition'.

Main conclusions

There is a consensus regarding the factors that influence the food crisis and the increase in the price of food at a global level. The factors can be classified according to their nature: temporal and stuctural. Due to their recurrence and influence on the terms of trade, some temporal factors can ultimately be grouped together with repercussions of a structural nature.

Temporal factors

The increase in energy prices.

- The increase in the price of fuels has made the production, transport and commercialisation of food products more expensive. Although at some point in time the prices of fuels will go down, the costs of production and commerce will not decrease, neither in proportion to nor with the speed with which the prices of energy will drop, affecting most small-scale agricultural and livestock producers.

Reduction in the supply of food (production, reserves, and exports)

- The decrease in the production of food, when referring to temporal factors, is a result of the natural disasters that take place. Subsequently, the use of reserves and the prohibition of exportation by countries with surpluses have intensified the lack of availability of food, followed by the consequent pressure from a rise in prices.

Speculative and financial pressure and subsidies

- Speculative factors and non-transparent factors have also impacted the rise in the price of foods: speculative pressure regarding basic products, as a result of the global financial crisis; the increase in liquidity in certain parts of the world; and the interest shown by investment fund managers in the future market possibilities for 'commodities'.
- Additionally, the recurring continuity displayed by industrialised countries to maintain high levels of subsidy and protection for agricultural and livestock production continues to distort the transparency of market prices, forcing pressure for the increase in prices of basic products.

Structural factors

The most important factors of a structural nature that affect the global food crisis can be looked at from the standpoint of demand and supply.

Demand driven:

- The high rate of growth of the world's population within the last five decades and its projections for growth give a glimpse that, in general terms, 50 percent more food will need to be produced in order to satisfy the needs for food.
- There is a greater demand in quality and variety of foods derived from the increase in demand from middle class sectors of the population, given the economic development of emerging countries and the greater degree of migration to urban areas.

Supply driven:

- The development model for agriculture and livestock that has been applied has given a higher priority to production for export over that of support to rural economies for the production of items for the national food supply. Additionally there has been a drastic reduction of participation by the State in planning rural development and providing of services, leaving it to market forces.

Pampamarca community, Ayacucho, Peru. Photo: Sergio Leon.

- In the long run, natural disasters will form the frontrunner of structural factors. Weather-related catastrophes are every day more harsh and frequent, given the serious climate change that the planet is experiencing derived to a great degree from the pressure resulting from the population's consumption patterns.

Recommendations

1 Measures to face the increase in food prices

- The FAO recommends that measures be adopted immediately which aim to i) mitigate the impact of the elevated prices of food and fuel among the weaker sectors of the population by security networks and direct transactions; and ii) implement policies and programmes destined to promote rural and agricultural development on a short term and long term basis.
- While keeping in mind the medium and long term situation, UN economists recommend the development and launching of strategic interventions and public investments in the agricultural sector, in addition to a refocusing of the process of industrialisation and an improvement in the balance between economic and social policies.
- With reference to the short-term measures that are being taken by the Andean countries, it is recommended to be especially careful with the reduction of taxes on food imports; that social programmes that are carried out do not turn into "populist" measures, and finally, to avoid the use of food donated from abroad so as not to compete with national production.

2 Measures to be taken to take advantage of the opportunities created by the global food crisis and meet challenges it produces

- For small-scale farmers and producers to be able to take advantage of the opportunities resulting from the increase in the demand for food products, a substantial change in the focus of agricultural policies is recommended. These policies should involve the political will and tacit compromise of governments for the development of rural economies and strengthening of links to the market, especially local markets.
- Policies should be developed to address rural territorial development. These should result in structural changes that contribute to the following: to benefit a greater equality in the distribution of income; legal transparency regarding the ownership of land by communities, small-scale farmers and producers; the management and sustainable use of natural resources and rich biodiversity that these countries have at their disposal.
- Measures and active participation by the State and the private sector are recommended to achieve the reinforcement of the value of traditional knowledge; the development of infrastructure transportation, services local and regional communication; support for the organisation of small-scale farmers and producers for them to be able to access the market and services of loan extensions and financing.
- There should be common interest in the adoption of commercial protectionism and unequal measures by

countries. It is recommended, in general, that policies for the development of biofuels made from food products or that imply the displacement of food production should be avoided.

3 Measures to take advantage of the potential of Andean crops

- Innovation is vital in the exploitation of the commercial potential of Andean crops. It is recommended that innovative ideas should be exploited to access niches in the market that value biodiversity.
- Likewise, conference participants recommended the creation of measures and mechanisms to allow the local population to have access to Andean products at reasonable prices, which would in turn help to reduce the indices of chronic malnutrition.
- It is recommended that a programme of education be developed to provide information on the appropriate use of food products, including adequate combinations and quantities of food, nutritious recipes and the use of medicinal plants.
- There needs to be the creation of mechanisms for the protection of property rights and patents for natural resources that originate from Andean ways of life, forms of use and customs as well as for the protection of intellectual property, especially in the area of plants that have nutritious and medicinal value.
- It is recommended that governments from Andean countries prioritise the development of strategies on various levels to counteract climate change, to guarantee the preservation of the biodiversity of food and food sovereignty in the towns of the sub-region, and to urge the countries to contribute towards reversing the process of climate change.

Edited by Grace Sarria, CONDESAN. This article was submitted by Info Andina. Judithkuan Cubillas *judithkuan@gmail.com* is a consultant with CONDESAN.

Invertebrate Monitoring at GLORIA Target Regions: The First Results From the Urals and Need for Global Networking

Yuri Mikhailov

Vascular plants remain the key objects in the research of alpine biodiversity and prime indicators for biological monitoring of climate change in alpine habitats. However, other organisms have clear potential as biosensors as well. For example, insect herbivores appear to be more sensitive to climate change than their host plants (Hodkinson and Bird 1998). In general, animal species diversity may exceed plants by factors of five to ten (Körner 2001). Therefore zoologists are able to provide an important contribution in our understanding of alpine biodiversity patterns in general. Unfortunately only very few of us participate in European or global networking activities as actively as botanists do.

GLORIA (Global Observation Research Initiative in Alpine Environments) is a long-term international observation network studying climate change impacts on mountain biodiversity (*www.gloria.ac.at)*. The basic attempt of GLORIA is the 'Multi-Summit approach'. Providing the data on the different altitudes on species richness, composition and distribution patterns along vertical and horizontal gradients are among the main aims of this approach (Pauli et al. 2004). This makes it possible to assess the potential risks for biodiversity losses due to climate change.

Although the 'Multi-Summit approach' focuses on vascular plant diversity in exact target regions, other organism groups are integrated on an optional basis as additional indicators. Taking into account the high indicator value of invertebrates, the decision was made to add them to the monitoring of the summits of the Urals as the target regions (RU-SUR and RU-PUR) during a re-recording campaign in 2008. As there has been no specific research protocol for invertebrate monitoring, the original one for this purpose was developed by myself *(www.gloria.ac.at)*.

As most typical alpine insects are wingless and crawl or run on the surface of the soil like spiders and millipedes, pitfall trapping (Barber's traps) is the best way for intercepting invertebrates. The standard plastic cups (75 mm) proved to be the best kind of containers for sinking into ground. Three percent water solution of acetic acid was used and strongly recommended as a fixative for the traps left for less than a week as the most ecologically safe and easily available means to trap the insects.

For GLORIA research, a so called "cross-pattern" of two lines with 10 traps each (20 traps per pattern) was first proposed and approved (Figure 1). For this purpose the main line (10 traps) of each "cross-pattern" follows one of the principal measurement lines: North, South, West, East (Figure 2) and another 10 traps form a perpendicular line to the first one. The "cross patterns" are established between the principal corner points p5m and p10m (see Multi-Summit sampling design in Pauli et al. 2004). If the summit area is very small, it is possible to establish traps between HSP and p5m, but in both cases their situation is fixed in connection with the corner of respective quadrant cluster. The "ideal case" for the "ideal summit" is shown on Figure 1. However, the complexity of the summit landscape and large number of stones always causes a different actual pattern.

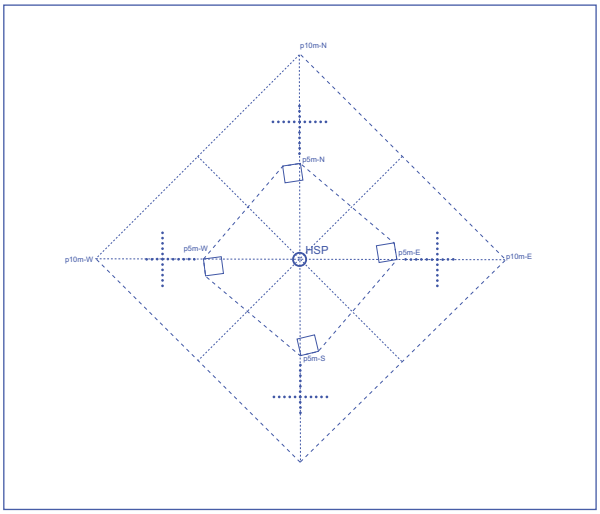


Figure 1: Cross pattern trap - ideal case for "ideal summit".

After a fixed period (from two or three days to one week) the traps are removed and the invertebrates from each trap are recorded separately in a field manual. If any insects are still alive, it is better to release them to minimise the negative effect on local fauna. The exact determination of collected insects is made in the laboratory by comparing them with reference collections.

As a result the species lists are made for each summit area section. Each species in the list is provided with the following information:

1 Number of collected specimens;

2 Abundance (in the form of dynamic density, i.e. number of collected specimens per unit of trappability (10 trap/days);

3 Role of a species in a biotope (Renkonen's dominance – rarity). Species with percentage five percent and more are dominant, from two percent to 4.9 percent - subdominant and less than two percent - rare;

4 Distribution area (longitudinal aspect): Holarctic, Palaearctic, Eurasian, Euro-Siberian, West- or East-Palaearctic, Siberian, subendemic or endemic to the Urals);

5 Distribution area (latitudinal aspect or zonobiome/altibiome preference): alpine, arctic-alpine, boreo-montane (including hypoarctic-montane), boreal (including arcto-boreal), polyzonal, etc.).

The above information is a subject for further comparisons between summit area sections inside one summit and between summits in space and time. The analysis is still in progress but the first results from the South Urals are important enough to present here.

Before, we expected (Mikhailov and Olschwang 2003) that climate change may cause the decrease of true alpine, arctic-alpine and similar species and increase of those of widespread (polyzonal) ones. This may be not only an indicator of the "well-being" of the local fauna on each summit but also show the nature of expected shifts. In this case the lower summits show what may happen on the higher ones under conditions of further climate change.

For dominant and subdominant species, the latitudinal aspect of their distribution (zonobiome/altibiome preference) was studied (Figure 3).

From this point of view, the highest summit – Bolshoy (Big) Iremel' (1,565 m.a.s.l.) – demonstrates classic composition of invertebrates: alpine + arctic-alpine + boreo-montane elements. Only these groups occur on the western and southern sectors. From these sectors, both alpine and arctic-alpine species constitute from 25 percent to 40 percent while boreo-montane species are less important (20-33 percent). Polyzonal species occupy only 13 percent both on the eastern and northern sectors and boreal species (13 percent) only on the northern sector. At the moment this summit is in perfect condition.

On the lower summit – Malyi (Small) Iremel' (1,437 m.a.s.l.) – composition is similar, but both alpine and arctic-alpine species constitute a lesser proportion (18-22 percent). At the same time, boreo-montane species play a larger role (20-44 percent). Boreal species here appear at all sectors and their proportion rises up to 30 percent. Polyzonal ones still constitute a lesser part (10-18 percent), everywhere except the eastern sector.

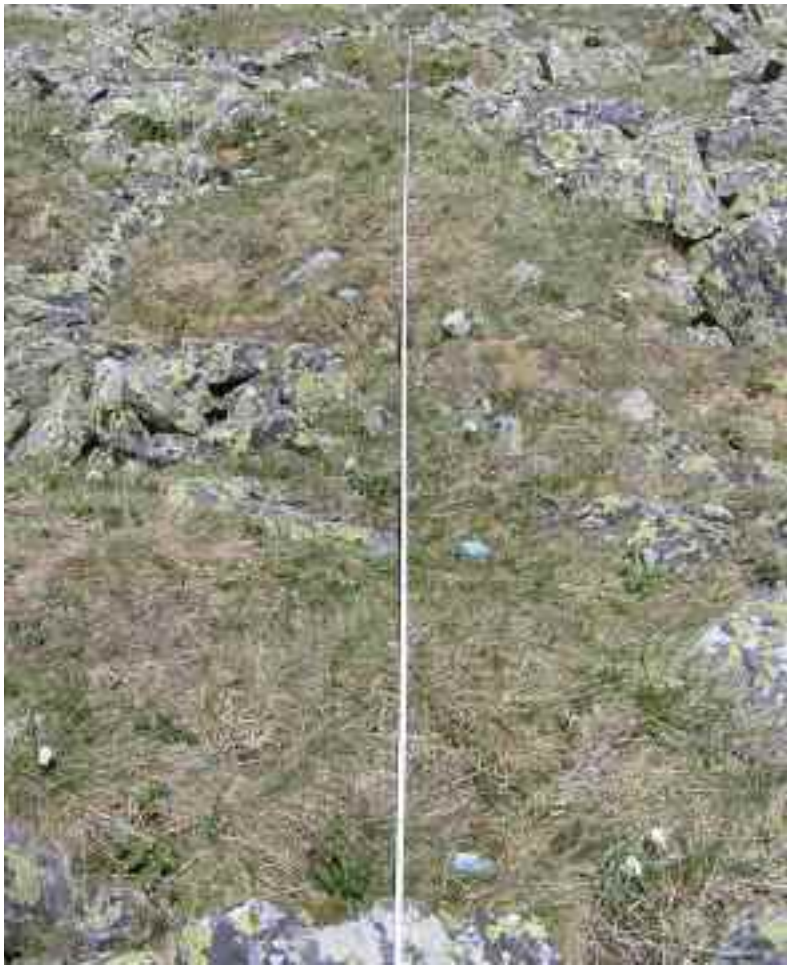
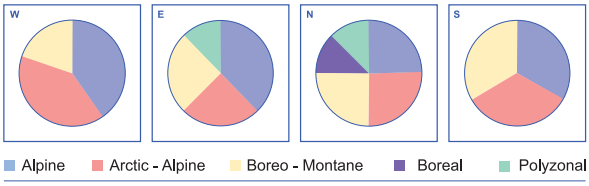


Figure 2: View of actual pattern of pitfal traps on the summit Bolshoy (Big) Iremel' (SUR-BIR). Photo: Yuri Mikhailov .

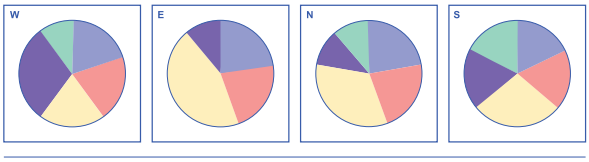
The lowest summit – Dal'niy Taganay (1,109 m.a.s.l.) – demonstrates quite a dramatic picture. Polyzonal species occupy from 27 percent to 38 percent of this area. Typical alpine groups (alpine + arctic-alpine + boreo-montane) occupy more than half only on the western sector; both northern and southern sectors share only 47 percent of these species. The eastern sector no longer posesses real alpine fauna. With boreal and polyzonal species (46 percent and 38 percent respectively) dominating, it has only eight percent of both arctic-alpine and boreo-montane species and no alpine species at all! This conclusion is supported by phytosociology. The eastern sector of Mount Dal'niy Taganay is covered not by true grass-moss mountain tundra as other sectors and other summits but by tundra-like vegetation of snow protected heath.

Still, these are only the first results and only from the south Urals. But the Urals as a whole, especially this part, have suffered more from climate change, as during the last 70 years the alpine zone in the south Urals has reduced by 10 - 30 percent (Moiseev and Shiyatov 2003). The data from Polar Urals is being analysed, while future investigations are planned for other parts (Pre-Polar, Northern, Middle Urals). Other target regions of GLORIA badly need their invertebrate researchers. Colleagues willing to join the zoo-team are welcome to contact GLORIA co-ordination or the author.

Mt. Big Iremel', 1565 m a.s.l. (RU-SUR-BIR)



Mt. Mal. Iremel', 1437 m a.s.l. (RU-SUR-MIR)



Mt. Dal'ny Taganai, 1109 m a.s.l. (RU-SUR-TAG)

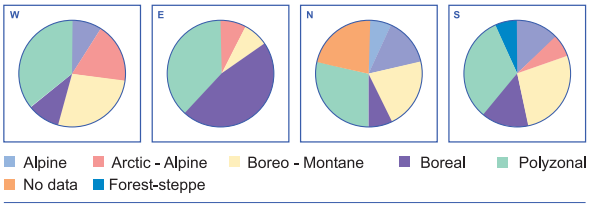


Figure 3: The percentae of species with diferent types of distribuation lalittudnal aspect or zonobime/attilsiome preference at the summit of the target region, South Urals.

References

Hodkinson I D; Bird J (1998) *Host-specific Insect Herbivores as Sensors of Climate Change in Arctic and Alpine Environments.* Arctic and Alpine Research. Vol. 30. pp 78-83.

Körner C (2001) *Alpine ecosystems. In: Encyclopedia of biodiversity.* Vol. 1. Academic Press. pp 133-144.

Mikhailov Yu E; Olschwang V N (2003) *High Altitude Invertebrate Diversity in the Ural Mountains.* In: Nagy L et al. (eds) Alpine Biodiversity in Europe. Ecological Studies, Vol. 167. Berlin - Heidelberg: Springer-Verlag. pp 259-279

Moiseev P A; Shiyatov S G (2003) *Vegetation Dynamics at the Treeline Ecotone in the Ural Highlands, Russia.* In: Nagy L et al. (eds.). Alpine Biodiversity in Europe. Ecological Studies, Vol. 167. Berlin - Heidelberg: Springer-Verlag. pp 423-435.

Pauli H; Gottfried M; Hohenwallner D; Reiter K; Casale R; Grabherr G (eds) (2004) *The GLORIA Field Manual - Multi-Summit Approach.* European Commission, Directorate-General for Research. *www.gloria.ac.at*

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For further information about GLORIA, contact Dr. Harald Pauli *harald.pauli@univie.ac.at* or go to GLORIA (Global Observation Research Initiative in Alpine Environments) *www.gloria. ac.at*).

Walking through My Land: A little Sparrow

Walter Bishop V.

With a diversity and quantity that makes them almost annoying, the sparrow, member of the *Passeriformes* order and of the *Emberezidae* family, is mentioned in an incredible amount of poems, songs and in plain literature of all languages.

In Mexico there is a famous song about this little bird: “Gorrioncillo Pecho Amarillo” (Yellow Breasted Sparrow) composed by Tomas Mendez and sung by all the Mexican country singers. In English there is an Australian song written by Bruce Woodly for the Seekers, appropriately called “The Sparrow Song”.

“Fly little sparrow
High above the clouds,
Looking for a place to
Lay your weary body down.

Fly on little sparrow
Northward to the sun,
Wonder if you'll ever
Find yourself a home.”

These are the first and second verses of this melancholic melody, that I bring to your attention because they exemplify the plight of one of Mexico’s sparrow species catalogued as ‘Endangered’, and about to disappear forever (2008 IUCN Red List Category, as evaluated by BirdLife International, the official Red List Authority for birds for IUCN).

The Sierra Madre sparrow, *Xenospiza baileyi*, Gorrion Serrano in Spanish, is the only species of the genus *Xenospiza* and is endemic to Mexico. Because of the loss of its habitat, it can only be found today in two locations in the country: one in the State of Mexico; and the other in the State of Durango. This is

Sierra Madre Sparrow. Photo: W. Bishop V.

a small bird of just five centimetres or less. Most of its feathers are in dark brown tones with creamy-white sort of eyebrows and a white-gray-black streaked breast with a very distinctive black central spot.

The mountain valleys of the Sierra Madre Occidental, populated with bunchgrass *Muhlenbergia macroura, M. Affinis*, were where the Sierra Madre sparrow lived and made its nests. Due to the loss of this particular grass caused by agriculture, i.e. the conversion of valleys to farm land by mountain inhabitants and the burning of bunchgrass in the dry season, the sparrows are in bad trouble.

The little bird was discovered or described in 1889 in the "Bolaños Mountains of the State of Jalisco" and was thought to be a hybrid of the Song sparrow. It was not till 1931 that Bailey confirmed the species after finding more than a dozen of the Sierra Madre sparrow in the mountains of Durango. Later on, and for a short time, it was thought that there might be some difference between these northern and southern populations, but it was determined that although there is no genetic connection between them, they are not distant relations, but are exactly the same.

Anyway, and what I was trying to get to, is that lately, a rainy and windy Saturday afternoon in the month of March, I was invited by some good friends from El Salto (a mountain town on the Km 100 of the Durango Mazatlan highway) to visit the area in question, to look for the elusive bird. This was something that we had been doing for the past year without success, as we needed for several reasons to confirm its existence or disappearance.

We were to meet in El Salto at the gas station in front of an old locomotive that stands as a monument to the past, when it was used to bring logs from the forest before there were any trucks and roads in this old lumber mountain town. We were also waiting for three Americans interested in the sparrow, together with a cattleman from the region who was our guide. We made a group of seven people in two vehicles, "cruising" the countryside to see what we could find.

Beforehand we had asked for permission to go into the communal property, but we had not driven a very long way before we had to ask permission again. This time officially to the Mexican army, because, as it turns out, the soldiers from a nearby fort have a training field with firing ranges that includes bombs and mortar fire exactly in the territory of our friend the Sierra Madre sparrow.

What bad luck! Not only is the habitat of the sparrow shrinking by the day, but the only place they have left to live in has become a heavy shell firing range.

This is a problem. A little one if we consider the birds' size or a big one if we think of the implications that this might have: the disappearance of a species from our earth. Some sort of arrangement has to be made. There has to be a "cease fire" - it sounds ridiculous - but a solution has to be found that is fair to both parties. On one side, we have our respected armed forces (Mexican) with a big investment in infrastructure, and on the other side, we have a not very interesting endemic of Mexico, a little bird, with God's given privilege to existence and a right to a piece of the land on this earth. We certainly hope that something can be done.

Because of the indignation and consternation that this unreal story causes me, I almost forget to conclude the search that we were on and where we started. And yes, after looking all the past year for our friend the little sparrow, at last, on this cold and rainy afternoon, we saw at least three of the Sierra Madre sparrows perching on the long blades of the bunchgrass where it lives, acting as if nothing was happening, defying both its fate and its destiny.

In search of the sparrow. Photo: W. Bishop V.

Sources: Sierra Madre Sparrow - BirdLife Species Factsheet

Walter Bishop V *panteradgo@yahoo.com* is a member of the North America Mountain Forum.

Metsovion Interdisciplinary Research Centre (MIRC) Database

Angeliki Geronteli, on behalf of the N.T.U.A. Metsovion Interdisciplinary Research Centre (M.I.R.C)

The Metsovion Interdisciplinary Research Centre (M.I.R.C.) of the National Technical University of Athens (N.T.U.A.) was founded in 1993. Its principal aim is to contribute to the protection and development of mountainous environments and local European cultures The activities of N.T.U.A. M.I.R.C include interdisciplinary research for the Protection and Development of Mountainous Environment and Local European Cultures, teaching and provision of continuing education, as well as conducting seminars and conferences relevant to the broader object of M.I.R.C., working in close cooperation with other universities, prefectures, local governments, local social groups, cultural, research and other organisations.

The research group of N.T.U.A. M.I.R.C. has initiated the creation of a database on the mountainous areas of Greece, including the protection and development of local cultures, interactions and interdependencies with the mountainous environment as a contribution to the region's Worth-Living Integrated Development. This initiative is of particular importance for Greece, since it is one of the two most mountainous countries in Europe (along with Austria) and faces the same problems as all the other mountainous areas.

The first area selected for the launch of the database is the region of Epirus. This is a border region of Greece with geopolitical importance, since it communicates, has relations and interacts with the neighbouring regions of the Balkans and the country's centre. At the same time Epirus is the most mountainous region in Greece. It is made up of 67 mountainous municipalities with 444 mountainous municipal or communal departments. It is also one of the most sparsely populated and poorest regions in the European Union (EU-15), although very rich in terms of nature and culture.

This database is a research initiative, drawing on bibliographic and internet sources, which tries to identify the natural and socioeconomic reality, cultural elements, traditions, craftsmanship, local environment and biodiversity in every mountain community of Greece. At the same time, this database is a way to investigate the interactions and interdependencies and their changes through time, between natural and human resources, as well as focusing on the problems and needs that occur within these multi-dimensional relationships.

The database includes 25 regularly updated data-fields for each mountainous community/municipality, such as: altitude, permanent population, historic monuments and museums, traditions and festivals, local products, traditional architecture, mountains, water resources, flora and fauna, biodiversity and protected areas, interactions between environment and local cultures, problems and needs etc.

It is known that Greece is regarded as a biodiversity hotspot in Europe, as well as a hotspot for endemism in Europe and the Mediterranean region, due to its topography with great mountain chains along the central part of the country and other mountain ranges. However, according to the Greek Ministry of Environment, the present rate of Greek biodiversity loss is relatively low compared to other European countries.

Epirus and Pindos Mountain, in particular, are well known for their high species and ecosystem diversity, for genetic variability and endemism as well as for medicinal plants and herbs that are noted for their antimicrobial and pharmaceutical properties. There is an obvious need for the protection of Epirus' biodiversity as a whole, with respect to human beings and their natural and cultural environment. With this in mind, an action plan has been implemented which includes the set up of three national parks that make up the most extended environmental protection area in Greece, covering the largest part of the mainland, from the borders with Albania, to Pindos Mountain, Tzoumerka-North Pindos and Grammos Mountain and the regions of Kastoria and Ioannina; a distance of approximately 150 kilometres.

Certain barriers have to be overcome in order to implement this plan properly and effectively. These include contending with bureaucratic and administrative issues that cause great delays, proper coordination of the competent authorities and avoidance of political expedience.

Essential prerequisites for the Worth-Living Integrated Development of the regions and the protection of their biodiversity are:

- Thorough investigation on the geographic distribution of species and the possible changes and losses in biodiversity due to climate change, land use and other man-made activities;
- Systematic collection, mapping, monitoring, analysis and interpretation of the necessary reliable, diachronic and up-to-date data on the area's natural and socioeconomic reality. In addition to statistical data, these Integrated Surveys of mountain areas require the use of photointerpretation, remote sensing methods and techniques in Geographic Information Systems (G.I.S.) for the systematic mapping and monitoring of biodiversity;
- Supply of the necessary financing and overall planning with scaling of needs and priorities;
- Provision of experienced and interdisciplinary trained scientific staff and volunteers;
- State-of-the-art specialised technology, infrastructure and know-how;
- Collaboration with local authorities and relevant national and international bodies;
- Distribution of knowledge and environmental awareness to local populations, students and educators;
- Adoption of a holistic and integrated view regarding the "development" of each area, taking into account its natural, socioeconomic and cultural advantages, potentials and limitations.

The database will be uploaded at the N.T.U.A. M.I.R.C. website *www.ntua.gr/MIRC/* in Greek.

For further infrormation, contact N.T.U.A. M.I.R.C. *(naturesl@central.ntua.gr or rslab@survey.ntua.gr)* or visit the website at *www.ntua.gr/MIRC/*

Technological Innovation Servicing Biodiversity

Lourdes Chuquipiondo (RAMP PERU)

Samuel, Antolin, Corina, Maria…. are only some of the names of ordinary people, of people like us. However, all of them have a common characteristic that unites them: they are creators of technology.

An innovator demonstrates an ecological stove. Photo: Fogon Multiusos Sr. Cuchillo Cusco.

At RAMP PERU we place our bets on them and it is for this reason that we have developed a model that contributes to the development and progress of the capabilities of the many inventors and innovators that we find in the country. Our intervention even goes beyond granting technical assistance for the development or financing of technological products. At RAMP PERU we work alongside the innovators so that they develop their own companies based on the technological products proposed.

Given the fact that our intervention, as a project, is carried out in areas located in the mountain regions of Peru (Cusco, Puno, and Cajamarca), we cannot stray from the importance of contributing to the conservation of biodiversity in these regions. It is because of this, that RAMP PERU has come to the conclusion that the technologies that support this project must be characterised by the following five themes: water, agriculture, energy, health and biodiversity, thus reinforcing the objectives of the millennium which consider these subject areas to be priorities for humanity.

Through RAMP PERU we are supporting those innovators that are conscious of the importance of biodiversity on the impact of people's lives, especially of the poorest. Until now, we have contributed to the development of eighteen technological prototypes, five of which consist of improved ecological stoves, one consists of a water heater run by a solar heating system and another consists of an ecological biodegradable flowerpot. Our creators, through proposals such as those already mentioned, present innovative solutions of a technological nature which also promote the appropriate and rational use of the components of the planet's biodiversity. If we observe the case of the ecological plant pot as an example, which is made based on the use of biodegradable materials instead of polyethylene bags (solid, non-degradable residues), or if we take into consideration the creation of the water heater or thermal heater which makes optimal use of the strong Andean sun to generate hot water for domestic use, we can clearly see the contribution RAMP PERU makes to the planet in terms of conservation of the environment.

The model that we propose with this project attempts to develop two programmes, open to the public, which provide professional and economic support to the innovators so that they are able to develop their inventions. These programmes are developed in four phases: incubation, launching, growth period and exit phase.

During the first phase of the programme, we submit the presented proposals to a process of defining their breadth and their capabilities in order to create a technological prototype and a business plan. In the launching phase, we provide consultancy, general support and financial support to take the technological product to the market by means of a business strategy. In the third phase we continue to provide advice and support for the growth and diversification of the business strategies of the proposals that are still continuing to develop in the market. Finally, in the exit phase, we work alongside the innovator to be able to ensure the future sustainability of the business strategy.

Among the main results that we hope to achieve with RAMP PERU in the protection of biodiversity, we highlight the promoting of the development of technologies that facilitate responsible and sustainable use of elements that comprise biodiversity. We seek to generate alliances with institutions that support our innovators' business initiatives through adequate financial mechanisms. These efforts are already bearing fruits: RAMP PERU has signed an agreement with the company MICROSOL S.A.C. to develop a complementary business to exchange carbon offsets associated with the innovations that involve improved stoves that contribute to the reduction of these emissions.

An ecological stove in use. Photo: Martin Cuchillo.

In addition, to date we have supported twenty innovators during the incubation phase of the First Strengthening Programme, having invested close to USD108,000 toward the development of their business plans and prototypes. We have also accomplished the establishment of important alliances with several of the country's universities, regional and local governments, organisations from the private sector and the State, interested in promoting the innovation of technologies that have social and environmental impact.

The job continues and by the middle of this year we will launch an innovation announcement for the Second Strengthening Programme, through which we hope to keep identifying, recognising and supporting our country's creators and inventors.

This article was submitted by Info Andina. Lourdes Chuquipiondo *lchuquipiondo@nesst.org* is a Communications Specialist at RAMP PERU.

RAMP PERU, established in the year 2007, is managed by an association of three institutions: NESsT (Nonprofit Enterprise and Self-sustainability Team), CONDESAN (Consortium for the Sustainable Development of the Andean Ecoregion) and the PUCP – GROUP (The Pontifical Catholic University of Peru's Group for the Support of the Rural Sector).

If you wish to obtain further information on this project, please contact Ricardo Ordoñez (National Coordinator) *rordoñez@nesst.org*, María Paz Montoya (Regional Coordinator) *m.montoya@cgiar .org*, or visit www.*ramp-peru.org.pe*

Birds from the Albertine Rift

Michel Louette - Royal Museum for Central Africa, Belgium (RMCA)

Humblotia dia. Photo: M. Louette.

RMCA provide "digested" historical collections data that has been presented to GBIF (Global Biodiversity Information Facility). Up to 43,443 geo-referenced occurrence records from Albertian Rift Birds can be seen *(http://data.gbif.org/datasets/resource/93)* using the recommended standards protocols (DiGIR and BioCase) and data schemas (DarwinCore and ABCD).

More collaboration in this field is also planned with Professor Charles Kahindo, University Bukavu, DR Congo, via the TDWG activities. See *www.tdwg.org/fileadmin/2008conference/slides/Poster_TDWG2008_PatriciaMergen.pdf*

Publications on this subject:

Bober, S O; Herremans, M; Louette, M; Kerbis Peterhans, J C; Bates, J M (2001) *Geographical and altitudinal distribution of birds endemic to the Albertine Rift.*

Proceedings 10th Pan African Ornithological Congress, Kampala, Uganda. Ostrich (Supplement 15): 189-196.

Louette, M (2006) *Albertine Rift zoodiversity: exploitation of the historical data in the Royal Museum for Central Africa, Tervuren.* pp 103-106 In: Segers, H., P. Desmet & R. Baus. Tropical Biodiversity: Science, Data, Conservation.

Proceedings of the 3rd GBIF Science Symposium, Brussels, 18-19 April 2005, Brussels, Belgium.

Michel Louette and Danny Meirte are collaborating in a project investigating potential climate change impacts on endemic birds in the Albertine Rift, in relation to the Important Bird Area Network in the region. They are also collaborating with David Hole, Institute of Ecosystem Science, Durham University, UK and with BirdLife/WCS MacArthur.

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Agrobiodiversity in the Alps: Establishment of a Long-Term Monitoring System

Elli Broxham

The Alpine Region provides a unique environment for agrobiodiversity. Over the centuries, animals and plants have been developed by farmers to suit the very different landscapes of the Alps. Animals were bred for hardiness, fertility and sure-footedness. Plants were selected that could cope with the harsh conditions of the Alps: high altitude, intense sun and short vegetation periods. However, this did not lead to a homogenous "Alpine" agrobiodiversity, as each valley and region has its own breeds and varieties.

Robust animals and crops are still essential in the Alpine Region. Although Alpine farmers are, naturally, also interested in high yields and large profit margins, there is also value in good average yields and for regional products. A consistent yield and a quality regional product can allow the farmer to sell in the growing "gourmet" market. Finding a place in a niche sector of the market can be far more profitable than selling standardised, over-produced products. Many Alpine farmers, due to the harsh conditions of mountain farming, can never undercut the prices of the massive, intensive, lowland farms.

The Alpine region is traditionally farmed using transhumant agricultural systems. These are important both ecologically and economically. The importance of semi-natural habitats such as the Alps cannot be overemphasised. Vast areas of Europe are now either intensively farmed or are part of the urban sprawl and the infrastructure needed to support it. Creating and managing protected areas is expensive. However, encouraging the upkeep of traditional agro-eco-systems in the Alpine region creates a large area of semi-natural habitat, which can be utilised by birds and other wildlife as well as providing space for wild plants to propagate.

In order to promote sustainable development of agriculture in the Alpine region and provide economic security for marginal areas, traditional agricultural methods rather than industrial methods need to be encouraged. This includes the conservation and promotion of traditional plants and animals in Alpine agriculture. Promoting these traditional systems also helps the conservation of Alpine wildlife, as they complement the ecosystem rather than placing additional strain upon it. Traditional farming systems help to prevent soil erosion and loss of soil fertility through the use of methods adapted over centuries, especially for the region they are used in. All these factors contribute to the production of the traditional Alpine landscapes which are attractive to tourists.

Due to the fragility of traditional plants and animals in the Alpine region, traditional agricultural systems use less imported fodder and fertiliser, thus placing less of a burden on other areas. The traditional agrarian system of the Alps has a small "ecological footprint" and its unique climate and altitude provide genetic resources adapted to harsh conditions, which may be essential for future food security in areas outside of the Alpine region.

Today it is still true in the alpine region that robust characteristics in animals and plants are of primary importance. In order to be armed against dry or wet, cold or

hot years, great diversity, especially among cultivated plant varieties, is significant even today. In the mountains, it is not superior performance, but reliable average yield, that matters. Extensive cultivation of locally adapted breeds and varieties is moreover important in the conservation and sustainable use of the alpine agricultural landscapes.

Monitoring agrobiodiversity

Long-term monitoring of agrobiodiversity trends is a very important part of conservation. Where no data already exists, the procedure of monitoring can be summarised as follows:

- Inventory of former diversity (regional or national):
  - Evaluation of old agricultural literature;
  - Search for old veterinary dissertations and other special reports;
  - Interviews with specialists, old farmers, chroniclers etc. (use photographs and/or illustrations found in old literature).
- Specific search:
  - In former locations (according to research);
  - Indications from interviews;
  - In places where other relicts have been found.
- Random search:
  - With ethnic minorities within countries who may have different agricultural systems and traditions;
  - In remote, inaccessible regions;
  - In borderline locations (altitude, topography, exposed positions etc).

A process such as this provides a baseline for all future monitoring. Procedures should then be put in place to make a regular census of the population. The demographic structure should also be obtained: number of herds, distribution of herd size etc., also geographical locations, rate of inbreeding and fitness.

However, domesticated animals and plants are inseparably bound to humans for their survival. This means that any long-term monitoring of agrobiodiversity also has to take into account the human structures surrounding it. This means that a "social indicator system" has to be established which can also be monitored.

Apple diversity from Switzerland and Liechtenstein-SKEK exhibition at the OLMA, an annual agricultural show in St. Gallen, Swizerland, 2007.
Photo: Waltfaud Kuglar, SAVE Moitoring.

The Alpine Delphi

Experts from the various sectors of Alpine Genetic Resources were invited to take part in a piece of research based on the Delphi method. The research was based on three questionnaires which the participating experts were able to fill in. Each expert filled out a first questionnaire especially tailored to his or her expert knowledge. The second questionnaire was a more general one, based on the results of the first. The third questionnaire presented the participants with a rough draft of this report and asked questions based on the results of the second questionnaire and the conclusions of the report.

In this way a broad picture was built up of the state of Alpine agricultural genetic resources and of the institutions working for its conservation. Trends that will influence the future of Alpine Agrobiodiversity were also identified.

Identified needs

The three rounds led to the identification of two factors that need urgent attention:

a. Cooperation between experts;

b. Research into the whole field of agrobiodiversity: from farmer through to consumer.

Specifically, cooperation between institutions should include an internationally agreed set of guidelines for collecting data so that it is comparable. Within bio-geographical regions there should be closer international and inter-institutional collaboration to ensure that the state of conservation is well documented.

It is clear, from the responses given, that the conservation of Alpine agrobiodiversity must extend from the farmers through to the consumers, with the experts acting as guides.

Without this strategic 'whole-system' approach to conservation, all attempts to conserve Alpine agrobiodiversity in vivo are futile. Lack of coordination between actors can lead to duplication of work and organisations and institutions working with different objectives or even against each other. The lack of cohesion in the conservation efforts can lead to inefficiency, a lack of transparency and a lack of usable data. Cooperation between stakeholders encourages a process of social learning within which they stand to gain further knowledge and understanding through collaboration with their peers. This process thus creates an epistemic community for the conservation of Alpine agrobiodiversity.

The future of the long-term monitoring programme in the Alps

The next phase of this monitoring process has started at the SAVE-Monitoring Institute. The identified needs have led to a three-pronged approach to the issues. Firstly, an Alpine-Stakeholder-Network will be established within the framework of the Agrobiodiversity Net website, as was agreed at the conference "Long-term monitoring and promotion of agrobiodiversity" held in Bozen, May 2008 by the Alpine Convention and the Monitoring Institute. Secondly, the next round of the Delphi project will be launched as soon as funding

is secured. And, last but not least, a feasibility study for collecting and recording traditional farmers' knowledge in the Alpine region has begun.

Knowledge about farming with the use of products from traditional agrobiodiversity can be lost very quickly as older generations die out and younger generations are more interested in modern cultures. There are many attempts made to save the actual genetic material through gene and seed banks or other forms of ex situ conservation. However, there is very little emphasis placed on gathering and storing the knowledge that goes together with each plant variety and each animal breed. Without this knowledge, any conservation efforts are doomed to long-term failure. Domesticated animals and plants are inseparably bound to humans for their survival; likewise, the cultural heritage of rural areas is bound to the plants and animals that are part of the traditional agricultural system.

Reference

Final Report of the Alpine Delphi: *www.save-foundation.net/pdf/ALM_Final_Report.pdf*

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Project Snow Leopard: Participatory Conservation Model for the Indian Himalaya

Pranav Trivedi

The high altitude region of the Indian Himalaya (including the Trans-Himalaya) is home to the snow leopard *Uncia uncia* – the elusive and magnificent big cat that symbolises the desolate, mountain landscapes. This globally threatened predator shares its rugged, climatically challenging and remote home with a unique wildlife assemblage of global importance that includes populations of many other threatened species such as the Black-necked Crane *Grus nigricollis*, two species of bears *Ursus spp.*, Red Panda *Ailurus fulgens*, mountain ungulates such as the Wild Yak *Bos grunniens*, *Chiru or* Tibetan Antelope *Pantholops hodgsoni*, *Gowa* or Tibetan Gazelle *Procapra picticaudata*, Tibetan Argali *Ovis ammon*, Ladakh *Urial Ovis vignei*, Himalayan Musk Deer *Moschus chrysogaster,* three species of the goat-antelope *Goral Nemorhaedus spp.*, *Serow N. sumatraensis* and *Takin Budorcas taxicolor,* to name a few. The traditional agro-pastoral communities and their domestic livestock also share this home of threatened and unique high altitude wildlife. Like every other human society that has been transformed through the twin agents of technology and markets, these once isolated, remote and near-subsistence societies are also in a socio-economic transition from their earlier rather benign existence.

The snow leopard, in the meanwhile has continued attracting attention for its feline beauty and grace on the one hand, while on the other it lives as a ghost haunting these communities as it preys on their livestock. It also draws those involved in the illegal international trade in its body parts, especially bones and skin or fur. Many other species of wildlife are also involved in some kind of conflict or issue, be it depredation on livestock, crop/forage losses, trans-boundary issues between neighbouring countries or poaching.

While a substantial proportion of India's population, including policy makers, are aware of the precarious conservation status of species such as the Tiger *Panthera tigris* and Asian Elephant *Elephas maximus* and of the efforts to conserve them (such as the Project Tiger), few are aware of even the existence of species such as the snow leopard. Besides low awareness, the snow leopard faces threats from inadequate measures for its conservation within the existing high altitude Protected Areas (PAs) in India. Acute lack of resources, manpower, training, absence of boundary demarcation, lack of proper management plans and low conservation attention are some of the problems plaguing the PAs in the region. Given the widespread occurrence of wildlife on common land, continued traditional land use within PAs and difficulties involved in creating and maintaining large, inviolate National Parks in this region, it becomes imperative that wildlife conservation efforts are participatory - both within and outside PAs. Such an approach could be facilitated by the relatively intact and functional traditional administrative bodies such as the village councils in most of the high altitude landscapes. A community-based livestock insurance scheme to compensate the damage caused by wild carnivores to livestock, coupled with setting up of village level grazing-free reserves and better herding initiated by at Nature Conservation Foundation (NCF) and the Snow Leopard Trust (SLT) in Spiti and Ladakh are among the few such models of success in participatory conservation. These point at

Snow leopard cub. Photo: Steve Tracy.

the desirability and feasibility of such models of wildlife conservation in the Indian high altitudes. The Project Snow Leopard initiatives were largely based on more than a decade-long scientific work that involved field research on human-snow leopard conflict, ecology of high altitude ungulate prey species and studies on the agro-pastoral communities in the Spiti Valley and Ladakh in the Indian Trans-Himalaya. Another successful example of the participatory conservation approach has been based on research carried out on snow leopard ecology, followed up by predator-proof corrals and community-run homestays in Ladakh by another NGO – the Snow Leopard Conservancy (SLC).

Building on these science-backed community-based conservation initiatives and taking into account the prevailing complex and challenging prospects, the Government of India launched "Project Snow Leopard" in January 2009 with an aim to safeguard India's unique natural heritage of high altitude wildlife populations and their habitats by promoting conservation through participatory policies and actions. This positive initiative has appeared on the Indian high altitude conservation horizon after five years of work with the central Government and the five Himalayan State Governments by scientists of NCF – an Indian NGO established in 1996 and its US-based counterpart the Snow Leopard Trust (SLT).

A document articulating the need and objectives of the Project Snow Leopard was drafted at a meeting in early 2004, which saw contributions from a small and diverse group consisting of scientists and conservationists, members of the Indian Forest Service and the local communities. The document was developed further through contributions by the Chief Wildlife Wardens of all the five snow leopard range states of India (who have strongly endorsed the effort), after NCF/SLT conducted consultative workshops within each of these states. In 2004-2005, we conducted state level workshops in all five high altitude snow leopard range states of the country (Arunachal Pradesh, Sikkim, Uttaranchal, Himachal Pradesh, and Jammu and Kashmir). Following these, we organised a National Workshop on 10-11 July 2006 in collaboration with the state government of Jammu and Kashmir and the Ministry of Environment and Forests, Government of India during which an outline of the strategy and action plan was developed *(see www.conservation.in/publication.php)*. Among the 13 recommendations of the workshop was the formation of a drafting committee with the responsibility of preparing a full strategy document that will guide Project Snow Leopard in the country. NCF scientists, Yash Veer Bhatnagar and Charudutt Mishra were part of this 13-member committee that drafted the document, which was released by the Honourable Minister of State for Environment and Forests, Government of India on 20th January, 2009 *(www.conservation.in/ publication.php)*.

Project Snow Leopard is unique as it encourages a landscape approach to wildlife conservation in the Himalayan high altitudes and is founded on the twin principles of robust science and strong community involvement in conservation. It is essentially a project that will help in the development of a clear conservation vision for biologically important landscapes and suitable scientific management plans, while also providing financial support for implementation of these plans. During the first year, each of the five states will identify one landscape under the project that may include PAs, but will not be limited to these areas alone. Surveys will be conducted to identify a mosaic of multiple 'cores' where human use will be minimised, harmonised or completely stopped in a consultative process with the community. The implementation structure of the project will include representation from the village cluster level up to a steering committee at the central level. At the central level, a Steering Committee chaired by the Director General of Forests and Special Secretary to the Government of India will help guide the project. Each Range State will have a State Snow Leopard Conservation Society that will coordinate work by the Landscape-Level Implementation Committees, which in turn will coordinate work by the Village Wildlife Conservation Committees. A central steering committee has been notified that has representation of NCF. In fact, NCF and the Wildlife Institute of India (WII) have been identified as the main NGO and government organisation, respectively, to help implement Project Snow Leopard. Project Snow Leopard also provides scope and resources for conservation and research by NGOs, individuals and civil society groups interested in the snow leopard and other high altitude wildlife of the Indian Himalaya.

Snow leopard. Photo: Milan Trykar (SLT).

To conclude, this exciting development represents a major up-scaling of our research and community-based conservation efforts in the higher Himalaya. It also is a sign of positive change and motivation for several other NGOs and civil society institutions involved in wildlife research and conservation in India to evolve and implement participatory conservation models with support of the government. This, in a sense, represents a success at the planning level in conservation – in that it has led to formulation of a people-sensitive, semi-decentralised and science-based wildlife conservation policy at the national level. The snow leopards will have much to rejoice if the project achieves its aims.

References:

Anon (2008) *The Project Snow Leopard*. Ministry of Environment & Forests, Government of India, New Delhi.

PSL (2006) *Towards Project Snow Leopard: report of the national workshop on Project Snow Leopard*. 10th & 11th July, 2006. Leh, Ladakh. Department of Wildlife Protection, Jammu

Honorable Minister of State, Environment and Forests Government of India at National workshop Project Snowleopard. Photo: Yash Veer Bhatnagar.

and Kashmir, Nature Conservation Foundation, and International Snow Leopard Trust, India.

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More details at: *www.conservation.in or www.ncf-india.org and www.wii.gov.in*

The Importance of Mediterranean Alpine Biodiversity in Central Spain

Rosario Gavilán and Alba Gutiérrez Girón

Alpine communities in central Spain are found at the top of the Sistema Central, an east-west running mountain range consisting of different mountain chains. These communities grow in a somewhat reduced space, at altitudes of over 2,000 metres; the summits in this range are always below 2,300 - 2,350 metres, except Almanzor (2,592 metres), Peñalara (2,429 metres) and El Calvitero (2,401 metres) among others. The threats affecting conservation of alpine biodiversity are mainly related to the influence of big cities such as Madrid, the third most populous city in Europe with over three million inhabitants and more than six million in the Greater Madrid Area. The city is only 60 kilometres from the Sierra de Guadarrama, one of the mountain ranges in the Sistema Central. There are other smaller cities such as Ávila and Segovia with populations of approximately 50,000 which are also located very near the Sistema Central mountains. They exert an influence on the landscape similar to Madrid and there are similarities in their use of mountain resources.

Threats to mountain environments come mainly from recreational uses such as the presence of traditional ski resorts or worse still, the new ski resorts being built in some areas of the western Sistema Central. Hiking is probably the least harmful leisure activity in mountain areas, but hiking trails in many cases require some form of refurbishment.

Water supply in Mediterranean countries is always a serious concern for governments. In Madrid water comes from precipitation, as well as from snowmelt from mountain areas and is conserved in reservoirs situated in the surrounding valleys in the Sierra de Guadarrama. The conservation of natural vegetation can guarantee slope stabilization and prevent erosion processes which impact plant communities at lower altitudes and exert a strong negative influence on the capacity of reservoirs downhill.

The outlook for conservation of small alpine areas close to high population concentrations is poor in terms of sustainable development. We are currently developing research into alpine vegetation which includes interspecific associations, spatial patterns and processes, the study of rare flora and the monitoring of alpine vegetation to detect future changes. These surveys may assist decision-makers and people in charge of these areas to improve their conservation policies.

We have studied the role of plant species in forming organised communities by comparing small-scale spatial associations among species. High-mountain vegetation in these areas includes different communities depending on the habitats. We have focused on vegetation that covers the top of mountains in two areas: Sierra de Béjar and Sierra de Guadarrama, where communities are organised in patches or sometimes strips. The particular geomorphology of these ranges and the natural erosion processes have caused the tops of these mountains to be more or less flat, usually exposed to strong winds. In these environments, plant communities have a wide variety of species adapted to extreme conditions. There is an abundance of cushion plants together with other hemicryptophytic taxa and a scarcity of annuals (Gavilán et al. 2002).

Patch composition shows a majority presence of perennial plants, mainly cushion chamaephytes and hemicryptophytes. Among cushion plants, *Armeria caespitosa, Jasione crispa* and *Plantago penyalarensis* are common in patches, restricted to the highest altitudinal level. There is a larger number of hemicryptophytic species than cushions and most of them have a wider altitudinal distribution range; these are grasses such as *Festuca curvifolia, F. iberica, Nardus stricta,* etc., frequently found in patches. Only a few species of Compositae, such as *Leucanthemopsis alpina* or *Pilosella vahlii* show a more restricted altitudinal distribution.

Aspect of alpine plant community in Sistema Central. Blooming cushions of Minuartia recurva enclosing plants of Jurinea humilis, Pilosella vahilii or Festuca curvifolia inside. Photo: Rosario Gavilán and *Alba Gutiérrez Girón.*

High summits of Sierra de Gredos, western Sistema Central. Photo: Rosario Gavilán and *Alba Gutiérrez Girón*

Geographical distribution of species is similar in both territories; however some species have a particular, territorial distribution. This is the case of *Festuca curvifolia* and *Armeria caespitosa,* which are distributed in eastern territories, or Dianthus gredensis in western areas. There are also differences in life forms in both territories. Cushion plants are more prevalent in Sierra de Béjar than in Sierra de Guadarrama, except for *Minuartia recurva*. This fact could be related to the stage of the patches, as those rich in cushion plants are at earlier stages. In other cases the presence of some herbs, such as Agrostis truncatula, could also be related to pioneer patches.

Some of the most frequent species do not show statistically significant associations, as has been demonstrated in similar studies. For instance, *Festuca curvifolia* does not facilitate the growing of other species, probably due to its particular clonal growth (Körner, 2003), which makes it able to colonise new environments by forming monospecific strips of vegetation in some special situations. Similarly, other species, mostly cushions, but also other hemicryptophytes such as *Leucanthemopsis alpina* or *Agrostis truncatula,* can also act as pioneers. These species form monospecific patches in pioneer stages that allow other species to become established, thereby contributing to the development of the plant community.

Differences in the number of species on patches between both territories could be due to the pressure of grazing on these communities; the mountain goat *(Capra pyrenaica)* is less common in the higher altitudes of the Guadarrama range than in Béjar. In Béjar there is a greater pressure of grazing by cattle (sheep and cows), although sheep grazing is increasing in Guadarrama. The presence of *Festuca curvifolia* means this grassland is not very palatable to cows due to the hard leaves of this plant. They prefer *Festuca iberica* or *Nardus stricta* pastures which usually develop in meadows or concave sites where snow remains for longer, except in very dry summers. The flowers of a cushion plant, Silene ciliata, are usually eaten by sheep. This could have consequences on its reproduction and on plant community development. However, the higher altitudes of the western mountains, with their greater influence by westerly winds which bring more winter precipitation in the form of snow or ice, could also produce a different plant community dynamism.

At the same time as there are positive interactions between plants, some plants also have a negative effect on others and do not allow seedlings to emerge or limit the potential growth of a newly established plant.

References

Callaway, R M; Brooker, R W; Choler, P; Kikvidze, Z; Lortie, C J; Michalet, R; Paolini, L; Pugnaire, F I; Newingham, B; Aschehoug, E T; Armas, C; Kikodze D; Cook, B J (2002) *Positive interactions among alpine plants increase with stress*. Nature 417: 844-848.

Gavilán, R; Sánchez-Mata, D; Rubio, A; Escudero, A (2002) *Spatial structure and interspecific interactions in Mediterranean high mountain vegetation (Sistema Central, Spain)*. Israel Journal of Plant Sciences 50(3): 217-228.

Körner Ch. (2003) Alpine Plant Life - *Functional Plant Ecology of High Mountain Springer-Verlag*.

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New Views of the Tibetan Plateau and Himalaya for Conserving Biodiversity

Daniel J. Miller

Astronaut photograph of Qinghai Lake in the region of Amdo in northeast Tibet. Photo: NASA.

From a global environmental perspective, few other places in the world are as important as the Tibetan Plateau and Himalaya is now. Concerns about global warming, climate change, receding glaciers, food insecurity and loss of biodiversity all point to the significance of this Asian mountain region in addressing these global challenges. Tackling these issues require greatly increased scientific research, improved understanding of current land use practices, especially of livestock grazing and greater participation by the local people in the entire conservation and development process. Critical examination of existing environmental conservation and economic development policies and programs is required. New perspectives and fresh thinking on how we view the Tibetan Plateau and Himalayan landscape is also needed if the unique biodiversity of the region is to be conserved.

A number of globally important biodiversity "hotspots" are located on the Tibetan Plateau and Himalaya. With their highly distinctive species, ecological processes and evolutionary phenomena, these areas are some of the most important places on earth for conserving biodiversity. The Tibetan Plateau is one of the most ecologically diverse landscapes on earth. It includes the most intact example of mountain rangelands in Asia with a relatively intact vertebrate fauna and is one of the largest remaining terrestrial wilderness regions left in the world. The area is home to numerous rare and endangered wildlife species such as the wild yak, Tibetan wild ass, or *kiang*, the migratory Tibetan antelope, or *chiru*, Tibetan argali and snow leopard (Harris 2008). Conserving these animals and their habitat is an important priority for the global conservation community.

The chiru, perhaps more than any other animal, embodies the expanse of the northern Tibetan steppe, or changtang, ecosystem. The *chiru* is a migratory animal and needs a vast landscape in which to roam between winter and summer ranges. They cover distances of up to 400 kilometres on their seasonal migrations. Observing herds of hundreds of female *chiru* with their female young of the previous year traveling on ancient paths as they have for thousands of years, is to bear witness to one of the earth's outstanding ecological spectacles. Understanding *chiru* migratory movements could provide valuable insight into the structure and function of the Chang Tang ecosystem and assist in efforts to protect biodiversity (Bolger et al. 2007).

If antelope embodies the expanse, the wild yak characterises the elemental wild nature of the Chang Tang. No other animal so evokes the raw energy and wild beauty of the Chang Tang. Standing almost two metres high at the shoulders and weighing up to a ton and with horns a metre long, wild yaks are magnificent creatures. The wild yak is an indicator species; its presence reveals a special place. With wild yaks roaming the landscape, an ecosystem is still intact. If the land can provide habitat for wild yaks, many of the other species of Tibetan wildlife will be there as well.

Photographs of the earth taken by astronauts provide an out-of-the-ordinary observation of the Tibetan Plateau. Taken at heights of 200 to 400 kilometres above the earth, these photos provide a fascinating point of view; an outlook that captures not only the magnificent splendour of the Himalaya mountains and other ranges, but also the immense expanse of the Tibetan Plateau. The photographs from space enable you to envisage the lay of the land from a broad, regional context (Robinson, et al 2002). The oblique angle images that show the earth's horizon provide a remarkable view of an entire landscape. Unhindered by the clutter of political boundaries one begins to define the land by watersheds, by mountain ranges and large lakes; the natural demarcations of an environment. One needs to keep in mind that on these astronaut photographs north is not always at the top of the image!

These views from space provide a new look of the Tibetan Plateau and Himalaya. They provide a perspective that enables you to see the landscape in its entirety. Conservation strategies for the Tibetan Plateau need to encompass a broad scale and implement programmes at the level at which natural systems operate. This landscape level of attention ensures persistence of populations and ecological processes and has to work across political boundaries. Artificial, man-made politically drawn lines on a map do not stop a river from

Astronaut photograph of Mount Everest region. View from the northeast looking southwest. Photo: NASA.

Astronaut picture of southern Tibet looking south to Upper Mustang, Nepal. Photo: NASA.

flowing downhill nor do they prevent black-necked cranes from migrating or Tibetan argali and Tibetan wild ass from crossing international borders in search of forage to graze on. Birds and animals do not need passports and visas, and we now need to adopt a similar style in how we perceive landscapes.

The American poet, Gary Snyder (1995:73), got it right when he wrote, "Now, with insights from the ecological sciences, we know that we must think on a scale of a whole watershed, a natural system. A habitat. To save the life of a single parrot or monkey is truly admirable. But unless the forest is saved, they will all die." Saving the Tibetan Plateau requires a new way of thinking; an approach that recognises watersheds instead of political frontiers to define plans of action for conservation and development. It also requires acceptance of the complex nature of the Tibetan landscape, not only in the ways that physical forces shape it, but also in ways that socio-economic and institutional forces interact and impact the nomads and farmers who use the natural resources.

George Schaller, who has spent decades working to conserve the wildlife of the Tibetan Plateau and adjoining Himalayan regions, when writing of the vast rangelands of the northern Tibetan landscape noted, "The beauty of these steppes and peaks will persist, but without wildlife they will be empty and the Tibetans will have lost part of their natural and cultural heritage. My vision for tomorrow is the past when humans, livestock, and wild animals lived in the vast steppes of the Chang Tang in ecological harmony" (1998:323). "To bequeath the Chang Tang far into the next millennium will require a never-ending moral vigilance, a passion to understand the ecology, and a deep commitment to a harmonious coexistence between the nomads with their livestock and the wildlife. Without such dedication there will ultimately be a desert where only howling winds break a deadly silence." (1998:332). Schaller's exhortation for heightened devotion to conserving the Tibetan ecosystem should be taken as a wake-up call for everyone interested in biodiversity in the region.

Conservation of wildlife depends on better protection of the species, improved understanding of their ecology and better insights into the dynamics of the Tibetan Plateau ecosystem, especially the rangelands. It also requires innovative approaches to conservation and pastoral development that adopt participatory, integrated ecosystem management models that work at the landscape level with the local people actually using the natural resources. As a first step, by looking at images from space, we can try to better understand the geography and ecology of the Tibetan Plateau. We also need to acknowledge the hallowed nature of the Tibetan landscape and start to treat it with a little more reverence and respect.

References

Bolger, D; Newmark, W; Morrison, T; Doak, D (2007). *The need for integrated approaches to understand and conserve migratory ungulates.* Ecology Letters 11: 63-77.

Harris, R (2008) *Wildlife Conservation in Western China: Preserving the Habitat of China's Wild West.* M.E. Sharpe, New York.

Robinson, J; Lulla, K; Kashiwagi, M; Suzuki, M; Nellis, M; Bussing, C; Long W; McKenzie, L (2002) *Conservation applications of astronaut photographs of earth: Tital-flat loss (Japan), elephant effects on vegetation (Botswana), and seagrass and mangrove monitoring (Australia).* Conservation Biology 15(4): 876-884.

Schaller, G (1998) *Wildlife of the Tibetan Steppe.* University of Chicago Press, Chicago.

Snyder, G (1995) *A Place in Space: Ethics, Aesthetics and Watersheds.* Counterpoint, Washington, D.C

Astronaut picture of western Tibet and the Himalaya looking west (space shuttle visible at the top). Photo: NASA.

(Images are available for viewing and downloading from the NASA website: *http://eol.jsc.nasa.gov/sseop/*).

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Vegetation Types of the Endangered Eastern Ghats Mountain Ecosystem in Southern Andhra Pradesh and Tamil Nadu, India.

G Areendran, Prakash Rao and Krishna Raj

Vegetation and land cover information have been generally recognised as the basis for planning and management and for detailed habitat inventories. The design and execution of these comprehensive inventories of natural resources, coupled with scientific assessments using Remote Sensing and GIS tools, have often led to a clear definition of management priorities. Vegetation management depends upon several factors including classification of habitats and the regular monitoring of these habitats permits the detection of change in vegetation components and immediate surroundings. The present study was conceived with a view to studying the land use/land cover of the southern parts of the Eastern Ghats in Andhra Pradesh and Tamil Nadu using Remote Sensing and Geographic Information Systems.

The primary objectives of this study was to prepare thematic maps and mapping of the existing vegetation of the region with a focus on land use and land cover and to study land use patterns in and around the natural forest patches.

The Eastern Ghats constitute an important biogeographic region in the Indian region and has been identified as a major centre of plant diversity with a unique floral diversity. Ranging from Orissa, Andhra Pradesh to Karnataka and Tamil Nadu the Eastern Ghats are spread over an area of about 75,000 square kilometres through a chain of fragmented and disjunct hill ranges. The scope of this project encompassed southern parts of the eastern ghats, particularly the Seshachalam-Chittoor hill ranges, in the Chittoor district and covering the Palamaner forest division in Andhra Pradesh. In Tamil Nadu, the study area primarily covered the Tiruvannamalai, Vellore, Villupuram, Salem (Yercaud) hill ranges and to some extent also the Dharmapuri and Nilgiris district where the Eastern Ghats converge with the Western Ghats evergreen ecosystems. The fragmented nature of the Eastern Ghats mountain ecosystem limited the extent of area that was included in the study and only some of the major hill ranges were covered for satellite interpretation. The Ghats have a rich assemblage of floral, faunal wealth including many endangered and endemic species. An estimated 3,000 species of flowering plants constitute the entire flora of the Eastern Ghats out of which at least 100 species are known to be endemic to the region. The overall vegetation structure of these hill ranges comprises several forest vegetation types including tropical dry deciduous, mixed dry deciduous, dry evergreen forests, scrub or thorn forests, riverine forests and small patches of evergreen forests.

The methodology for the present study was carried out through a combination of different field techniques which included field surveys, satellite data processing and GIS data analysis.

The land use and land cover information of the Eastern Ghats within the study area covered an area of 153,934 square kilometres. The data analysis included assessment of the forest cover and land use distribution pattern across 17 different thematic elements, relevant to the landscape of the region. Dry deciduous forests, thorn forests and scrub vegetation constituted 38 percent of the forest cover. Dry deciduous forest constituted a substantial part covering an area of 14,967 square kilometres (10 percent). In the Chittoor district of Andhra Pradesh these forests occupied 1,518 square kilometres mainly in the Seshachalam hills and the Palamaner forest ranges apart from reserve forests. Including other deciduous forest types and scrub, these constitute over 6,600 square kilometres in the district. These hills also harbour endemic floristic elements like *Shorea tumbuggaia, Boswellia ovalifolia, Pterocarpus santalinus, Terminalia pallida, Pimpinella tirupatensis, Cycas beddomi* and faunal assemblages like *Golden Gecko, Slender Loris Loris tardigradus.* In Tamil Nadu, as per the surveyed area dry deciduous forests were largely recorded in Vellore, Villupuram, Tiruvannamalai, Salem (Yercaud), Dharmapuri and Nilgiris districts

Mixed dry deciduous forests accounted for 18,514 square kilometres (12 percent) according to the satellite data. These non teak-bearing forest patches occur in the Seshachalam ranges in the Chittoor districts, Andhra Pradesh and in Vellore. Only 2,482 square kilometres (1.6 percent) of dry evergreen forests were recorded through our analysis. The presence of these forests is characterised by low and dense forest thickets, at times impenetrable, with distinct thorny elements. The vegetation has typical elements like *Manilkara hexandra, Memecylon umbellatum, Syzygium cumini, Albizia amara, Albizia lebbeck, Strychnos nux-vomica,* Increased economic activities along coastal regions have led to exploitation of these unique forest ecosystems for fuelwood and fodder purposes.

Dry deciduos forest. Photo: G Areendran.

Scrub vegetation classified as scrub forests constituted nine percent or 14,040 square kilometres of the study area according to satellite data interpretation. The increasing use of existing natural lands has shown that about 43,416 square kilometres (28 percent) of the landscape is being converted for human use, particularly for irrigation and cultivation.

The loss and decline of native vegetation can have serious implications on the biodiversity of the landscape. The Eastern Ghats have long been recognised as a major centre of plant diversity with several species of rare and endangered floral and faunal elements. Several floral species of this landscape have a narrow distributional range and any adverse impact on their habitats can lead to serious decline in the native populations of these species. The use of Remote Sensing as a tool has brought out the salient features of the present status and distribution of some of the forest types as well as the overall land use pattern of the southern part of the Eastern Ghats. We suggest a more detailed assessment and analysis at a higher scale of the rare and endangered biological diversity, using modern technology for future conservation planning in a region which is facing increasing pressures from economic and developmental activities.

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To Meet Climate Change: Strategies for Promoting Resilience in Protected Areas (What the PA Manager can do)

Lawrence S Hamilton

- Inventory taxa surveys to know what you have. Be alert for unusual sites/communities, refugia.
- Sustain the slow variables (e.g. soil resources and the species pool) that accumulate slowly and provide buffers.
- Sustain both ecological legacies (e.g. old growth forest, woody debris) and cultural legacies (e.g. peoples' connection to the land).
- Relieve the stresses that drive change (e.g. pests, invasives, pollution).
- Increase the effective size of the protected area where and when possible (e.g. enlarged core protection zone, enlarged buffer zone of nature-friendly land use).
- Protect altitudinal gradients.
- Restore or facilitate recovery of missing keystone species (e.g. wolf, beaver)
- Build linkages across multiple scales from hedgerows to landscape-scale connectivity corridors. Stepping-stones may also be valuable.
- In connection with connectivity, think big-bioregionally, even at continental scale.
- Cooperate to develop common approaches with adjacent or nearby protected areas. Transborder cooperation is especially important.
- Increase interchange with and education of stakeholders about planned interventions.
- Develop flexibility and ability to move in new directions as scenarios change. Employ adaptive management. Treat crises as an opportunity for constructive change.
- Think outside the box.

A "take-home" summary of paper presented for the German-French Biosphere Reserves Transboundary Workshop, October 22, 2008.

Solukhumbu flora, Nepal. Photo: Marianne Heredge.

Useful Resources on Mountain Biodiversity

This list of organisations and resources on mountain biodiversity is aggregated from different sources, and focuses on global and key regional information. As the emphasis is on integrated approaches to mountain biodiversity, organisations or activities dealing with any single species have been left out. For projects and initiatives, our focus is on key activities that can serve as an example to others.

Organisations and networks

Policy Bodies

The Convention on Biological Diversity (CBD) is one of the key agreements from the 1992 Earth Summit in Rio de Janeiro. The goals are conservation of biological diversity, sustainable use of its components and fair and equitable sharing of the benefits from the use of genetic resources. The Secretariat is hosted at the United Nations Environment Programme (UNEP) in Montreal, Canada. Its main functions are to support the Conference of the Parties and other subsidiary bodies of the Convention and to coordinate with other relevant international bodies. *www.cbd.int*

The Alpine Convention is a Framework Treaty between Austria, France, Germany, Italy, Liechtenstein, Monaco, Slovenia, Switzerland and the EC for the protection and sustainable development of the Alpine region. It came into force in March 1995 and sets out the basic principles and general measures for the sustainable development of the Alpine region. As well as the framework Treaty, eight thematic protocols have been adopted in the fields of: land planning and sustainable development, nature protection and landscape, mountain agriculture, mountain forests, soil protection, energy, tourism and transport. An action plan on climate change was adopted in 2009. The Secretariat of the Alpine Convention is located in Innsbruck, Austria, with a branch office in Bolzano-Bozen. *www.alpconv.org*

The Ramsar Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. It works through local, regional and national actions and international cooperation. The Secretariat is located in Gland, Switzerland. *www.ramsar.org*

The Covention on Migratory Species (CMS): The aim of the Convention on Migratory Species of Wild Animals, also known as the CMS or Bonn Convention, is to conserve terrestrial and avian migratory species. It is an international treaty that was concluded under the aegis of the United Nations Environment Programme (UNEP). It promotes the conservation of habitats and wildlife. In November 2008, 110 states from all continents, amongst them all the alpine states, were parties to this convention. *www.cms.int*

Regional Strategy for the Conservation and Sustainable Use of High Andean Wetlands was formulated within the Ramsar Convention framework, with the active participation of the countries that enclose the High Andean wetlands and related areas. This strategy is a guiding framework for regional cooperation among the countries involved, for a ten year projection period (2005-2015). Its purpose is the conservation and sustainable use of wetlands and wetland complexes in páramos, jalca, puna, and other High Andean ecosystems which maintain a unique biological diversity.
www.ramsar.org/cop9/cop9_doc26_e.htm

Andean Community (CAN) is a Bolivian/Ecuadorian/Colombian/Peruvian organisation with the objective to integrate the Andes ecoregion. The joint Andean Environmental Agenda contains both short- and medium-term subregional actions that add value to national efforts and help strengthen the capacities of the member countries with regard to environmental and sustainable development issues. Biodiversity is one of its four core subjects. The Andean Environmental Agenda guides the actions of both the Council of Ministers of the Environment and Sustainable Development, and the Andean Council of Environmental Authorities.
www.comunidadandina.org/endex.htm

The Carpathian Convention is a framework agreement between the Czech Republic, Hungary, Romania, Poland, Serbia, Slovakia and Ukraine for the protection and the sustainable development of the Carpathian Region through a multi-sectoral and integrated approach. The convention also represents a platform for joint strategies for sustainable development, and a forum for dialogue between all stakeholders. The Secretariat is hosted on an interim basis by UNEP in Vienna, Austria. The first Protocol to the Framework Convention on the Protection and Sustainable Development of the Carpathians (the Carpathian Convention) - the Biodiversity Protocol - was signed by five of the Carpathian countries on the occasion of the Second Meeting of the Conference of the Parties (COP2) on 19 June 2009 in Bucharest, Romania. The Parties are currently undertaking the necessary steps to ratify the text of the Protocol and have already started the implementation process, as agreed during COP2. *www.carpathianconvention.org*

Research Organisations

Global Research Organisations

DIVERSITAS is an international programme of biodiversity science that aims to integrate biological, ecological and social disciplines to produce socially relevant knowledge and provide a scientific basis for the conservation and sustainable use of biodiversity. The organisation runs several biodiversity core projects and supports cross-cutting networks.
www.diversitas-international.org

Global Mountain Biodiversity Assessment (GMBA) is a cross-cutting network of DIVERSITAS. It aims to assess the biological richness of mountains globally and responses to global change, to synthesise results of research, to increase the visibility of mountain biodiversity on the policy agenda, to advocate for research on human influence on natural and cultural mountains landscape, encourage sustainable development of rural upland areas and provide input to policy makers and stakeholders.
www.gmba.unibas.ch/

Global Earth Observation System of Systems (GEOSS): The Group on Earth Observations (GEO) is coordinating international efforts to build a Global Earth Observation System of Systems (GEOSS). This public infrastructure is interconnecting an array of instruments and systems for monitoring and forecasting changes in the global environment to support policymakers, managers, researchers and decision-makers. Biodiversity is one of nine themes of *GEOSS*.
www.earthobservations.org/geoss.shtml

Useful Resources on Mountain Biodiversity

Global Research Centre for Biosphere Reserve Advancement (C-BRA) is operating as the scientific communication hub under the forth-coming Clearing House Mechanism for UNESCO's World Network of Biosphere Reserves. It coordinates research in and for biosphere reserves, promotes cooperation with politics and media and provides a substantial library on case studies and best practice examples. *www.biosphere-research.org*.

Mountain Invasion Research Network (MIREN) strives to monitor and evaluate plant invasions in high mountain systems on a global scale. MIREN uses broad surveys in addition to standardised protocols and experiments in different mountain systems, spanning the major climatic zones.
www.miren.ethz.ch

UNEP World Conservation Monitoring Centre (WCMC) is a collaborative effort between the United Nations Environment Programme and World Conservation Monitoring Centre. It develops biodiversity indicators and contributes information to global environmental assessments to synthesise and promote use of information on adaptation to climate change in biodiversity conservation. *www.unep-wcmc.org*

Global Observation Research Initiative in Alpine Environments (GLORIA) aims to establish and maintain a world-wide, long-term observation network in alpine environments. Vegetation and temperature data are used for discerning trends in species diversity and temperature, and the assessment and prediction of losses in biodiversity and other threats to fragile alpine ecosystems due to climate change. Currently (May 2009) the network has active observation sites in 65 mountain regions distributed over five continents. *www.gloria.ac.at*

IUCN-WCPA Mountains Biome (Mountain Protected Areas Network) is a global network of about 300 experts devoted to preserving and protecting precious mountain regions of the world. *www.mountains-wcpa.org/index.htm*

A Global Biodiversity Observation Network (GEO BON) focuses on identifying unique or highly diverse ecosystems and supporting migratory, endemic or globally threatened species, whose biodiversity is of socio-economic importance. *www.earthobservations.org/cop_bi_geobon.shtml*

International Potato Center (CIP) seeks to reduce poverty and achieve food security on a sustained basis in developing countries through 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. *www.cipotato.org*

International Center for Tropical Agriculture (CIAT) is a not-for-profit research and development organisation dedicated to reducing poverty and hunger while protecting natural resources in developing countries. *www.ciat.cgiar.org*

Conservation International (CI)'s work is based on science, comprehensive partnerships and concern for human well-being. CI focuses on safeguarding valuable species, preserving the most important landscapes and seascapes and supporting communities. CI focuses on innovation, raising awareness about conservation and maintaining business-like effectiveness. *www.conservation.org*

Regional Research Organisations

Europe

European Network for Arctic-Alpine Environmental Research (ENVINET) is a network of 17 research organisations in Northern Europe. It focuses on multidisciplinary environmental research, primarily within atmospheric physics and chemistry, marine and terrestrial biology. ENVINET is funded by EU and managed by the Norwegian Polar Institute *www.envinet.npolar.no*

International Scientific Committee on Research in the Alps (ISCAR)'s objective is the promotion of the Alpine and scientific collaboration in Alpine research as well as the transfer of research results into practice. ISCAR particularly covers research interests of the Alpine Convention. *www.alpinestudies.ch/iscar*

Science for the Carpathians (S4C) is a new and quickly developing network originating in the intention of the Carpathian Convention. Biodiversity is one of the priority areas of future research in the Carpathians, as defined by the S4C members.
www.mri.scnatweb.ch/networks/mri-carpathians/s4c-science-for-the-carpathians.html

Bioplatform. European Platform for Biodiversity is a thematic network which aims to improve the effectiveness and relevance of European biodiversity research, to contribute to European Research Area for Biodiversity and to promote the dissemination of current best practices and information regarding the scientific understanding of biodiversity conservation. *www.bioplatform.info/index.htm*

Latin America

Consortium for the Sustainable Development of the Andean Ecoregion (CONDESAN) is a network of research organisations, NGOs, universities, private sector and government agencies. It aims to facilitate cooperation for sustainable development of the Andes region by information exchange via electronic communication, virtual working groups, e-conferences and newsletters. CONDESAN hosts the Latin America Mountain Forum regional network InfoAndina as well as the decentralised hub for the Mountain Partnership Secretariat. It implements a GEF-UNEP project focused on the Paramo Ecosystem. *www.condesan.org*

Ecuadorian Foundation of Ecological Studies (Ecociencia) is a scientific, private and nonprofit Ecuadorian institution which conducts scientific research on wildlife, conservation of natural and human environments, renewable and non-renewable resources and ecological systems, and promotes protection of wildlife and ecosystems. *www.ecociencia.org*

Research Institute Alexander von Humboldt Biological Resources (IAvH) or Instituto Alexander von Humboldt is a non profit organisation with members including the Ministry of the Environment, public and private universities, local government and non-governmental organisations. The Institute's mission is the promotion, coordination and realisation of research which contributes to the conservation and sustainable use of biodiversity in Colombia. *www.humboldt.org.co/humboldt/*

The Institute of Environmental Sciences (ICAE) is an academic institution, attached to the Faculty of the Universidad de Los Andes, dedicated to multidisciplinary research in the field of ecology and environment, and also building capacity for scientific research in these areas. *www.ciens.ula.ve/icae*

Asia Pacific

ASEAN Center for Biodiversity (ACB) is an intergovernmental regional centre of excellence that facilitates cooperation and coordination among the members of ASEAN, and with relevant national governments, regional and international organisations on the conservation and sustainable use of biological diversity. ACB is guided by fair and equitable sharing of benefits arising from the use of biodiversity. It reinforces efforts to engage more

sectors and stakeholders in the quest to save the region's biodiversity, and it also forms alliances with key stakeholders at the regional and global levels. The headquarters are located in the Philippines.
www.aseanbiodiversity.org

The Kunming Institute of Botany (KIB), (the Chinese Academy of Sciences) is a leader in exploring plants, especially from south west China and the Himalayas, for better understanding, sustainable use and conservation of plant diversity. It also focuses research on biodiversity and sustainable bio-resource use in the south west of China, disseminating scientific knowledge and training future scientists. *www.kib.ac.cn/KIBEnglish/english/index.html*

Africa

International Council for Science Regional Office, Africa (ICSU ROA)'s vision is excellence in science, linked to policy making and sustainable socio-economic development in Africa. It seeks equitable access to scientific data and information and the establishment of scientific capacity that may be used to contribute to the production of new scientific knowledge for sustainable social benefits. *www.icsu-africa.org*

African Section of the Society of Conservation Biology (SCB) is an international professional organisation dedicated to promoting the scientific study of the phenomena that affect the maintenance, loss and restoration of biological diversity. The Society's membership comprises a wide range of people interested in the conservation and study of biological diversity: resource managers, educators, government and private conservation workers and students who make up the more than 10,000 members world-wide. *www.conbio.org/Sections/Africa/*

South African National Biodiversity Institute (SANBI)'s mission is to promote the sustainable use, conservation, appreciation and enjoyment of the exceptionally rich biodiversity of South Africa for the benefit of all people. *www.sanbi.org*

Global Change Research Network for African Mountains (GCRN_AM) is a research network founded by GMBA, MRI and partners from universities in Africa and Switzerland. Its aim is to connect and support global change researchers working in different mountain regions of the African continent. *www.mri.scnatweb.ch/networks/mri-africa*

Development and Conservation Organisations

Global Development and Conservation Organisations

United Nations Educational, Scientific and Cultural Organisation (UNESCO): UNESCO'S Man and Biosphere Programme (MAB) has initiated programmes and activities focusing on diversity and resources provided by nature, humans' impacts on biodiversity as well as how biodiversity affects human activities. These initiatives are intended to contribute to the fulfilment of a global biodiversity agenda. *www.unesco.org/mab*

The Mountain Forum is a global network of over 5,000 individuals and organisations concerned with sustainable mountain development. It fosters information sharing and communication between stakeholders in the research, development and policy sectors. It provides access to on-line and off-line resources and tools, facilitates networking and capacity building and supports policy processes in strategic areas including mountain biodiversity. The Mountain Forum is composed of regional networks in Africa, Latin America, North America, Europe and Asia Pacific with a global Secretariat hosted by ICIMOD in Kathmandu, Nepal. *www.mtnforum.org*

The Mountain Partnership was launched at the World Summit for Sustainable Development in 2002 as a voluntary alliance of partners dedicated to support national governments and fostering matchmaking between partners. One area of focus is mountain biodiversity. The Mountain Partnership has decentralised hubs in Latin America, North America and Asia Pacific with a global Secretariat at FAO, Rome. *www.mountainpartnership.org*

The Mountain Institute (TMI) is an international non-profit organisation focusing on education and outreach to enhance mountain livelihoods, ecosystems and culture of mountain people. It implements programs with communities in cooperation with a wide variety of development, government, academic and technical partners. It has programmes in Asia, North America and South America. *www.mountain.org*

Worldwide Fund for Nature (WWF) focuses on conservation of species of special importance. Its mission is to conserve the world's biological diversity, ensure use of renewable natural resources and promote reduction of pollution and wasteful consumption. It works with diverse partners in implementing projects and carrying out research. *www.panda.org*

International Union for the Conservation of Nature (IUCN) supports scientific research, with projects in all parts of the world bringing together various stakeholders to develop and implement policies, laws and share best practice on biodiversity. IUCN has offices across the globe with its headquarters in Gland Switzerland. *www.iucn.org*

Conservation International (CI) aims to conserve global biodiversity. It focuses on biodiversity hotspots and biodiversity wilderness areas across the globe. It works in partnership with local non-governmental organisations and indigenous people. *www.conservation.org*

Wetlands International's mission is to sustain and restore wetlands, their resources and biodiversity for future generations. Recently, it has started to focus on high altitude mountain wetlands and their biodiversity. It is a science-based organisation and provides tools and information to assist governments in protection and restoration of wetlands. *www.wetlands.org*

Ramsar Regional Center for Training and Research on Wetlands in the Western Hemisphere (CREHO for its initials in Spanish) is a not-for-profit international organisation that promotes management and wise use of wetlands in the Americas via capacity building, research and communication. CREHO is an organisation recognised by the Contracting Parties of the Ramsar Convention and has the support of environmental organisations such as WWF, BirdLife and Wetlands International. *www.creho.org*

RARE Conservation is the leader in social marketing for biodiversity conservation with a successful track record in more than 50 countries. RARE trains and supports leaders from the world's top environmental organisations, local grassroots groups, and governments, in order to create support at the community level and improve the chance of conservation success. *www.rareconservation.org*

Equator Initiative is a partnership that brings together the United Nations, governments, civil society, businesses and grassroots organisations to build capacity and support local efforts to reduce poverty through conservation and the

sustainable use of biodiversity. The Initiative started in 2002 and addresses the two interrelated problems of biodiversity loss and abject poverty. In collaboration with a wide range of partners, the Equator Initiative concentrates on three thematic action areas: Equator Prize, Equator Dialogue and Equator Knowlegde. *www.equatorinitiative.org*

Regional Development and Conservation Organisations

Europe

The International Commission for the Protection of Alps (CIPRA) is a network to exploit the potential of the Alpine space and preserve its cultural and natural diversity. It provides multilingual information in the form of news, a calendar of events and publications and runs a broad knowledge-management project, "Future in the Alps", targeted at projects and initiatives for sustainable development. CIPRA participates in the network 'Alliance in the Alps' to achieve sustainable development with local citizenry. CIPRA has offices in Austria, France, Germany, Italy, Switzerland, south Tirol and Slovenia with an international Secretariat in Liechtenstein. *www.cipra.org*

Alpine Network of Protected Areas (ALPARC) brings together the large size protected areas within the Alpine Convention area. It fosters exchange between the alpine parks, nature reserves, biosphere reserves, tranquillity zones and others. It links with organisations and institutions of nature protection, local actors, populations and scientists. The main goal is the practical implementation of the protocol of the Alpine Convention, nature conservation and landscape management. *www.alparc.org/the-alparc-network*

Network Enterprise Alps (NENA) is a network of innovation ('green') enterprises and umbrella organisations across the Alps. The network aims to help alpine enterprises to stay innovative and competitive whilst increasing their contribution to sustainable development. It allows enterprises and organisations to exchange experiences, share know-how, and carry out long term cooperation on specific topics within the Alps. *www.NENA-network.net*

Carpathian Network of Protected Areas (CNPA) was established by COP1 (11-13 December 2006, Kyiv, Ukraine). Its mission is to contribute to the protection and sustainable development of the Carpathians. CNPA is a tool for the implementation of the Carpathian Convention, by enhancing the cooperation of Carpathian protected areas with each other and with other mountain regions of Europe. Currently, a medium-term strategy along with a work plan for the period 2010 - 2015 are being developed and should be finalised by the end of 2009. *www.sopsr.sk/karpaty*

The European Platform for Biodiversity Research Strategy is a forum for natural and social scientists, policy-makers and other stakeholders to identify structure and focus of strategic research, to use biodiversity in a sustainable way, maintain ecosystem functions that provide goods and services, and conserve, protect and restore the natural world, thereby halting biodiversity loss. *www.epbrs.org/epbrs*

The Woodland Trust is the UK's leading leading conservation charity, founded in 1972. It is dedicated to improving biodiversity, protecting existing ancient woodlands and increasing native woodland cover. They also aim to enhance people's awareness and enjoyment of woodland. *www.woodlandtrust.org.uk/EN/Pages/default.aspx*

Asia Pacific

International Centre for Integrated Mountain Development (ICIMOD) is a regional knowledge development and learning centre serving the eight countries of the Hindu Kush-Himalayas. It supports regional trans-boundary programmes through partnership with regional partner institutions. It facilitates the exchange of experiences and serves as a regional knowledge hub. *www.icimod.org*

Alliance of Central Asian Mountain Communities is a network of municipalities active in the field of sustainable development via knowledge-sharing at a community level. The organisation focuses on sharing good practices and successful projects. It also conducts excursions, tours and shares information among different institutions. *www.cipra.org/en/netzwerke/zentralasiatische-bergdorfallianz*

North America

Foundation for the Living Forest (VIBO) is a civil society non-profit organisation founded in 1999. Its main objective is the development and promotion of natural protected areas of the Sierra Madre Occidental within the State of Durango, with particular emphasis on reserves of Biosphere Michilía Mapimí in Mexico. *www.bosquevibo.org.mx*

Northwest Habitat Institute (NHI) is a non-profit scientific and educational organisation. Its mission is to promote and facilitate the conservation of Pacific Northwest native species and habitats through development and dissemination of data-rich and verifiable information, maps and tools and restoration and enhancement of native habitats. *www.nwhi.org*

Yellowstone to Yukon Conservation Initiative (Y2Y) is a joint Canada-US not-for-profit organisation aiming to preserve and maintain the wildlife, native plants, wilderness and natural processes of the mountainous region from Yellowstone National Park to the Yukon Territory. It connects and supports networks of organisations, agencies, and individuals engaged in conservation work. *www.y2y.net*

Latin America

Bolivian Mountain Institute is a La Paz based non-profit organisation with projects in implementation and plans for the years ahead. Inspired by the International Year of Mountains (IYM 2002), the BMI was founded in the same year. *www.bolivian-mountains.org*

ProNaturaleza's mission is to contribute to the conservation of Peru's natural heritage, especially its biodiversity. ProNaturaleza promotes and executes conservation projects, develops means and management schemes for the sustainable use of natural resources and supports the creation of environmental awareness. *www.pronaturaleza.org*

Association of Andean Ecosystems (ECOAN)'s mission is to conserve species of Peruvian flora and fauna in danger of extinction, threatened ecosystems, wetlands and migratory bird species, through protection of biodiversity and sustainable use of natural resources in a framework of mutual commitment and participation with local communities. *www.ecoanperu.org*

Natura Foundation Colombia is a civil society organisation dedicated to the conservation, use and management of biodiversity to generate social, economic and environmental benefits within the framework of sustainable human development. It carries out research and development and implements projects for environmental management and sustainable development in Colombia. *www.natura.org.co*

Useful Resources on Mountain Biodiversity

AndigenA is a Venezuelan non-profit foundation whose mission is the conservation of the Neotropical Biodiversity, with emphasis on the Andean Region. AndígenA respects native cultures, while searching for viable solutions to current problems of nature conservation. It carries out projects and applied biological research, analyses of economic alternatives and the implementation of environmental education programs, based mainly on community participation. *www.andigena.org*

Pro Biodiversity of the Andes (PROBIOANDES) is a small NGO focused on improving public awareness about the importance of conservation, sustainable use of biodiversity in Peru and the preservation of ecosystems. It contributes to conservation of Peruvian genetic resources by reinforcing in situ and ex situ conservation and promoting market opportunities to exotic products derived from them.
www.geocities.com/probioandes/home.htm

International Conservation Bolivia is an NGO that for over 20 years has promoted the conservation of Bolivian natural heritage and biodiversity. It promotes human welfare and development in a sustainable manner and with respect for nature. *www.conservation.org.bo*

Nature's Friends Foundation (FAN) is a private, non-profit, organisation founded in 1988 dedicated to the conservation of biodiversity in Bolivia. Their work is characterised by scientific, technical, social participation and administrative transparency. *www.fan-bo.org/1/menu.html*

The Mountain Institute (TMI) South American Program, Lima, Peru: TMI developed a comprehensive community-based project in the Huascaran Biosphere Reserve to demonstrate through pilot projects the potential to diversify local livelihoods through community-based tourism and protection of biodiversity hotspots.
www.mountain.org/programs/southamerica/index.cfm

Africa

African Highlands Initiative (AHI) is an eco-regional program of the Consultative Group for International Agricultural Research (CGIAR) and a network of the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), hosted by the World Agroforestry Centre (ICRAF). Its aim is to improve livelihoods and reverse natural resource degradation in the densely settled highlands of eastern and central Africa. AHI is a consortium of eastern African and international research organisations that work with local communities, local governments and development partners.
www.africanhighlands.org

Funding Organisations

The World Bank supports activities in the area of biodiversity including establishment and strengthening of protected areas such as buffer zones; sustainable use of biodiversity outside protected areas; control of invasions of alien species; biodiversity conservation through improved management; and sustainable use of natural resources in the production landscape.
http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/EXTBIODIVERSITY/0,,menuPK:400959~pagePK:149018~piPK:149093~theSitePK:400953,00.html

Rufford Maurice Laing Foundation is a grant-making organisation that provides funds for research, development and social welfare initiatives. Under it's Small Grants Programme, it has funded several research and development projects focused on mountain ecosystems in developing countries. Different projects on mountain conservation can be accessed online. *www.rufford.org*

Critical Ecosystem Partnership Fund (CEPF) was founded in 2000, and is a global leader in enabling civil society to participate in and benefit from conserving some of the world's most critical ecosystems. The grants are awarded to target biodiversity hotspots in developing and transitional countries. It provides grants to international organisations, small farming cooperatives and community associations.
www.cepf.net/Pages/default.aspx

Christensen Fund is a grant-making organisation for maintaining the biological and cultural diversity of the world, focusing on five geographic regions. Its current focus is on the mountains and valleys of Central Asia and Turkey. The Global Bio-Cultural Initiative is directed towards building and sharing global knowledge, wisdom and practice of bio-cultural diversity, landscape integrity and resilience, as well as supporting global institutions. *www.christensenfund.org/frame_grants.html*

Global Environment Facility (GEF) is a global partnership to address global environmental issues while supporting national sustainable development initiatives. It provides grants for projects related to six focal areas: biodiversity, climate change, international waters, land degradation, the ozone layer, and persistent organic pollutants. A list of GEF funded projects on biodiversity in mountain ecosystems can be accessed at *www.gefweb.org*

Swiss Agency for Development and Cooperation (SDC) is Switzerland's international cooperation agency within the Federal Department of Foreign Affairs (FDFA). Biodiversity is a priority topic under the theme 'Environment'. SDC undertakes direct actions, supports programmes of multilateral organisations and helps to finance programmes run by Swiss and international aid organisations. *www.sdc.admin.ch/en/Home*

Global Diversity Foundation is a charity which generates funds and focuses on applied research on diverse aspects of bio-cultural diversity and culture at selected field sites, providing training and education from community workshops to university courses and field projects that improve health, education and rights of communities under threat from the globalised economy. *www.globaldiversity.org.uk*

JRS Biodiversity Foundation is a grant making organisation in the field of biodiversity, aimed at enhancing knowledge and promoting the understanding of biological diversity for the benefit and sustainability of life on earth. Interdisciplinary activities are carried out in collaboration in developing countries and economies in transition, in particular focusing on Africa.
www.jrsbdf.org/v2/home.asp

MacArthur Foundation supports creative people and effective institutions committed to building a more just, verdant and peaceful world. The Foundation works to defend human rights, advance global conservation and security, make cities better places and understand how technology is affecting children and society. *www.macfound.org*

Darwin Initiative is a small grants programme that aims to promote biodiversity conservation and sustainable use of resources in less developed countries. The Initiative is funded and administered by the UK Department for Environment, Food and Rural Affairs (DEFRA). The Darwin Initiative assists countries that are rich in biodiversity but poor in financial resources to implement the Convention on Biological Diversity (CBD) through the funding of collaborative projects which draw on UK biodiversity expertise. *http://darwin.defra.gov.uk*

Information and Databases

Mountain Forum holds resources on global mountain biodiversity: 330 searchable profiles of mountain organisations working on biodiversity in Who is Who in Sustainable Mountain Development *www.mountainforum.org/wisw/index.php*; over 300 searchable documents on mountain biodiversity. *www.mtnforum.org/rs/ol.cfm* and lists of Mountain Forum organisations, experts and practitioners from different regions across the world

The World Bank Projects Database contains project documents and information on biodiversity-related projects mostly financed by the Global Environment Facility.
http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/EXTBIODIVERSITY/0,,contentMDK:20484516~menuPK:1170120~pagePK:148956~piPK:216618~theSitePK:400953,00.html

Global Biodiversity Information Facility (GBIF) mobilises biodiversity data, develops protocols and standards to ensure scientific integrity and interoperability of data types from disparate sources. It also promotes capacity building and development of tools for improved decision-making. The GBIF's secretariat is in Copenhagen, Denmark. *www.gbif.org*

UNEP/WCMC World Database on Protected Areas is a comprehensive global spatial dataset of protected areas with information from national governments, non-governmental organisations, academic institutions and international biodiversity convention secretariats. It is used for ecological gap analysis, environmental impact analysis and is increasingly used for private sector decision-making. *www.wdpa.org*

Biodiversity Hotspots Database was initiated by Conservation International to facilitate free and open access to biodiversity hotspots worldwide. It contains information about species, hotspots by region, sub-region and different Geographic Information System maps. *www.biodiversityhotspots.org*

ICIMOD's Information Resources holds documents on different cross cutting issues and good practices on mountain biodiversity in ICIMOD's online library, especially relevant to the Hindu Kush Himalayas. *www.books.icimod.org*

GEF Supported Projects on Mountain Ecosystem links projects on different themes of biodiversity and mountain ecosystems funded by GEF, especially related to government organisations and civil societies. *www.sgp.undp.org*

Global Biodiversity Outlook 3 (GBO-3) is the flagship publication of the Convention on Biological Diversity and preparations are underway to produce its third edition. GBO-3 will be formally launched in 2010, the International Year of Biodiversity. *www.cbd.int/gbo3*

InfoAndina Portal is a CONDESAN initiative to promote knowledge generation and to bring access to Information on biodiversity experts, organisations, projects and documents. *www.infoandina.org*

Paramo Information Mechanism (PIM) is managed by InfoAndina and the Andean Paramo Project (PPA) and makes available information about paramo ecosystems in the north Andean region. Information resources include a directory of researchers, projects and institutions and a virtual library. *www.infoandina.org/site.shtml?x=3903*

The Inter-American Biodiversity Information Network (IABIN) is a forum to foster technical collaboration and coordination among countries of the Americas in collection, sharing and use of biodiversity information relevant to decision-making on natural resources management and conservation, and education to promote sustainable development in the region. *www.iabin.net*

The Encyclopedia of Life (EOL) is an ambitious project to organise and make available via the Internet virtually all information about life on Earth. At its heart lies a series of Web sites - one for each of the approximately 1.8 million known species - that provide the entry points to this vast array of knowledge. *www.eol.org/index*

Map of the Ecosystems of the Northern and Central Andes provides specific guidelines for the preparation of management plans for biodiversity and for developing policies to promote sustainable regional development in the Andean region. This study includes information obtained at the country level and transformed through an approval process database. This is accomplished by a regional overview on the state of conservation of biodiversity in the Andes. *www.infoandina.org/ecosistemasandinos*

The Biodiversity Information System (SIB) of Colombia is a national initiative wich provides all the information of the country in terms of conservation and sustainable use of biological resources. The process of implementation of the SIB revolves around three main elements: capacity, infrastructure and information content. *www.siac.net.co*

Catalog Biodiversity Colombia is an important data bank of species of animals, plants and fungus and is related to biodiversity in Colombia.
www.siac.net.co/sib/catalogoespecies/welcome.do

Biodiversity in Latin America is a website which works to disseminate information, manage documentation and share activities and proposals of Latin American organisations who works in defence of biodiversity.
www.biodiversidadla.org

Exemplary projects and initiatives

The following list of projects is not meant to be final or evaluative. The idea is to give a brief glimpse of the range of projects concerned with mountain biodiversity at different levels. If the exemplary projects are mainly from Latin America and Europe, this does not mean that there are less projects in other regions – but merely that these projects have come to the editors' attention through our regional networks.

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBes) is a proposed scientific and social platform to strengthen relations between knowledge holders on biodiversity and ecosystem services and actors involved in decision/policymaking processes. *www.ipbes.net*

LIFE WEB is a Global Initiative on Protected Areas initiated by the CBD Secretariat, aimed at establishing regional and national protected areas by supporting national governments.
www.cbd.int/lifeweb/

European Biodiversity Network Project (EBONE) is an EU FP7 project. The key challenge of the EBONE project is the development of a cost effective system of biodiversity data collection at regional, national and European levels. The need for the project is to develop a system for coherent data collection that can be used for international comparable assessments, including CBD reporting against the 2010 target *www.ebone.wur.nl/UK*

Governance of Biodiversity (GoBi) Research Group investigates which appropriate management and governance structures of biosphere reserves and protected areas can contribute to significantly reduce the rate of global biodiversity loss. *www.biodiversitygovernance.de*

Ecological Networks in the European Alps is an initiative of CIPRA, the Network of Alpine Protected Areas (ALPARC), the International Scientific Committee for Alpine Research (ISCAR) and the Alpine Program of WWF, in collaboration with the Alpine Convention.
www.alpine-ecological-network.org

The Alpine Space "ECONNECT" project, co-financed under the Alpine Space programme, and involving sixteen partners from six Alpine countries, promotes conservation of biodiversity through an integrated and cross-sectoral approach. The aim is to ensure an ecological continuum within the Alpine region. The project's emphasis is on the implementation of measures in pilot regions in order to then magnify results using guidelines and best-practice dissemination. The project became operational in September 2008 and will run until the end of August 2011. *www.econnectproject.eu*

Conservation Area Project Talamanca (ProCAT) is an international initiative of the Institute of the Rockies to improve research on biodiversity in the Caribbean Talamanca area, Costa Rica. The project consists of an interdisciplinary team of scientists and local stakeholders working on various issues and projects including habitat modeling, mapping land use, social perceptions, conservation plans and monitoring of cats and their prey. *www.procat-talamanca.org*

The Data Center for Conservation-National University La Monila (CDC-UNACM) manages information about the ecological and biological diversity of Peru. It works with species, communities and landscapes, identifying where there is high biodiversity or important natural habitats for conservation. It also collects data about natural protected areas in Peru and uses them for making recommendations on development and environmental management. *http://cdc.lamolina.edu.pe/Quienes_Somos/cdcunalm.htm*

Bioandes is a regional programme designed to strengthen the sustainable management of biodiversity in the Andean region. It aims to contribute to conservation and the economic, sociocultural and political status of biodiversity on the basis of livelihood strategies, knowledge and dialogue. *www.bioandes.org*

Andean Paramo Project (PPA) seeks alternatives for the conservation of páramos through the implementation of management actions. PPA works in the fields of research, training, and awareness raising of people linked to the ecosystem. *www.infoandina.org/ppa/sitio.shtml*

Paranios Altoandinos Génova-Quindio is a project focusing on enrichment of the number of birds and forests in the Páramos Altoandinos Génova-Quindío, promoting education and environmental awareness around the high mountain ecosystems. The project was designed to enrich the number of birds in selected zones and generate ownership of the high-Andean ecosystems amongst landowners and the wider community. Strategies concentrate on education and environmental awareness. Email: *feremellizas@gmail.com*

Sacred Himalayan Landscape is an initiative in the Himalayas of Bhutan, Nepal and India with a mission to conserve the biological and cultural treasures of the world's highest sacred mountains. It implements conservation projects that include health services, informal education and livelihood projects. It has focused on engaging governments in the equitable sharing of benefits from natural resources and empowering local communities to manage the rich natural heritage of the Himalayas.
www.worldwildlife.org/what/wherewework/easternhimalayas/projects.html

July

2-4 July 2009
Large Carnivores: Management, Research and Public Relation Strategies of the Protected Areas
Liptovsky Jan, Slovakia.
Contact: *carpathian-cooperation@alparc.org*
Web: *http://fr.alparc.org/calendrier/les-manifestations-d-alparc/large-carnivores-management-research-and-public-relation-strategies-of-the-protected-areas*

6-11July 2009
7th International Conference on Geomorphology
Melbourne, Australia.
Contact: *geomorphology2009@tourhosts.com.au*
Web: *www.geomorphology2009.com/default.asp*

11-18 July 2009
Stewardship and Conservation in Canada: Strengthening Stewardship - Investing at Every Step
Alberta, Canada.
Contact: *2009@landstewardship.org*
Web: *www.stewardship2009.ca/*

18-21 July 2009
Society for Conservation GIS (SCGIS) Annual Conference
California, USA.
Contact: *scgis@scgis.org*
Web: *www.scgis.org/Lev3Page.aspx?Page3ID=21*

20-24 July 2009
3rd National Conference on Ecosystem Restoration
California, USA
Contact: *bmt@ufl.edu*
Web: *http://conference.ifas.ufl.edu/NCER2009/*

August

15 June-31 August 2009
2009 Summer Environmental Exchange (SEE)
California, USA.
Contact: *jsmith@tahoebaikal.org*
Web: *www.tahoebaikal.org/projects/exchange/*

4-8 August 2009
1st World Congress of Environmental History
Copenhagen, Denmark.
Contact: *wceh2009 @ ruc.dk*
Web: *www.wceh2009.org/*

12-16 August 2009
Squamish Mountain Festival
Squamish, BC, Canada.
Contact: *info@squamishfilm.com*
Web: *www.squamishmountainfest.com/*

16-22 August 2009
27th Conference of International Association of Agricultural Economists (IAAE)
Beijing, China. 16-8-2009 / 22-8-2009
Contact: *christian.flury@art.admin.ch*
Web: *www.iaae-agecon.org/conferences/conferences.html*

24-28 August 2009
Sixth International Scientific Conference on the Global Energy and Water Cycle
Melbourne, Australia.
Deadline for abstract: 15-1-2009
Web: *www.gewex.org/2009gewex_ileaps_conf.html*

24-28 August 2009
Second Integrated Land Ecosystem-Atmosphere Processes Study Science Conference
Melbourne, Australia.
Contact: *anni.reissell@helsinki.fi*
Web: *www.ileaps.org/*

28-29 August 2009
Mountain Song Concerts
Alberta, Canada.
Contact: *sandra_laronde@banffcentre.ca*
Web: *www.banffcentre.ca/programs/program.aspx? id=831*

29 August-2 September 2009
Geomorphometry 2009
Zurich, Switzerland.
Contact: *2009@geomorphometry.org*
Web: *http://2009.geomorphometry.org/*

September

8-15 September 2009
2nd Circular, International Workshop on the Northern Eurasia High Mountain Ecosystems
Bishkek, Kyrgyzstan.
Contact: *ch.akulueva@caiag.kg*
Web: *http://neespi.org/*

9-12 September 2009
The 6th International Symposium on Digital Earth (ISDE6)
Beijing, China.
Contact: *secretariat@isde6.org*
Web: *www.isde6.org/*

11-13 September 2009
Sierra Nevada Alliance Annual Conference
Kings Beach, California , USA.
Contact: *sna@sierranevadaalliance.org*
Web: *www.sierranevadaalliance.org/conference/*

15-18 September 2009
Geoecological Problems of High Mountains
Tatranska Lomnica, Slovakia.
Contact: *erojan@uw.edu.pl*
Web: *www.sgs.sav.sk/index_EN.htm*

15-18 September 2009
International Conference on Mitigation of Natural Hazards in Mountain Areas
Bishkek, Kyrgyzstan
Contact: *m.cerny@mountainhazards2009.com*
Web: *www.mountainhazards2009.com/*

15-25 September 2009
Managing Natural Resource Conflict: Concepts and Practice
Bangkok, Thailand.
Contact: *leela@recoftc.org or contact@recoftc.org*
Web: *www.recoftc.org/site/index.php?id=698*

Mountain Calendar 2009

15-18 September 2009
Mitigation of Natural Hazards in Mountain Areas
Bishkek, Kyrgyzstan.
Contact: *m.cerny@mountainhazards2009.com*
Web: *www.mountainhazards2009.com*

16-18 September 2009
Climate Change and Water Resources Management in Mountains
Göschenen, Switzerland.
Contact: *viviroli@giub.unibe.ch*
Web: *http://mri.scnatweb.ch/events/mri-events/climate-change-and-water-resources-management-in-mountains-16-18-sept.-2009-goschenen-ch.html*

17-18 September 2009
3rd European Biennial Event of Highland Regions
Plombières-les-Bains (Vosges), France.
Contact: *grebiere@vosges.cci.fr*
Web: *www.euro-event-mountain.eu*

20-24 September 2009
16th Annual Wildlife Society Conference
California, USA
Contact: *lisa@wildlife.org*
Web: *http://joomla.wildlife.org/Monterey09/index.php?option=com_content&task=view&id=174&Itemid=276*

24-29 September 2009
Ozarks Studies Symposium
Springfield, Missourie, USA.
Contact: *LeighAdams@MissouriState.edu*
Web: *http://ozarksymposium.wp.missouristate.edu/*

October

4-8 October 2009
International School on "Alpine Ecology and Global Change"
Tyrol, Austria.
Contact: *alpiner.raum@uibk.ac.at*
Web: *http://c719-71-22.uibk.ac.at/ecoschool/*

8-9 October 2009
4th Annual Real Estate and Development in the Northern Rockies Conference
Montana, USA.
Contact: *conferences@newwest.net*
Web: *www.newwest.net/realestate08/*

13-16 October 2009
Second DIVERSITAS Open Science Conference
Cape Town, South Africa.
Contact: *info-OSC2@diversitas-international.org*
Web: *www.diversitas-osc.org/*

19-25 October 2009
The XIIIth World Forestry Congress (WFC)
Buenos Aires, Argentina.
Contact: *info@wfc2009.org*
Web: *www.wfc2009.org/index_1024.html*

21-23 October 2009
ASEAN Conference on Biodiversity 2009
Singapore.
Contact: *amlecciones@aseanbiodiversity.org*
Web: *www.aseanbiodiversity.org/index.php?option=com_content&view=article&id=355:acb2009&catid=131:acb-2009&Itemid=177*

26 October- 6 November 2009
Landscape Functions and People - Applying Strategic Planning Approaches for Good Natural Resource Governance
Bangkok, Thailand.
Contact: *contact@recoftc.org*
Web: *http://portals.wi.wur.nl/landscapes/*

November

6-13 November 2009
9th World Wilderness Congress "Feel, Think, Act (Siente, Piensa, Actua)!"
Merida, Mexico.
Contact: *Julie@wild.org*
Web: *www.wild9.org/02_ING/01_00_Home.php*

15-18 November 2009
2009 Carnivore Conference: Carnivore Conservation in a Changing World
California, USA
Contact: *kati.dancy@defenders.org*
Web:
www.defenders.org/programs_and_policy/wildlife_conservation/imperiled_species/wolves/conferences_and_seminars/carnivore_conference/index.php

30 November- 11 December 2009
Conference of the Parties, Fifteen session and Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol , Fifth session: COP15 and COP/MOP5
Copenhagen, Denmark.
Contact: *cop15civil@um.dk*
Web: *www.cop15.dk*

December

1-3 December 2009
British Columbia Protected Areas Research Forum: Closing the Loop - Putting Research into Action
Prince George, BC, Canada.
Contact: *pwright@unbc.ca*
Web: *www.unbc.ca/bcparf/*

3-4 December 2009
Workshop on Peace River Break Landscape
Prince George, BC, Canada.
Contact: *wendy@y2y.net*
Web: *www.y2y.net/ViewEvents.aspx?cid=83□=1&eid =349*

Supporting Organisations

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development and Cooperation

Food and Agriculture Organisation of the United Nations

Corn outside Marpha, Nepal. Photo: Molly Angstman.

Host Organisations and Partners

African Highlands Initiative

Association Européenne des Elus de Montagne

Bellanet

Consorcio para el Desarrollo Sostenible de la Ecorregión Andina

Fundació Territori i Paisatge

International Centre for Integrated Mountain Development

International Potato Center

Mountain Research and Development

Mountain Research Initiative

The Banff Centre

The Mountain Institute

World Agroforestry Centre

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