Global Mountain Biodiversity Assessment
a research network of DIVERSITAS

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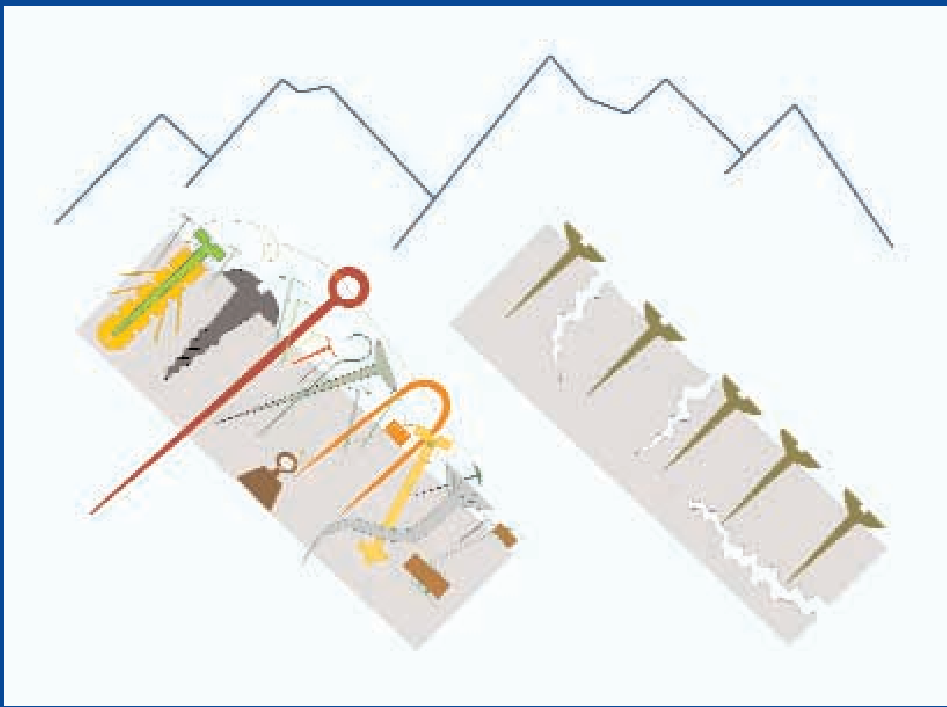
Mountain Biodiversity Matters



Global Mountain Biodiversity –
A synthesis of principles and facts





Why care for mountain biodiversity?

- Ethical responsibility: Treasure for future generations
- Ecological value: Ecosystem integrity and adaptability
- Economical value: Food, water, safety, other ecosystem services
- Natural and cultural heritage
- Aesthetical value: Beauty and recreation

Front cover: Roots and rhizomes, nature's diverse screws and nails for mountain soils. Sustained upslope services and downslope safety depend on slope stability, which in turn depends on a diverse and intact vegetation cover with the associated animal and microbial life.

| Upper Langtang, Nepal, 3500 m

| Matterhorn, Switzerland, 4000 m

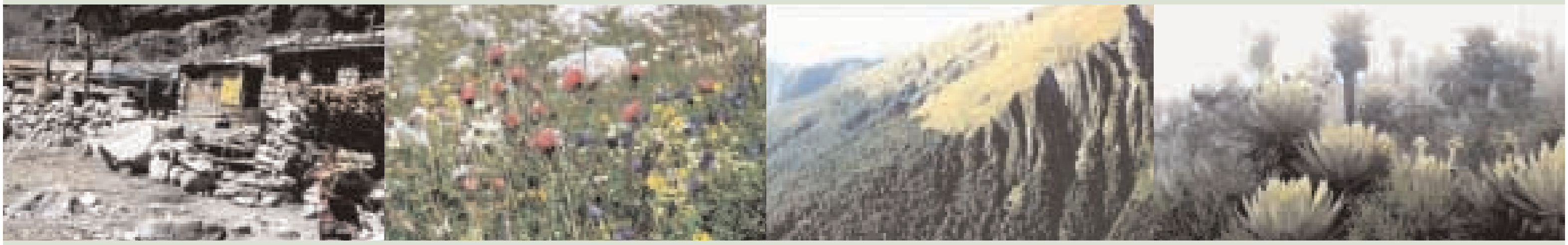
| Central Caucasus, Kasbegi, Georgia, 1900 m

| Chamois, Pangboche, Nepal, 3900 m

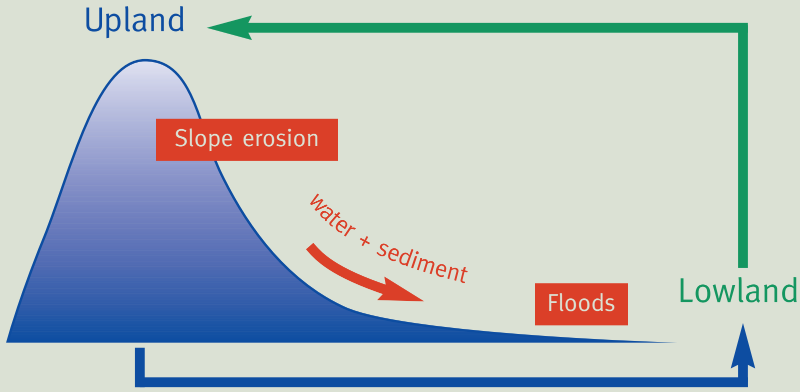
| *Doronicum clusii,* Alps, 2600 m

Executive Summary of the first GMBA conference

September 7–10, 2000, Rigi–Kaltbad, Switzerland



Mountains and Highlands cover about 25% of the Earth's land surface, and more than 50% of the world's population depends directly or indirectly on mountain resources and services. The lowland-upland contract:



Langtang, Nepal, 3300 m

Tyrolean Alps, Austria, 2200 m

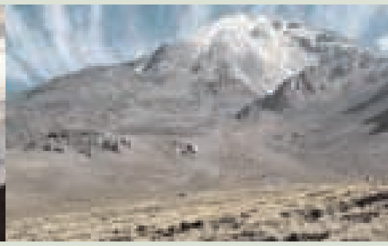
Mt. Brewster, New Zealand, 1200 m

N-Ecuador, 3600 m

Natural drivers of biological richness at high altitudes

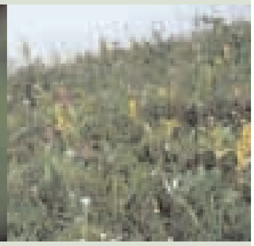
Snowy Mountains, Australia, 1950 m

Metrosideros polymorpha, Mauna Loa, Hawaii, 3000 m



Tussock grassland, Pico di Orizaba, Mexico, 4100 m

Dodecatheon sp. California, 2800 m



Alpine meadow, Sichuan, China, 3500 m

The compression of climatic zones along elevational gradients causes mountain biota to represent hotspots of biological richness. At very high elevation biodiversity diminishes gradually but so does land area, leading to very high biodiversity / land area ratios, which often exceed those of lower elevations.

Mountain terrain is commonly highly fragmented and topographically diverse, leading to great habitat diversity, adding to the biological richness of many high elevation biota.

Mountain ranges or peaks often represent isolated archipelagoes of peculiar life conditions explaining their richness in endemic species found only at one location worldwide. Endemism also reflects geological and climatological history.

Mountains that bridge between biogeographic zones are richer than isolated ones.

Biodiversity depends on type of parent rock: Calcareous terrain is richer than any single other type of surface, but highest biological richness is found in regions with mixed geology including calcareous rock.

Within a given mountain, transition zones between elevational belts of vegetation are particularly rich in taxa (e.g. the forest-alpine transition).

Photo: Alexander Kocyan

Mount Kinabalu, Malaysia

‘Alpine vegetation patterns, life forms and oceanic environments in New Zealand show strong affinities with the tropical high mountains and subantarctic islands.’ Alan Mark, New Zealand

‘The Rocky Mountains have higher community and landscape diversity than surrounding lowlands.’ Bill Bowman, USA

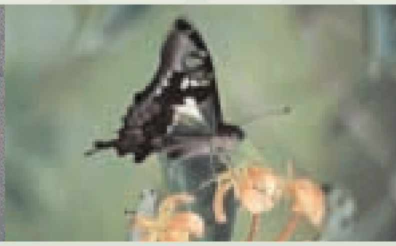
‘More than 50% of the Romanian endemic plant species are confined to highlands.’ Gheorghe Coldea, Romania

‘Tropical montane forests are richer in species than lowland forests of similar size. The mountain forests of South Ecuador host the highest epiphyte diversity worldwide.’ Rainer Bussmann, Germany

Biological richness in mountain terrain

Drakensberg escarpment Natal, South Africa, 2300 m

High Andean plant diversity, Cayambe, Ecuador, 4600 m



Mount Kaindi, Wau, Papua New Guinea, 2360 m

Leontopodium sp., Sichuan, China, 3200 m

Inventories of organismic taxa do not require the visitation of every square kilometer of mountain landscape. 90% of the taxa and good approximations of overall biotic richness often can be retrieved in sample areas of 10–20 km^2 (or less) within a given biogeographic zone.

Remote sensing (satellite) data offer new avenues of docu-menting habitat and community diversity over large areas hence provide tools for up-scaling local inventories.

Intraspecific genetic diversity drives evolution and secures long-term presence of taxa. Genetic diversity strongly depends in the breeding system and life history strategy of organisms. An open question is the degree to which variance reflects functionally significant traits.

Our current mountain biodiversity database has large gaps, with data for some groups of organisms missing completely for some regions. Therefore a rapid improvement of a mountain biodiversity database is of prime importance. Given the regionally different levels of knowledge, a more even distribution of research efforts is needed to arrive at a more balanced understanding of biodiversity and conservation needs worldwide.

Biodiversity ratios: diversity within one group of organisms (e.g. plants) is often linked with diversity in another group of organisms (e.g. butterflies). Since we have neither the resources nor the time for a complete biological inventory of all mountain biota across the globe, taxonomic ratios (between groups) are promising tools in biodiversity assessments.

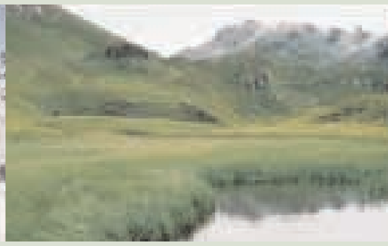
Life form and functional diversity have a value by their own and provide most useful ways of ecological interpretation of taxonomic diversity.

Per unit land area high mountain biota are biologically richer than most lowlands. Three examples for plant species:

	Total number of species	Species found above treeline	Species exclusively found above treeline (as % of total)	Area above treeline (% of total) incl. ice & rock
Chile	4000	1900	870 (22%)	19%
New Zealand	2200	620	210 (10%)	10%
Switzerland	2570	1280	570 (22%)	23%

Functional significance of mountain biodiversity






Keystone species and the eveness of species distribution are key elements of a functional interpretation of diversity data (abundance, facilitation, and competitive exclusion).

Ecosystem integrity on steep mountain slopes and high elevation landscapes in general is a question of soil stability, which in turn depends on plant cover and rooting patterns (see cover page). The more morpho-types of plants co-occur the less likely will extreme events lead to vegetation failure and soil erosion (insurance hypothesis). Although intuitively plausible this is a field poorly supported by data, a prime topic in the GMBA agenda.

Mountain hydrology is strongly influenced by the type of vegetation and its stability. Streams and lakes, but also water reservoirs depend on the integrity of upslope ecosystems.

Although mountain vegetation is co-determined by snow distribution, vegetation type itself affects snow cover and snow stability (avalanches). Diverse upper montane forests offer sustainable mechanical barriers, which prevent major downslope ecosystem disturbances.

Andes, Venezuela, 4000 m

Snowy Mountains, Australia, 2050 m

Tyrolean Alps, Austria, 2300 m

Soil erosion, Tafi del Valle, Argentinia, 2500 m

Change of mountain biodiversity with time

Pioneer vegetation, Alps, Switzerland, 2500 m

Biodiversity research, Alps, Switzerland, 2500 m

Lilium bulbiferum, Dolomites, Italy, ca. 2000 m

CO_2 enrichment of the atmosphere affects biodiversity, Switzerland, 2500 m

Old databases have great value for detecting long-term trends in biodiversity. Site revisitations and long-term monitoring of permanent plots seem to be the most promising tools for detecting changes in vegetation.

Environmental changes often affect species abundance and distribution more than they determine presence or absence of taxa. However, reduced abundance and habitat fragmentation may lead to species extinction in the long run (inbreeding depression).

Climatic warming will reduce available land area for cold adapted organisms (summit trap phenomenon). Unless suitable microclimates for migration are available, many species are likely to become locally extinct.

GLORIA (Global Observation Research Initiative in Alpine Environments) is a global network aiming to monitor effects of climate change in high mountain biomes, chaired by Prof. Georg Grabherr, Austria

For more information see: www.gloria.ac.at
or contact: gloria@pflaphy.pph.univie.ac.at

'Ongoing warming and reduced snow cover will exert strong pressure on nival plants by competition from alpine species. In the long term, nival plants will lose habitats. Plant species of very limited distribution area, e.g. summit endemics, are threatened even in the short term.' Michael Gottfried, Austria

'Species from alpine plant communities are usually long-lived and strongly rely on reproduction by vegetative or clonal growth. Nevertheless, genetic diversity in populations of such plants is usually surprisingly high. Seed dispersal, seedling establishment and the colonization of new sites are probably much more frequent in alpine plant life than previously thought. For the response of alpine plant species to global warming and associate changes this is good news.' Jürg Stöcklin, Switzerland

Photos: L.N. Tyulina, P. Moiseev

Change of the Ural treeline ecotone

Land use at high elevations




Human land use has shaped mountain biota worldwide and will continue to do so. The ways mountain biota are managed co-determine their biological richness and integrity. Land use practices need to be judged by their effect on biodiversity and ecosystem integrity.

There is a direct link between land use and biological richness. Sustainable land use often increases biodiversity and enhances ecosystem services.

The mountains of the globe supply 40% of mankind's usable water either directly or indirectly. Mountain biota co-determines the amount, reliability and cleanness of these supplies.

When poverty drives human life, sustainable uses rather than 'set aside' scenarios are realistic. Adequate traditional land use of mountain biota may even increase their biodiversity and may improve ecosystem values.

Grazing and fire management are the major components of mountain land use at or above treeline. Both can enhance or reduce biological richness and system integrity, depending on intensity and post-fire management of grazing.

‘Highlands are more valuable in terms of resources of medical plants than lowlands.’ Aditya Purohit, India

‘Mountain crop systems: below the treeline high altitude agroecosystems become more reliable with spatially diverse crop rotational cycles.’ Alejandro Camino, Peru

‘Factors, which determine biodiversity in the Highlands of Central Mexico are land ownership, the local dynamics of agricultural production, cultural and economic issues. In a study of Mazahua campesino agriculture, people use 246 plant species of the local flora for medicinal, ornamental and ritual purposes and as food, spices, forage, live fences, fuel and tools.’
Cristina Chavez-Mejia, Mexico

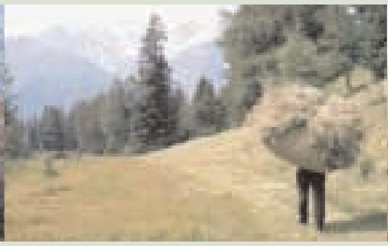
Market, Ecuador, 2000 m

Degraded mountain pastures, Langtang, Nepal, 3300 m

Intact agro-landscape, N-Ecuador, 3300 m

Arnica montana, a world rank medical plant

Man & Mountain Biodiversity

In some areas of the globe a change in social climate is likely to affect mountain biota more and faster than a change in physical climate.

In areas with mountain diversity of global significance, the global community has to take on responsibility and assist in conservation measures.

Tibetan child, Langtang, Nepal

'We cannot separate people and nature anymore.'
Fausto Sarmiento, USA

'When poverty is the driver of human life in the uplands, how can we guarantee sustainable land use?'
'Mountain economies must create added value beyond the production of raw materials, if they are to survive.'
Mohamed Saleem, Ethiopia

'In the central Andes, except in the driest parts, over 90% of the subalpine forest have been destroyed during millenia of human habitation. But: Certain forest use practices are compatible with the conservation of the endangered forest biota in the Andes.'
Michael Kessler, Germany

'An important human dimension of global mountain biodiversity is the diversity of the human species itself. Indigenous populations seem to have better functional capacity than newcomers when measured in terms of traits such as health, physical work capacity, and reproductive success, that are important for long-term success. Andean and Tibetan populations have different physiological adaptations to high altitude and illustrate biodiversity in this sense.'
Cynthia Beall, USA

Potato cultivation, Langtang, Nepal, 3550 m

Tyrolean Alps, Austria, 1700 m

Tien Shan, Kasachstan, 2600 m

Tyrolean Alps, Austria, 1700 m

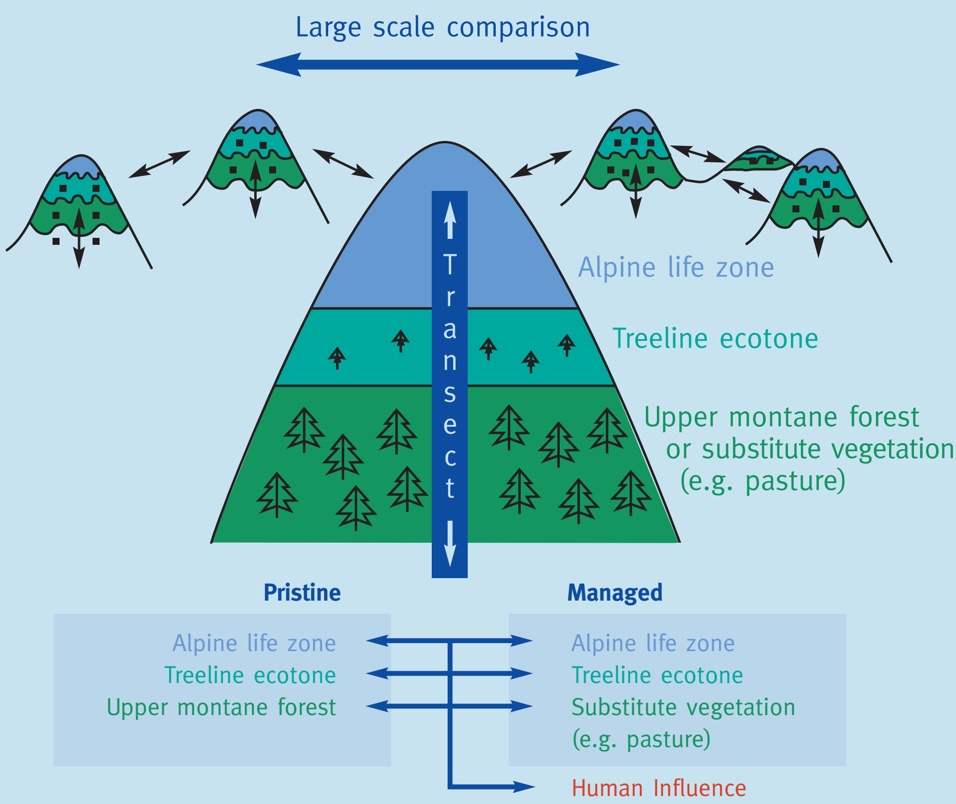
The global research network on mountain biodiversity: One of the core projects of DIVERSITAS

DIVERSITAS (Paris) is the international umbrella programme of biodiversity science (see: www.icsu.org/DIVERSITAS/).

GMBA asks:

- How much mountain diversity is there regionally and globally?
- What is its function?
- How does it respond to human land use?
- How does it change in response to climatic change?

GMBA focuses on biodiversity of high mountains worldwide



The aims of GMBA

- To document and synthesize knowledge on the biological richness of the mountains of the world and its change through direct and indirect human influences ('global change').
- To investigate the mechanisms which create and maintain mountain biodiversity and the functional consequences in both, natural and rural high elevation terrain.
- To stimulate new research activities with a comparative emphasis and of large scale scope.
- To shape a corporate identity of the global scientific community on mountain biodiversity research and to induce transfer of knowledge. Mountain biota provide a unique opportunity for a global scientific network, since they occur at all latitudes.

The network activities of GMBA

The GMBA network was initiated by the Swiss Academy of Sciences in 1999 and was inaugurated at the first International Conference on Mountain Biodiversity in Rigi–Kaltbad, Switzerland in September 2000. The GMBA network office is directed at the University of Basel under the auspices of the Swiss Academy of Sciences (Swiss Biodiversity Forum) and DIVERSITAS (Paris). It will support and coordinate the following network activities:

- Worldwide stimulation of scientific research within the GMBA scope, formation of consortia for joint research and platform for peer evaluations of contributions for coordinated research initiatives (e.g. in the frame of DIVERSITAS, the IGBP Mountain Research Initiative (MRI), GCTEs Focus 4; United Nations Environmental Programme (UNEP), Global Environmental Facility (GEF)).
- Organisation of thematic workshops (see: www.unibas.ch/gmba/workshops.html).
- Edit and distribute reports on GMBA activities and maintain links to international organisations and funding agencies.
- Production of executive summaries and press releases to inform national and international agencies, politicians and the public.

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Prof. Guangwei Chen, Nepal (Asia)
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