

# Global Mountain Biodiversity Assessment



Global Mountain  
Biodiversity Assessment  
a cross-cutting network of DIVERSITAS



**DIVERSITAS**  
an international programme  
of biodiversity science

Of all people, 12% live in mountains and 50% depend on goods and services provided by mountains, such as water. While mountains cover one fifth of the terrestrial land area outside the polar regions, the alpine life zone alone (above the treeline) makes up only 3% of the Earth's surface, but harbours at least 10'000 or 4% of all vascular plant species. This disproportionate richness in species is important for slope stability and the key ecosystem services in mountains. Mountain Biodiversity is of prime conservation value, as mountains host half of all 34 global biodiversity hot spots.

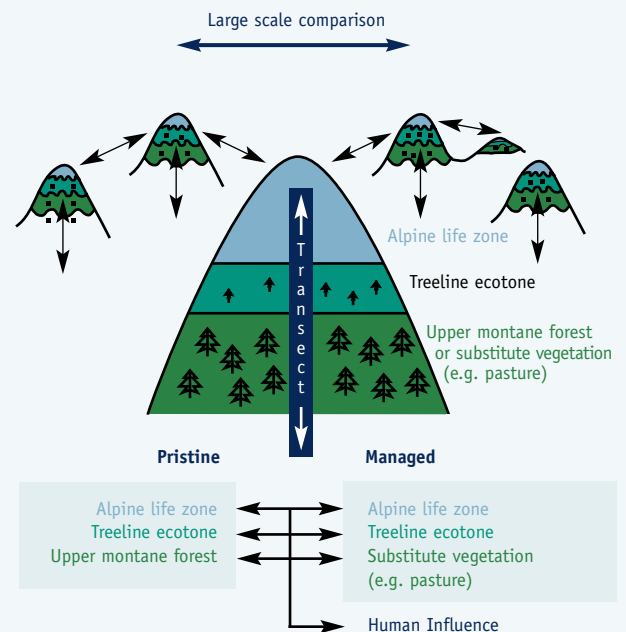


Photo: E. Hiltbrunner

## Facts on Mountain Biodiversity

- Steep terrain, the compression of climatic zones and landscape fragmentation cause high biological richness of mountains.
- While absolute species richness declines with altitude, the elevational decline of land area causes species richness per area to remain fairly constant for certain organismic groups such as higher plants.
- High alpine plant species diversity is also related to the small size of individual plants permitting the coexistence of a diverse suite of taxa (with their animal and fungal partners) in a small area.
- Although alpine species are mainly long-lived and geographically isolated, their genetic diversity within populations is surprisingly high due to effective breeding systems.

## GMBA focuses on biodiversity of high mountains worldwide



# Global Mountain Biodiversity Assessment

A Cross-cutting Network<sup>1</sup> of DIVERSITAS



**Mountains occur globally at all latitudes, thus providing an excellent opportunity for a global biodiversity research network. The Global Mountain Biodiversity Assessment (GMBA) of DIVERSITAS aims at exploring and explaining the biological richness of mountains and its responses to global change.**



GMBA aims at synthesising high elevation biodiversity data. The network has a specific high elevation focus, including the upper montane belt, the treeline ecotone, the alpine and nival belt and their human transformations. A central paradigm is that functional insight and theory will only emerge from large-scale comparison. This includes cross- and intercontinental comparisons, as well as elevational transects.



GMBA is dedicated to shaping a global corporate identity in the widely scattered mountain research community. GMBA organises workshops and publishes synthesis papers and books on important mountain biodiversity themes and develops research programs (e.g. the Moshi-La Paz Research Agenda on land use effects on (sub-) tropical mountain biodiversity).



GMBA has become a major scientific partner of the Convention on Biological Diversity for mountains and contributes to the implementation of the work program on mountain biological diversity. GMBA also coordinated and contributed to the mountain chapter of the Millennium Ecosystem Assessment (the “IPCC of Ecosystems”, [www.maweb.org](http://www.maweb.org)).



<sup>1</sup> DIVERSITAS' Cross-cutting Networks address topics of high global importance including biodiversity in mountain, freshwater, and agricultural ecosystems, and the issue of invasive alien species. Their foci are aligned with DIVERSITAS Core Projects – bioDISCOVERY, ecoSERVICES and bioSUSTAINABILITY – which aim to identify and monitor existing biodiversity, gather information about how biodiversity change affects ecosystem functions and services, and aim to provide the scientific basis for policy to support a sustainable use of biodiversity.

# bio diversity

## Mountain biodiversity and bioDISCOVERY

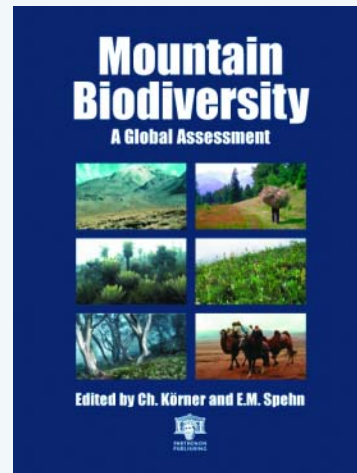


Photo: E. Hiltbrunner

### How much mountain biodiversity is there? How is it changing – and why?

Mountains have been described as islands of biodiversity surrounded by an ocean of human-altered landscapes. Indeed, many plants and animals found in mountain habitats have disappeared from lowland regions, crowded out by human activities. The alpine life zone above the climatic treeline hosts a vast biological richness, exceeding that of many low elevation biota. Many organisms adapt and are highly specialized to these high-altitude microhabitats.

Mountain biodiversity is currently threatened by human induced global change. Cold regions with their specifically adapted biota are those areas where climatic warming would have greatest ecological consequences, reducing available land area for alpine species with the possible loss of some alpine ecosystems from low-altitude summits (see GLORIA project: <http://www.gloria.ac.at/>). However, these changes in mountain biodiversity caused by climatic warming will most likely be superseded by heavy anthropogenic impacts, such as overgrazing, complete abandonment and inappropriate land management in the short term.



Mountain Biodiversity: A Global Assessment (eds Ch. Körner & EM Spehn), 2002, Parthenon Publishers, New York, London.

This book contains the result of the first global conference on mountain biodiversity of GMBA, in the year 2000 at Rigi-Kaltbad, Switzerland.

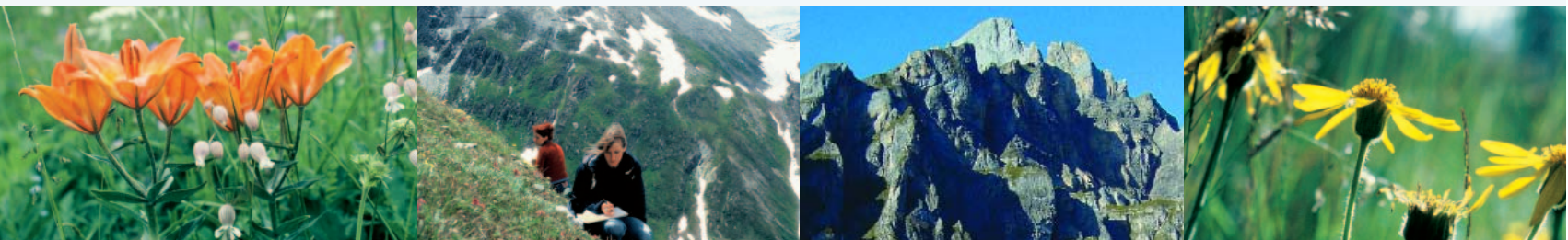


Photo: E. Hiltbrunner

### Focus 1

#### Geo-referenced species databases – a new tool for the assessment of mountain biodiversity

GMBA carries out assessments of available geo-referenced mountain biodiversity information. The network office of GMBA is currently assembling information on mountain species richness available in large databases. Using a standardized procedure, we aim for a global, statistical assessment of geo-referenced mountain biodiversity information of various mountain regions. Up to now, worldwide databases on organisms have not been mined for such an assessment with the goal to elaborate global conditions and trends in organismic taxonomic diversity with altitude. Results will be presented at a forthcoming, GMBA mountain-data base conference (to be held late in 2006 or early in 2007) and published in a volume of the GMBA series with CRC Press.

We highly welcome input to this latest topic.

# ecosystem

## Mountain biodiversity and ecoSERVICES



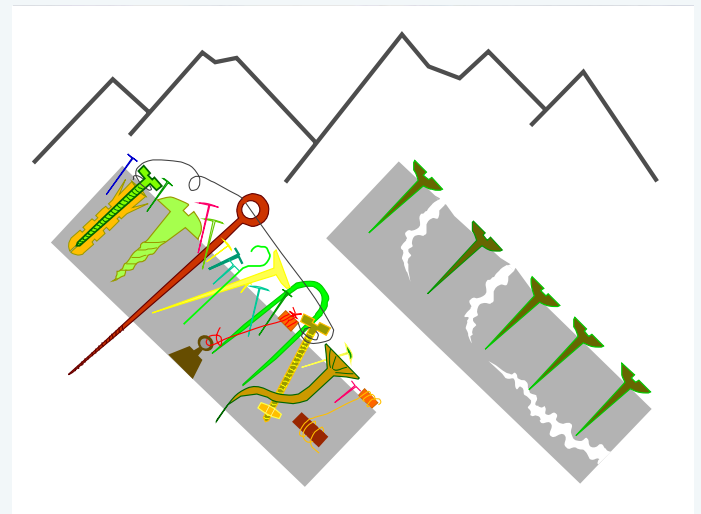
Photo: E. Hiltbrunner

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### What is the significance of biodiversity for mountain ecosystems and for the delivery of ecosystem services?

Mountain biodiversity is probably the best indicator of mountain ecosystem integrity. Functional implications of mountain biodiversity are strongly related to slope stability. Traffic routes, settlements, streams and lakes, and also water reservoirs all depend on the integrity of upslope systems. Mountain hydrology is strongly influenced by the type of vegetation and its stability. Sustainable land use of high elevation grassland is associated with high biodiversity, productivity and catchment value.

Does it matter for catchment value whether the vegetation is composed of trees, shrubs, dwarf shrubs, grassland or a diverse mixtures of these? What if specific taxa become dominant in response to land use?



### Roots and Rhizomes: nature's diverse screws and nails for mountain soils.

Sustained downslope services such as water yield and erosion control depend on slope stability, which in turn depends on a diverse and intact vegetation cover with its associated animal and microbial life.

# nservices



**ecoservices**

a core project of DIVERSITAS



## Focus 2

### Soil and slope stability are key mountain ecosystem services

One of the core hypotheses of GMBA is that a highly structured and diverse ground cover is the best insurance for the maintenance of intact slopes exposed to erosional forces. Natural diseases, divergent life cycles, and varying sensitivity to stress and disturbance may eliminate different players, at least periodically. The more physio- or morphotypes of plant species co-occur, the less likely will extreme events lead to vegetation failure and resulting soil erosion.

Both intensification and abandonment of land use in the alpine zone decrease plant biodiversity as compared to traditional land use patterns. Sustainable grazing regimes can, however, facilitate high diversity and reduce evapotranspiration and increase runoff without causing erosion, a commonly unaccounted benefit of grazing the highlands.

GMBA advocates research in this field with specific reference to extreme events (heavy rainfall, drought).

### Mountain Biodiversity and catchment value – a global network of field experiments

GMBA is currently setting up a network of field experiments, aiming at a quantification of the influences of land use and biodiversity on catchment value in steep mountain terrain. A comparison of different mountain regions with different land use histories will allow to generalise results.

Currently, GMBA associated research sites are located in the Swiss Alps, the Central Caucasus (Georgia), the Bolivian Altiplano. A new research site will soon be established in central Tibet.

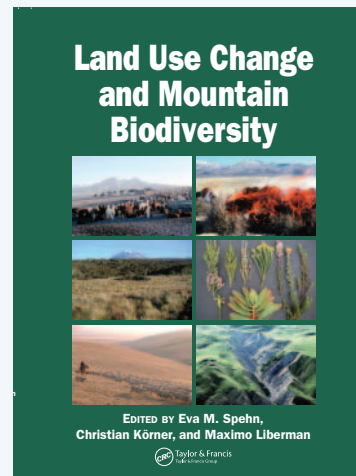
## Mountain biodiversity and bioSUSTAINABILITY



### What can we do to promote more sustainable use of biodiversity and improve human well-being?

The “global” mountain biome is currently under great threat. Human land use has shaped mountain biota worldwide, however the expansion and intensification of land use in the uplands as a result of population growth and poverty is endangering this fragile ecosystem. Nevertheless, there is a direct link between land-use and biological richness, since sustainable land-use often increases biodiversity, thus enhancing ecosystem services like water supply and soil stability.

Upland grazing and pasturing and the associated animal trampling in the tropics and subtropics have a significant influence on the integrity and biological richness. The sustained usefulness of large mountain areas is one of the prime concerns of conservationists all over the world. Intact alpine ecosystems are also crucial for life downslope, through teleconnections for distant lowland regions which depend on mountain water (e.g. the Nile connects Cairo with the highlands in East Africa).



Land Use Change and Mountain Biodiversity  
(eds. E.M. Spehn, M. Libermann, C. Körner) 2005, CRC Publishers, Boca Raton.  
Also available in Spanish.



Moshi – La Paz Research Agenda on land use effects on tropical and subtropical mountain biodiversity, 2003, DIVERSITAS newsletter n° 5, pp. 12–14.  
Main topics: please see opposite page.





**bioSUSTAINABILITY**

a core project of DIVERSITAS



Photo: E. Hiltbrunner

### Focus 3

#### Land use change and mountain biodiversity

GMBA advocates studies on the human influence on natural and cultural landscapes in the mountains aiming at encouraging sustainable development in rural areas. This was implemented in a recent GMBA project tackling the effects of changes in land use traditions on mountain biodiversity, with a focus on worldwide experiences with management of high elevation biota.

The project “High Mountain Biodiversity and Sustainable Land Use in the Subtropical and Tropical mountains”, with financial support by the Swiss Agency for Development and Cooperation and food and Agriculture Organisation FAO, included two workshops in Tanzania (2002) and the Bolivian Andes (2003). A synthesis of these workshops provides examples on how mountain land use enhances or reduces biological richness, depending on grazing or fire intensity, post-fire management and the pace of land use changes.

(See publication on the opposite page.)

#### The GMBA Moshi – La Paz Research Agenda on “Land use effects on tropical and subtropical mountain biodiversity”

##### Priority research questions on

- 1 The use of highland vegetation and husbandry systems (food)
- 2 Fire ecology
- 3 Highland cropping, hunting and gathering, and medicinal plants
- 4 Regeneration and re-vegetation outside forests
- 5 Upper montane forest and the high elevation treeline (fiber and fuel)
- 6 Cross-cutting research issues (e.g. watershed management, climate change, indigenous knowledge and participation of local stakeholders).

Download at: <http://gmba.unibas.ch/publications/pdf/GMBAResearchAgenda.pdf>

# Top reasons to promote conservation and sustainable use of mountain ecosystems

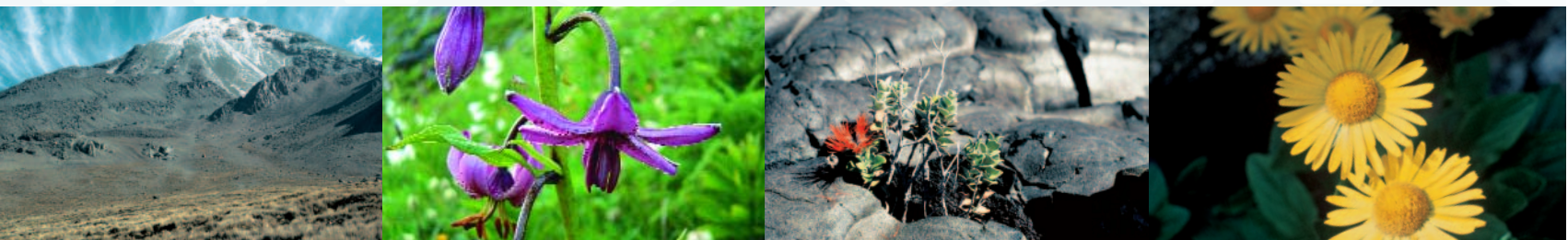


Photo: E. Hiltbrunner

## Mountains harbour an extremely high biological diversity

Because of the compression of climatic life zones with altitude and small-scale habitat diversity caused by different topoclimates, mountain regions are commonly more diverse than lowlands and are thus of prime conservation value. They support about one quarter of terrestrial biological diversity, with nearly half of the world's biodiversity hot spots concentrated in mountains.

## The remoteness of mountains helped to preserve a high cultural diversity

Geographically fragmented mountains support a high ethno-cultural diversity. For many societies, mountains have spiritual significance. Mountain populations have evolved a high diversity of cultures, including languages, and traditional agricultural knowledge commonly promoting sustainable production systems.

Source: Koerner, C., Ohsawa, M. et al, 2005: Mountain Systems.

Chapter 24 in: Millennium Ecosystem Assessment, 2005. Current State and Trends: Findings of the Condition and Trends Working Group. Ecosystems and Human Well-being, vol. 1., Island Press, Washington DC.

## Half of the human population depends on mountains

Mountains occupy about one fifth of the terrestrial surface. Twelve percent of the world's human population lives in mountains, and eight percent at their edges (20% or 1.2 billion in total), and half of humankind depends in one way or the other on mountain resources (largely water).

## Mountain ecosystems are exceptionally fragile

Mountains are subject to both natural and anthropogenic drivers of change. These range from volcanic, seismic events and flooding to global climate change and the loss of vegetation and soils because of inappropriate agricultural and forestry practices and extractive industries. Mountain biota are adapted to relatively narrow ranges of temperature (and hence altitude) as well as precipitation. Because of the sloping terrain and the relatively thin soils, the recovery of mountain ecosystems from disturbances is typically slow or does not occur at all. Ecological integrity of mountain ecosystems is key to the safety of settlements and transport routes.

# Mountain



## **Mountains are water towers of the world**

Mountains supply water to nearly half of the human population, including some regions at great distance from mountains. Mountains are especially important in buffering water supply in those regions with only one wet season per year (monsoon and mediterranean climates, in the tropics and subtropics), i. e. where most people live.

## **Recreation and tourism**

Scenic landscapes and clean air make mountains target regions for recreation and tourism. In many mountain areas, tourism is a special form of highland-lowland interaction and forms the backbone of regional as well as national economies. Thirty-two percent of protected areas are located in mountains (9345 mountain protected areas covering about 1.7 million square kilometers).

## **Mountains often represent political borders, restrict transport to narrow corridors, and are refuges for minorities**

Mountains are often focal areas of armed conflicts. Further conflicts arise from the commercial exploitation of natural resources, usually by outside interests, and from ambiguity regarding traditional land use rights. Profits from extractive industries in mountains are neither reinvested in the management of upland resources nor in the provision of benefits to mountain communities.

## **In general, poverty and vulnerability of people is higher in mountain regions than elsewhere**

Of the 1.2 billion people which live in or near mountains, 90% live in developing countries and countries in transition, with one third of these in China and half in the Asia-Pacific region. Some 90 million mountain people (and almost all people living above 2500 meters) live in poverty and are considered especially vulnerable to food insecurity. Both poverty and remoteness are responsible for poor medical care and education systems in many mountain regions. Upslope land use pressure puts mountain ecosystems at risk in many parts of the world. Industrial use, forest destruction, overgrazing, and inappropriate cropping practices lead to irreversible losses of soil and ecosystem function, with increased environmental risks in both mountains and adjacent lowland areas.



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**GMBA Scientific Steering Committee 2006–2008**

Christian Körner, University of Basel, Switzerland (Chair)  
Mary Kalin Arroyo, University of Chile, Chile  
Richard Bardgett, University of Lancaster, United Kingdom  
Ray Callaway, University of Montana, USA  
Katharine Dickinson, University of Otago, New Zealand  
Michael Donoghue, University of Yale, USA

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Hang Sun, Kunming Institute of Botany, China

**Official delegates of associated initiatives:**

Harald Pauli, University of Vienna, Austria (GLORIA)  
Hansjörg Dietz, ETH Zurich, Switzerland (MIREN)

**GMBA Executive Director:** Eva Spehn, University of Basel, Switzerland

The GMBA Scientific Steering Committee (SSC), which comprises leading scientists from around the globe, provides guidance for the programme as a whole. The staff of the GMBA office (Eva Spehn, Sylvia Martinez) carries out the management and coordination of GMBA network activities. In collaboration with the GMBA office based at the University of Basel, the Steering Committee evaluates and endorses research projects in order to facilitate inter-/national funding, initiates new and collaborative research projects and organises workshops on specific mountain biodiversity themes.

Like all international global change research networks, GMBA is not a funding agency. GMBA rather depends on funds. The GMBA office is currently (2004–2007) funded by the Swiss National Research Foundation (SNSF). Additional activities rely on project based funds provided by different Swiss and international sources. GMBA activities so far (2000–2005) received funding by the Swiss Agency for Development and Cooperation (SDC), the Swiss Federal Office for Education and Science, the Swiss Agency for the Environment, Forests and Landscape, the Swiss Federal Office for Agriculture, the Swiss Academy of Sciences (SCNAT). International funds were provided by DIVERSITAS (Paris), Food and Agricultural Organisation (FAO, Rome), United Nations University (UNU, Tokyo), SERNAP (Servicio Nacional de Areas Protegidas de Bolivia)/GEF II (La Paz).

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