



Working paper N° A/2008

**Background document to the EURECA spotmeter  
on Peak Performance  
Alpine ecosystems under pressure**

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**October 2008**

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**Context:**

The Topic Centre has prepared this Working paper in collaboration with the European Environment Agency (EEA) under its 2008 work programmes as a contribution to the EEA's work on ecosystem assessment.

**Citation:**

Please cite this report as Halada, L., 2008. Background document to the EURECA spotmeter on Peak Performance - Alpine ecosystems under pressure. ETC/BD report to the EEA.
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ETC/BD Working paper N° A/2008

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The following document was prepared as a background for discussion to the expert group workshop on EURECA spotmeters to be held in Copenhagen on 10-11 November 2009.

The expert meeting will explore the potential of a story-line based assessment, including on which 'hotspots' to focus in order to illustrate state and trends of areas/issues of particular interest - from an ecosystem service perspective - within major ecosystems in Europe.

This Background Document introduces some of EEA's ideas on what the FBtN Spotmeter could look like, based on consultation with different stakeholders since the 1<sup>st</sup> EURECA general expert meeting of January 2008, and puts forward some key considerations for its further development. It aims at helping prepare and guide discussions at the Spotmeter expert meeting of 10-11 November 2008.

## Peak Performance

### Alpine ecosystems under pressure

#### Introduction

Mountains cover 24% of the land surface of our planet. Twenty percent (1.2 billion) of the world's human population lives in mountains or at their edges, and half of humankind depends in one way or the other on mountain resources (largely water) (Körner et Ohsawa 2005).

The importance of mountain ecosystems is highlighted also by inclusion of separate chapter 13 (Managing fragile ecosystems: sustainable mountain development) in Agenda 21 adopted by the UN. Agenda 21 stated: "About 10 per cent of the Earth's population lives in mountain areas with higher slopes, while about 40 per cent occupies the adjacent medium- and lower-watershed areas. Mountains are an important source of water, energy and biological diversity. Furthermore, they are a source of such key resources as minerals, forest products and agricultural products and of recreation. As a major ecosystem representing the complex and interrelated ecology of our planet, mountain environments are essential to the survival of the global ecosystem".

Environmental conservation and sustainable land use in the world's mountains are not only a necessary condition for sustainable local livelihoods, they are also key to human well-being for nearly half the world's population who live downstream and depend on mountain resources. The mountain ecosystem services make specific contributions to lowland and highland economies. Mountains play a key role in the water cycle, with feedback to the regional climate and by modulating the runoff regime. Mountain vegetation and soils play a significant role in reducing or mitigating risks from natural hazards. Mountain forests, for instance, protect from avalanches and rockfall; their waterholding capacity reduces peak stream flow; they are an important carbon pool; and they provide timber for fuelwood and non-timber products, including game and medicinal plants. Mountains are also used for grazing and subsistence farming. Mountain ecosystems are significant for global biodiversity and in addition they have intrinsic spiritual and aesthetic value.

Worldwide, 13.3% of the mountain area is cultivated, while the urban ("artificial") land area amounts to 0.05%, or 15,400 square kilometer, making it nearly negligible at the global scale. Overall, it is very likely that about half of the global mountain area is under some sort of human land use.

The social dimension is an important element in mountains. Mountain regions are considered as having permanent natural handicaps, due to topographic and climatic restrictions on economic activity and/or peripherality. As consequence, both poverty and ethnic diversity are higher in mountain regions, and people are often more vulnerable than people elsewhere. Of the 8% living above 2,500 meters, almost all (about 90 million) live in poverty and are considered highly vulnerable to food insecurity. Both poverty and remoteness are responsible for poor medical care and education systems in many mountain regions worldwide.

Mountains are highly vulnerable to human and natural ecological imbalance. The fragility of mountain ecosystems represents a considerable challenge to sustainable development due to the fact that the impacts of unsustainable development are more rapid, heavier, and more difficult to correct than in other ecosystems. Some consequences can be irreversible, such as the extinction of species and the loss of soil and cultural diversity.

The above mentioned topics emphasize need of considering mountains as systems in the European Ecosystem Assessment. EURECA should reflect specific features related to mountain ecosystems within the European territory, including the following:

- European mountain landscapes are cultural landscapes reflecting long-term interactions of human beings with biophysical systems.
- The poverty in European mountains is not such crucial problem as in some other parts of the world, it has different dimension. Nevertheless, mountains in Europe often represent marginal regions with typical consequences for local economies and mountain communities.
- While the agricultural utilization persists or its pressure increases in other mountain regions, European mountains are facing with abandonment of agricultural land and reduction of traditional systems of the land use.

- The tourism and recreation are highly developed in European mountains and represent the significant contribution to national economies. They are connected with urbanization of mountains, development of centres of tourism, infrastructure and transport facilities building.

## Issues at stake

Several issues could be addressed in a Spotmeter chapter on high mountains.

### **Mountains are centres of biodiversity and endemism**

Mountains are a storehouse of biological diversity and endangered species (Agenda 21). They support about one quarter of terrestrial biodiversity, with nearly half of the world's biodiversity hot spots concentrated in mountains (Körner et Ohsawa 2005). It is not only the diversity of natural mountain species that is of value to humankind, both intrinsically and as a source of "wild foods" such as mushrooms, game and birds, and many other non-timber forest products. Mountains are also important as centres of crop diversity.

### **Mountains are important for nature protection**

Worldwide, thirty-two percent of protected areas are in mountains (9,345 mountain protected areas covering about 1.7 million square kilometers) (Körner et Ohsawa 2005). Many protected areas are also designated as UNESCO Biosphere Reserves, in 2003, there were 436 Biosphere Reserves (Chape et al. 2003), at least 190 of which were in mountain areas (UNEP-WCMC 2002). In the World Heritage List of UNESCO are 88 natural World Heritage Sites and 16 mixed (natural and cultural) ones in mountain areas (UNEP-WCMC 2002). A major weakness in the mountain protected areas global system is that most of the units are discrete, covering single mountains. Connectivity between these isolated islands is needed along the ranges or in biogeographic clusters.

### **Tourism/recreation in mountains**

The importance of mountain regions as global centres of tourism continues to grow. 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. The urbanisation of mountain centres of tourism creates and building of relevant infrastructure is often in conflict with principles of sustainable development and fragility of mountain ecosystems. Winter tourism is particularly vulnerable to climatic change in areas near the lower winter snowline. For example, it is likely that a number of winter resorts in the European Alps situated below 1,500 meters above sea level will be forced to close in the near future, which in turn will increase demand on high-elevation resorts.

### **Mountainous agriculture**

Mountain agriculture provides subsistence for about half a billion people. Mountain livelihood systems are generally diverse within a variety of agricultural and nonagricultural activities. The general trends reflect the common economic, developmental, and demographic differences between industrial and developing countries. While abandonment of high-elevation rangelands is common in the former, overexploitation has reached dramatic dimensions in many developing countries, a result of unprecedented population pressure.

### **Mountains and forests**

Mountain forests account for 26.5% or 9.5 x 10<sup>6</sup> square kilometres of the global closed forest area. Nearly 10% of the global mountain forests are under some sort of protection. These forests are essential to protect fragile mountain slopes from erosion and leaching processes, for protection of mountain species and integrity of mountain forest ecosystem. Sustainably managed semi-natural forests provide many ecosystem services, including tradable products such as timber and various non-timber products, and at the same time retain high biodiversity (Peterken 1981). But heavily disturbed or damaged montane forests are often invaded by fast-growing, early successional tree or shrub species. Recent changes in how forest services are valued, with a shift from simple timber production

toward biodiversity, aesthetic, spiritual, and recreational aspects, may help change forest plantations to more natural forest in some cases. The forest cover recently increases in the mountainous countries of Europe (FAO 2001).

### **Role of mountains as carbon sources and/ or carbon sinks**

Globally, mountain ecosystems at temperate latitudes are among the largest biotic carbon reserves because these mountains tend to be forested, accounting for, for instance, 25–50% of the contribution to the total U.S. carbon stock and up to 75% of the western U.S. carbon stock .

### **Importance of mountains in water supply and water quality maintenance**

At the global scale, mountains' greatest value may be as sources of all the world's major rivers, and many smaller ones. Mountains play a critical role in the water cycle by capturing moisture from air masses ("water pumps") and by storing water in mountain glaciers, permafrost, snowpacks, soil, or groundwater ("water towers"). Mountains supply water to nearly half the human population, including some regions far from mountains - in semi-arid and arid regions, over 90 percent of river flow comes from the mountains.

### **Importance of mountains in erosion and natural hazards prevention**

Services provided by mountains depend on slope stability and erosion control provided by a healthy vegetative cover. Soil erosion can have a devastating impact on the vast numbers of rural people who depend on agriculture in the mountain and hillside areas."

### **Sensitivity /fragility/resilience of mountain ecosystems**

Mountains are subject to both natural and anthropogenic drivers of change. Because of the sloping terrain and the relatively thin soils, the recovery of mountain ecosystems from disturbances is typically slow or does not occur. Human activity in mountains that is not in balance with the environment can have serious consequences, resulting, for example, in soil erosion, pollution of natural waters, disruption of water and energy balances, elimination of both animal and plant species, loss of soil productivity, increasing food deficits, malnutrition and poor standards of living. Land use pressure puts mountain ecosystem integrity 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.

Mountains are the areas most sensitive to all climatic changes. Mountain biota are adapted to relatively narrow ranges of temperature (and hence altitude) and precipitation. General circulation models predict a warming in high northern latitudes and also in the mid to upper troposphere in the tropics and sub-tropics. Climatic change may enhance or reduce precipitation, depending on the region. A reduction of moisture in already dry mountain regions will enhance fire frequency. The reduction in glacier volumes is expected to have a strong impact on dry-season river flows in rivers fed largely by ice melt. This will very likely affect the provision of downstream water for drinking, hydropower, and irrigation. Conversely, it is likely that some maritime mountain regions may experience increased precipitation under warmer conditions, which may lead to slope instability, mass movement, and accelerated erosion. Climatological changes in mountain ranges are likely to have much more readily apparent impacts than in the surrounding lowlands. Winter recreation, availability of water, hydroelectricity, irrigation, and the sudden release of glacier lakes as glaciers continue to thin and retreat are all potential components.

The European mountains are exposed to increased deposition of pollutants for decades. The deposition rates of sulphur decreased significantly in 90-ties while nitrogen deposition is still in high concentrations. The chronic pollution has important impact to mountain ecosystem health, their productivity and resistance to other disturbances.

### **Mountains as sanctuaries of traditional land use, life style and traditional knowledge**

Mountain populations have evolved a high diversity of cultures, including languages, and traditional agricultural knowledge commonly promotes sustainable production systems. Mountain regions are

considered as having permanent natural handicaps, due to topographic and climatic restrictions on economic activity and/or peripherality. The consequences of such marginal position include poverty, unemployment, poor health and bad sanitation. The vulnerability of mountain people has a variety of aspects and many different causes: availability of land; ownership of land; environmental constraints (climate, soils, slope, natural hazards); food insecurity; lack of access to markets, education, and health care; dependence on one single economic factor (such as only forests, livestock, or tourism); inappropriate governmental or industrial interventions; high specialization and interdependency of mountain social and land use systems; and globalization. Often mountain resources are extracted without benefit to local communities in order to support lowland economies, thereby contributing to the further marginalization of mountain people.

### **Drivers of biodiversity change**

Environmental and economic change is a constant and familiar factor in mountains, but the magnitude and rate of change and its influence on social systems in recent times threatens to overwhelm mountain ecosystems - with serious consequences for the well-being of mountain communities as well as hundreds of millions of people downstream. Mountain systems are changing more rapidly than at any time in human history.

Direct drivers – natural: earthquakes and volcanoes. Anthropogenic and man-induced: climate change, conversion of land in mountains, the use of fire, and animal husbandry is another major driver, large-scale mining, construction of roads in mountain areas, the large-scale building of vacation homes and resorts, forest clearing for commercial timber. Threats to human well-being from these drivers range from increased risk of avalanche to loss of income from tourism.

Indirect drivers: lack of public awareness, lack of real valuation of resources and services, lack of knowledge transfer and indirect socioeconomic forces.

### **Relevant policies**

There exist many initiatives and policies to protect mountains, but a worldwide mountain-focused convention is still missing.

#### **Legal frameworks and other international initiatives for mountain areas:**

- UN Agenda 21, chapter 13 “Managing fragile ecosystems: sustainable mountain development” (FAO – task manager)
- Convention on World Heritage
- UNESCO MAB - Biosphere Reserves programme
- CBD work programmes on mountain areas (<http://www.cbd.int/mountain/wopo.shtml>)
- International Geosphere-Biosphere Programme - the Mountain Workplan
- the Global Mountain Initiative (GMI) of the Consultative Group on International Agricultural Research (CGIAR)
- Alpine Convention (1991)
- Carpathian Convention
- National legal instruments

#### **Other relevant legal frameworks for sustainable management of mountain areas**

- EC Water Framework Directive
- EC Directive on Environmental Impact assessment
- EC Directive on Strategic Environmental Assessment

#### **European policies and strategies**

- Common Agricultural Policy, including rural development
- Communication of the European Commission "Halting the loss of biodiversity by 2010 – and beyond; sustaining ecosystem services for human well-being" and Action Plan to 2010 and beyond
- European Biodiversity and Landscape Strategy EPBLS
- European Landscape Convention

- Kiev Ministerial Declaration 2003 - Sustainable development in mountain areas has been a work area/theme in the Environment for Europe process since the 2003 Kiev Environment for Europe Ministerial Conference. Article 64 of the Kiev Declaration states:  
*"We welcome the progress made in the protection, sustainable development and management of mountain regions, and the strengthening of cooperation among transboundary mountain regions, such as the Alps, the Carpathians, the Caucasus and Tianshan, through the sharing of experiences and technical cooperation. We emphasize the importance of implementing the partnerships for sustainable development of mountain regions in order to effectively address imminent challenges in biodiversity conservation, sustainable local development, water management and flood prevention and control in mountains and adjacent lowlands. (...)"*
- Belgrade Ministerial Declaration - Paragraph 22 of the Belgrade Ministerial Declaration states:  
*"We welcome the mountain partnerships within and between the Alps, the Carpathians, the South-East European mountain region, the Caucasus and the mountain regions of Central Asia. We recognize the benefits from the existing legally binding instruments for the protection and sustainable development of the mountain regions such as the Alpine and Carpathian Conventions, and welcome the initiative of South-East European and Caucasian countries to develop such instruments. We encourage the international Global Mountain Partnership to promote and foster exchanges of experience and expertise with other mountain regions in the world."*

## Preliminary ideas

Definition of mountains is different in different countries and for different purposes. The formulation of the operative definition of mountains for EURECA should represent the first step.

Several issues could then be addressed in a SPOTmeter chapter on mountain ecosystems. The following ones are tentatively proposed:

- **Provisioning services** - freshwater supply
- **Provisioning services**- food and timber
- **Regulatory services** - erosion prevention and natural hazard regulation
- **Cultural services** – recreation and (eco)tourism
- **Socio-economic perspective of mountain areas and biodiversity conservation**
- **The highland-lowland links**
- **Efficiency and sustainability of mountain areas in a highly dynamic world**

## Process

Focusing on Alps and Carpathian Conventions

## Data availability

Possible data-sources: Carpathians outlook, HNV analysis, EEA mountain assessment, Country assessments

## Selected References

Chape, S., S. Blyth, L. Fish, P. Fox, and M. Spalding, 2003: 2003 United Nations List of Protected Areas. IUCN/UNEP-WCMC, Cambridge, 27 pp.

Huber, Uli M.; Bugmann, Harald K. M.; Reasoner, Mel A. (Eds.), 2005: Global Change and Mountain Regions: An Overview of Current Knowledge. – Springer, Advances in Global Change Research, vol 23, 650 pp.

Körner, Ch., Ohsawa, M. (eds.), 2005: Mountain Systems – In: Ecosystems and Human Well-Being: Current State and Trends. Island Press: 681-716.

Nordregio, 2004: Mountain Areas in Europe: Analysis of mountain areas in EU member states, acceding and other European countries. -  
Spehn, E.,M., Liberman, M., Körner, Ch, 2006: Land Use Change and Mountain Biodiversity. – CRC Taylor & Francis, Boca Raton, 361 pp.

Thorsell, J. and L. S. Hamilton, 2004: A global overview of mountain protected areas on the world Heritage list. In: Managing Mountain Protected Areas in the 21st Century, D. Harmon and G. Worboys (eds.). Andromeda Editrice, Colledara, Italy.  
UNEP-WCMC (World Conservation Monitoring Centre), 2002: Mountain Watch: environmental change & sustainable development in mountains. Cambridge, UK.

### Relevant research projects

- Commission on Mountain Geocology and Resource Management (now Mountain Geocology and Sustainable Development) of the International Geographical Union (IGU), established in 1968;
- United Nations University (UNU) project on Highland-Lowland Interactive Systems in 1977 (now Mountain Ecology and Sustainable Development);
- International Mountain Society (IMS), founded in 1980;
- International Centre for Integrated Mountain Development (ICIMOD) in Kathmandu, Nepal, founded in 1983.
- Global Environment Facility (GEF) identified mountain ecosystems as the subject of one of ten operational programmes
- The Global Mountain Initiative is a global ecoregional research programme for sustainable mountain agricultural development, coordinated by CIP
- The Mountain Research Initiative
- Mountain Partnership
- Mountain Forum (1995), network of networks

### Links:

Mountain Research Initiative: <http://mri.scnatweb.ch/>

Alpine Convention: <http://www.convenzionedellealpi.org/index>

Carpathian Convention: <http://www.carpathianconvention.org/index.htm>

Carpathian project: <http://www.carpathianproject.eu/portal/>

Carpathian Ecoregion Initiative: <http://www.carpat.es.org/>

UNEP: [www.unep.org](http://www.unep.org), [www.unep.ch](http://www.unep.ch)

Mountain Partnership: <http://www.mountainpartnership.org/>

CBD for mountains: <http://www.cbd.int/mountain/wopo.shtml>

EUROMONTANA: <http://www.euromontana.org/>

### Projects:

Gloria project - [www.gloria.ac.at](http://www.gloria.ac.at)

SARD-M: <http://www.fao.org/sard/en/sardm/home/index.html>

GLOCHAMORE – mountain research strategy