# Applied Remote Sensing in Mountain Regions: A Workshop Organized by EURAC in the Core of the Alps

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Source: Mountain Research and Development, 27(3) : 286-287

Published By: International Mountain Society

URL: https://doi.org/10.1659/mrd.0928

# Creative Use of Mountain Biodiversity Databases: The Kazbegi Research Agenda of GMBA-DIVERSITAS

*Geo-referenced archive databases on mountain organisms are very promising tools for achieving a better understanding of mountain biodiversity and predicting its changes. The Global Mountain Biodiversity Assessment (GMBA) of DIVERSITAS, in cooperation with the Global Biodiversity Information Facility, encourages a global effort to mine biodiversity databases on mountain organisms. The wide range of climatic conditions and topographies across the world's mountains offers an unparalleled opportunity for developing and testing biodiversity theory. The power of openly accessible, interconnected electronic databases for scientific biodiversity research, which by far exceeds the original intent of archiving for mainly taxonomic purposes, has been illustrated. There is an urgent need to increase the amount and quality of geo-referenced data on mountain biodiversity provided online, in order to meet the challenges of global change in mountains.*

## Aims

The Global Mountain Biodiversity Assessment (GMBA), a cross-cutting network of DIVERSITAS, aims to encourage and synthesize research on high-altitude organismic diversity, its regional and global patterns, and its causes and functions (Koerner and Spehn 2002; Spehn et al 2005). Existing and emerging electronic databases are among the most promising tools in this field. Gradients of altitude and associated climatic trends, topographic and soil peculiarities, fragmentation and connectivity among biota and their varied geological and phylogenetic history are the major drivers and aspects of mountain biodiversity, and electronic archives provide avenues for testing their impact on life at high elevations.

This research agenda was developed at a GMBA workshop in the Central Caucasus in July 2006. It capitalizes on expertise from different fields of biology and database experts, and was developed in cooperation with the Global Biodiversity Information Facility (GBIF).

Enhancing awareness of the central role of geo-referencing in database building and use is one of the central tasks of this agenda. Once achieved, this permits linkage of biological information with other geophysical information, particularly climate data. The mountains of the world exhibit different climatic trends along their slopes, with only few factors, such as the decline in atmospheric pressure, ambient temperature and clear sky radiation changing in a common, altitude-specific way across the globe. None of the other key components of climate, such as cloudiness and, with it, actual solar radiation or precipitation and associated soil moisture show such global trends, and hence are not altitude-specific. The separation of global from regional environmental conditions along elevational transects offers new perspectives for understanding adaptation of mountain biota. Similarly, information on bedrock chemistry and mountain topography offers test conditions for edaphic drivers of biodiversity and species radiation in an evolutionary context across geographical scales.

## Data-sharing for the mountain research community

Many research projects generate biodiversity datasets that may be relevant for the wider scientific community, government and private natural resource managers, policymakers, and the public. GBIF has a mission to make the world's primary data on biodiversity freely and universally available via the Internet (www.gbif.org).

## The principle of open access

The UN Convention on Biological Diversity has called for free and open access to all past, present and future public-good research results, assessments, maps and databases on biodiversity (CBD Dec. VIII/11). Furthermore, all 47 current member countries and 35 international organizations in GBIF have committed themselves to "improving the accessibility, completeness and interoperability of biodiversity databases," and to "promote the sharing of biodiversity data in GBIF under a common set of standards." Added value comes from sharing data (Arzberger et al 2004a, b), but sharing requires respect of author rights and observation of certain rules as defined by GBIF standards (Stolton and Dudley 2004). Quite often it is only through the linking of data that scientific advance is achieved. Hence protective habits are counterproductive, given that an individual database commonly does not contain sufficient information for developing and testing theory and furthering broad understanding. Moreover, many taxonomic databases rely on the collective work of generations of scientists in a country.

## Data sources and data structure

There are 1) individual-based data (primary occurrences, an individual at a place at a particular time), and 2) taxon-based data (biological taxon characteristics such as morphology, physiology, phylogeny, ecology, genetics). These may refer to: a) vouchered primary occurrences,

b) observational data, or c) literature data. The quality and use of primary species and species-occurrence data are highlighted in Chapman (2005a–c).

A full, best-practice database entry should include the following types of data:

- Organismic data (conventional taxonomic information);
- Geo-information (coordinates, altitude);
- Habitat information (edaphic, topographic, atmospheric);
- Date and time of observation/collection/recording;
- Reference to a voucher or archive code;
- Name of collector/observer/recorder;
- Metadata provide information on datasets, such as content, extent, accessibility, currency, completeness, accuracy, uncertainties, fitness-for-purpose and suitability-for-use and enable the use of data by third parties without reference to the originator of the data (Chapman 2005b).

## Mountain-specific aspects

Given the significance of topography and elevation in mountains for local biotic conditions, reported geographical coordinates using GPS should at least provide a resolution of seconds. Elevation should always be obtained independently of GPS. Chapman and Wieczorek (2006) provide Best Practices for Georeferencing (assigning geographic coordinates to) a range of different location types. Should coordinates be missing, the BioGeomancer Classic online tool (www.biogeomancer.org) may be able to reconstruct these from locality, region or names.

Elevation data can have the following structure:

- Point data (for vouchers, data loggers, climatic stations): report as precisely as possible, with uncertainties given. In most cases a precision of 10 m elevation is enough, although earlier GPS data will offer less precision.
- Stratified range elevation data, which offer entries for certain taxa in a step by step elevational catena (eg 100-m steps). If this is not available, at least the elevational center of the variable/taxon should be provided.
- Full range or amplitude data (maximum and minimum elevation) with uncertainties. Range data are critical for making up lists of species for different elevational bands. The mid-point is insufficient.

Note that such information becomes almost useless if uncertainties in the observation are not identified. One way of getting around this is to quote the data within range width (100 m, 200 m, 1000 m). Uncertainty associated with geo-referenced localities along elevational gradients can be measured with post-hoc 3-dimensional geo-referencing (Rowe 2005).

## Additional information (some useful examples in a mountain context)

- Plants: Biological attributes such as size (height), life form, flower features, current phenology, seed size, growth form, and other special attributes. These data can sometimes be obtained from taxonomic sources and stored in relational databases.
- Animals: Biological attributes such as size (width, length, etc), trophic habit, interactions (prey, mutualistic species, host, phenology, life stage).
- Abundance or frequency measures (eg random sample of quadrats). Information on rareness, conservation status, dominant associates, population structure, if available.

## Visions and suggestions for scientific use of mountain biodiversity e-data

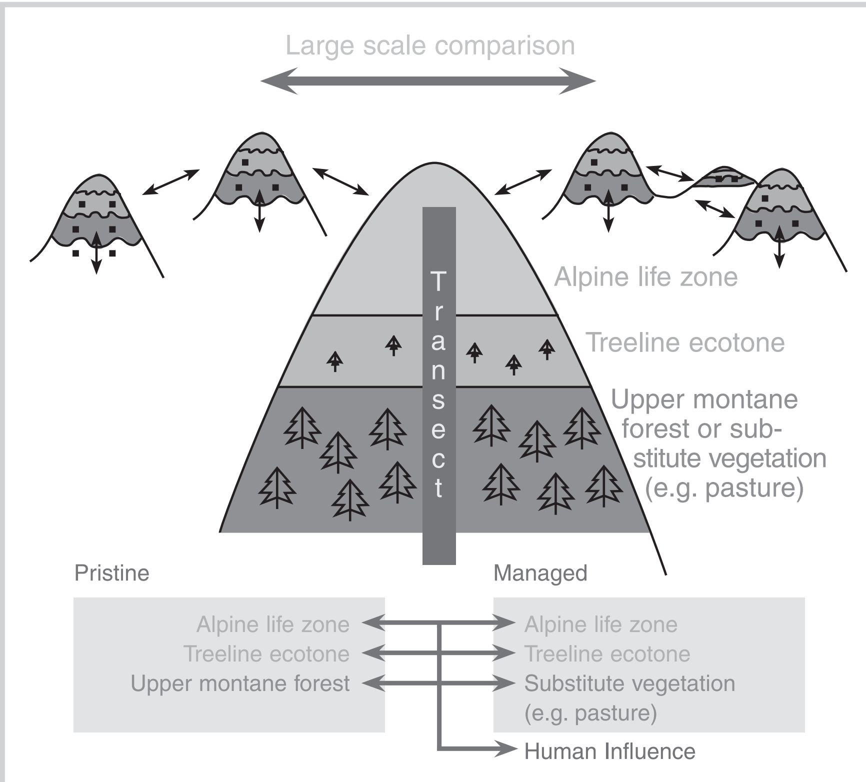
The power of openly accessible, interconnected electronic databases for scientific biodiversity research by far exceeds the original intent of archiving for mainly taxonomic purposes, as will be illustrated by the following examples. Each example starts with a scientifically important question or hypothesis **(what?)** and continues by providing a motive (**why** would we want to know this?) and suggestions about **how** to approach this task by data mining and data linking. The application of a common mountain terminology (a convention) is an essential prerequisite for communication (Figure 1).

## Mountains—a laboratory for understanding basic questions of evolution: How is mountain biodiversity generated, evolved, assembled?

***What?*** The origin and assembly of mountain biota have to be understood in a historical context. For a given mountain area: where did its taxa arise, and how were taxa assembled over time? How many of the extant species resulted from the radiation of lineages that evolved within the area as opposed to the radiation of lineages that were introduced from other areas or even continents or other ecosystems? How important has long-distance dispersal been for the assembly of mountain biota, and how and when did evolutionary lineages migrate from one mountain area to others? What are the main sources of long-distance dispersal events? Has the capacity of long-distance dispersal itself been a factor in the rapid radiation of alpine lineages?

***Why?*** Mountains are islands of varying size, and thus present a good opportunity to ask questions about genesis of mountain biota, the impact of competition from oth-

**FIGURE 1** The GMBA concept of vertical and horizontal comparison of mountain biota.




er biota on speciation rates, and adaptive evolution. Where arid climates have developed at lower elevations, alpine areas can act as "conservation areas for phylogenetic lineage" for lowland lineages (see Hershkovitz et al 2006). Mountains have acted (and will act) as refugia for species survival during extreme climatic events, including for ancient phylogenetic lineages. Rapid rates of speciation have been documented in recent phylogenetic studies for genera in high-elevation areas (eg Hughes and Eastwood 2006). Rapid evolution is also a factor for predictions related to climate change.

***How?*** Combine data from phylogenetic and phylogeographic databases, regional species lists, classification by elevation (eg selection of alpine species), geographic distribution and species range limits. Information on resilience of a species to change (life form, life cycle characteristics, reproduction, and phenological data).

### Are there common elevational trends in mountain biodiversity? What drives them?

***What?*** The overarching issue is to challenge the common notion that species richness in alpine areas is necessarily low. Life conditions change with elevation in global but also in very regional ways, and equal steps in elevational climatic change are associated with decreasing available land area per step (belt; Koerner 2000). Furthermore, land surface roughness (habitat diversity) commonly increases with elevation. Finally, mountains represent archipelagos of contrasting connectivity and island size. How is biodiversity influenced by these 4 aspects of elevation (climate, area, fragmentation and roughness)?

***Why?*** The wide amplitude of climatic conditions and topographies across the world's mountains offers an unparalleled opportunity for developing and testing biodiversity theory. How does species richness in mountains change with latitude or elevation; do reductions in species richness on opposite-facing slopes parallel altitudinal gradients and/or similar temperature gradients (Figure 1)? Ratios of trends in various taxonomic groups make it possible to distill biotic interdependencies or at least correlative associations. Such biodiversity ratios can serve as predictive tools. The climatic relatedness of emerging trends can assist in projections of climate change impacts.

***How?*** The major tool is selective comparison of stratified biodiversity data for various organismic groups across elevational transects of major mountain systems. Key problems to be solved are the confounding between altitude-specific (global) and region-specific (local) climatic trends and the geological age and spatial extent of mountain systems. Links with fine resolution GIS and world climate databases are essential.

### Are there typical elevational trends in organismic traits across the globe?

***What?*** Across the globe we observe the independent evolution of certain traits as elevation increases (convergent evolution). Are these trends and traits related to common elevational gradients under environmental conditions (eg temperature) or do they reflect specific climatic trends that are not common to all mountains (eg precipitation), and would they thus also be found at respective gradients at low elevations? Would common edaphic conditions (eg presence of scree) alone explain certain trends? Typical traits to be explored are size and mass of organisms, special functional types such as the cushion plant life form, giant rosettes or woolly plants, certain reproductive strategies, plant breeding systems, pollinator types, hibernation, dispersal characteristics, diffusivity of egg shells, etc.

***Why?*** Most of these traits cannot be modified experimentally and thus presumably reflect long-term evolutionary selection. Many of these trends relate to the basic functioning of plants and animals. We need to separate taxonomic relatedness from independent environmental action. A functional interpretation would require a mechanistic explanation: are cushion plants abundant at high elevations because of loose, poorly developed substrate, insufficient moisture, strong wind, too low temperature, short seasons, or certain combinations of these? Is high pubescence truly and generally more abundant at high elevation, and if so, under which high-elevation environmental conditions does this trend become enhanced?

***How?*** The compressed width of climatic belts in mountains offers 'experiments by nature' to test such hypotheses over short geographical distances (Koerner 2003) by comparing trends in traits across a suite of mountain transects in areas of contrasting geological/evolutionary history and different climates. A test across different phylogenetic groups would reveal taxonomic relatedness. A comparison across different latitudes could separate seasonality and absolute altitude (pressure) effects because low temperatures such as those at treeline are found at 4000 m near the equator and 500 m above sea level at the polar circle.

## Are biotic links and biodiversity ratios among organismic groups tighter with elevation?

***What?*** Functional interactions between organisms (trophic, mechanical, physiological and pathogenic) drive coexistence and competition among taxa. Do these ties become looser or tighter as elevation increases? For instance, does generalist pollination increase with elevation? Are such links (eg mycorrhization, predation, facilitation) becoming simpler (multiple vs unique partner organisms)?

***Why?*** Alpine areas provide a unique opportunity for understanding how coevolution developed. Functionally, the maintenance of species richness and mutualism is known to be critical for maintaining plant fitness in harsh environments. As biodiversity of montane environments usually decreases with elevation, it may be more and more difficult to find a host for any specialized organism, and having a wider range of hosts could be favorable. Biodiversity ratios are a promising (to be explored) tool for rapid inventory works (the diversity of key taxonomic groups as indicators).

***How?*** Comparisons of altitudinal patterns of diversity of species assemblages, use of known data on mutualistic species (eg specific pollinators, prey, mycorrhiza), linking data for different taxonomic groups (eg butterflies vs. angiosperm diversity).

## Are there functional implications of mountain biodiversity?

***What?*** What is the contribution of mountain biodiversity to ecosystem integrity, ie slope stability? What is the functional redundancy in traits among organisms in a given area, what is their sensitivity to stress and disturbance (insect outbreaks, avalanches)?

***Why?*** Ecosystem integrity on steep mountain slopes and in high-elevation landscapes is mainly a question of soil stability, which in turn depends on plant cover. The insurance hypothesis of biodiversity suggests that the more diversity (eg genetic diversity, morpho-types) there is, the less likely it is that extreme events or natural diseases will lead to a decline in ecosystem functioning or a failure of vegetation to prevent soil erosion. In steep terrain, more than anywhere else, catchment quality is intimately linked to ecosystem integrity. The provision of sustainable and clean supplies of water is the most important and increasingly limiting mountain resource.

***How?*** Old vs new inventory data, recent loss or gain of certain plant functional types (eg trees). Recent land cover change (remote sensing evidence, NDVI). Apart from information on composition of vegetation and functional traits of taxa (eg rooting depth, root architecture, growth form), geographical information is needed (geomorphology: slope, relief, soil depth; climate, precipitation, evapotranspiration, extreme rain events, snow cover duration). Comparison of different mountain regions (eg presence/absence of woody/nonwoody vegetation). Spatial land cover information can be used to develop scenarios at landscape scale.

### What are the socioeconomic impacts on mountain biodiversity?

***What?*** Humans shape mountain vegetation by clearing land, grazing, abandoning, collecting, etc, which may increase or decrease mountain biodiversity (Spehn et al 2005) and, through this, affect slope processes, erosion, water yield and inhabitability. Are areas with traditional burning regimes, in combination with grazing, poorer in species of flowering plants, butterflies, and wild ungulates than grazed areas in which burning is not a tradition? Do these trends interact with precipitation? Is high human population density at high elevations related to the specific loss of woody taxa? Is the biological richness of inaccessible microhabitats (topography-caused 'wilderness') a measure or good reference of potential biodiversity of adjacent, transformed land?

***Why?*** Of all global change effects, land use is the predominant driver of changes in mountain biodiversity. By comparing areas of historically contrasting land use regimes we can learn how these human activities shape biota. Ratios of wilderness biodiversity to adjacent managed biodiversity indicate

### Mountain terminology and GMBA concept of comparative mountain biodiversity research

GMBA distinguishes between three elevational belts and a transition zone:

- The ***montane*** belt extends from the lower mountain limit to the upper thermal limit of forest (irrespective of whether forest is currently present or not).
- The ***alpine*** belt is the temperature-driven treeless region between the natural climatic forest limit and the snowline that occurs worldwide. Synonyms for "*alpine*" are "*andean*" or "*afro-alpine*".
- The ***nival*** belt is the terrain above the snowline, which is defined as the lowest elevation where snow is commonly present all year round (though not necessarily with full cover).
- The ***treeline ecotone*** is the transition zone between the montane and alpine belts.

the actual impact of land use. The abundance of red list taxa or medicinal plants can be related to human population pressure and land use intensity.

***How?*** Linking thematic databases for land cover type, population density and climate with regional biodiversity inventories. Global comparisons across different climates and land use histories should permit distilling certain overarching trends. Comparison of intensively used high-elevation rangeland in regions of contrasting natural biodiversity should illustrate the significance of regional species pools for biodiversity in transformed landscapes (eg Caucasus vs Alps). A comparison of rangeland biodiversity in geologically young (steep) mountain regions with that in geologically old (smooth) mountain landscapes could reveal interactive influences of landscape roughness and land use on biodiversity.

### Effective conservation of mountain biodiversity under global environmental change: how best to assess effects of current efforts and future trends?

***What?*** Which is the minimum altitudinal range required for protected areas in mountain regions? What are the minimum habitat size and requirements for long-term viable (meta-)populations under high mountain conditions and under future climate change? Which are the best diversity/area relationships in high mountain environments for conservation purposes? What is the relevance of connectivity through gene flow for geographically isolated populations on high mountains? Which are suitable indicators and the most likely drivers of biodiversity change in protected areas in mountains?

***Why?*** With many global mountain biodiversity hotspots increasingly threatened, efforts are underway to preserve these unique biota, largely by establishing a system of protected areas on mountains (Koerner and Ohsawa 2005). Relevant variables for conservation biology such as minimum range, viable population size, and connectivity become especially critical in high mountain environments, where range sizes are generally small and where populations are often geographically isolated. In combination with population, genetic, ecological, and phylogeographic data for species of high conservation concern, analysis of such comparative data from different mountain ranges should provide guidelines for critical habitat sizes and minimum coverage of elevational ranges, with the overall task of maximizing the evolutionary potential through phylogenetic diversity and of capturing unique elements of mountain biota (see Box).

***How?*** For conservation planning it will be important to integrate occurrence data across multiple organismic groups from different mountain areas, which need to be analyzed in combination with other biotic and abiotic data using information such as in the Global Database of Protected Areas of IUCN and WCMC.

## Open access and a GBIF portal to shared mountain biodiversity data

The Global Biodiversity Information Facility (GBIF) has already established biodiversity information networks, data exchange standards, and an information architecture that enables interoperability and facilitates mining of biodiversity data. GBIF's technical expertise is an essential prerequisite for this project and we welcome the idea of creating a specific GBIF data portal on mountain biodiversity. GMBA in turn can help to encourage mountain biodiversity researchers to share their data within GBIF, in order to increase the amount and quality of geo-referenced data on mountain biodiversity provided online. These tasks are also in line with the implementation of the program of work (PoW) for the Global Taxonomy Initiative (GTI) and for mountain biological diversity of the Convention on Biological Diversity (CBD).

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**ACKNOWLEDGMENTS**

We gratefully acknowledge the hospitality of the Institute of Botany, Georgian Academy of Science (George Nakhutsrishvili, Otar Abdalaze). Funds were provided by the Swiss National Science Foundation (SNSF), DIVERSITAS (Paris), and individual travel grants to participants from their home institutions.

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doi:10.1659/mrd.0880

# Ecotourism in Old-growth Forests in Turkey: The Kure Mountains Experience

*Forests are crucial for the well-being of humanity. They provide foundations for life on earth through ecological functions, by regulating climate and water resources and serving as habitats for plants and animals. Forests also furnish a wide range of essential goods such as wood, food, fodder and medicines, in addition to opportunities for recreation, spiritual renewal and other services (FRA 2003). Forestland covers 21,188,746 ha, which corresponds to approximately 27% of the surface area of Turkey (OGM 2007). Forests are among the most popular ecotourism destinations because of their unique values for tourists interested in nature in local values and culture. It is therefore critical to adopt a sustainable development approach in the management of mountains and forests, where biodiversity must be conserved in the long term to minimize the negative impacts of tourism. This is increasingly being acknowledged by governmental institutions and non-governmental organizations in some areas of Turkey. We report here on the development of ecotourism and the support of local communities and other stakeholders in the Kure Mountains, emphasizing awareness-raising activities and benefits to the local economy.*

## Ecotourism in Turkey

The Kure Mountains, located in the provinces of Kastamonu and Bartın—one of the largest protected areas in Turkey with old-growth forest formation—have been visited by growing numbers of tourists since 2000. There are no statistical visitor data about the Kure Mountains, but tourism statistics for Kastamonu (2000–2006) give a picture of the increasing numbers of tourists in the region (Table 1).

It is encouraging that there are different environmentally sensitive

**TABLE 1** Kastamonu city tourism statistics. (Source: Ministry of Culture and Tourism 2006)

| Year | Number of visitors | | Number of tourists accommodated in Kastamonu | |
|---|---|---|---|---|
| | Domestic | Foreign | Domestic | Foreign |
| **2000** | 35,366 | 326 | 47,304 | 567 |
| **2001** | 32,547 | 360 | 47,545 | 515 |
| **2002** | 87,453 | 441 | 139,430 | 651 |
| **2003** | 59,729 | 211 | 88,850 | 729 |
| **2004** | 69,489 | 387 | 94,490 | 1079 |
| **2005** | 108,738 | 652 | 133,557 | 1048 |
| **2006** | 129,063 | 1025 | 182,380 | 3313 |

undertakings supported by both the local public and conservationists in the Kure Mountains region. In particular, the Kure Mountains Ecotourism project of WWF Turkey, and the Zumrut Village Ecotourism Project run by the Kastamonu Ecotourism Association, were successfully implemented in the region. These efforts make the region a pioneer not only in biodiversity conservation but also in environmentalist enterprises such as ecotourism in protected areas of Turkey.

## General characteristics of the Kure Mountains

The Kure Mountains are situated in the temperate forests of North Anatolia and the extension of the Eastern Black Sea Mountain system to the west; 37,000 ha of this area were officially gazetted as national park on 7 July 2000. The buffer zone surrounding the park comprises approximately 60 villages with a total of 20,000 to 30,000 inhabitants, mainly middle-aged and older. The main economic activities include forestry, agriculture, apiculture, woodcarving, weaving, chestnut farming, and tourism. The average annual income is below €400 (US$ 536) per capita (Anonymous 1999; Kalem 2005). The settlements in the buffer zone are rich and diverse in folklore. In addition to the natural assets of the park, these folkloric values and traditional wooden houses are highly important for tourism (Anonymous 1999).

### Land, landscape, and biodiversity

The area represents a unique karstic system, which is the result of a malm-cretaceous old shallow marine transgression as well as wildlife and old-growth forest formation, which are of both social and environmental value (Kalem 2001). The Kure Mountains provide a rich variety of habitat diversity. As one of the 9 Mediterranean forest hotspots in Turkey identified by the WWF, the national park is a contribution of the Turkish Government to WWF's "Gifts to the Earth" initiative (DHKV 2000).

The western section of the mountains has been identified as one of the 122 important plant areas in Turkey by a recent study of WWF Turkey. The site represents the best remaining example of the deciduous and coniferous forests of the North Anatolia sub-ecoregion as well as of the highly endangered karst mountains of the Black Sea humid forest ecotype (Kalem 2005). There are 80 endemic and 45 endangered plant taxa, 32 of which are rare species (Ozhatay et al 2005). The Kure Mountains are also one of the important bird habitats of Turkey. Additionally, they provide habitats for approximately 30 of the 132 mammal species of Turkey (Eken et al 2006; Kalem 2005).

## New opportunities and ecotourism development for local people and tourists

Alternative job opportunities compatible with education, awareness-raising, and sustainable resource management in the area are of special interest for the local public. A number of projects were developed to involve these local communities. The first was implemented by the Kastamonu Foundation for Development, Health, Environment, Education and Tourism with financial support from the WWF Mediterranean Programme in 2000. Involving local communities in protecting their environment was the primary aim of the project. Ecotourism was identified as one of the best options for developing alternative livelihoods for these local communities. Educational activities for local communities and the local authorities included seminars on the sustainable use of forest resources and conservation of biodiversity. In addition, a traditional village house was renovated as an ecotourism center. After opening the Pinarbasi Ecotourism Center in 2001, tourist guide training courses were organized and certificates were issued to 20 local nature guides.

In 2002, ecotourism guide maps were published to inform both domestic and international visitors about multifunctional forests in the Kure Mountains. In 2003, income from the maps was used to establish the Kastamonu Ecotourism Association, which brings local nature guides together and aims to enhance the attractivity of the villages around the park for tourists. Both publication of the maps and the foundation of the Kastamonu Ecotourism Association helped to draw media attention to biodiversity conservation and ecotourism activities in the area (Anonymous 2006a; Bulus 2006).

Another successful undertaking is the Zumrut Village Ecotourism Project, financially supported by the GEF Small Grants Program and executed by the Kastamonu Ecotourism

Association between 2004 and 2006. Zumrut village in Azdavay district in the southeast of the national park has more than 350 inhabitants, but only 35 of them live permanently in the village. Most of the people migrated to Istanbul to find a job or obtain education. The village has experienced economic loss as a result of the designation of the national park, which creates a negative attitude among local people towards the national park and nature conservation in general. This project aims to improve ecotourism in the Kure Mountains and its environs in order to create alternative livelihoods for local people.

The project contributed to awareness-raising about sustainable use of forest ecosystems and participation of local communities in the management of the national park. Ecotourism opportunities and threats were determined and potential nature-based ecotourism activities were identified, such as bird and wildlife watching, trekking, hiking, horseback riding, mountain biking, caving, canyoning, and rock climbing.

In 2006, a public awareness programme was finalized; one village house and one mansion with 25 beds were restored in the traditional architectural style. The old village school building was refurnished as the Visitor and Public Awareness Center. The village house and mansion are now operated by the local public; training courses on packaging and preparation of organic products are very popular among women. Probably the most important contribution of the project to the local community, especially for women, foresters, and unemployed youth, was to offer alternative livelihoods in local nature guidance, organic and traditional hand-made products, bicycle and horse rental, and accommodation in village houses. The villagers made approximately € 2300 (US$ 3082) in 5 months from ecotourism activities (Anonymous 2006b; Bulus 2006).

At the end of 2006, the PAN (Protected Area Network) Park letter of intent was signed by the Ministry of Environment and Forestry for the Kure Mountains National Park, and the verification process was initiated.

## Conclusions

Although the Kure Mountains have legally been a national park since 2000, the area suffered from lack of management that promoted sustainable use of forest landscapes, since the management plan had not yet been approved by the Ministry of Environment and Forestry. Moreover, the local public receives no revenues from the national park. Therefore, the alternative livelihoods aspect of ecotourism is one of the most important outcomes of the multifunctionality of forest landscapes in the Kure Mountains.

The Kure Mountains offer an almost ideal combination of natural, traditional, and socio-cultural assets. The hospitality of the local community makes the area even more attractive for ecotourism. Successful efforts have contributed to awareness-raising on conservation and ecotourism among the local inhabitants and authorities by involving local NGOs, donors, sponsors, media, and scientific institutions.

Among the further steps to be taken, the highest priority is to revise and approve the new Management Plan with its multifunctionality of forest landscape approach. Following that, a "Sustainable Tourism Development Strategy" and a "Visitor Management Plan" should be developed, implemented, and monitored in a systematic way.

A sustainable perspective for the Kure Mountains National Park and the region can never be realized by tourism alone. Tourism, if planned and monitored carefully, is one of the tools of multifunctional forestry development. Through sustainable and integrated management efforts, the Kure Mountains area will be one of the pioneer protected areas in an international context and the first PAN Park in Turkey representing a successful balance of conservation and use.

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### ACKNOWLEDGMENTS

The authors would like to thank Mert Altintas (Engineer), Mehtap Oztekin (Biologist), and Sedat Kalem (Forest Program Officer in WWF–Turkey) for helpful comments on this article.

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doi:10.1659/mrd.0926

# Sensitizing People to Natural Forest Dynamics
## A Report on a Project in the Northern Black Forest, Germany

**FIGURE 1** Dynamics of natural reforestation along the “Lothar” trail in the Black Forest, Germany: within a few years of the devastating 1999 storm, young trees could be seen thriving between the dead wood left lying on the ground. (Photo by Heidi Megerle, 2005)

On Christmas Day 1999 winter storm “Lothar” devastated large areas of forest in Southern Germany. Storm damage is part of natural forest dynamics. For the local economy, however, the damage caused by “Lothar” was an economic catastrophe, and most areas were cleared and reforested within months. The forested areas of the Black Forest are indeed an essential part of the local economic system and an important basis for landscape-oriented hiking tourism.

In parallel with this clearing-up process, a very unconventional idea materialized in the visitor center at Ruhestein. A 10-hectare site on top of the Northern Black Forest Mountain Range, belonging to the state of Baden-Württemberg, was left undisturbed as a monitoring area for natural forest dynamics (Figure 1). This concept followed the innovative idea in German national parks of leaving nature to itself and avoiding all human-induced changes. Originally the concept was conceived as a sort of outdoor laboratory to observe the process of natural reforestation. But due to growing interest on the part of the general public concerning the consequences of the winter storm, it was decided to open up the area to allow everyone a chance to gain personal insight.

### The “Lothar” trail: a new didactic approach

Because a storm-devastated forest area can only be observed safely from a distance, an adventure trail had to be constructed to make the area accessible to the general public. This trail now provides thrilling insight in the form of a fixed rope route, leading over and under fallen trees. By contrast with the still very popular traditional panel trails that provide quite a lot of information in the form of long written texts, the didactic concept of the “Lothar” trail is quite extraordinary. Only a single panel positioned near the beginning of the trail contains information about the specific ecosystem of this mountain forest and the dynamics of natural reforestation. Further on, no other panels are found on the 800-m-long trail, which takes about half an hour to walk through. The didactic idea behind this new approach is to give visitors a personal experience and induce an awareness-raising process by insight rather than by pre-selected information. The concept is complemented by guided tours offered on a regular basis by the nearby visitor center, as well as a brochure giving additional information if desired. Also in contrast to the classical panel trails, the “Lothar” trail is multi-sensual, involving not only eyesight but hearing, smell, touch, and balance as well.

### Experiencing forest dynamics as a new tourism highlight

Originally the intention of the “Lothar” trail concept was forest monitoring, and later on awareness-raising for the general public—but not to create a new hot spot of local tourism. Nevertheless the “Lothar” trail has emerged as a favorite tourism destination in the Northern Black Forest. In 2005 the total number of visitors was estimated at about 40,000 a year. This high frequency of visitation was mostly due to the fascination inspired by this small “wilderness area” and the possibility for self-experience, which is rarely available in a highly urbanized country like Germany. By contrast with traditional panel trails, which today are hardly frequented at all, especially by families with children, unusual trail concepts attract a high number of visitors.

Empirical research conducted by questioning and observing visitors on the trail yielded interesting results. The majority of visitors came from nearby districts and visited the "Lothar" trail on a day-trip with their families. Motivation for the visit was mostly attributed to personal experience (45%), because nearly every inhabitant of Baden-Württemberg above a certain minimum age had witnessed "Lothar" and was therefore interested in the consequences as well as the later development of the devastated areas. Children were the second motivation for a visit, because on the one hand parents wanted to show their children the outcome of the storm. On the other hand, the special concept of the trail, which provides an exhilarating climbing experience, closely matched the needs and wishes of children. It was therefore no great surprise that the number of regular visitors reached an astonishingly high point, with 21% coming for a second or third time and 9% coming even more often.

This was also due to the natural dynamics of the reforestation process. Whereas in the first years the area looked dead and uninviting, new trees later grew up between fallen dead trees (Figure 1). Regular visitors therefore had an opportunity to observe the yearly changes personally and to witness the exciting process of the emergence of a new forest.

## Success of awareness-raising for natural forest dynamics

Visitors' assessments of the trail were very positive; 98% gave it the two top school marks. Most visitors were impressed by their walk through the storm area and had feelings of respect at the breathtaking and overwhelming sight of the power of nature. In general, seniors and people with little education regard the fallen tree trunks as depressing for the most part, and did not like the aesthetics of the area. There were even comments from this group about clearing up "this mess" and replanting an "orderly German forest."

The success of awareness-raising correlated closely with the form of communication. Participants on the guided tours showed considerable understanding of natural forest dynamics and were the best informed group about the forthcoming development of the area. But even people who chose the self-guiding trail gained significantly more insight than those who had never been on the trail. Due to explanations and the personal insight gained during the guided tour, 97% of the tour participants knew the area would be transformed into a forest in the coming years, which would be closer to the potentially natural forest in this area than the monoculture of spruce trees which had been planted before the storm.

## Is the "Lothar" trail suited as a model for environmental education in forest areas?

In the above-mentioned context, some aspects of the "Lothar" trail seem worth transferring to other regions. This is especially true of the didactic concept chosen, which can be very well adapted to the needs and wishes of a leisure-time audience, consisting mostly of families with children. Due to the resulting high number of visitors, the awareness-raising process is more successful than an elaborate information trail, which reaches only a small number of participants. Also, the different levels of information available (self-guiding, guided tours, additional brochures and visitor center) address a wide range of interest groups.

The multi-sensual approach is highly recommendable, especially for children, as the most effective way of learning about and experiencing a forest ecosystem is not by reading or hearing information but by touching, smelling and personal experience. Putting children in contact with forests is particularly important, because the basis for awareness and understanding of nature is formed in the most impressive phases of early childhood. In a highly urbanized country like Germany, current research results show a declining rate of contact with nature, combined with a frightening indifference towards "real nature" and a lack of knowledge, especially among teenagers. The concept of the Lothar trail, with its high degree of regional reference, authenticity and potential as a tourist attraction, can serve as an example for other trails in forest areas. Therefore a successful sensitizing concept for natural forest dynamics, especially in mountain areas, has to take modern didactic approaches for a leisure-time audience into account, as well as the necessity of an individual concept tailored to special regional circumstances. Accordingly, copying the "Lothar" trail is not a realistic possibility, but the adoption of the leading principles is recommendable.

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doi:10.1659/mrd.0927

# Applied Remote Sensing in Mountain Regions
## A Workshop Organized by EURAC in the Core of the Alps

### Remote sensing supports monitoring in mountain areas

Mountain areas are highly dynamic and sensitive regions. Changes in human land use and climate conditions, an increasing number of natural hazard phenomena, and increased competition in a globalized economy are putting the environment and societies in mountain regions under pressure. Consequently, the observation of these phenomena or their representative indicators at various scales in time and space has become an urgent task. Monitoring—ie the repetition of such observation activities—in sufficient frequency for large and remote areas is only economically feasible when supported by remote sensing techniques. Some products based on Earth Observation (EO) data have been developed successfully and have become standard applications over the last decade, an example being land use mapping. However, a large number of potential remote sensing based tools are still "work in progress," eg those aiming to take advantage of the latest available techniques such as very high resolution optical satellite images, radar, or laser sensors. This is particularly true for mountain regions, where steep terrain complicates image processing, whilst the heterogeneous landscapes demand products in fine resolution and of high spatial accuracy at the same time.

In order to identify the status quo and future potential of EO based applications in mountain areas, the European Academy (EURAC) organized a workshop on "Applied Remote Sensing in Mountain Regions" in February 2007, in its own conference facilities in Bolzano, South Tyrol. Altogether 70 scientists, politicians, entrepreneurs, and public administrators attended the presentations and participated in the discussions about problems and their current and future potential solutions. The workshop embraced a range of topics, from technical solutions through institutional settings to communication problems between scientists, commercial image providers, clients and decision makers.

### What are the burning issues remote sensing can contribute to?

Among the hot topics to which remote sensing methods have the potential to contribute are:

- Nature and environmental protection issues such as air quality, loss of biodiversity, forest and water management;
- Hazardous events such as landslides, mudflows, and avalanches;
- The impact of global climate change such as the change of glacier extent, snow cover, and water balance;
- The impact of tourism and increased traffic activities on the natural and cultural characteristics of mountain environment and societies.

Most of these topics are interrelated and need to be looked at in a systemic way. Remote sensing technology can contribute to the generation of relevant information and improve it significantly, but it is only one instrument in a box of numerous applicable tools. For example, an assessment of water available for hydropower within a mountainous catchment area relies on modeling runoff quantities. The outcomes of such a runoff model can be enhanced significantly by remote sensing data, which can provide up-to-date information about snow and vegetation cover.

### Why is applying remote sensing techniques in mountains difficult?

Changes in surface altitude and slope angles in mountain areas challenge the remote sensing analyst in a number of ways. Data pre-processing steps, namely geometric enhancement (ie the allocation of correct or most accurate coordinates to the image pixels), is more difficult in steep terrain as there are differences in the distance between ground surface and the receiving sensor. Shadows, in the sense of non-illuminated areas for passive sensors and non-accessible areas for active sensors, hamper the homogeneous interpretation and classification of remotely sensed data. This is even more so for the very high resolution sensors of the latest satellite generations, due to their lower platform orbits and varying viewing angles. However, without smoothing geometric distortion and shadow effects, any application requiring the techniques of data fusion and multitemporal analysis is hardly accomplishable.

### Pros and cons of remote sensing based products; how to improve services

Remote sensing based products are increasingly used in an operational manner for a number of applications in mountain areas, in particular for monitoring changes in ground cover types (eg snow, forest, built up). Nevertheless, significant drawbacks to remote sensing applications hinder a wider dissemination and limit their benefits: the timespan from data acquisition to product delivery, a non-constant or non-standardized level of accuracy, and a non-guaranteed reproducibility within acceptable time periods. For example, a reliable risk monitoring system for mountain hazards such as avalanches or mass movements requires daily data updates, which are often not achievable with existing satellites or depend too heavily on suitable weather conditions. At present these problems are addressed with a successful but resource-consuming combination of various satellites and sensors.

Likewise, there are still a number of technical problems concerning already established receiving systems that are tackling data pre-processing steps and the automatization of image correction and classification methods. At the same time scientific resources need to be allocated for the development of new tools and solutions, in order to process data from the newly emerging platforms and sensors that are constantly emerging. This triggers discussion about how to justify the continuous resource allocation being spent on 'digesting' new technical developments, when user demands require priorities in other areas.

In fact there is a strong call for more user-oriented approaches to remote sensing. Scientists and practitioners are being asked to supply user-tailored services rather than single working step products. Such service provision would rely on an improved data flow and process chain in order to meet 2 crucial criteria: the timespan up to product delivery and the cost. Potential points of enhancement are improved availability and reliability of remote sensing data access with standardized data management. A centralized satellite data supply organized, for example, by national or international private–public partnerships with a transparent data policy, is imaginable. General agreement exists on the strong need to better integrate the user or client of remote sensing products in the whole product generation chain.

## How can we better link research activities and user demand?

There are several levels of users, ranging from the intermediate user with a strong technical background and interest, to the end-user with very limited or no understanding of the production process. These differences result in varying demands regarding the products to be delivered and also with respect to the type and degree of consultation required by the user. Evidently there is a need to inform the user about available tools for solving his / her problem and the respective possibilities and constraints linked to them. A solution involving the creation of an information platform was suggested, which would enable knowledge exchange with the user in both directions: 1) presenting research and operational work's results and available services to the user/client; and 2) allowing users to express their needs and to provide feedback and communicate desired changes or adaptations of existing products/services.

As an initial action for such a platform, EURAC offered to host a web site for the exchange of information and ideas. The continuation of this action incorporating annual workshops or conferences about remote sensing applications in mountain areas was welcomed by the participants.

More information about this event can be found at: **https://www.eurac.edu/Org/AlpineEnvironment/RemoteSensing/workshop0107.htm**

The communication platform will be hosted under: **www.imount.eu** and **www.imount.org**

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doi:10.1659/mrd.0928