Newsletter of the Mountain Research Initiative

MRI NEWS

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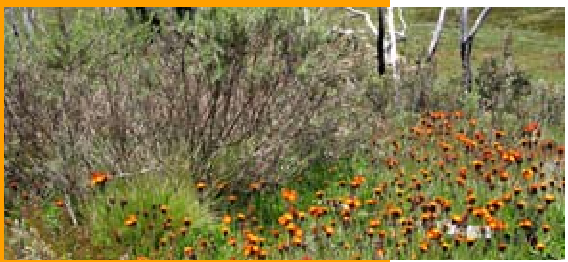

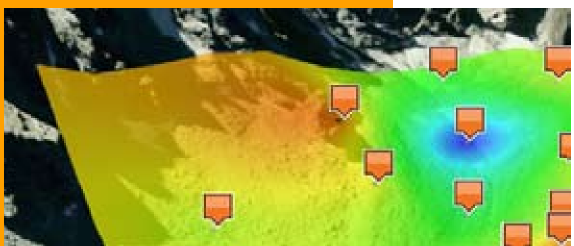

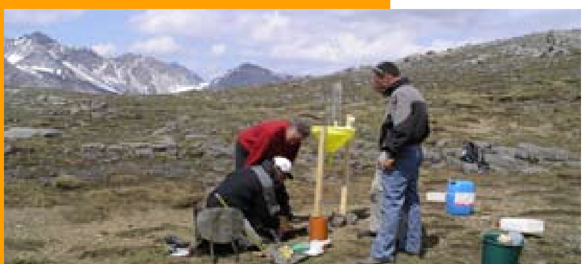

Global Change in Mountain Regions

The Mountain Research Initiative

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This Newsletter comes out twice a year.
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If you have been forwarded this newsletter and would like to subscribe directly to the MRI database please go to http://mri.scnatweb.ch

Editorial

Science to share

Dear Reader,
We are happy to present you the first edition of the Mountain Research Initiative Newsletter!

The MRI community is growing rapidly and a lot of information on global change research in mountains is passing through our hands. One of MRI's role is to act as an information clearinghouse and to process this information quickly and efficiently, as in our four regional Newsflashes.

With the "MRI News" we can now share in more detail exciting global change science from mountain regions around the world.

The six articles in the section "Science Peaks" cover a broad range. Read them to learn how global change topics have made it onto the research agenda of protected areas, e.g. the Swiss National Park, and to draw inspiration from successful networks such as CIRMOUNT (Consortium for Integrated Climate Research in Western Mountains) and MIREN (Mountain Invasion Research Network). Cooperation and exchange become more compelling as the complexity of research topics and data grows. The article on the "Swiss Experiment" talks of a new dimension in data sharing across disciplines.

Remote sensing is a discipline often associated with monitoring climate change in mountains. Stefan Wunderle discusses in his article if and what remote sensing can contribute to the work on global change in mountains. The Italian contribution to this Newsletter comes from the High Altitude group of CEOP (Co-ordinated Energy and water cycle Observation Project). It is an answer to the lack of basic data at high elevations, and an effort to fill the gaps.

This first edition of the MRI News is Switzerland-biased, reflecting the MRI science community in our host country. The next editions will be focussed on science supported by MRI's regional networks in other parts of the world.

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Inside MRI

Starting on 1st of October 2008, the MRI and the Forschungsstelle für Gebirgsforschung: Mensch und Umwelt (IGF) of the Austrian Academy of Science will begin the joint implementation of MRI Europe. The MRI Europe program, and the position of Astrid Björnsen Gurung, will be financed by the Austrian partner while the office infrastructure and logistics remain with the Institute of Geography of the University of Bern. The agenda of the MRI Europe network will remain unchanged. This shift will enhance the cooperation between the MRI and the IGF primarily through information exchange on ongoing and planned activities, but also through joint initiatives generating added value for the participating institutions and the larger Global Change community.

The contact details of AstridBjörnsen Gurung remain unchanged.

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How the MRI works

The MRI's goal is to promote and coordinate high profile interdisciplinary and transdisciplinary research on global change and its impacts in mountains around the world. Activities to reach this goal fall under four categories, each expressing a distinct understanding of how the scientific world functions.

One way to reach MRI's overall goal would be to get huge budget and finance exactly that type of research! Or, one could, at a much lower cost, induce others - scientists, funding agencies, institutions - to act in ways that lead to such research. MRI operates in the latter fashion.
The activities proposed to induce others to act are themselves predicated on assumptions, often unspoken and unexamined, of how change occurs within the scientific enterprise. These assumptions therefore describe the underlying rationales for why such programs as MRI even exist. Recent program planning by MRI surfaced at least four different approaches, each of which arises from a different appreciation of how the world works. While none of the resulting approaches are mutually exclusive, changes in the relative importance accorded to each of the different worldviews would lead to quite different configurations of the MRI program.

The first approach, labeled "Key Players", sees the enlistment of key scientists and their adoption of the MRI goal of inter- and transdisciplinary research as the critical path in creating change. MRI does not need to establish inter- and transdisciplinary research itself but rather evangelizes that vision to a coterie of high-visibility scientists who will themselves do what is necessary to establish that research. Activities based on this narrative would focus on the identification, management and support of this "Inner Circle" of researchers.
The "Key Players" approach assumes that certain researchers have disproportionate influence over the prioritization of topics and the allocation of funding by donor agencies. This assumption may be common in the Global Change-International Project Office (GC-IPO) world where each project has a inner circle of Scientific Steering Committee members who are strongly invested in the central premise of the project and do what they can in various venues to achieve the vision.

The second approach focuses on "Peer-Reviewed Publications". Since MRI isn't a typical funding organization, these peer-reviewed publications would not report individual project results but would be either synthesis papers emerging from MRI workshops that allow comparisons among heretofore separate datasets, or review and strategy papers focusing on key scientific issues. This approach further assumes that the Key Players are already over-committed and not likely to run workshops and write papers. Instead the narrative sees early career academics as central.
This approach assumes that ideas - syntheses, leading to recommendations - rather than personalities are central to changing funding priorities. This assumption may also be widespread as nearly ever GC-IPO seeks to produce such syntheses.

The third approach emphasizes "Products and Events" that increase the profile of global change in mountain regions for a broader audience than that reached with the peer-reviewed papers. The emphasis here is more on popular content that explains the long-term goal, and sketches progress and opportunities in both basic and applied research. A program based on products is journalistic in nature, requiring the on-going identification of many different potential stories, negotiations with authors, and a tight production schedule. This approach assumes that change in priorities requires one to effect a change in the scientific zeitgeist of the larger community, including both scientists and practitioners, which will in turn lead to specific changes in programs.

Finally the fourth approach sees "Proposals to Funding Agencies" as paramount. The next best thing to having the money to fund research is organizing proposals to get that money. In this approach, researchers who apply for funding are the key actors. Identifying them and appropriate funding sources, and promoting proposal development become key program activities. This approach assumes that the limiting factor to more research desired by MRI is not funding per se but rather the lack of good proposals to obtain funding that already exists. This approach further assumes that the promise of new money galvanizes the community and leads to a level of creativity and networking that rote academic exercises seldom achieve.

In fact, all of these worldviews are correct at different times and places. The art in conducting MRI over the next several years will consist of determining what combination of the four is appropriate in any given situation. Maybe even more important will be an openness to the possibility of yet new worldviews with consequently new program directions that arise from them.

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During the 2007 to 2010 grant of the Swiss National Science Foundation (FNS-SNF) MRI is headed by a group of five Co-Principal Investigators. We want to take the opportunity to introduce to the readers these five scientists, and their respective fields of research. You will find portraits of Rolf Weingartner, Harald Bugmann and Martin Grosjean in this edition, while the Spring 2009 edition of the MRI Newsletter will portray Wilfried Haeberli, and Lukas Baumgartner.

The hydrologist

Rolf Weingartner heads MRI's group of Principal Investigators during the 2007 to 2010 grant of the Swiss National Science Foundation (FNS-SNF). He hosts the Coordination Office of MRI at the Institute of Geography of the University of Bern, and plays an important role in the definition and implementation of MRI's strategy.

Rolf Weingartner is Professor of Hydrolgy at the Institute of Geography, University of Bern. He is the President of the Swiss Hydrological Commission of the Swiss Academy of Sciences. He has been the leading scientist in the compilation of the Swiss Hydrological Atlas, first published in 1992 and updated on a regular basis since then (http://www.hades.unibe.ch).

What aspects of "Global Change in Mountains" are you looking at in your daily scientific work?

As a geographer and hydrologist I am interested in water related topics on different temporal and spatial scales. The topics cover on one hand water balance and hydrological extremes and on the other integrated water resources assessments. The impacts of climate change on hydrological systems, a rather applied topic, play a significant role in our projects. In addition, regionalization and statistical and deterministic modeling as well as field studies are very important. The latter provide a sound process understanding which is crucial for climate change research. A considerable and pleasant part of my time involves the teaching and supervision of young students on different academic levels.

What has been your most exciting piece of research in the last 5 years?

Thanks to the increased availability of highly resolved global data sets, it is possible now to perform extensive studies covering the whole of our planet. Hence, we can now quantify the hydrological role of world's mountains. An important finding is that at a global level, and outside of the humid tropics, mountains produce double the runoff that would be expected based on the land surface they cover. As a result, changes in the mountain environment have a considerable impact on the distribution and availability of water on our globe. This important linkage is our motivation for global change research in mountain areas, where unfortunately in-depth data are often missing.

Why is the Mountain Research Initiative important?

In today's scientific world, in which high-quality disciplinary research frequently fails to elucidate the coupled natural-human system, networks and interdisciplinary approaches, which are at the core of the MRI, are increasing necessary, especially in climate change research. Let us profit from the opportunities for interdisciplinary work offered by MRI!

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What aspects of "Global Change in Mountains" are you looking at in your daily scientific work?
In the scientific work of our group at ETH, we are focusing on the impacts of Global Change, notably climate and land use change, on (1) forest succession at the stand scale, (2) large-scale disturbance regimes such as wildfires, insect infestations and windthrow, and (3) the exchange of carbon and water between mountain catchments and the atmosphere.

What has been your most exciting piece of research in the last 5 years?
Among others, we have developed a model that predicts the wildfire regime in complex topography based on climatic and vegetation data alone, without necessitating assumptions about future fire frequencies, thus enhancing the predictive capability. Further information on this project and our other research can be found on the internet under http://www.fe.ethz.ch/research/index_EN.

Why is the Mountain Research Initiative important?
To me, the MRI is important because it links research and researchers across the widely scattered mountain regions worldwide, and across disciplines. Comparisons of the sensitivity of mountain ecosystems to Global Change are important to identify those regions that are most at risk, and interdisciplinary collaboration (monitoring, experimentation, and modeling) is required to provide vital information for the sustainable management of mountain resources, so as to guarantee mountain livelihoods.

The climatologist

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My primary research interest is current and past climate change as recorded in sediments of lakes at high elevation sites. Mountain lakes offer a powerful set-up for the study of temperature and precipitation variability, impacts of climate change on mountain ecosystems and the history of pollutants at high and remote places. Many mountain lakes are also located in areas that are relatively undisturbed by direct anthropogenic influence being thus ideal sites for paleoclimate research.
We use a range of sedimentological, mineralogical, biogeochemical and paleontological proxies in lake sediments and statistical tools to investigate long-term climate and environmental variability and change. The spotlight of investigation is currently on very high-resolution (seasonal to annual), quantitative climate reconstructions, process studies and pollution history covering the industrial period, the last Millennium and the late Holocene. The South-Central Andes and the Swiss Alps are the main areas of interest. Research is typically highly interdisciplinary (http://www.geography.unibe.ch/lenya/giub/live/research/see_en.html).

The current highlight is the quantitative, seasonally to annually resolved multi-proxy climate reconstruction from Lake Silvaplana (Engadine, eastern Swiss Alps) for the past 1000 years. This lake has annually laminated sediments (varves) for the past 3500 years and is, therefore, an outstanding paleoclimate archive. Biological and geochemical proxies provide quantitative information about temperatures for all of the four seasons separately at a quality that is comparable with tree-ring based climate reconstructions. This is unique worldwide.

In my view MRI is most relevant. Too little attention is being paid to building global research networks and platforms for knowledge exchange, building frameworks for strategic and systematic research avenues, and lobbying the research agenda setting and political decision making. The mountain research community needs the MRI to gain adequate momentum and to have a voice; mountains research needs to get in touch with the ongoing international programs of the Earth System Science Partnership (ESSP). This is where MRI comes in and plays a pivotal role.

Global change research in the Biosphere Reserve Val Müstair and the Swiss National Park

The Research Program 2008-2018 of the Biosphere Reserve Val Müstair and the Swiss National Park (BVM–SNP[1]) is an example of applied global change research in a mountain protected area.

Interdisciplinary research topics

The scientific research program in the Swiss National Park first established in 1916 was recently revised to address interdisciplinary topics arising from changing environmental and institutional conditions. Research in the Park is planned and organized by the Swiss Academy of Sciences and the Research Council of BVM-SNP, a group of 15 scientists nominated by the Swiss Academy of Sciences. The growing importance of climate and global change and the shift from a first generation to a Sevilla-based Biosphere Reserve drove the revision of the research program. As global change issues and international cooperation are important for BVM–SNP, the revision used the GLOCHAMORE Research Strategy[2] as a general framework for developing the following five core topics for future research in the core wilderness zone of the SNP as well as in the buffer and transition zones of the BVM :

1) Impacts of global and climate change on BVM–SNP and neighboring regons.
2) Importance of disturbances in the long-term evolution of ecosystems.
3) Population dynamics of ungulates in alpine habitats.
4) Benefits to society from protected ecosystems and sustainably used natural resources.
5) Success factors for a sustainable regional development integrating BVM-SNP.

The research program (Forschungskommission SNP, 2008) envisages a ten-year period (2008-2018) to establish, execute, publish and evaluate research and monitoring projects.

These core topics reflect both (1) the contribution of research and monitoring in BVM–SNP to progess in science and (2) the main challenges for BVM–SNP in its regional socio-economic context.

(1) Scientific contribution: As a scientific site, BVM–SNP provides for long-term studies (observation, monitoring) on ecosystem evolution, with no or minimized human impacts in the core area or with well-characterized impacts in the buffer and transition zones. The BVM–SNP area thus serves as a near-natural or sustainably used reference area to be compared to more urbanized regions, especially in the context of studies on changing climate, disturbance regimes or grazing pressure by ungulates. Long-term studies on these three topics will occur along gradients of altitude, vegetation, land use, grazing by ungulates, etc. and will lead to a better understanding of ecosystem evolution over the long-term. The value of this research will be greatly enhanced through comparisons to similar long-term studies in other mountain protected areas.

(2) Challenges for BVM–SNP in its regional socio-economic context: The perception by the local population of clear social and economic benefits is essential for public acceptability and continued public funding of the BVM–SNP. While such benefits have long been assumed to exist, it is now important for research to delineate and quantify these benefits, i.e. to develop an evaluation scheme to assess the benefits of the management of BVM–SNP for regional socio-economic development.

Rapid Biodiversity Assessment (RBA): Trap on Munt la Schera in the Swiss National Park (photo Thomas Scheurer)

Linking science and park management

Science can make important contributions to park management if it generates knowledge of a type and in a form useful to National Park and Biosphere management. The Research Council of BVM–SNP thus specified the following kinds of knowledge generation and other activities as critical for management:

a) Up-to-date scientific knowledge on the nature of the BVM-SNP coupled human-earth systems (systems knowledge): Basic data and knowledge on the main systems of the BVM-SNP must be updated using new methods and new approaches. Therefore close cooperation with scientists is necessary.

b) Long-term studies, monitoring and modeling as a basis for early detection (transformation knowledge): Research in BVM–SNP should guarantee a regular and scientifically sound monitoring of relevant parameters. These data from long-term studies should be used for modeling and for early detection of change. Geographical Information Systems (GIS) are necessary to manage such data and to support the modeling needed to assess different future management options.

c) Specific problem-oriented information for management and decision making (targeted knowledge): While research on the 5 core topics is relevant for National Park and Biosphere management, scientists will need to translate their findings into a form useful for management measures.

d) Contributions to communication and education: Scientists and BVM–SNP staff must cooperate closely to ensure continuous integration of new results into visitor information and education programs.

e) Knowledge and data management: Research and monitoring in BVM–SNP are long-term activities. Therefore, good documentation, storage, availability and dissemination of all types of data and knowledge are crucial for management and development of research in BVM–SNP.

f) Guidance and coordination: As the research capacities of BVM–SNP are low, good coordination and information exchange between BVM–SNP administration and external scientists is needed.

Protected areas such as BVM–SNP offer excellent opportunities for scientific research on the long-term evolution of ecosystems and on the regional governance of natural resources. The research program designed by the Research Council of BVM–SNP for the next 10 years focuses research activities on the most forward-pressing topics as expressed in the GLOCHAMORE Research Strategy. The cooperation with other mountain protected areas will be an important element for implementing this research program.

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1 Swiss National Park (SNP) was founded in 1914 and nominated as Biosphere Reserve in 1979. Currently the Biosphere Reserve is planned to be completed by a buffer and transition zone in Val Müstair. The future Biosphere Reserve will include two management units, the existing Swiss National Park (SNP, core zone) and the new Biosfera Val Müstair (BVM).

2 The GLOCHAMORE "Global Change in Mountain Regions" project was a Support Action of the EU's Sixth Framework Programme on "Sustainable Development, Global Change and Ecosystems". This project was coordinated by the MRI and the University of Vienna and developed a state-of-the art integrated and implementable research strategy to gain a better understanding of the causes and consequences of global change in a selection of 28 UNESCO Mountain Biosphere Reserves (MBRs) around the world. See http://mri.scnatweb.ch/projects/glochamore/ for more information.

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The Research Programme 2008-2018 (30 pages) is available in German and French: scheurer@scnat.ch (paper copy) and http://www.nationalpark.ch/deutsch/A_4_3.php (pdf)

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Swiss National Park Research
A Commission of the Swiss Academy of Sciences

The Consortium for Integrated Climate Research in Western Mountains – a progress report

CIRMOUNT (the Consortium for Integrated Climate Research in Western Mountains) is a collaborative, open, science consortium comprising agency and university scientists, natural-resource specialists, and program managers. It is dedicated to improving understanding of climate variability and change, and to enhancing the capacity to sustain western North American society.

CIRMOUNT goals are to 1) define regional vulnerabilities to climate variability and change in the unique landscapes that define western North American mountains; 2) measure and understand climate-driven changes in these regions; 3) develop information, products, and processes to assist natural resource decision-makers throughout the West; and 4) assist resource managers and others to respond to the scientific needs and challenges of western society for mountain resources.

CIRMOUNT's core topical scope and foci are the intersection of climate, water, society, ecosystems, and western North American mountains (Figure 1). CIRMOUNT has both disciplinary (monitoring, databases) and integrative (integrated research, decision-support) goals.

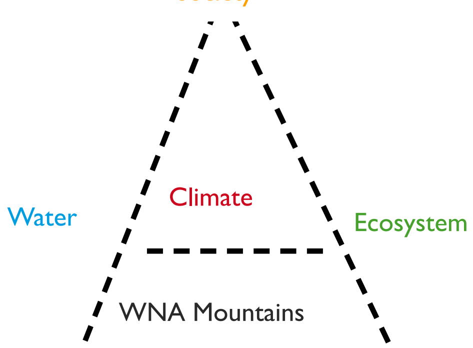


Figure 1: Key scope and foci of CIRMOUNT (WNA is western North America)

Background and Accomplishments

With the successful completion of the Mountain Climate Sciences Symposium (MCSS, Diaz and Millar 2004), an ad hoc association of western United States climate science professionals established the Consortium for Integrated Climate Research in Western Mountains (CIRMOUNT) in 2004. Our goal was to promote and integrate understanding of the physical and ecological processes relating to climate in western North American mountain environments, and to improve communication of scientific findings to decision-makers.

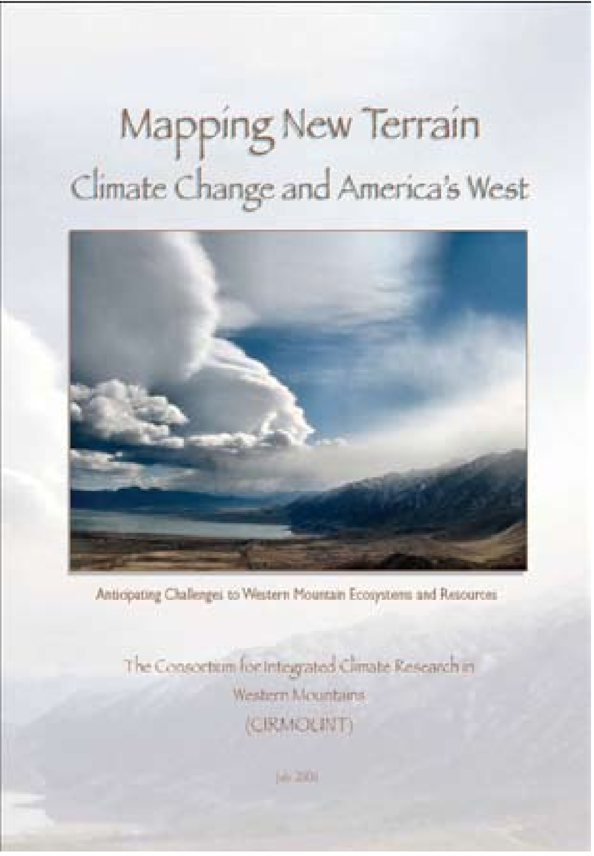
An important outcome from the MCSS meeting was the identification of critical questions related to ongoing and future climatic changes in the US West. They include the following:

- How are the vertically stacked ecosystems in the West changing as a result of climate change and variability?
- How can we best link climate, ecosystem and human processes?
- How can we overcome insufficient integration of disciplinary research in the region?
- How can we enhance the delivery of information and effective communication of important scientific findings that are relevant to western mountains decision-makers?

As a result of the MCSS and subsequent efforts by members of CIRMOUNT, a general audience publication highlighting key issues regarding climate change impacts on western United States society was published and made available online (CIRMOUNT 2006). In this "Mapping New Terrain" publication, Consortium members reiterated the framework and motivation for their association: "… the growing recognition that the climate of the West is changing, and that impacts are rapidly emerging in the form of changes in streamflow patterns, plant phenology, ecosystem structure, wildfire regimes, and the like…" [by bringing together] "a group of scientists representing a wide range of disciplines … crossing traditional disciplinary lines, exchanging ideas, and coordinating research efforts, Consortium participants seek to identify the greatest threats to western mountains arising from climate change and to develop priorities for a research strategy that addresses those concerns."

In March of 2005 CIRMOUNT launched the first of a series of mountain climate conferences (MTNCLIM) near Yellowstone National Park, Montana to further its goals to enhance communication of the available information about climate change science, climate impacts, and policy-related issues. A second MTNCLIM conference was held in Mount Hood, Oregon in September 2006, and a third conference in June 2008 in Silverton, Colorado. Abstracts and copies of the presentations given at these meetings, as well as for all other related meeting activity related to CIRMOUNT can be accessed via the Consortium's website (see weblinks).

Other activities of the Consortium designed to foster interactions between mountain science researchers and highlight mountain science research include the convening of annual disciplinary sessions at the Fall Meeting of the American Geophysical Union (AGU). The first of these was held in December 2004 with the theme of "Climate Challenges to Mountain Water Resources and Ecosystems". The topics for the other three AGU Fall sessions were: "Extreme Events in Western Mountain Climate, Resources, and Ecosystems" (2005); "Elevational Gradients and Mountain Climates, Resources,



CIRMOUNT 2006: "Mapping New Terrain"

and Ecosystems" (2006); and "Climate Change in High-Elevation Mountain Environments" in 2007. Proposed for 2008 is, "Complexities in Mountain Climates, Ecosystem Response to Climate Change, and Resource Management".

With the launching of the Mountain Views Newsletter in 2007, CIRMOUNT took another tangible step toward the accomplishment of one its primary goals - to inform scientists, resource managers, and decision-makers of the latest developments regarding the dynamics of western climate, and the evolving natural and societal impacts associated with those changes. The newsletter is meant to be a clearinghouse for information about the state of regional and larger-scale climate patterns, and about climate- and related environmental and ecological-science activities bearing on western society. Current and past issues of the Newsletter can be downloaded from the CIRMOUNT website.

In addition to these communication activities CIRMOUNT has fostered, through focused working groups, interdisciplinary activities around a number of key climate issues. In 2004, CIRMOUNT launched the North American chapter of the International Global Research Initiative in Alpine Regions (GLORIA), a program that addresses responses of alpine flora to climate change. Nine multi-summit target regions are now installed, ranging from Alaska, through British Columbia, the Sierra Nevada, to the northern and central Rocky Mountains. An equal number of regions are planned for installation in 2008 and 2009. Similarly, the CIRMOUNT Mountain Climate Monitoring group has leveraged installation of long-term climate monitoring stations in several mountain ranges from Alaska to California. In addressing a CIRMOUNT goal to extend beyond its regional borders, an international effort resulted in the start-up of CONCORD, (Climate Change Science for the American Cordillera) in collaboration with the MRI. An initial meeting was held in Mendoza, Argentina in 2006 (see Diaz et al. 2006). One result from this effort is the development of CORFOR, the Cordillera Forest Dynamics Network, which was established in association with the Western Mountain Initiative, the MRI, and other international partners to establish and analyze standardized forest state measurements and trend information along the American Cordillera.

Future Directions

CIRMOUNT is organized as a grass-roots initiative, with no program staff or direct support; a 15-member scientific core team serves as the ad hoc coordinating body to a mailing list participation of over 700. Even without a formal insti-tutional framework, we have galvanized widespread interest and support for integration of climate and climate impacts work on western mountains. We have been seeking funding for a program base, and in the meantime continue to pro-mote consortium goals of research, coordination, and communication through many existing and new venues and projects. A strategic plan developed by CIRMOUNT members outlines a program vision and set of primary goals linked to the critical questions facing mountain environments under the impacts of climate change.

Current high-priority and near-term goals include the establishment of at least five new GLORIA Target Regions, installation of long-term climate monitoring (including sampling through elevational gradients) in key mountain regions presently lacking coverage and filling in gaps in the CORFOR forest plot transect. Intermediate range goals are to produce comprehensive mountain-climate issue papers, and to promote a coordinated climate policy relationship for western North American mountain regions with other federal agency programs, such as the NOAA RISA (Regional Integrated Synthesis and Assessment) program. A long range "dream goal" is for CIRMOUNT to develop a unified interdisciplinary research program for western mountains, envisioned as a "Climate Change Science Program for Western Mountains."

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Weblinks

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CIRMOUNT Strategic Plan:
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The Mountain Invasion Research Network (MIREN)

MIREN is a boundary organization bridging research and management for addressing plant invasions in mountains.

As a result of global change, mountain areas may become increasingly threatened by invasive non-native plants. The Mountain Invasion Research Network (MIREN), launched in 2005, initiates and integrates surveys, monitoring, experimental research, and management of plant invasions into mountains at a global scale (Dietz et al. 2006). MIREN is associated with the Mountain Research Initiative (MRI), the Consortium for Integrated Climate Research in Western Mountains (CIRMOUNT) and the Global Mountain Biodiversity Assessment (GMBA) one of the 4 networks of DIVERSITAS.

The MIREN core research program includes 6 mountain regions (Pacific Northwest [USA], Swiss Alps, Chilean Andes, Australian Alps, Hawaii, and the Canary Islands [Spain]), covering the major climatic zones and including island and continental systems. All core areas participate in standardized monitoring of non-native plant distributions and demography, and comparative experiments. Beyond the core program, MIREN networks researchers and managers in an extensive set of mountain regions and thereby functions as a boundary organization bridging research and management for addressing plant invasions in mountains (Kueffer & Hirsch Hadorn 2008, page 34 of this newsletter).

MIREN reviews, integrates and advances knowledge on plant invasions, uses elevational gradients in mountains as a model system for global change ecology, and promotes proactive approaches to managing potential future risks of plant invasions into mountains. The following sections briefly illustrate each of the three pillars of MIREN and give some current developments.

Towards a conceptual framework for understanding and predicting plant invasions into mountain ecosystems

In 2005, a special issue of *Perspectives in Plant Ecology, Evolution and Systematics* on plant invasions into mountains (Vol 7 No 3) brought together 6 articles showing that non-native plants are present in mountain ecosystems around the world, but that the distribution patterns and impacts along elevation gradients differ between regions. In an upcoming article in *Frontiers in Ecology and the Environment* (Pauchard et al. in press), we present a conceptual framework for understanding these differences and more generally plant invasion into mountains. Although factors determining plant invasions into high elevations are the same as in other ecosystems, the manner by which they influence the outcome of invasions changes in mountains because of the extreme conditions. Harsh climatic conditions, isolation and limited human pressure have made mountain ecosystems relatively resistant to plant invasions. However, this situation may start changing as species adapt to cold and harsh environments, as the climate changes, and as human pressures expand into mountainous environments, making mountain ecosystems as susceptible to invasions as other historically invaded areas.

Mountains as model system for global change ecology

MIREN believes that due to steep environmental gradients over small spatial scales, mountainous regions provide particularly useful model systems for understanding ecological and evolutionary processes associated with plant invasions. As most non-native plant species reach their distribution limit at some point along these gradients, mountains provide the opportunity to study processes at the invasion front. This can help to disentangle the relative contributions of

Figure 1: *Hieracium aurantiacum* infestation (in flower) in Kosciuszko National Park, Australia. This species has the capacity to invade undisturbed vegetation and quickly attain dominance. The site shown was searched two years prior to the photograph and no *Hieracium* was detected (photo Keith McDougall).

Figure 2 : Globally, the most widespread mountain plant invaders to date are species typical of European pastures (e.g. grasses, *Trifolium* spp., *Verbascum thapsus*), which were probably introduced during the past few hundreds years for livestock grazing in many mountain regions. The picture shows a pasture in the native range of these species in the Swiss Alps (photo Tim Seipel).

propagule pressure (i.e. input of seeds or other types of propagules to a site), biotic interactions, phenotypic plasticity and local adaptation as limiting factors of invasions.

A particularly promising approach is to make reciprocal comparisons of mountain regions, using species native to one region but invasive in the other, and vice versa. In a recent study, Alexander et al. (in press) compared patterns of trait variation in natural populations of eight Asteraceae species along altitudinal gradients in the Wallowa Mountains, Oregon (USA) and the southern Swiss Alps. Four of the species were native to North America and four to Eurasia, and all were present in both study areas. Despite having been introduced to these regions only within the last 200 years, all species had similar altitudinal ranges and showed parallel clines in plant height, capitulum (flower head) number and seed size. These results indicate that the need to respond to altitudinal gradients, possibly by local adaptation, has not limited the ability of these species to invade mountain regions. However, the authors also found differences in patterns of resource allocation to capitula among species in the native and the introduced areas. These suggest that the mechanisms underlying trait variation, for example increasing seed size with altitude, might differ between ranges.

A proactive approach for managing potential future risks of plant invasions into mountains

At the next annual meeting of MIREN, to be held December 2008 in Australia at Kosciuszko National Park, a Mountain Biosphere Reserve, priorities for control of invasive species in mountains will be discussed with park managers. The meeting is timely because Australian park managers face a significant threat to mountain biodiversity in the form of a recent invasion and rapid spread of two Hawkweed (*Hieracium* spp.) species (see Figure 1). The emergence of the Hawkweeds as a threat in Australia is typical of a global change in invasion patterns in mountains. A review of mountain invasions by MIREN (McDougall et al. in prep.) has identified almost 1500 plant taxa worldwide that are naturalized or invasive in mountain areas. Far from being resistant to invasion as commonly thought, mountains are home to a large number of non-native plant species. More than half the taxa in any mountain region are not found in other regions, suggesting that the total pool of potential invasive species is large and all regions can expect further invasions. The most widespread mountain plant invaders are species typical of European pastures (e.g. *Holcus lanatus, Rumex acetosella, Trifolium repens*, Figure 2), which were probably introduced during the past few hundreds years for livestock grazing in many mountain regions. These species appear to have had relatively little impact on local biodiversity. Some invaders (e.g. *Hieracium* spp., *Cytisus* spp., *Salix* spp.), how-ever, have appeared recently, as mountain land use has shifted in many regions from agriculture to tourism. These species have often been selected for cold adaptation and now pose an important threat to biodiversity. This threat is likely to grow as tourism expands and global warming allows invaders to reach higher altitudes.

Prevention is widely considered the most cost-efficient management strategy against the threat posed by invasive non-native species. Mountains are one of very few ecosystems not yet badly affected by plant invasions. In mountains, thus, invasive species researchers and managers have the unique opportunity to respond in time to the threat by preventing invasions before they are actually happening. MIREN is therefore researching and promoting efficient implementation of proactive measures, such as restricting the transport of likely invasive species into mountain areas and early detection searches, to prevent invasions before they become another major threat of vulnerable mountain ecosystems.

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MIREN Consortium http://www.miren.ethz.ch/people/

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CIRMOUNT: http://www.fs.fed.us/psw/cirmount/
GMBA: http://www.gmba.unibas.ch/index/index.htm

Swiss Experiment: an e-science platform for interdisciplinary collaboration in environmental research

Swiss Experiment (SwissEx) is an initiative of the Center for Competence in Environment and Sustainability (CCES) of the ETH Domain to provide a platform for scientific collaboration across the environmental science domains. The aim is to enable real-time monitoring by providing advanced wireless sensor network technology and flexible database middleware, which allows scientists to store and share data easily without designing database schema. A metadata infrastructure and query user interface are also designed into SwissEx to provide the tools required for effective collaboration.

Combining data from across the environmental science domains in a single distributed database will allow diverse measurements to be compared, providing scientists with access to measurements outside their area of expertise and encouraging interdisciplinary data sharing and collaborative work on a unprecedented scale. Swiss Experiment incorporates projects on environmental sustainability funded by CCES, the Swiss National Science Foundation, EU FP7 and private partners.

The SwissEx projects range from earthquake precursors to landslide/avalanche release or extreme value statistics of natural phenomena. The core experiments involve scientists from EPFL[1], ETHZ[2], WSL/SLF[3], and Microsoft Research, although the infrastructure is currently also used by scientists in Austria and Finland. This endeavor brings together experts in hydrology, geophysics, atmospheric science, seismics and ecology as well as databases, peer-to-peer technology, sensor technology, data management and other expertise in many related areas. The environmental research projects will provide databases of inter-related data, whereas (with the aid of the environmental scientists) the technological projects will provide the infrastructure platform with which the environmental research projects will collect, share and search for data as well as collaborate on analysis. A list of the participating projects is provided below.

- **APUNCH** - Advanced process understanding and prediction of hydrological extremes and complex hazards
- **BigLink** - Biosphere-geosphere interactions: linking climate change, weathering, soil formation and ecosystem evolution
- **COGEAR** - Coupled seismogenic geo-hazards in alpine regions
- **EXTREMES** - Spatial extremes and environmental sustainability: statistical methods and applications in geophysics and the environment
- **HYDROSYS** - On-site monitoring of events and analysis of natural resources
- **MOUNTLAND** - Sustainable land-use practices in mountain regions: integrative analysis of ecosystem dynamics under global change, socio-economic impacts and policy implications
- **RECORD** - Restored corridor dynamics: assessment and modelling of coupled ecological and hydrological dynamics in the restored corridor of a river
- **TRAMM** - Triggering of rapid mass movements in steep terrain
- **Global Sensor Networks (GSN)** – Middleware for sensor networks
- **SensorScope** - A new generation of measurement system based on a wireless sensor network with built-in capacity to produce high temporal and spatial density measures
- **Permasense** - Innovative sensor technology for automated, unattended long-term data acquisition in the extremes of the Swiss high-alpine regions
- **Hydromon** - Real-time quantitative water quality monitoring
- **SenseWeb** (SensorMap, figure 1) - A geo-spatial database and visual interface for managing sensor data
- **SwisScope** - A SwissEx initiative in environmental education

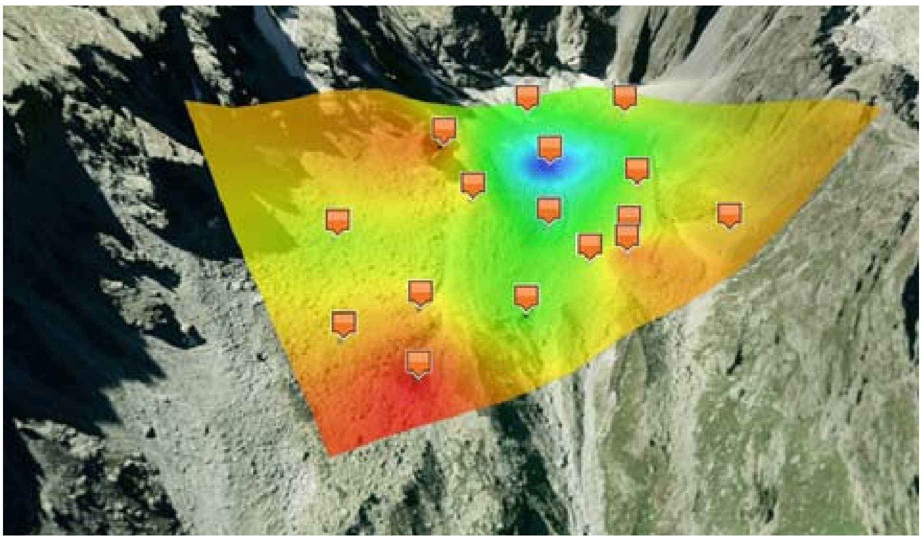

Figure 1: SensorMap supports gridpoint interpolation of sensor data (in this case temperature) which may be overlayed onto a topographic model.

The SwissEx platform currently provides facilities for sharing of: experimental methods; data (a database for streaming data); sensor metadata (supplementary data on the sensor itself) and data quality metadata (automated), as well as allowing data visualization using a 3D topographical model and providing a store of results alongside the data. There are currently many services offering support for one or more aspects of the scientific work process, but Swiss Experiment aims to incorporate the entire process and to maintain the infrastructure to be as generic as possible, enabling it to be used across the natural science domains.

Figure 2: The SwissEx wiki makes use of semantics to become an integrated part of the data acquisition infrastructure.

Collaborative work is the key to efficient data collection. SwissEx eliminates the requirement for each experiment to create its own system for archiving data and storing results. The experiment also aims to collocate measurement sites where possible, so that common measurements such as meteorological/ climatic measurements may be shared and hence costs reduced and benefits gained from measurements outside the budget of a single project.

Infrastructure

For the experimental background information, such as general site details and experimental methods, a wiki is used. The wiki allows all scientists involved in the project free access to update online information and hence to store and share the information. Protected access is also available. This wiki also provides an interface for sharing of results or for links to related papers.

For sensor metadata, the use of semantics within the wiki is exploited to provide a database of sensor details and observations of the sensors or their data. This database is then queried along with the data to provide timely background information on the reasons for data anomalies and to provide an information trail from the data to the sensor, its previous history and its location, capabilities etc. (Dawes et al. submitted, Michel et al. submitted).

GSN (Global Sensor Networks) is a middleware software package designed to configure a SQL database automatically, take data from sensors or data files, and store the data in the database. GSN is used within SwissEx to store streaming data efficiently in a database with minimal planning or interaction from the scientist. GSN also provides a simple visual query interface to allow downloading or plotting of data. This tool is currently being expanded to allow an easy interface for complex real time in-line processing.

One of the uses for which this will be exploited is to provide real-time feedback on data quality based on statistical analysis and complex data processing algorithms. This will be useful for both the sensor owners and downstream users of the data in defining the invalid data. An interface for efficient recording of manual measurements is also currently under development, such that both streaming and static (non-streaming) data will be queryable under the same interface (Aberer 2007, Aberer et al. 2006).

For data visualization and download, Microsoft Research is currently developing SensorMap[4] for SwissEx. This platform provides a geo-spatial visual interface for data access as well as tools for interpolation to grid points such that the spatial distribution of measurement parameters may be viewed in 3 dimensions on a topographic interface. This capability allows the scientist a better appreciation of the processes which are occurring and allows him/her to associate them with the topography.

This tool will be further developed to allow the user to query the measurements, e.g. to obtain those with specific parameters available between a specified date range. The user will then be presented the geospatial distribution of all the measurements available, and will have direct access to the data for which they have permission. By providing information through the wiki and Sensormap SwissEx aims to be a public portal for environmental science in Switzerland.

Swiss Experiment will begin on the 1st September 2008 and will continue for 4 years. The infrastructure developed during the pilot period is already proving to be advantageous to scientists, and will become more so as more sensors are incorporated and advanced tools are developed.

Application Example

Imagine that you want to collect information on local meteorology at a high alpine site in Switzerland. You may want to check for local snow distribution in winter or you may want to see the maximum wind speeds during the last storm. The participating scientists will have collected their data using automated or manual techniques and these data will have been entered into the SwissEx database using GSN. Once all of the

measurements have been registered into Microsoft SensorMap which should occur in the coming year, you will be able to browse the data available using a 3D topographical map interface, filtering the data according to your specific query or measurement type, e.g. all wind speed measurements between 27th July and 30th July 2008 with a magnitude > 20m/s or the identity of the sensor which registered the maximum windspeed in Switzerland between these two dates.

Thousands of sensors will be available on this interface. By selecting the sensor of interest, you will be able to view the data and metadata, or in the case of protected measurements, e.g. Swiss national infrastructure measurements such as the meteorological station network (IMIS), you will be able to view what measurements are available on application or even view the data at a reduced temporal resolution according the preferences of the data owner.

The data will not be limited to sensor data. Plans are in progress to integrate model data, providing a gridded spatial distribution of data points which will be viewable as an overlay on top of the topographical model. Once you have selected your sensors of interest, you can view all other types of measurements in your area of interest. There may be measurements in the middle of your area of interest using a sonic anemometer from another institution or there may be manual snow profiles carried out by local snow scientists. All of these measurements can be overlaid on top of each other, so that previously unknown influences of the surrounding environment may be easily discovered.

In a second example, you may be interested in the plant growth conditions during the last few weeks above an altitude of 2000m in order to compare the local conditions of your own field site to those of the rest of Switzerland. The IMIS meteorological station network plus local meteorological stations from across Switzerland will be available, though still protected, in SensorMap. A query to find stations above 2000m will show the relevant stations, and an application to obtain data from these specific stations may be submitted. You may then find that there are a series of measurements around your field-site generating data to which you previously had no access. There may, for instance, be precipitation radar measurements from a point nearby which can help you in your analysis or a series of measurements from around the watershed, combined with a runoff measurement below the watershed and even measurements from the nearby hydro-electric station, all measured by separate institutions with no knowledge of what other measurements were taking place nearby. When plotting all of these measurements together, you find that all measurements seem to relate very well, but the automated quality values of one measurement show it to have bad data. When you read the metadata, you find that there was a problem with the sensor which is not reflected in the data, hence you can eliminate it from your analysis.

These examples show that scientists using this infrastructure can obtain access to data which normally would be well outside their budget, should they have to acquire it themselves. Using external data sources usually comes with a warning that you may not know what is happening in the data, but with a well managed metadata infrastructure, any anomalies should be automatically highlighted by the data owner.

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1 Ecole Polytechnique Fédérale de Lausanne

2 Eidgenössische Technische Hochschule, Zürich

3 Eidgenössische Institut für Wald, Schnee und Landschaft (WSL) Institut für Schnee und Lawinen Forschung (SLF)

4 http://atom.research.microsoft.com/sens-webv3/sensormap/

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The contribution of satellite remote sensing to the monitoring of cryosphere in mountains

Snow and glacier monitoring in mountains

The dynamic of snow accumulation and ablation is important for life, human and other, in almost all mountain regions. Depending on latitude, elevation and climate, water run-off, and therefore water supply for irrigation, tourism and power generation derives mostly from snow and to some extent from glaciers. Slowly changing glaciers need two or three observation times per year, but the ephemeral snow cover needs daily or at least weekly measurement. Point measurements made by automatic devices give detailed information on snow depth, density, and temperature but are frequently not representative for the region. In mountains an interpolation between single point measurements is at best a first guess of the real situation. Satellite remote sensing could improve interpolations with additional data. As glaciers and snow cover respond at different time scales, it is essential to monitor the cryosphere at high spatial and high temporal resolutions.

At present, it is not possible to realize both requirements simultaneously. Hence, one should distinguish between near real-time monitoring, e.g. as a contribution for run-off calculation, and longer term climate related studies of glacier mass balance changes.

The European Association of Remote Sensing Laboratories (EARSeL) addressed these important topics in detail at the 5th workshop on Remote Sensing of Snow and Ice, held at the Institute of Geography, University of Bern, in February 2008. More than seventy scientists from Europe, Turkey, Japan, USA and Canada discussed the latest developments and techniques for remote sensing of snow and ice. Most of the talks are available on the webpage of the Remote Sensing Research Group, Institute of Geography, University of Bern[1]. The following sections are conclusions from individual talks (referenced and listed at the end of the text).

Glacier monitoring

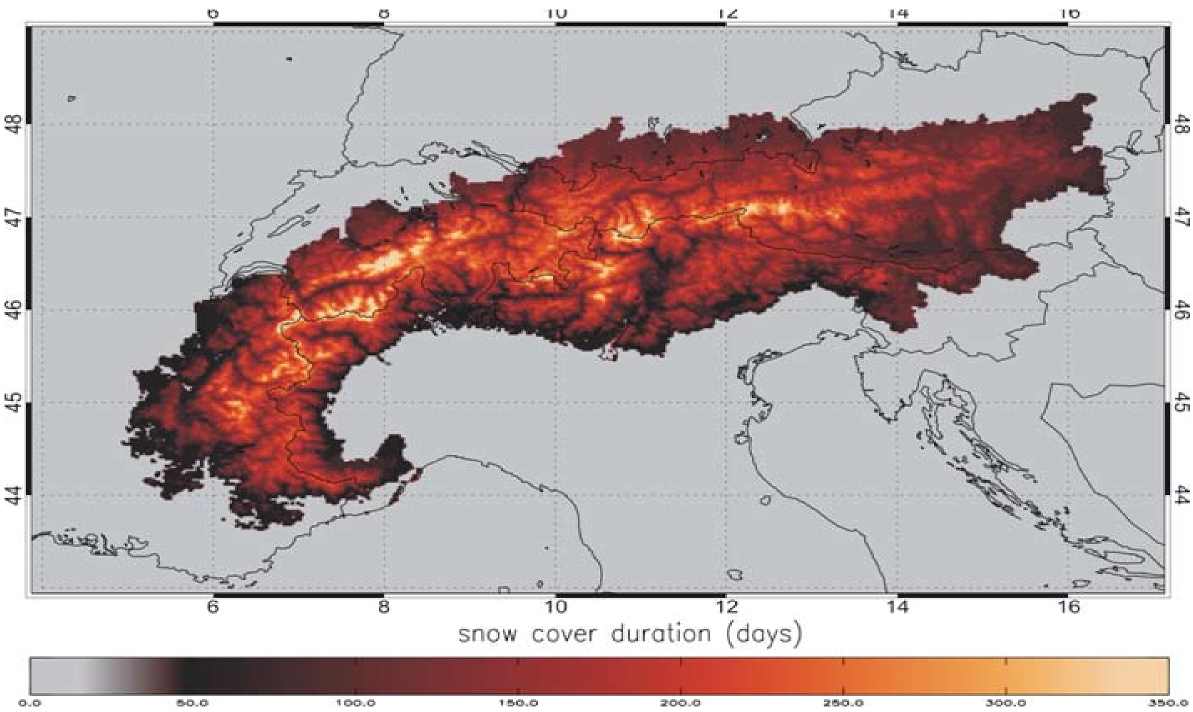
The data of the World Glacier Monitoring Service (WGMS[2]) are a combination of high resolution satellite imagery, aerial photos, numerical glacier models and in-situ measurements. The inclusion of these different data types in a Geographical Information System offers the possibility to determine changes in length, thickness and mass balance of glaciers and to link changes in the cryosphere with climate change.

Investigation of future trends of glaciers would be impossible without the knowledge of their past behaviour. The work of WGMS is a prerequisite for mapping glacier coverage today and gives a basis to calculate future scenarios (Paul et al. 2008; Korona et al. 2008).

Snow monitoring

Contrary to glaciers, which are relatively inert, the snow cover is highly variable and volatile. After a stormy period of some days, snow may cover hundreds of square kilometres but after a few warm days the white blanket disappears, presenting a challenge to remote sensing. During cloudy conditions only RADAR systems are able to deliver useable information but their repetition rate of weeks is not sufficient to capture short-term changes. Optical wide-swath sensors (MODIS on Terra and Aqua or AVHRR on NOAA satellites) are characterized by daily mapping capabilities and reasonable spatial resolution but are only useable during clear weather conditions. A combination of both products (snow maps derived from RADAR and optical sensors) is the best choice to obtain reliable information on the daily dynamics of the snow cover (Nagler et al. 2008; Solberg et al. 2008).

View from Jungfraujoch shows an important part of the cryosphere of the European Alps (photo R. Ottersberg, Remote Sensing Research Group, University of Bern, 2005)



Mean snow cover duration of the European Alps derived from NOAA-AVHRR data of the years 2002 - 2007.
The work was done by Fabia Hüsler, Remote Sensing Research Group, University of Bern, as a feasibility study for a 20-year time series.
(Diploma thesis by Fabia Hüsler, 2007: Analysis of short-term trends in snow cover variability in the European Alps – based on subpixel snow mapping with NOAA AVHRR data)

Remote sensing techniques to map the snow cover are used for regional studies, continental mapping and global monitoring[3]. With the launch of Meteosat Second Generation (MSG) the temporal resolution is further improved and optimizes cloud detection for better snow monitoring (Seiz et al. 2008).

In the near future new sensors will be launched and the algorithms for snow detection will have to be improved to achieve the target objectives of the snow and ice community published in the 2007 Report of the International Global Observing Strategy (IGOS)[4] (see table 1 on the next page).

Climatic change issues – the need for long time series

When talking about climate change we should take into account the definition of a climatic period made by the WMO[5] . Only a time series of 30 years fulfills the requirements for climate related studies. If we believe this statement, the remote sensing community analysing satellite data for climate purposes should stop its activity – unless the scientists are engaged in passive microwave or in Advanced Very High Resolution Radiometer (AVHRR) data of the NOAA series, which offers a reasonable period. The AVHRR sensor was made to support the weather services with daily information on the cloud types and coverage. But the sensor has also been used for remote sensing of the Earth surface and oceans for many years. The 25 years of historical AVHRR sensor data allow climate related studies. The daily repetition in combination with the wide swath of 2.700km makes the sensor a powerful tool for near-real time snow monitoring. As the sensor has changed very little over time, the data are suitable for time-series analysis. This long time series is exceptional for an operational sensor.

At the EARSeL workshop Prof. Hans v. Storch, a climatologist of the Coastal Research Centre, Geesthacht, and the Max Planck Institute for Climatology, Hamburg, made the case for long time series. He impressed the audience with an elaborated presentation on the need of long time series and, depending on the dynamic of the observed topic, a high temporal resolution. As he pointed out, five years of satellite data and the word "climate" in a study's title do not fit together. Nevertheless, the information on snow cover or glacier extent derived from satellite data can be used as source to validate the output of climate models (v. Storch et al. 2008).

This is but one side of the coin and the view of a climate scientist. But his message was well-taken. Most of the subsequent speakers were more cautious in using th e word "climate".

Contrary to this talk the following speakers showed the huge advantage of using satellite data for investigations of the northern continental area and the Arctic Ocean. The time series of snow coverage and sea ice extent were not sufficiently long but even so the satellite data provided detailed information on changes of the northern environment that could not otherwise have been obtained – illustrating the other side of the coin. Depending on the complexity, interaction and scale of some cryospheric parameters (snow cover, glacier extent, etc.) remotely sensed data are the only usable source to observe and monitor areas with limited accessibility. Certainly, some parameters of the cryosphere, for example the snow water equivalent (SWE), are not yet detectable by remote sensors but future missions promise such capability (Pulliainen et al. 2008; Stroeve et al. 2008; Trishchenko et al. 2008).

A step forward: new sensors and new missions for global and mountainous observations

Most of the world's space agencies accept the need for new sensors designed for cryospheric purposes. As part of ESA's Living Planet Programme (LPP) new explorer missions and Earthwatch/GMES missions are in the pipeline. CryoSat-2 is ready to be launched in 2009 and will improve our understanding of thickness and mass fluctuations of polar and marine ice as well as more precise information on the thinning and thickening of ice sheets (Drinkwater 2008).

A step forward in the monitoring of snow hydrology in mountains will be CoReH2O (Cold Regions Hydrology High Resolution Observatory) - one of the six ESA Earth Explorer candidates. If the sensor is selected it will provide snow observations to improve hydrological, climate and NWP (numerical weather prediction) modelling. Furthermore permafrost monitoring and sea ice thermodynamics will be improved (Rott et al. 2008). These are only two examples of new sensors that are in the selection, planning or building process. But all of the future sensors and systems will contribute to the requirements defined by the International Global Observing Strategy (IGOS) to improve our understanding of the cryosphere. As pointed out by IGOS's Cryosphere Theme Report 2007[6] the following terrestrial snow parameters should be detected with the spatial and temporal resolution shown in table 1.

Data acquisition at the targeted spatial and temporal resolution will offer new possibilities to study snow dynamics in rugged areas and mountains of the world with sufficient precision.

In the above mentioned IGOS report additional tables exist to show the current and future requirements for sea ice, lake and river ice, ice sheets, icebergs, glaciers and ice caps, snow and ice temperature and albedo, permafrost and snowfall.

Conclusion and recommendations

Every topic of this article could fill several books. During the EARSeL snow and ice workshop 2008 the following recommendations could be extracted from the lively discussions after the talks and during the coffee breaks.

Without doubt, it is essential to use remote sensing data but one has to ask whether the available data will yield the desired results.

Limited financial resources often constrain the procedure in small research groups. Very often students' master theses start with the question: which data are freely available? It is not productive if they have to write a proposal just to obtain better data for a short project. This may be one reason why some scientists analyse data of a short period and then talk about climate.

Recommendation 1: An open data policy and easy access to the data are the most important requirements to improve our knowledge of the key cryospheric variables.

Data analysis should not start at "square one". The literature is full of excellent examples of how to proceed. Furthermore, numerous software packages to analyse satellite data are available free of charge. This may help to improve the data analysis and accelerate the progress to generate new knowledge of the cryosphere.

Recommendation 2: Bring algorithms to maturity, so that they can be used by other research groups. This consolidation would accelerate the rate at which we gain knowledge of the cryosphere.

It is not easy to find evidence of the changing climate in a time series based on satellite data. There are numerous parameters which influence the data set. Atmospheric composition differs and may cause artifacts. The drifting equator crossing time will lead to changes in illumination. Slight changes of the spectral response function and band width will cause other responses of the surface. Due to additional bands in the course of new sensor developments the algorithms change, and the extent of sea ice or snow coverage may include artifacts. Thus, it is challenging to prove homogeneity of time series.

Recommendation 3: Improve satellite calibration of NOAA-series (NOAA-9 to NOAA-18 and Metop-AVHRR) in order to lengthen the time series to 30 years, making them useable for climate research.

After the launch of new satellites and sensors the research community will develop algorithms designed for the new sensor specifications. The outcomes of new or modified algorithms must be proofed, validated and combined with products based on older sensor technologies. A higher spatial resolution of the new sen-

Parameter	Measurement Range Low – High (%)	Measurement Accuracy (%)	Resolution spatial - temporal
Snowcover	C: 20 – 100 O: 0 - 100	C: 15 – 20 O: 5	C: 1km / day O: 0.1km / 12h
Snow Water equivalent (shallow)	C: 0 – 0.2 m O: 0 – 0.3 m	C: 2 – 10 cm O: 2	C: 25km / day O: 0.1km / 12h
Snow Water equivalent (deep)	C: -- O: 0.3 – 3m	C: -- O: 7	C: -- O: 0.1km / 12h
Snow depth (deep)	C: -- O: 1 – 10 m	C: -- O: 6 cm	C: -- O: 0.1km / hr

Table 1: Current and planned capabilities and requirements for terrestrial snow parameters.
C: current capability; O: Objective Requirements (Target). Only four out of seven parameters of the original table are shown, see Table B1, page 82 of the IGOS's Cryosphere Theme Report 2007.

sors can be expected, which makes the comparison between the results of old and new products a demanding task. The great heterogeneity of the snow cover in mountains requires sophisticated techniques and a persistent program to produce good quality products.

Recommendation 4: The validation of algorithms and results should be a focus of future research programs.

1 http://www.geography.unibe.ch/lenya/giub/live/research/remotesensing/Forschung/earselworkshop_en.html
2 http://www.geo.unizh.ch/wgms/
3 NSIDC (National Snow and Ice Data Centre): http://nsidc.org/
4 http://www.wmo.ch/pages/prog/wcp/ccl/faqs.html
5 http://igos-cryosphere.org/
6 http://cryos.ssec.wisc.edu/documents.html

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Frank Paul et al.: GlobGlacier: Mapping the worlds glaciers and icecaps from space for improved climate change impact assessment.

Jérôme Korona et al.: Topography of glaciers and ice caps with Spot 5 HRS devices.

Thomas Nagler et al.: Demonstration activities for snow cover monitoring and hydrology using satellite data.

Rune Solberg et al.: Time-series fusion of optical and SAR data for snow cover area mapping.

Gabriela Seiz et al.: Alpine Snow Cover Climatology – a Swiss GCOS Pilot Project.

Hans v. Storch et al.: Potential and limits of satellite data for climate issues.

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Julienne C. Stroeve et al.: Arctic Sea Ice in 2007: A Year to Remember.

Alexander P. Trishchenko et al.: Mapping Arctic albedo and cryosphere from MODIS for the International Polar Year at the Canada Centre for Remote Sensing.

Mark Drinkwater: New Missions of ESA's Living Planet Programme in the context of the IGOS-Cryo Theme.

Helmut Rott et al.: CoReH2O – A dual-frequency SAR mission for improved et al.: CoReH2O – A dual-frequency SAR mission for improved snow and ice observations.

Weblinks

Find the abstracts and the presentations at
http://www.geography.unibe.ch/lenya/giub/live/research/remotesensing/Forschung/earselworkshop_en.html

High Elevations working group: a new element of the Coordinated Energy and water cycle Observation Project

The High Elevations (HE) initiative has been recently implemented as new component of "regional focus" with-in the Coordinated Energy and water cycle Observation Project (CEOP) of GEWEX (Global Energy and Water Cycle Experiment). HE aims at studying multi-scale variability and change in hydrological and energy cycles in high elevation areas and understanding their role within the climate system on a regional and global scale. One of the first priority issues that the HE initiative will address is the identification of representative high elevation sites that are significant for the study of physical and dynamic processes.

Background and motivation

The Coordinated Energy and water cycle Observation Project (CEOP) is an integrated program focused on hydrological processes and water resources and their response to changes in the environment. CEOP's general goal is to understand and predict continental to local-scale hydroclimate. In this framework, CEOP has recently launched the High Elevations working group which aims to advance knowledge of climate factors impacting the water and energy budget, particularly in high altitude and remote areas (Nogués-Bravo et al. 2006).

Mountains are sensitive indicators of human activities affecting the world's climate and provide interesting locations for the early detection of climate change signals on hydro-climatic systems (Beniston 2003). Mountain regions provide essential freshwater for numerous downstream populations especially in the world's arid and semiarid zones, but their hydrological significance needs to be clarified. Likewise, the water balance of mountains still remains uncertain (Viviroli et al. 2003, 2007).

In order to understand how climate change influences hydrology, cryosphere, geomorphology, ecosystems, human livelihoods, etc., we need high quality, long-term climate data to support modeling and long-term prediction. So far, the majority of high elevation regions lack such datasets, primarily because of difficulties such as extreme topography, harsh climate, lack of appropriate technical equipment and a general underappreciation of the data's scientific benefit.

Defining "high elevations"

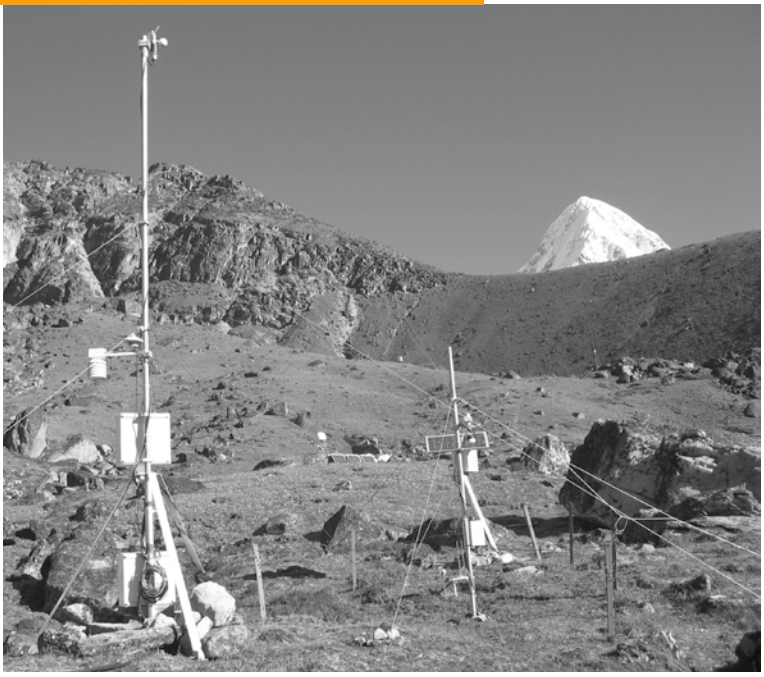
There is no commonly accepted definition of "high elevation". Connotations vary and the threshold altitude above which terrain can be considered "high elevation" is disputed. In mountain hydrology, for example, an accepted definition of "high elevations" includes only the parameters altitude, temperature and roughness (Meybeck et al. 2001). Such a definition is incomplete when extended to climate and water cycle studies, as it excludes high plateaus and low altitudes in high latitudes where the hydro-climatic characteristics are similar to high altitudes with respect to major global change factors. In addition, climate changes affecting high plateaus and high latitudes can also influence global atmospheric circulation and the land-atmosphere water budget.

Based on these considerations we are proposing a definition of "high elevations" in which we consider obvious factors such as relief roughness (>40 ‰ according to Meybeck et al. 2001), high plateaus, altitudes or latitudes above the timberline, low atmospheric pressure and low average temperatures. We are also interested in those sites that directly create or influence regional climate patterns and allow for monitoring of boundary layer dynamics. Our connotation of "high elevations" therefore should be understood as corresponding to the context of our scientific activity, and not with any literal encyclopedic definition.

Objectives

The goal of the HE Working Group is to

Figure 1: Map of the CEOP sites based on Google Earth



CAMP/Himalayas (Pyramid AWS; 5,050m a.s.l.)

Pakistan Karakorum Network (Urdukas AWS, 4,000m a.s.l.)

Figure 2: High altitude Reference Sites located in the Himalayan and Karakorum regions and included in the CEOP network. These meteo-climatic stations represent the initial stage of implementation of a global HE network (Photos courtesy of Ev-K2-CNR Archive).

study multi-scale variability in energy and water cycles in high elevation areas, while improving observation, modeling and data management.

In particular, HE aims to establish a network of high elevation climatic stations, including but not limited to CEOP reference stations, and to coordinate the activity of these stations. HE also intends to contribute to the understanding of water and energy cycles at high elevations and the study of their role within the climate system using globally integrated analysis of CEOP reference sites, ground-based methods, remote sensing observations and models analysis and application. Another of HE's aims is to study the transportation processes of aerosols and other atmospheric components in high troposphere/low stratosphere. HE furthermore proposes to explore synergies between meteorological-climate and hydrological studies in order to improve management of water resources. HE will also emphasize the importance of long-term monitoring and improvement of observation, numerical simulation and data assimilation techniques at high elevations.

Finally, given the important social and economical consequences for about 40% of the world's population (Viviroli et al. 2007), HE aims to improve the forecasting capabilities of the hydro-climate system at high elevations for water resources applications.

Implementation strategy

HE began in early 2008 with the establishment of the HE Working Group, which convened for the first time at the HE Kick Off Meeting held on April 16-17, 2008, in Padua, Italy. Activity so far has concentrated on elaboration of a Scientific Plan (SP) which describes the strategy for achieving HE's specific objectives in line with the goals of CEOP. The SP is being developed with the contribution of a dozen experts in several disciplines, including climatology, hydrology and atmospheric chemistry. Priorities identified so far include detection of the main factors affecting the water, energy and material cycles at high elevations in diverse climates and locations, studying the effects of such factors on glacial areas, and understanding the hydrological regime in surrounding lower altitude areas.

Given their importance in global climate dynamics and climate change, and the existence of quality data and monitoring stations, the high elevation areas of the Himalayas, Tibetan Plateau and Karakorum mountain ranges have been identified as the starting point of the study, subject to CEOP's approval of the SP (Lau et al. 2008). Specific attention will be given to the network of high altitude meteo-climate monitoring stations located along the Himalayan and Karakorum chains, which include some CEOP research network Reference Sites (RS) (CAMP/Himalayas and Pakistan Karakorum Network, Figures 1- 2). Continuous measurements are carried out at all these stations, thus providing representative and relevant data important for furthering the understanding of hydrological and climatic phenomena at high elevations and their role in the climate system.

In order to improve our understanding of variability and change in hydrological and energy cycles at high elevations and their role in the climate system, significant high elevation reference sites, where physical and dynamic processes can be studied, will be identified over the next two years. Mountain ranges with good data coverage and which contribute the significant water resources to surrounding lowlands may be taken into consideration, as might typical sites for each climatic zone. Climate and surface properties data will be compiled within a coordinated framework, both using ground-based and remote sensing methods. All data will be stored in an electronic archive and datasets will be analyzed and integrated with satellite data. The data will also be used to improve the implementation of hydro-climatic models.

Expected outcomes

HE will contribute to hydro-climate study in the framework of CEOP by providing information on physical and dynamical processes at high elevations through the coordination of a global observation network among existing high altitude climatic stations and implementing new observatories where absent in significant areas. Planned activities will be oriented towards the development of specific models on the interaction between global climate circulation and high mountains. Quality hydrologic and meteo-climatic datasets will be collected and integrated to provide a complete view of the water/energy budget in high elevation areas. The issue of variability and seasonal-to-decadal trends in climate system analysis will also be addressed.

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Acknowledgment

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Weblinks

CEOP: http://www.ceop.net/
CEOP-HE: www.ceop-he.org
Ev-K2-CNR: www.evk2cnr.org

The first year of the global change research network for African mountains

The goal of the network is to implement the GLOCHAMORE Research Strategy[1] in African mountains, that is, to create inter- and trans-disciplinary research on those topics of the strategy that are compelling within the African context.

The Global Change Research Network for African Mountains (GCRN_AM) was launched at a conference held at Makerere University, Kampala, Uganda on 23-25 July 2007. This conference organized by the MRI and Universities in Africa and Switzerland brought together sixty researchers, principally from Eastern and Southern Africa but with representation from Cameroon and from the Fouta Djallon in West Africa. Presentations varied from paleoclimate to biodiversity to governance.

The network as it existed at the close of the conference consisted of three concentric circles of people. The outer and largest circle includes all people who proclaimed an interest in the workshop or have joined the network later. This circle now numbers over 400. The middle circle includes the participants in the Kampala meeting while the inner circle consists of those twelve people who assure the basic functioning of the network and who push initiatives in the three main areas of climate, biodiversity and human dimensions. This steering group confers monthly by telephone.

After the Kampala conference the steering group focused on three medium-term objectives:

1) Promoting the network.
2) Taking stock of researchers and sites.
3) Starting new projects to further global change research in African mountains.

(1) Promoting the network: The participants in the Kampala conference constituted a kernel for a GCRN_AM but a fully functional network will need both more funding and more participants. The network thus needed a focused communication strategy by which to inform the broader community about its existence, thereby surfacing more potential participants, and to inform the key international organizations that often influence priorities for funding.

The first task was the creation of products from the conference. The conference report produced by MRI and the Centre for Development and Environment of the University of Bern (CDE) includes abstracts of the presentations and a Who's Who in African mountain global change research, available from the GCRN_AM website (see links below). MRI recorded the presentations to facilitate review by non-attendees. The recordings are also available for viewing or for downloading at the same website.

Second, MRI used these products to inform other entities. Particularly important in this regard are IGBP, IHDP, Global Land Project, as well as specific African organizations: ICSU/Regional Office for Africa, CGIAR/African Highlands Initiative (AHI), the consortium of researchers who participated in the development of the Africa Network for Earth System Science (AfricaNESS), and the South African Environmental Observation Network (SAEON). The IGBP Congress in Cape Town, South Africa on May 5-9, 2008 provided a first opportunity to inform these organizations. MRI published an article in the IGBP Congress Newsletter that focused on the proposed climate network for the Ethiopian Highlands (see section 3 below).

In addition, MRI distributed the Kampala conference report to key participants.

Third, MRI publishes and distributes a monthly Newsflash to the 400 network members. Past issues can be found at the website.

Several up-coming events provide venues for further exchange among researchers and promotion of a global change research network for African mountains:

Iphakade: Climate Changes and African Earth Systems: Past, Present and Future, 12-16 January 2009, Cape Town.

Diversitas OSC2, 13-16 October 2009, Cape Town.

(2) Taking stock of researchers and sites: As was clear in Kampala, there are many researchers working in specific ranges who are not coordinating their activities with other researchers working in the same area. Thus a simple, but non-trivial task is to take stock of existing research activities in African mountains and to make this knowledge available to all participants in hopes that they, on their own initiative, confer and develop more interdisciplinary projects.

The Rwenzori Mountains in Uganda
(photo Bob Nakileza, the Mountain Centre at Makerere University, Kampala, Uganda)

The first step in this task consisted of the Who's Who section in the Kampala conference report. This compendium was developed after the workshop by representatives from each part of the continent based on their first-hand knowledge and inquiries, and thus was but a first snapshot of what was known in mid-2007 regarding global change (GC) researchers in African mountains.

The second step consisted of bringing in sites from the development community, especially those of the CGIAR African Highlands Initiative (AHI). The steering committee invited participation by a representative of the AHI.

At the current time, MRI and CDE are preparing in-depth profiles of current GC research at mountain sites in Africa both to characterize what exists now and to discern gaps that should be filled if we are to achieve inter- and transdisciplinary research programs. This effort focuses at the start on research highlighted in Kampala but will be expanded to include sites of the AHI as well as sites and programs run by the conservation community. The target of this initiative is both a publication describing these sites as well as a proposal of how to close the gaps in the current work. Such a document would be a key piece in marketing the network to funding agencies.

(3) Starting new projects to further global change research in African mountains: Funding opportunities arise frequently and the GCRN_AM has pursued and will continue to pursue these opportunities.

During the first year, Gete Zeleke (CGIAR/Global Mountain Program) and Stefan Grab (University of Witwatersrand) co-organized a workshop in Addis Ababa on 15-16 January 2008 to develop a proposal for a high elevation observation network in the Ethiopian Highlands. The workshop was attended by forty delegates, including representatives from various academic institutes and organizations, the Global Mountain Programme, FAO, UNEP and the Netherlands Embassy.

Three working groups were established on:

- high altitude climate change observatory stations,
- climate change and vulnerability in the Ethiopian Highlands,
- a Climate Change Research Network for Ethiopia.

The workshop concluded with a commitment to draft a proposal during 2008 for the establishment of high altitude climate observatories in Ethiopia.

Stefan Grab began working with the CEOP-High Elevation (HE) Project (see article pp 21-23). CEOP-HE advocates for the implementation of mountain climate observation sites world-wide within GEWEX and thus provides both a context and a mechanism whereby the GCRN_AM can lobby for African mountain observatories.

Eva Spehn of the Global Mountain Biodiversity Assessment (GMBA) and Willem Ferguson (University of Pretoria) similarly collaborated on a proposal to the JRS Biodiversity Foundation to create a database of geo-referenced biodiversity information from six African mountain ranges with standardized data storage of biodiversity records and associated climatic and geophysical records. The project would also generate digital tools to facilitate the interpretation of biodiversity change associated with climatic trends.

MRI collaborated with Prof. Dr. Martine Rebetez of the Swiss WSL on Net-DYNAMO, an European Science Foundation Research Networking Program (see Notes of page 34). Some of the collaborating researchers are Europeans working in African mountains, so that this project should help standardize integrated assessments within African watersheds.

At the current time, Willem Ferguson is also developing the institutional arrangements needed to create a mountain observation network within South Africa with sites at Mariepskop in the north, in the Sani Pass portion of the Drakensberg and in the mountains of the Western Cape. The South African Environmental Observation Network is quite interested and could greatly reinforce this effort. Taelo Letsela of the National University of Lesotho is developing a similar research site in the Lesotho Highlands, which could be associated eventually with the South African network.

The next Environment Call of the EU Seventh Framework Programme was published in early September 2008 and includes a call for better climate change predictions and assessments of impacts in Sub-Saharan Africa. While this call covers more than mountains, it is important to recall that mountains are the preferred human habitat in tropical Africa.

Any project that does not include a significant mountain component misconstrues the nature of global change in Africa. MRI will endeavor to ensure that mountain researchers are included in the consortia that respond to this call.

Finally, MRI hopes that many of key actors in the GCRN_AM will be able to participate in the upcoming Ipkahade Conference in order to plan in greater detail the deployment of the network.

The participants of the Kampala Workshop on a "Global Change Research Network for African Mountains", Kampala, Uganda, 23-25 July 2007 (photo Philip Omondi Aming'o)

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Weblinks

MRI Africa: http://mri.scnatweb.ch/networks/mri-africa/
Launching Workshop, Kampala, Uganda, 23-25 July 2007:
http://mri.scnatweb.ch/events/mri-events/gcrn_am-kampala-workshop-july-2007.html
African Network for Earth System Science (AfricanNESS): Eric O. Odada, University of Nairobi, Kenya, eodada@uonbi.ac.ke
Consultative Group on International Agricultural Research (CGIAR)/African Highlands Initiative (AHI): http://www.africanhighlands.org/
Consultative Group on International Agricultural Research (CGIAR)/Global Mountain Program (GMP): http://www.globalmountainprogram.org/
Coordinated Energy and Water Cycle Observation Project (CEOP): http://www.ceop.net/
Global Mountain Biodiversity Assessment: http://gmba.unibas.ch
Global Land Project (GLP): http://www.globallandproject.org/
International Council for Science (ICSU)/Regional Office for Africa (ROA): http://www.icsu-africa.org/
International Geosphere Biosphere Programme (IGBP): http://www.igbp.kva.se/
International Human Dimensions Programme (IHDP):
http://www.ihdp.unu.edu/
JRS Biodiveristy foundation: http://www.jrsbdf.org/v2/PreProposalHome.asp

Iphakade Conference: http://www.humboldt5.uct.ac.za/
Diversitas Open Science Conference 2009: http://www.diversitas-osc.org/

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1 The GLOCHAMORE "Global Change in Mountain Regions" project was a Support Action of the EU's Sixth Framework Programme on "Sustainable Development, Global Change and Ecosystems". This project was coordinated by the MRI and the University of Vienna and developed a state-of-the art integrated and implementable research strategy to gain a better understanding of the causes and consequences of global change in a selection of 28 UNESCO Mountain Biosphere Reserves (MBRs) around the world. See http://mri.scnatweb.ch/projects/glochamore/ for more information.

MRI Europe progress report 2008

The MRI Europe science network for Global Change research is the logical consequence of the FP6 project "Global Change and Mountain Regions" (GLOCHAMORE, 2003-05).

The GLOCHAMORE Research Strategy, as the main product, sets thematic foci and calls for integrated approaches, thereby giving clear directions of "where to go" in global mountain research. How can these global goals be translated and implemented in the European context?

For the MRI, the answer lies in the mobilization of the existing research communities and their resources at the regional level. This process was initiated in a first meeting on the "Global Change Research Network for European Mountains" (February 2007, Zurich). The meeting brought forward the MRI Europe network, defined as an interdisciplinary, purpose-driven network aiming at the implementation of the GLOCHAMORE Research Strategy in European mountains. The network aims at capitalizing on the research capacity and resources in Europe, for instance, by linking scientists, projects and initiatives. The following paragraphs briefly outline how these aims have been pursued in 2007 and 2008.

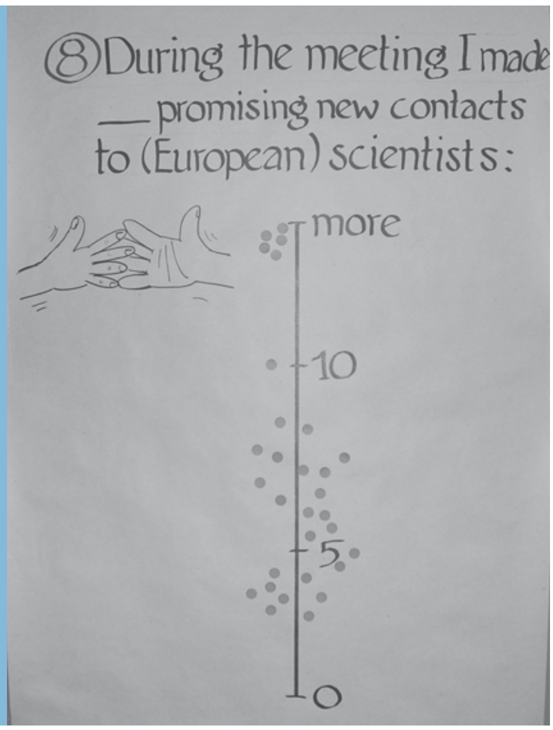
MRI Networking Events

After the successful networking meeting in February 2007, a similar meeting took place in Innsbruck in October 2007, focusing on interdisciplinarity in international research collaborations. The work approach of these networking meetings differed from other science workshops. With tools like the "research market" and "coffee table discussions" based on the open space method, these events attributed high importance to interaction and individual communication. Networking meetings aim at the formation of working groups, which elaborate project proposals congruent with the GLOCHAMORE Research Strategy.

Science for the Carpathians

With an unprecedented speed the Science for the Carpathians (S4C) initiative developed within the European network. Requested by a group of researchers who had received a mandate from the Interim Secretariat for the Carpathian Convention (ISCC, UNEP-Vienna) to organize science in the Carpathian region, the MRI engaged in the development of this network. In May 2008, the first S4C meeting was organized by the Jagiellonian University, setting the first milestone for a new science network for Global Change research in the Carpathian mountains. The workshop aimed at defining the current status of Global Change research in the Carpathians, at drafting a research agenda for topics relevant to the region, and at establishing an active science network.

The workshop succeeded in stimulating a lively discussion on what future research in the Carpathian region should look like and drafted a roadmap for the further development of the new science network. While events such as the "Forum Carpaticum" or thematic workshops are anticipated in near future, the MRI engages in facilitating the institutionalization process. For more information on the history of the Carpathian Convention and the S4C initiative see article "Sci-



MRI Europe Networking Meetings are based on the open space method and attribute high importance to interaction. Picture: workshop evaluation by the participants ence for the Carpathians" on page 29.

Development of Research Proposals

MRI allocates considerable time to the development of research proposals, be it as initiator or partner. Most promising among the proposals from the MRI Europe community is the successfully evaluated FP7 proposal for a "Network for Integrated Assessment of the Dynamics of Mountain Catchments under Global Change" (NET-DYNAMO) submitted by the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) with help from MRI in October 2007. This Research Network Programme aims at producing policy-relevant integrated assessments under global change scenarios in selected mountain catchments by means of existing models. It is currently being proposed to the over 20 partner countries for funding (see MR Notes on page 34).

Communication and Research Database

Targeted and effective communication is the core of a functioning science network. The MRI Europe NewsFlash, an electronic newsletter coming out every other month, is used as an information platform for the network members who contribute a large amount of information. It is supplemented with information on funding opportunities, events, proposals, and summaries of mountain science events.

The "MRI Europe List" developed for the purpose of creating transparency in the wake of the first FP7 Environment call has been refined and lists scientists working in the mountains of Europe with their expertise and research interests. In summer 2008 the database of MRI Europe consisted of almost 1000 scientists! The "Carpathian List" developed for the S4C initiative has grown to 253 scientists with specific interest in the Carpathian region.

Future products

With the move from the Swiss Federal Institute of Technology Zurich to the Institute of Geography at the University of Berne in September 2007 the European network got a new impetus.

From September 2008 onwards, MRI Europe will be part of the Forschungsstelle für Gebirgsforschung: Mensch und Umwelt (IGF), of the University of Innsbruck (see also "Inside MRI"), which will surely benefit the science network and its members. In future, more emphasis will be laid on the generation of scientific products (peer-reviewed papers, synthesis papers, workshop reports, proceedings) to supplement the idea of research coordination and networking.

Global change in mountains always has a human dimension (Bondo, Val Bregaglia, Switzerland, photo Claudia Drexler)

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Weblinks

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IGF: http://www.uibk.ac.at/igf/

Science for the Carpathians (S4C) – a brief history

Science for the Carpathians (S4C) is a new and quickly developing network with roots going back to 2001.

The idea germinated during the negotiation process of the Carpathian Convention, which benefited, particularly in its early growth stage, from several strong facilitators such as the Italian Government, United Nations Environment Programme and the European Academy. In 2008, with the support of the Jagiellonian University, Joanneum Research Center, Humboldt-Universität zu Berlin, University of Applied Sciences Eberswalde, and the Mountain Research Initiative, the idea of S4C took shape and became a network of scientists with an interest in developing Carpathian mountain science.

The initiation of the Carpathian Convention

The Carpathian Convention started in 2001 when the Ukrainian Government requested the United Nations Environment Programme (UNEP) to facilitate a process similar to that of the Convention on the Protection of the Alps (Alpine Convention). The UNEP forwarded the request to the Italian Ministry for the Environment and Protection of Territory as the Italian Government demonstrated a lively interest in promoting sustainable development in mountain areas after the Johannesburg Summit 2002. At that time, Italy held the presidency of the Alpine Convention and the European Academy (EURAC) in Bolzano hosted the permanent Alpine Convention Secretariat. Together with UNEP and the financial support of Italy, EURAC hosted a first meeting in Bolzano with representatives from the Alpine Convention. Subsequent meetings occurred in Vaduz, Vienna and Bolzano.

Upon acceptance of the Carpathian Convention in Kiev (23 May 2003) the Italian Ministry for the Environment and Protection of Territory committed to continued support of the operation of the Convention and the development of the specific implementation projects.

Science and the Carpathian Convention

EURAC played a central role in the framing of scientific issues related to the Convention. The first Ad Hoc Expert Meeting of the Carpathian Convention in Bolzano in May 2004 welcomed the scientific support activities offered by EURAC and recommended stronger cooperation between the Carpathian Convention's Interim Secretariat at UNEP in Vienna and EURAC. In October 2004, the two parties signed a Memorandum of Cooperation, including scientific, logistical and communication support. Consequently, EURAC hosted expert meetings and the preparatory meeting for the Conference of the Parties of the Carpathian Convention scheduled for 2006. EURAC was also central in the development of numerous reports.

The INTERREG CADSES[1] "Carpathian project" was an important stimulant for the creation of the Carpathian science initiative, as it clearly showed the necessity of organizing science in the region. Initiated by ISCAR and the Secretariat of the Carpathian Convention, a small group of scientists and stakeholders met at the Forum Alpinum 2007 in Engelberg, Switzerland, to develop initial ideas for a science network in the Carpathians similar to the one existing in the Alps. These ideas were further elaborated during a consecutive meeting in Bolzano in October 2007. At this stage, the group coined the name "Science for the Carpathians" (S4C).

First fruits

In early 2008 S4C joined with the Mountain Research Initiative (MRI). The Global Change and Mountain Regions

Jacek Kozak, Astrid Björnsen, and Marc Zebisch, members of the international organizing team of the S4C Launching Workshop in Krakow, 27-28 May 2008 (photo Bartosz Zaluski).

(GLOCHAMORE) Research Strategy, a product developed by MRI and the University of Vienna in an FP6 project, provided a suitable starting point for the definition of a Carpathian Research Strategy. That definition, however, had to be made by the people to whom it really matters: local scientists and stakeholders with an interest in the Carpathian mountains.

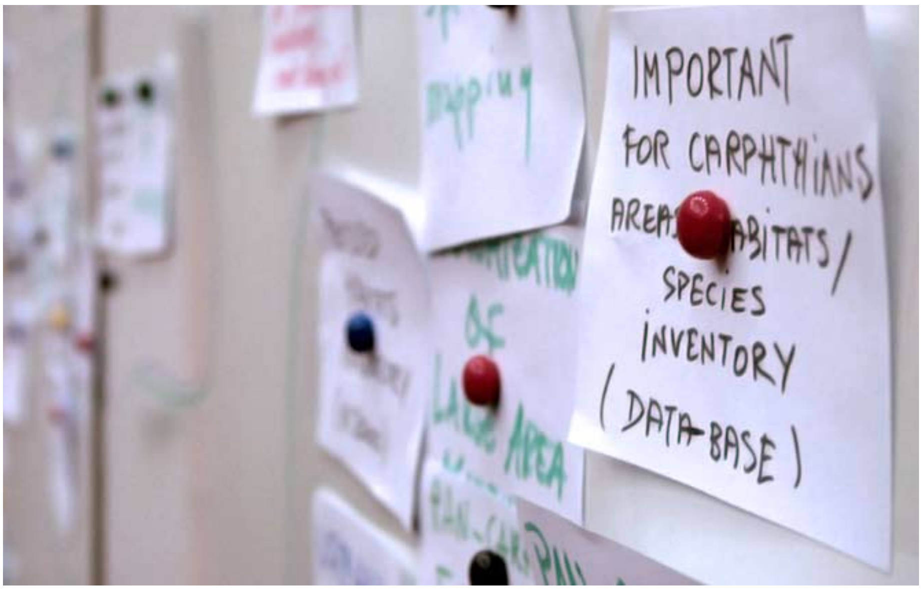
With this insight in mind, the Institute of Geography and Spatial Management, Jagiellonian University, Kraków, Poland and partners[2], organized a launching workshop addressing people from the Carpathian region in May 2008, with the financial support of UNEP, MRI and EURAC. A crucial prerequisite for this event was the generation of a "Who's Who" in Carpathian science. MRI established an initial database of scientists who might have an interest in shaping future research activities in the region (the "Carpathian List", see Weblinks).

About seventy people from this list attended the workshop and initiated the development of a research strategy for the Carpathian mountains. Participants began developing a peer-reviewed synthesis paper outlining the current status of research in the Carpathians on selected topics, including land use and land cover change, ecosystem services, biodiversity, water and tourism. The workshop will be documented in a report compiled by the Polish organizer.

The participants of the S4C Workshop, 27-28 May 2008, Jagellionian University, Krakow, Poland.

What ripens next?

Together with the S4C partners the MRI maintains and expands the S4C network and provides a communication platform among researchers. In addition the MRI lobbies for the long-term ideological and financial support of the Carpathian governments and of the Science Academies for this emerging network. To achieve this aim, Dr. Björnsen presented the results of the Kraków Workshop to the 2nd Ministerial Conference of Parties (COP) of the Carpathian Convention in Bucharest, Romania, in June 2008. She asked the countries' representatives to support S4C in principle, to decide on an institutional model for the network and to finance the network from national and international funds.



Workshop particpants developed the first elements of a research strategy for the Carpathians (photo Bartosz Zaluski).

One of the institutional models, an international commission of the Scientific Academies of all Carpathian countries similar to that of ISCAR for the Alps will be discussed with the concerned Academies. For this purpose, the Swiss Academy of Sciences, ISCAR and the MRI proposed a side-event for the international conference of the National Academies in Podgorica, Montenegro, in October 2008, to discuss the options and directions of the S4C network.

The S4C will go beyond Bucharest and Podgorica. The road map outlined during the Kraków workshop gives members of the network the opportunity to shape and steer the new S4C initiative. Members of the S4C network are invited to contribute news to the Carpathian Flash (Newsletter), to organize S4C events, to act as a member of the steering committee, to assist in expanding the science network, to propose new projects and to advocate the idea of S4C in their countries. One expected product from the S4C initiative could be the "Forum Carpaticum" (similar to the Forum Alpinum, see Weblinks), a thematic symposium for Carpathian scientists and stakeholders occuring every other year. The first Forum Carpaticum is tentatively scheduled for Fall 2010.

Growing on Carpathian soil

Transplanting saplings is a delicate issue. As for the S4C network, the transplantation seems to succeed. Encouraging as well are the developments driving the institutionalization process in the region, which again may benefit from experiences of the Alpine Convention. Good gardeners know that in the end fruit is more important than vegetative growth. In future, the S4C network clearly needs to become productive, i.e. to generate scientific products such as multi-national and interdisciplinary research projects supporting sustainable development in the region. Joint publications, data sharing, improved access to data, common methodologies and joint protocols are other examples for Carpathian products.

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Weblinks

S4C: http://mri.scnatweb.ch/networks/mri-carpathians/
Who is Who in Carpathian research:
http://mri.scnatweb.ch/dmdocuments/Carpathian_List_V8.pdf
Carpathian Convention: http://www.carpathianconvention.org
European Academy at Bolzano (EURAC): http://www.eurac.edu/index
Forum Alpinum: http://www.forumalpinum.org
International Scientific Committee on Research in the Alps (ISCAR):
http://www.alpinestudies.ch/iscar/
Jagiellonian University, Institute of Geography and Spatial Management:
http://www.uj.edu.pl/index.en.html
Joanneum Research: http://www.joanneum.at/
Humboldt-Universität zu Berlin, Geomatics Lab, Geography Department:
http://www2.hu-berlin.de/hurs/index.php
University of Applied Sciences Eberswalde, Faculty of Forest and Environment:
http://www.fh-eberswalde.de/Faculty-of-Forest-and-Environment/

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1 Interreg III B CADSES
Central European - Adriatic - Danubian - South Eastern - European - Space Neighbourhood Programme 2000 - 2006
http://www.cadses.net/en/home.html

2 EURAC, Joanneum Research, Humboldt-Universität zu Berlin, University of Applied Sciences Eberswalde, UNEP and the MRI.

Science focuses on snow

Conference of the Swiss Hydrological Commission (CHy)
Alpine Hydrology - Snow Hydrology
22 August 2008
Davos, Switzerland

Snow plays a central role in Switzerland's capacity to provide water for downstream users. As climate change will have far-reaching consequences for snow conditions, so too will it affect Switzerland's capacity to export water in the future. Research on climate impacts on the availability and use of water is an important part of the National Research Foundation programme no. 61, which will start this autumn.

Engadine at Christmas 2098: there is hardly any snow on the lower slopes of the valley. They are white only above about 2200m. Snow on the valley floor has become a rare phenomenon at this time of year. Winter is two to three months shorter than it was 100 years ago. Even at an altitude of 3700m the snow no longer remains through the summer. The snow-melt reaches a peak at the beginning of May and is more or less over by June.

This scenario is based on calculations from a model devised by the Swiss Federal Institute for Snow and Avalanche Research (SLF) in Davos. For Tobias Jonas, Head of the Snow-Hydrology Research Group at the SLF, just how closely it resembles the future is but one of many unanswered questions concerning the effects of climate change in the Alps. "If the currently available climate scenarios are accurate, our calculations will on the whole be correct."

All the scientists who attended the meeting "Alpine Hydrology – Snow Hydrology", organised in Davos in mid-August by the Swiss Hydrological Commission, were unanimous: snow plays a central role in the hydrology of Alpine catchments. Snow has a far greater effect on runoff from the Alps than does the ice stored in glaciers. In Switzerland, between 40 and 90% of precipitation above 1500m falls in the form of snow, and in the summer months up to 80% of the runoff from the Alps is melted snow. Future changes in snowpack will have major impacts on downstream users.

We need a great deal of detailed knowledge

According to Prof. Dr. Rolf Weingartner, President of the Swiss Hydrological Commission of the Swiss Academy of Sciences, current knowledge indicates that in the Alps not only temperatures but also precipitation will change in the future. Most models indicate that there will be less precipitation in summer but slightly more in winter.

The challenge facing hydrologists today is to downscale these general predictions to a regional or even local context. Hydrologists are in a dilemma, because their models are based on those devised by climatologists. This dependence means that the approximations of the climate models are transferred to hydrological models, which are, of necessity, of much finer scale.

The difficulties involved in downscaling are easily seen. In the area immediately around a glacier snow transport by wind is central to the fate of the glacier, since wherever the snow accumulates the ice will melt away more slowly. This feature can be seen on the Arolla glacier: Thanks to this drifted snow more ice has been able to survive on the flanks of the glacier. This accumulation of snow may explain the persistence of this glacier in a site where, according to theories, it should not exist at all.

In a computer model, a jagged mountain summit often becomes a rounded peak as computer capacity cannot allow for a greater degree of topographic precision.

Guaranteed snow (here the ski pistes in Samnaun) is extremely important for winter sports. Snow also plays a central role in Alpine hydrology (photo Urs Fitze).

This approximation is adequate for general predictions of snow behavior in a mountain area because opposing effects cancel each other out. But, for a precise picture of what happens at the summit, much more detailed rendering is needed.

Forest is also challenging for hydrology researchers, since snow that falls on a forest behaves quite differently from that which falls on non-forested land. Part of it will remain in the forest canopy, from where it will eventually either evaporate or fall to the ground. Furthermore, the canopy protects the snow from solar radiation during the day. So far researchers have been only moderately successful in transferring these factors to a numerical model.

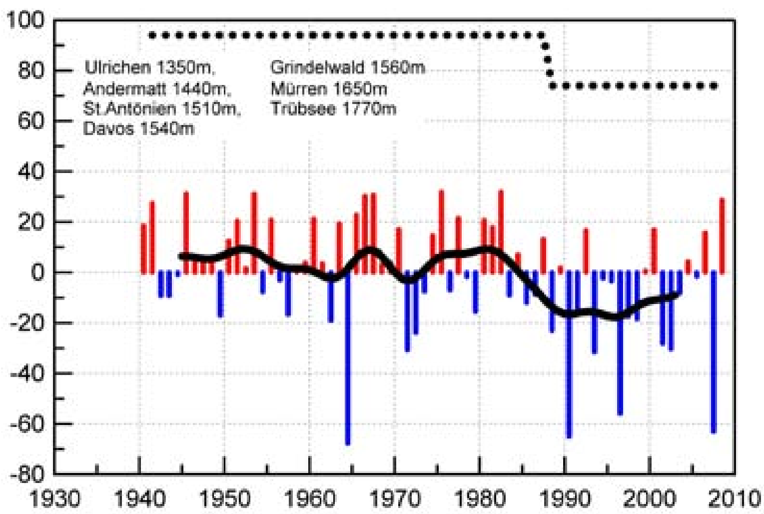

Figure 1: Annual deviation in the duration of snow cover from the long-term mean for 1961 to 1990 and the resulting trend (black line). The change at the end of the 1980s, which has so far not been followed by a come-back, can be clearly seen (Christoph Marty, SLF).

Despite less snow, recurring good winters

The degree of change in the Alps can be seen from a survey of the past 100 years (Figure 1). If we look closely, the recent "100-year winter" of 2007/2008, which brought tourist resorts and transport companies record earnings, was only an average winter in terms of the historical record. This perception shows how limited our temporal viewpoint has become. Statistics on total snow depth and depth of new snow evaluated by SLF researcher Christoph Marty show a marked change at the end of the 1980s. Since then both snow depths and volumes of new snow have decreased considerably. In Marty's opinion it is too early to talk of a trend: "We need to have data series from at least three decades to do statistically sound analyses. However, similar changes in the snow cover have been observed not only in Switzerland but in the whole of the Alps".

What will be the consequences?

Carmen de Jong of the Savoy University Mountain Institute has already observed a growing conflict of interests concerning water in the French Alps, an area considered to have a plentiful supply. For example, following the summer heat-waves in 2003, a number of springs in limestone areas dried up. Farmers had to fetch water for their cattle from the valley by tractor. At the same time, the tourist sector was using an increasing amount of water to create artificial snow to ensure a good cover for skiers. This water was stored in basins and consequently was not available in the valleys. As far as the resort companies were concerned, snow-making was and is an economic necessity, since in 50 years' time only ski resorts above 1500-1800 m will have sufficient snow throughout the season. For this reason the SLF is also studying the development of artificial snow makers, especially those machines which are able to run without using energy from other sources.

A new National Research Programme

These issues are among those raised in the context of National Research Programme no. 61, entitled "Sustainable supply and use of water". If the Federal Council gives its approval, this programme will start this autumn. For Christian Leibundgut, head of the NRP 61 management group, this programme must address not only climate change but also social and economic issues, since conflicting interests are apparent in many aspects of water use. "So far the whole hydrological system in Switzerland has been able to meet all these demands. Whether this will be the case in the future, with the new global challenges, remains to be seen. With NRP 61 we hope to be able to supply an answer to this question." The priority for this project will therefore be multidisciplinary team work – a challenge for hydrologists too.

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CHy, Swiss Hydrological Commission:
http://chy.scnatweb.ch/

! ESF Proposal Net-DYNAMO

On June 19th, 2008, the European Science Foundation informed Prof. Dr. Martine Rebetez of WSL that her proposal to the Research Networking Programme entitled Network for Integrated Assessment of the Dynamics of Mountain Catchments under Global Change (Net-DYNAMO) had been recommended for funding by the ESF Member Organizations. Prof. Dr. Rebetez developed the proposal in conjunction with Dr. R. Grote of IMK, Dr. Prof. U. Tappeiner of the University of Innsbruck, and Drs. Greenwood and Björnsen of MRI.

Net-DYNAMO will expand the capacity of European researchers to produce policy-relevant integrated assessments of socially-relevant variables under global change scenarios, yielding comparable outputs and promoting comparisons among catchments (100 to 10000 km^2) that sample the diversity of European mountain environments. It will focus on potential linkages between existing models and on translation of outputs into policy relevant terms. It will downscale existing scenarios to catchment scales, develop methodologies and compare results. When funded, Net-DYNAMO will conduct conferences and workshops from 2009 to 2013, coupled with assessments in catchments throughout Europe funded by national or third-party sources. Workshops will develop one or more integrated assessment methodologies based on existing models and scenarios, and on cross-site analysis of results. The network includes scientists working across Europe, in adjacent countries, and on catchments in Africa, South America and North America as well.

Researchers who are interested in supporting Net-DYNAMO funding and eventually participating in the programme are urged to make their support of Net-DYNAMO known to the ESF member organizations of their country. For more information, please contact Dr. G. Greenwood at green@giub.unibe.ch.

! Publication: How to achieve effectiveness in problem-oriented landscape research

Kueffer, C., and Hirsch Hadorn, G., 2008. How to achieve effectiveness in problem-oriented landscape research: The example of research on biotic invasions. Living Reviews in Landscape Research 2: 2. http://www.livingreviews.org/lrlr-2008-2

Abstract: It is increasingly expected from environmental research such as landscape research that science directly contributes to the solving of pressing societal problems. However, despite increased efforts to direct research towards societal problems, it is not obvious if science has become more effective in supporting environmental problem-solving.

We present in this article a framework that facilitates the analysis and design of problem-orientation in research fields. We then apply the proposed framework to a concrete example of a problem-oriented landscape research field – namely research on biotic invasions. Invasion research addresses the problem that some organisms, which have been introduced by humans to a new geographic area where they were previously not present, spread in the landscape creating negative impacts.

We argue that problem-oriented research is more than applied research. Besides research on specific questions it also encompasses boundary management, i.e., deliberations among experts and stakeholders on the framing of adequate research questions about processes, values and practices for effective problem-solving. We postulate that such research may assist problem-solving in three ways, by analysing causal relationships (systems knowledge), clarifying conflicts of interests and values (target knowledge), or contributing to the development of appropriate means for action (transformation knowledge).

We show that over the past decades a broad range of different research approaches has emerged in the young field of invasion research in order to produce systems, target and transformation knowledge for invasive species management. Early research in the field was dominated by the development of systems knowledge, but increasingly the three knowledge forms have been treated more equally. The research field has also become more interdisciplinary and contextspecific.

Boundary management in invasion research is mainly restricted to informal networks (communities of practice), while formal processes such as transdisciplinary research are rare. We suggest that the paucity of structured and explicit boundary management processes will limit the future development of a more effective science for invasive species management.

In particular, we envisage three obstacles that can only be removed through explicit boundary management. First, the existing theoretical frameworks are currently only partly able to integrate natural and social sciences research on the processes underlying invasions. Second, a clarification of the normative thinking about alien plant invasions is needed. Third, research on transformation knowledge has so far not fundamentally challenged the existing conceptual framing and institutional setup of invasive species management.

! MRI Newsflashes

The Mountain Research Initiative produces bi-monthly Newsflashes for its regional networks of researchers working on the different aspects of global change in mountains. Read our regional Newsflashes to get up-to-date information on projects, institutes and organizations, funding calls, events, positions, publications!
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Newsflash of the Global Change Research Network for African Mountains
http://mri.scnatweb.ch/networks/mri-africa/

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http://mri.scnatweb.ch/networks/mri-amercian-cordillera/

MRI Europe Newsflash
http://mri.scnatweb.ch/networks/mri-europe/

S4C (Science for the Carpathians) Newsflash
http://mri.scnatweb.ch/networks/mri-carpathians/

! Call for contributions

to the Mountain Research Initiative Newsletter.
If you would like to contribute a "Science Peak", a "Workshop Report", or the abstract of a publication please contact Claudia Drexler at drexler@giub.unibe.ch. The next deadline will be 1 February 2009.

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