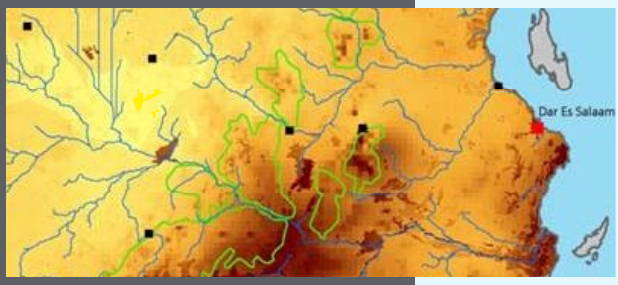
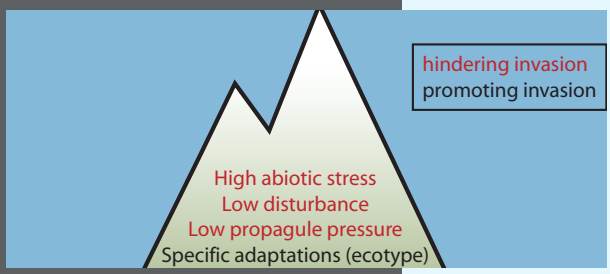
Newsletter of the Mountain Research Initiative

MRI NEWS

no. 3, October 2009





Global Change in Mountain Regions

The Mountain Research Initiative

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Impressum
The Mountain Research Initiative
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Economists, and political and social scientists wanted!

Dear Reader,

The Mountain Research Initiative continues to strengthen and expand its role as a hub of global mountain research. The third MRI Newsletter is ample proof of these efforts. It includes contributions on the character of mountain areas as "model systems for understanding drivers of plant invasion" and their significance for ensuring the water supply well into their foothills, under conditions of global change. Regional studies in Poland and Peru present and discuss global change and adaptation strategies.

By integrating such national and regional studies into international research and networks, it is possible to make much better use of their findings. This is where the MRI has an important role to play, as it does in its large-scale involvement in a new EU project of the 7th Framework Programme "Mountain. TRIP: Mountain Sustainability: Transforming Research into Practice", which will work out new methods transferring research findings into the world of the practitioners.

With the bulk of contributions on natural-science research and events, the new MRI Newsletter also indicates two weak points of mountain research everywhere. The focus is much more on climate change as such and its effects on ecosystems and much less on the impact it has on the people living in mountain areas. Moreover, global change is often reduced to climate change. However, globalization with its impact on the economy, on culture, demographics and policies – as well as on the environment – affects mountain systems just as severely as climate change and calls for sustainable adaptation strategies.

Here geography, in the sense of a systemic science, can develop and disseminate integrative approaches and solutions. In addition, we need the involvement of economics, regional economics, political science, sociology and cultural studies.

In 2006, an Institute for Mountain Research: Man and Environment (IGF) of the Austrian Academy of Sciences (ÖAW) was established in Innsbruck. It is headed by the author, together with Georg Grabherr and Hans Stötter. In close cooperation with the MRI, this institute, with its interdisciplinary composition, brings a systemic and integrative approach to mountain research as well as contributing – especially within the MRI Europe programme run by IGF – to networking and international cooperation. The research network GLORIA of the IGF, headed by Georg Grabherr, provides global network links and expert knowledge.

Recently I had a discussion with the new Presiding Committee of the ÖAW, on the role of basic versus applied research. Unlike my discussants, I am convinced that these two branches of research cannot be separated from each other. Basic research makes no sense in our complex world unless you take into account aspects of application. Our generation and all subsequent ones are faced with challenges that surpass anything gone before and that urgently call for solutions. Mountain areas as complex and sensitive systems are open-air laboratories where scientists can monitor and assess current processes as well as the effectiveness of mitigation and adaptation strategies particularly well.

The global mountain research community is working on these topics and deserves increased support in their efforts, not only in the interest of mountain areas themselves but also in the interest of the foothills dependent on and affected by the mountains. I am very pleased that in the Mountain Research Initiative we have a good partner on this route.

Axel Borsdorf

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For this third edition of the MRI Newsletter we have asked our partner Prof. Dr. Axel Borsdorf to give us his thoughts about global change research in mountain regions. Prof. Axel Borsdorf is the Director of the Institute for Mountain Research: Man and Environment of the Austrian Academy of Sciences and hosts the MRI Europe Programme.

Progress Report

Perhaps the biggest news at MRI was the selection of Mountain.TRIP by the EU for final negotiations and likely funding.

Mountain.TRIP (Transforming Research in Practice) is a Coordination and Support Action to provide stakeholders, end-users and practitioners with readily accessible and understandable forms of research-based information relevant to sustainable development in mountain regions.

The Mountain.TRIP consortium is lead by Prof. Dr. Axel Borsdorf of the IGF (Austrian Academy of Sciences) and includes Prof. Martin Price from Perth College, Prof. Jacek Kozak of Jagiellonian University, Alexia Rouby of Euromontana and Melanie Kemper of Ecologic.

Mountain.TRIP is a particular important project as it addresses directly the issue of making research results useful to stakeholders and decision-makers. It will employ a web-based social network in multiple languages from the very start of the project in order to address as many stakeholders and end users as possible more than can normally be accommodated by an FP consortium. Through the web-based social network project partners and other individual stakeholders and end users from across Europe will be involved in the synthesis and translation of research results. The social network will communicate research summaries quickly and inexpensively to a wide audience and to receive feedback from this audience, permitting better targeting of project outputs.

Mountain.TRIP will complement this interactive communication with a user needs assessment and tailored information strategy. This process will target specific groups and design information products that will communicate the results of the on-going synthesis via a variety of media, including video, graphics, and text. The project will employ its feedback mechanisms to assess the effectiveness of its information products early in the project, so that lessons learned can be incorporated into later products.

Given MRI's strong communication focus, MRI has taken on the role of developing Mountain.TRIP products, starting with the design of the social network and continuing through to the development of printed material, videos and software products. Mountain.TRIP will start on 1 November 2009 and run for two years.

MRI continues to participate in the framing of global change research in mountain regions where we have not yet created regional networks. We do not yet have regional networks in Asia, in part because of MRI's limited resources, but also because of the existence of other important mountain-centric projects and programs in the region. Under these conditions, MRI has found it more effective to work with these existing partners as evidenced by our participation during 2008 in two conferences organized by ICIMOD on cryosphere and hazards, and biodiversity, respectively.

MRI'S most recent participation was in the Third Pole Environment scoping workshop held in Beijing and then in Lhasa by the Institute of Tibetan Plateau Research of the Chinese Academy of Science from 15 to 20 August 2009.

The „Third Pole" region includes and surrounds the Tibetan Plateau, extending from the Karakorum, Pamir Plateau, and Hindu-Kush in the west to the Hengduan Mountains in the east, and from the Kunlun and Qilian Mountains in the north to the Himalaya Mountains in the south. It is a Pole in the sense that it has a very important cryospheric component, one that, like the Arctic, is sensitive to current rates of global warming. This region encompasses more than 5 million km^2 with an average elevation of over 4000 m. The Third Pole region includes parts of more than 10 countries.

Changes in the Third Pole environment, including changes to the cryosphere, to the hydrologic system and to the biosphere are significant not only to residents of the Third Pole through changes in ecosystem goods and services, and to the hundreds of millions of people who depend on water flowing out of the Third Pole, but also to the entire globe. As the Third Pole influences circulation on a global scale, changes in Third Pole Environment can feed back onto stakeholders far removed from Tibet itself.

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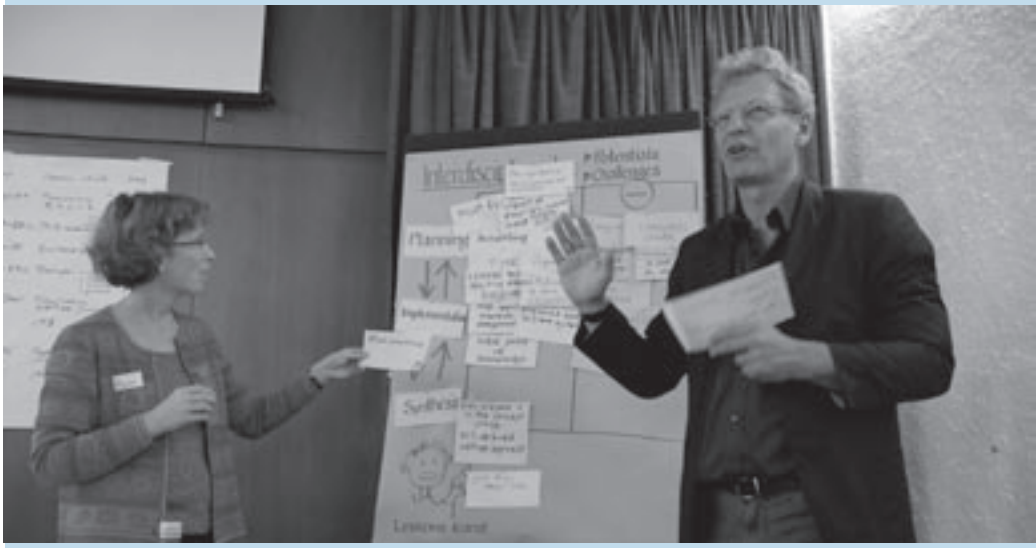

Upcoming MRI Events

Global Change and the World's Mountains
Perth II - Five Years Later
27 September - 1 October 2010, Perth, UK
The conference aims at communicating new results between scientists working in the mountains of both industrialized and developing countries around the world and present scientific advances on the topics defined in the GLOCHAMORE Research Strategy.
www.perth.uhi.ac.uk/mountainstudies/2010

Glacier Hazards, Permafrost Hazards and GLOFs in Mountain Areas Processes, Assessment, Prevention, Mitigation
10-13 November 2009, Vienna, AT
http://www.baunat.boku.ac.at/workshop09.html

Towards Sustainable Fine Resolution Hydro-Ecological Observatories in Southern African Mountains
2-6 November 2009, Zernez, Davos, and Lausanne, Switzerland
http://mri.scnatweb.ch/events/mri-events/-swiss-south-africa-joint-scientific-conference-on-mountain-observatories-2-6-nov.-2009.html

Find more information in the five regional Newsflashes of MRI

Newsflash of the Global Change Research Network for African Mountains
http://mri.scnatweb.ch/index.php?option=com_docman&Itemid=57

Newsflash of the American Cordillera Transect
http://mri.scnatweb.ch/index.php?option=com_docman&Itemid=58

Newsflash of MRI Europe
http://mri.scnatweb.ch/index.php?option=com_docman&Itemid=73

Newsflash of Science for the Carpathians, S4C
http://mri.scnatweb.ch/index.php?option=com_docman&Itemid=72

Newsflash of SEEmore, the South Eastern European Mountain Research Network
http://mri.scnatweb.ch/

Impacts of Global Change on the Dynamics of Snow, Glaciers and Runoff over the Himalayan Mountains and their Consequences for Highland and Downstream Regions

Background

The Himalayan range (Fig. 1) is literally the 'abode of snow' with glacier ice covering roughly 17% of the mountain area while seasonal snow cover every year an additional area ranging from 30-40%. The meltwater from the extensive snow cover and glaciers in the Himalayas drains into the perennial Himalayan river systems, so critical for the billions of people inhabiting the mountain slopes and plains in the south.

But increased deglaciation currently observed in the Himalayas due to climate change is leading to changes in the hydrology of the region (Barnett et al, 2005; IPCC, 2007) that are likely to cause a temporary increase in annual flow followed by a reduction of Himalayan river flows in the long run. This reduction in turn is likely to have a significant and broad impact on the livelihood of the people and economies of both the highland and downstream regions.

Due to the ruggedness of the Himalayan terrain and inaccessibility of its higher regions, there is however a great paucity of adequate scientific data leading to uncertainty and knowledge gaps in understanding and projecting such hydrological changes in the region.

A better and much more detailed knowledge of how future climate change will affect glaciological and hydrological systems in the Himalayas would be essential for any effective mitigation and adaptation strategies for sustainable development of the region (Shrestha, 2005 and 2006).

The APN project and its objectives

The project runs from September 2008 to August 2010, and is supported by the Asia Pacific Network for Global Change Research, APN, under Project ARCP2008-16NMY-Shrestha. It has been launched to investigate fresh water related issues in the Himalayas resulting from future global climate change.

The project's objectives are

- to assess the impacts of climate change on the dynamics of snow, glaciers and runoff in the Himalayan mountains,
- to assess the consequences for people's livelihoods and the economies and societies in the upland and downstream regions; and
- to provide scientific information to planners and policy makers for identifying and implementing adaptation and mitigation strategies for a sustainable development of the regions.

Participating countries and collaborating institutions

China, India, Nepal and Pakistan are participating in the project. The collaborating institutions are the Institute for Tibetan Plateau Research (ITP) in China, the Institute for Development and Innovation (IDI) in Nepal, the G. B. Pant Institute for Himalayan Environment and Development (GBPIHED) in India, and the Global Change Impact Study Centre (GCISC) in Pakistan. As shown in Table 1, each institution leads the basin study in its respective country and is responsible for collecting data, running models, and making desk and field studies for the respective basin. In addition the project works in close partnership with the various national and international organizations involved in similar research activities.

Project study sites

In the Initial Meeting of the Project Partner Institutions held on 13 to 14 November 2008 in Kathmandu, three representative research sites were selected to investigate the impacts of global change along the length of the Himalaya from east to west.

These research sites include the Koshi basin in the east, Upper Bhagirathi basin in the center and Shigar basin in the west and were selected on the basis of their locations, glacier coverage, socio-economic importance and availability of past data. Their locations are shown in Figure 1, with a more detailed map and description of one of the basins, namely Koshi basin. The salient features of the selected sites are presented in Table 1.

Particulars	Selected river basins			
	Koshi River Basin		Upper Bhagirathi River Basin	Shigar River Basin
	Northern parts in Tibet (Pumqu, Poiqu and Rongxer River Basins)	Southern parts in Nepal (Sunkoshi, Arun and Tamor River Basins)		
Primary institution	ITP, China	IDI, Nepal	GBPIHED, India	GCISC, Pakistan
Latitude	27.49° – 29.05° N	27° – 28° N	30.75° – 31.25° N	35° - 37° North
Longitude	85.38° – 88.57° E	86.4° – 88.4° E	78.9° – 79.3° E	74° - 76.5° East
Basin area (km^2)	28,737	25,300	10,700	6,984
Altitudinal variation	2,000 m to 7,093 m	140 m to 8,448 m	465 m to 7,075 m	2,195 m to 8,611 m
Economic potential	Irrigation	Hydropower, irrigation, tourism	Hydropower, pilgrimage	Irrigation
Population	100,000 (Rural)	3,307,500 (96% Rural)	42,100 (78% Rural)	Sparse
Socio-economic structure	Agro-pastoral	Subtropical agriculture to agro-pastoral	Subtropical agriculture and agro-pastoral	Agro-pastoral and dry fruits
Vegetation	Trans Himalayan alpine meadows	Subtropical vegetation to alpine meadows	Subtropical vegetation to alpine meadows	Virtually devoid of vegetative cover
Major peaks	Kharta Changri, Xixiapama, DuokaPula and others	Mount Everest and other five out of 10 highest peaks in the world	Chaukhamba range (Satopanth and several peaks over 6,000 m)	Haramosh and Kanjut Sar peaks including K2, the second highest peak in the world
Glacierized area (km^2)	2,017.62	1,409.84	755.0	2,240.08
Numbers of glaciers	1,356	779	238	194
Major glaciers	YeBokangjiale, Poiqu Co and others	Solokhumbu, Imja and others	Gangotri, Dokriani and others	Baltoro, Baifo and others
Ice volume (km^3)	193.03	152.06	67.0	581.27

Table 1: General features of the selected basins and primary institutions involved in their study

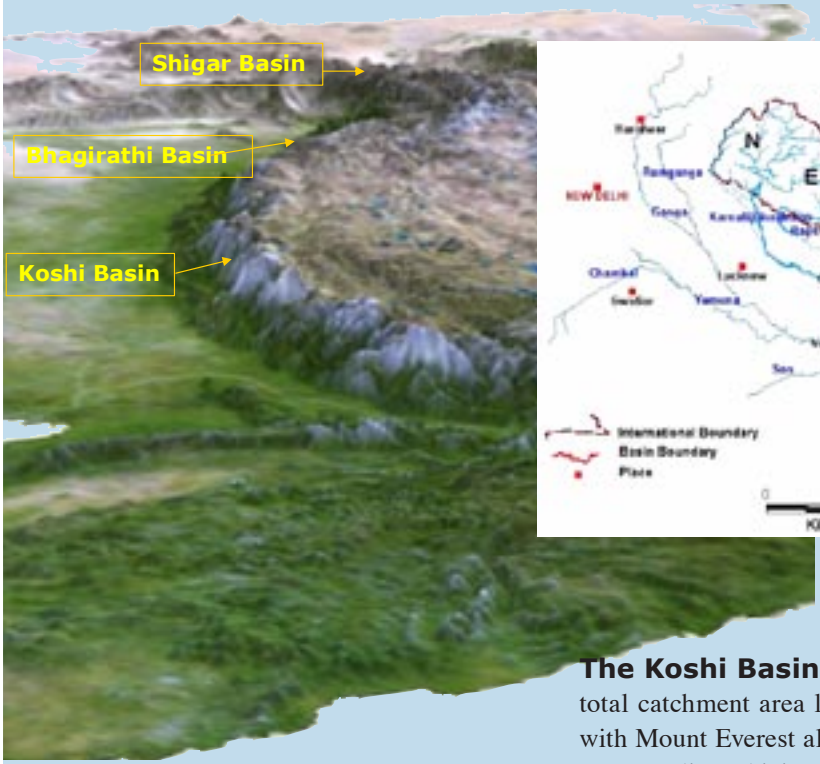

Figure 1: Himalayan range and the selected river basins

Figure 2: Koshi Basin in the regional context

The Koshi Basin: The northern part of the basin covering 54% of the total catchment area lies in Tibet, while the remaining part lies in Nepal, with Mount Everest almost at the centre of the basin. The Koshi river then enters India and joins the Ganges river which ultimately drains into the Bay of Bengal. As it causes flood havoc occasionally in the Indian State of Bihar, it is also known in India as 'sorrow of Bihar'. By the construction of a barrage in Nepal, a large area in Bihar is now irrigated with water from the Koshi river. While the replenishment of snow in the western basin Shigar happens mostly in winter due to the westerlies, the eastern basin Koshi gets its snow replenishment mostly in summer due to the south-westerly monsoon. Likewise, the northern and southern side of the Himalaya have different precipitation pattern which influence the hydrograph of the river.

Research framework and project activities

Figure 3 shows the project research framework. As the figure shows the project activities during the first year have been the following:

- The Department of Hydrology and Meteorology (DHM) and the Institute for Development and Innovation (IDI) in Nepal simulated for both the northern and southern part of the Koshi basin the present climate (1971–1980) and the future climate under IPCC SRES A1B scenario (2049–2061) at a spatial resolution of 25 km x 25 km using the PRECIS Regional Climate Model (RCM) nested within the Global Climate Modes (GCM) HadCM3. Likewise, they have also simulated the present climate (1961–1990) and the future climate under IPCC SRES A2 scenario (2071–2100) at a spatial resolution of 50 km x 50 km using the PRECIS Regional Climate Model (RCM) nested within the Global Climate Modes (GCM) HadAM3P.

- Meanwhile, the Global Change Impact Study Centre (GCISC) in Pakistan simulated the present climate (1961–1990) and the future climate under IPCC SRES A2 scenarios for the 21st century periods of the so-called "2020s" (2010 – 2039); "2050s" (2040 – 2069,) and "2080s" (2070 – 2100) at a spatial resolution of 50 km x 50 km, using the RCM PRECIS nested within the GCM ECHAM4 and RegCM3 nested within ECHAM5.

- Likewise the GBPIHED has accessed from the Indian Institute of Tropical Meteorology (IITM) Pune, India, the PRECIS derived RCM data at a resolution of 50 x 50 km for the upper Bhagirathi basin for the period 1961-1990 and for the A2 scenario for the period 2071-2100.

- The respective country study teams for the selected river basins acquired, pre-processed, and analyzed the necessary hydro-meteorological data, prepared the DEMs (Digital Elevation Models) using global datasets from the Shuttle Radar Topographic Mission (SRTM) / HYDRO-1K, and developed necessary hypsometric curves dividing the watershed into different elevation zones. The teams also extracted geo-physical characteristics for each elevation zone from the Land Cover Dataset from the United States Geological Survey (USGS). Acquisition and processing of satellite images from LANDSAT, MODIS Terra Snow, and other sources for determining snow and glacier covered areas are in progress. The country teams use the Positive Degree-Day (PDD)/Energy Balance Model (EBM), the Snowmelt Runoff Model (SRM) and the University of British Colombia Hydrological Model (UBC) for an estimation of the distribution of solid and liquid precipitation, and for an estimation of snow and glacial melt. Precipitation data from the Tropical Rainfall Measurement Mission (TRMM) are used to complement ground based precipitation data.

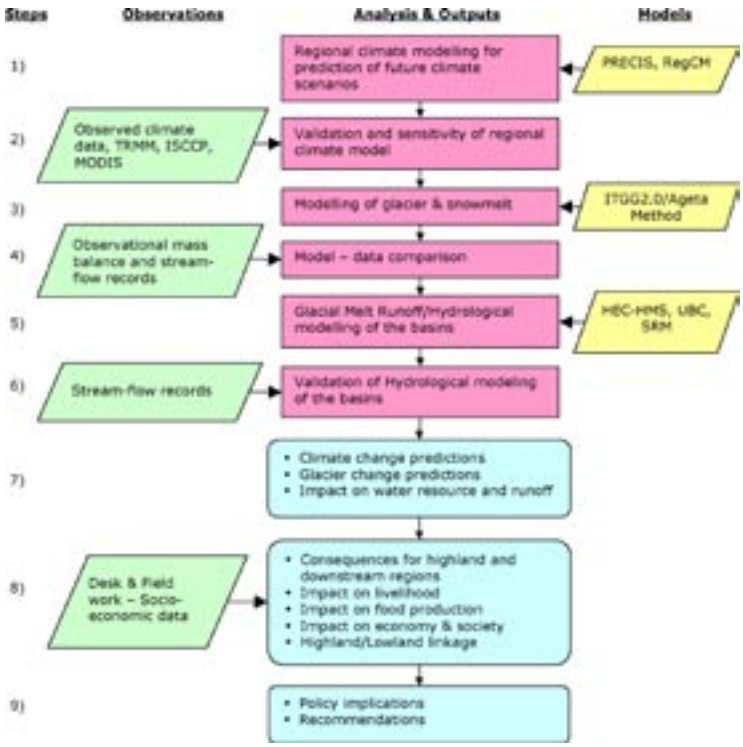

Figure 3: Project Research Framework

- The country study teams calibrate the various snow and glacial melt runoff models using the observed field data as well as current (1961-1990) climate data generated by using RCMs, namely RegCM3 and PRECIS. After the calibration and validation of the models, the teams will develop the future flow scenarios for the three periods namely the 2020s, 2050s and 2080s in the last year of the project.

Impact assessment

In the last year of the project each country study team will also work on the assessment of the implications of the predicted changes for the economies and social structures of the mountain and downstream regions of the selected basins in terms of food security, hydropower development potentials, and flood disasters. They will also elaborate potential adaptation and mitigation strategies for a sustainable development of the regions. The respective instruments will be developed in course of the impact assessment activities.

The project leader along with the country coordinators will collate the country studies in order to arrive at a regional picture of such impacts.

Consultative cum dissemination workshops involving researchers and policy makers will be held at the end of each year to deliberate on research results and to communicate those to the policy makers through presentations of techni-

cal and non-technical papers prepared for the purpose. The first such workshop will be held on the second week of October 2009.

The research results will be published at appropriate times in peer reviewed journals and mass media, for the use of researchers, end users, and stakeholders.

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Weblinks

Institute for Development and Innovation, Nepal: http://www.idi.org.np; mail@idi.org.np

Institute of Tibetan Plateau Research, Chinese Academy of Sciences: http://www.itpcas.ac.cn/System/english.asp

G.B. Pant Institute of Himalayan Environment and Development: http://gbpihed.gov.in/

Global Change Impact Studies Centre, Islamabad, Pakistan: http://www.gcisc.org.pk/

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Water Rights and Irrigation for Indigenous Communities in the Chilean Altiplano

The Chilean Government has used several economic instruments over the years to promote in- and off-farm irrigation infrastructure. Indigenous communities, however, show limited access to these subsidies. In the project "Diagnóstico y Propuestas de Fomento al Riego y Drenaje para la Pequeña Agricultura y Etnias Originales: Agricultura de Pueblos Originarios" we analyzed the current situation of water rights in indigenous communities of the Andean plateau in northern Chile, and made policy recommendations to improve their access to economic instruments such as subsidies for irrigation infrastructure.

The communities and their territory

The ethnic groups of northern Chile - the Aymaras, Atacameños, Quechuas, Collas and Diaguitas - are distributed within a vast territory of 3,280,000 ha that covers the Puna in the Altiplano, the foothills of the Puna, oases in the Salar de Atacama, and several valleys along rivers in the arid and mountainous regions of Arica-Parinacota, Tarapacá, Antofagasta, and Atacama on the border with Peru and Bolivia (see figure 1). The communities of these ethnic groups have conserved their cultural beliefs and practices inherited from their ancestors such as their vision of the world, rites and festivities, agriculture, husbandry, hunting and gathering, textile and pottery handicrafts, and the utilization of native plants for medical purposes. Most of these ethnic groups hold the land in communal arrangements. Agriculture and animal husbandry have historically sustained the local economies, and are still the main activities now. This territory is relevant because it provides ecosystem services, especially related to the water cycle, in the dry environments surrounding the hyper arid Atacama Desert.

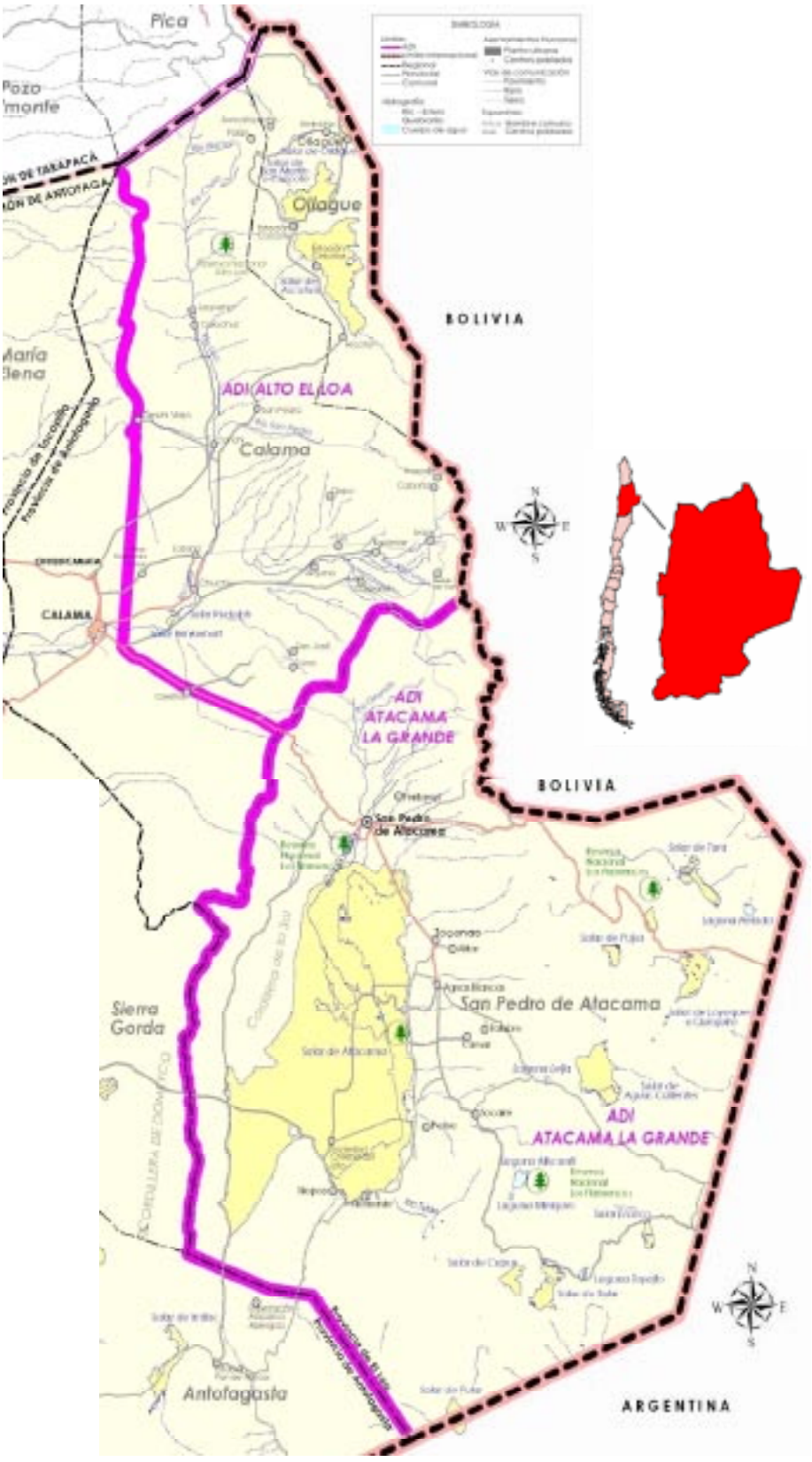

Figure 1: Location of the two main areas of indigenous development (ADI's) in the Andean Plateau

The Indigenous Law Nº 19.253 from October 5, 1995, initiated the regularization of indigenous properties with the identification of their limits and resources. This law recognizes the existence of ethnic groups, and permits the existence of Areas of Indigenous Development (ADI in Spanish). An ADI must be a territory traditionally inhabited by indigenous groups, with a high percentage of indigenous people amongst its population using the land, and depending on its natural resources. Each ADI has a Territorial Committee formed by the community leaders who elect a board. The board is in charge of representing the community and coordinating activities with public agencies and private (i.e., mining) companies.

Irrigated agriculture in the Quebrada de Oxa, Andean Plateau (photo by Alonso Barros)

The Water Code and water rights within the communities

The Water Code of 1981 created private water-use rights that can be obtained from the General Directorate of Water (DGA, in Spanish). If ground- or surface water is available within a basin, it may be appropriated freely and perpetually by an applicant. The water right holders can then trade them in the market. Out of a total of 52,583 petitions for water rights in Northern Chile, only 14,095 correspond to indigenous communities or small farmers while 38,488 have been made by private mining, agricultural corporations or utility companies.

Prior to the application of the Water Code, however, the ethnic groups had water rights that were recognized by the Code as customary rights. But because of increased demand from large consumers (for e.g. mining and water utility companies) prices have risen steadily and many groups decided to sell part or all of their rights. Thus, the market transactions have been dominated by the wealthier buyers, and impacted the ancient ways that governed water use in the Altiplano because in many cases these buyers have used more water than the rights they hold (Yañez and Molina, 2008). León (2007) reports that in other parts of the country customary right holders sold them to the highest bidder to buys goods (e.g. trucks) but after some time found themselves without money to use them and without water to farm their land. This could have been the case in the Altiplano.

Monopolization and overuse of the resource created environmental conflicts and a sharp decrease in the availability of water in the studied indigenous communities (Yañez and Molina, 2008). These communities report excessive pumping from the aquifers, beyond the amounts granted to the mining companies by the DGA. The consequences are outmigration and abandonment of traditional agricultural activities. A striking example are the communities Chiu Chiu and Yalquincha near the Chuquicamata mine (see Figure1. The mine is located to the north of Calama, and to the west of the ADI Alto El Loa), a state-owned company and one of the largest copper mining companies in the world. These communities abandoned their land because of the lack of water due to excessive water extraction by the mine. This situation has also affected animal husbandry since the bofedales, extensive pastures in the Altiplano, have gone dry because of over pumping from the aquifers for the mine (Barros, 2007).

Mining requires large amounts of water. Our interviews and workshops indicate that community members perceive that the public agencies mandated with environmental control have enforced the law loosely (see for e.g. Palacios, 2009) in order to promote investment projects. Thus, central and local authorities have in the eyes of the community privileged corporate interests over the rights of local and/or indigenous communities.

In spite of that, some traditional practices prevail, such as the mita, a communal arrangement that regulates water use among indigenous users (e.g., in oasis of Pica and some Atacameños communities near the Salar de Atacama). Most of the communities, however, do not have irrigation or are just starting to implement irrigation, but with low efficiency.

The Indigenous Law provides the indigenous communities with special protection of their ancestral water rights in wetlands and bofedales of Aymaras and Atacameños, and forbids the extraction of water feeding these ecosystems. The law, however, has been inadequate to prevent the monopolization process, as the DGA is unable to monitor water extractions and enforce the law. This is despite law suits that have been settled in favor of the communities by the Supreme Court. This weak respect of ancestral rights has resulted in an increased vulnerability of traditional communities. In September 2009, how-

ever, the parliament approved a project that would provide more power to the Ministry of Public Works (to which the DGA belongs) to deny, among other issues, water claims that do not come from indigenous communities (El Mostrador, 2009).

Subsidies for the indigenous communities

The Chilean government has used several economic instruments over the years to promote in- and off-farm irrigation infrastructure. Indigenous communities have, however, received few of these subsidies. Between 2000 and 2005 the National Commission for Irrigation subsidized 117 irrigation projects in the indigenous communities of northern Chile. These projects included a surface area of only 1,247.69 ha, a rather small surface if compared to the amount of land the communities control.

Changes to the current legislation

In a report to the National Commission for Irrigation CNR we propose several measures aimed at modifying the current legislation and rules to recognize the prior appropriation of water by indigenous communities and their specific management models.

Recognition of communal rights and local systems of control and use
In terms of the establishment of water rights, the role of communities should be strengthened by recognizing the local systems of control and use. Hence, at least two processes need to be combined, regarding indigenous water issues:

- Implement prior appropriation rights effectively as they are recognized by the Indigenous Law and the Water Code. As mentioned above, the indigenous communities have been favored by the Supreme Court sentences but these sentences have not been fully implemented by governmental agencies.
- Provide the communities with funds provided by the Indigenous Land and Water Fund, managed by the National Agency for Indigenous Development (CONADI, in Spanish), to buy water rights, with the collective agreement of the communities who own the water sources.

In terms of water management, the communities have traditional water users' organizations. The central government must ensure their proper functioning by adjusting the legislation to their particular circumstances. The central government should not impose a foreign organizational model, nor rules for water management and use (i.e., flows, turns, construction of infrastructure, water rights reallocation, crop surface per season), as happens under the current law. This concept is in line with the recognition of the heterogeneity of the strategies of the production systems of the pre-Columbian people, which are deeply linked to the location of the community: the Andean plateau, the foothills, or the irrigated valleys.

A new categorization of beneficiaries
In order to improve access of indigenous communities to state funds for irrigation projects we propose a new categorization of beneficiaries of subsidies. The Chilean State has a permanent system through which irrigators apply for subsidies. Currently, the State subsidizes up to 75% of the cost of in- and off-farm irrigation projects and the beneficiaries cover the balance in cash. This requirement prevents individuals from indigenous communities from participating because of their lack of funds. Hence, commercial agriculture has been favored by the system.

Another problem is that the calls for projects from Water Users Organizations currently only include formally constituted Water Users Organizations. We propose that future calls should allow applications from indigenous water users organizations or indigenous organizations even if they are not organized as formal Water User Organizations. New categories of eligible participants, specifically tailored to accommodate indigenous communities' needs would be:

Photo 2: Dry terraces in Capuna, in the Andean Plateau, 2006. It is likely that water has been diverted to mining operations (photo by Alonso Barros)

Category A: historic territories and communal lands, whose owners demonstrate their indigenous heritage and are engaged in subsistence agriculture. These irrigation projects should be subsidized entirely. There are numerous subsistence farmers in Chile and the state has provided a wide array of incentives to them. These incentives, however, are oriented to individual farmers who are owners of their land, and use it as collateral. This is not the case in indigenous communities because common property cannot be used as collateral for individual subsidized loans.

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Category B: historic territories and communal lands whose owners demonstrate their indigenous heritage and establish water management systems to protect and develop sustainably their water sources (bofedales, wetlands). Since this category is oriented to the provision of ecosystem services, the State should be ready to subsidize 100% of the cost of irrigation projects.

Category C: communal lands whose owners demonstrate their indigenous heritage and are oriented to supply the market. These cases should get at least 90% of the cost.

The Chilean political and administrative system is highly centralized and has tended to neglect the needs of different segments of society inhabiting remote ecosystems. We believe that by applying these measures Chile´s government would recognize the diversity of productive systems and cultures in the country.

Canadian Climate Research Networks Focus on Mountain Research in Western Canada

Improved Processes and Parameterization for Prediction in Cold Regions (IP3) and the Western Canadian Cryospheric Network (WC2N) are two networks of scientists funded by the Canadian Foundation for Climate and Atmospheric Sciences (CFCAS), investigating glaciers and snow melt processes for improved climate modeling in cold regions.

Background and network objectives

A better understanding of climate change and its effects on glaciers, snowpack and water supply is essential for the sustainable management of mountain and northern water resources. The Canadian Foundation for Climate and Atmospheric Sciences (CFCAS) provides support for university-based research focused on an improved understanding of climate change and its impact on the environment. IP3 and WC2N are two networks funded by CFCAS with mandates for research from 2006 through 2010.

The IP3 research network focuses on the study of water resources; snow, ice and permafrost in cold regions, particularly Canada's Rocky Mountains and western Arctic. This network is headquartered at the University of Saskatchewan's Centre for Hydrology in Saskatoon, Canada. Other Canadian investigators within the network include scientists from the University of Waterloo, Wilfrid Laurier University, University of Calgary, University of Toronto, Carleton University, Memorial University, Environment Canada and Yukon Environment, with international investigators from the University of Edinburgh. International collaborators include researchers from the University of Idaho and University of Colorado in the USA, the Institute de recherché pour la Developpement in Grenoble, France, and the Centre for Ecology and Hydrology in the UK.

The WC2N research network seeks to understand the behavior of the climate system and its effects on glacier mass balance in the mountain ranges of British Columbia (BC) and western Alberta. This network is headquartered at the University of Northern British Columbia in Prince George, Canada and involves investigators from the University of British Columbia, Simon Fraser University, University of Calgary, University of Alberta and the University of Victoria in Canada, and the University of Washington and Western Washington University in the United States. WC2N also includes government and industry scientists from Environment Canada, Natural Resources Canada, and BC Hydro.

Investigators from the University of Saskatchewan, University of Calgary, University of Northern British Columbia and University of Toronto carry out field observations within the two networks at several different mountain research locations in western Canada.

IP3 researchers at the Universities of Saskatchewan and Waterloo are using successful parameterization of various cold regions processes including snow redistribution by wind, snow interception by trees, and slope aspect in snowmelt in model tests combining both hydrological and atmospheric models. WC2N researchers from the University of Northern British Columbia and University of Victoria are documenting present and former glacier extent in British Columbia and western Alberta, using glaciers as indicators of past climate change. Detailing contemporary meteorological and climate processes and their importance for glacier mass balance allows model development for projecting future changes in glacier cover and glacier runoff.

Highlights of work performed under the auspices of the two research networks are presented as follows:

Present and former glacier extent (WC2N)

Researchers at the University of Northern British Columbia used satellite images, provincial and national digital databases, historical topographic maps, and aerial photographs to map glacier extents and former surface elevations to determine changes in glacier area and volume. These data are fundamental to understanding how recent climate change has affected water resources in western Canada as well as providing an important calibration dataset with which to train and verify glaciological modeling schemes under development. Data from BC Terrain Resource Inventory Management program (TRIM) Digital Elevation Model (DEM), earlier DEM's from National Topographic Database (NTDB) contours (1950-1985) and the Shuttle Radar Topographic Mission (SRTM) allowed the assessment of downwasting/ ice mass loss for BC glaciers between 1985 and 1999 (Schiefer et al, 2007). Ortho-rectified Landsat scenes were also used to describe glacier extents through 2005 (Bolch et al, 2009). Glacier basins and flowsheds have been generated from DEM's to create glacier parameters including area, elevation, slope and aspect, data that are critical for identifying glacier units and allowing comparison between different time periods and locations of individual ice units (see figure 1).

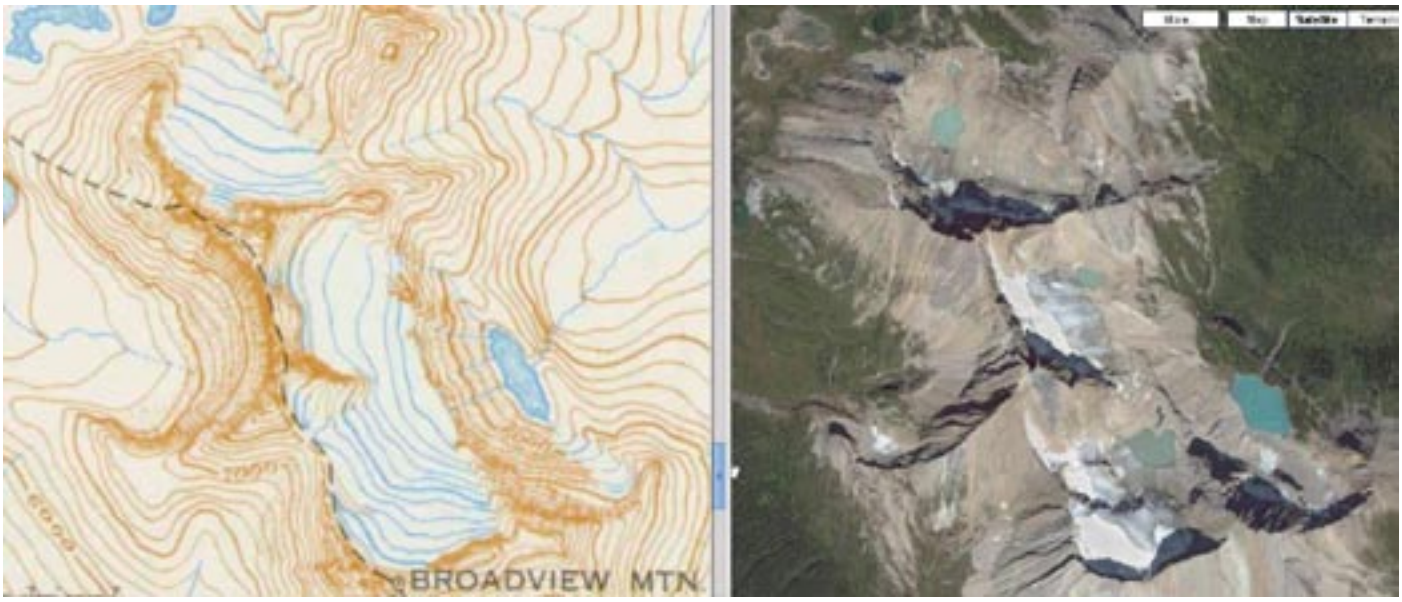


Figure 1: left: 1920 (British Columbia-Alberta) Boundary Commission map near 120° W and 54° N (Kakwa Provincial Park) right: Landsat satellite image of the same area, August 2004, showing glaciers almost completely ablated and with new meltwater lakes in their place (Roger Wheate – WC2N)

Glacier model parametrizations (IP3 and WC2N)

Current research at Peyto Creek (a 24 km^2 glacierized alpine basin in Banff National Park) examines sublimation and air temperature effects on glacier melt modeling (Munro, 2006) as well as ice/snow albedo, with Landsat determined representations of glacier albedo fields used for ice/snow albedo designations (Scott and Munro, 2009). Energy-balance process studies are ongoing at other glaciers in British Columbia and Alberta to parameterize heat flux, air temperature, humidity and wind speed for use in regional glaciation models (Munro and Marosz-Wantuch, 2009).

Atmospheric modeling and impacts (IP3 and WC2N)

Work is focused on high-resolution regional climate modeling of potential future climate over the Rocky Mountains with the highest resolution (6 km) domain centered over the specific glaciers monitored by the process researchers. Environment Canada's Global Environmental Multiscale numerical weather prediction model (GEM) is being run at high resolution (200 m) over research basins in the Rocky Mountains and being used to drive cold regions hydrological models. Other work aims at the development of high-resolution climate-forced models of regional glaciation involving the development of suitable ice dynamics models, development and application of methods for predicting subglacial topography beneath ice covered regions, refinement of strategies for downscaling temperature and precipitation fields from the North American Regional Reanalysis (NARR) dataset and others, and developing and testing the interaction between glacier mass-balance models and ice-flow models.

Snow redistribution, forest effects on snowmelt and snow-covered area depletion (IP3)

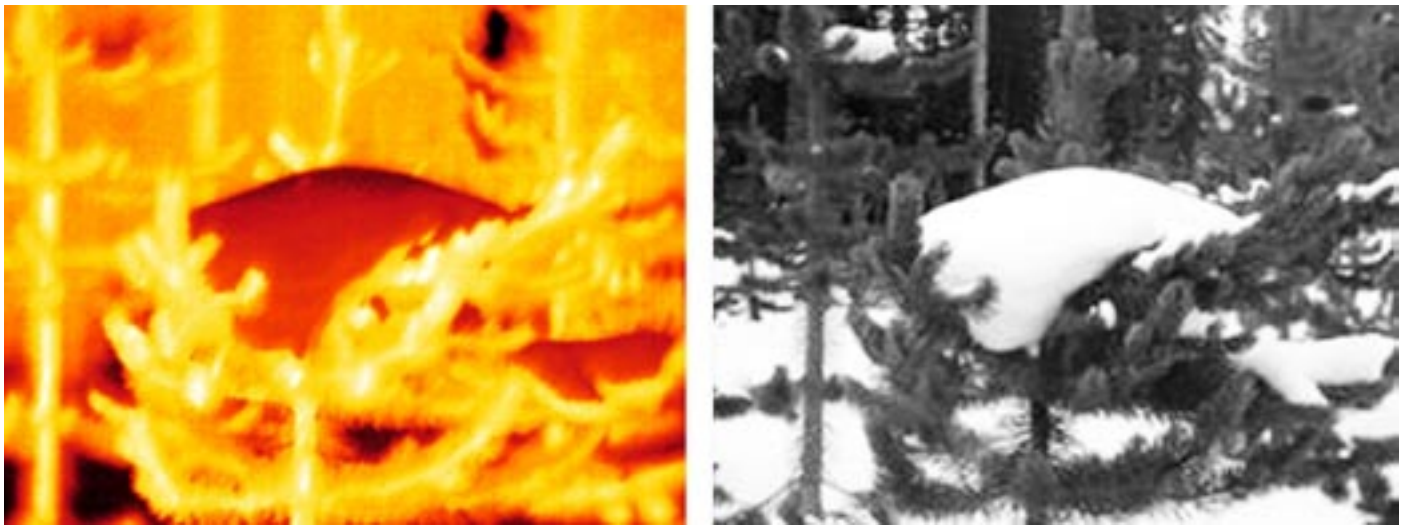
Marmot Creek Research Basin is a 14 km^2 headwater basin of the Bow River in the Kananaskis valley of the Canadian Rocky Mountains. The basin has hydrometeorological stations at varying sites including alpine, treeline, clearcut, high elevation forest, low-elevation forest, north-facing forest, south-facing forest, and meadow sites. The hydrological and atmospheric data collected by investigators from the University of Saskatchewan is used by researchers at the University of Idaho, University of Edinburgh, Memorial University and Environment Canada for a variety of studies on snow redistribution, including snow accumulation in forested versus non-forested areas, wind redistribution of snow in alpine areas, interception and unloading of intercepted snow, snow ablation under forest canopies, snow melt on slopes of varying aspect, and snow-covered area depletion in alpine terrain. Recent model development has coupled blowing snow ablation in alpine zones and snow interception to snowmelt in forested zones using the modular, object oriented Cold Regions Hydrological Model (Pomeroy et al, 2007).

The following summarizes some key findings in snow redistribution and snowmelt:

Forest effects on snowmelt

Estimates for shortwave irradiance energy beneath conifer forest cover is necessary for driving energy balance snowmelt models in evaluating the hydrological impacts of forest-cover change over mountainous terrain. Potential snow melt energy from sub-canopy shortwave irradiance exhibits the greatest variability under south-facing forests with changes in forest cover density (Ellis and Pomeroy, 2007; Pomeroy et al, 2008) (see figure 2).

In snow energy balance calculations, sub-canopy longwave irradiance to snow in coniferous forests is often estimated using air temperature as a proxy.



Thermal infrared images of intercepted snow and heat from trees – Marmot Creek

However it is now understood that longwave enhancement due to shortwave extinction becomes important during clear, sunny conditions, increasing with a higher solar elevation angle and decreasing air temperature (Essery et al, 2008; Pomeroy et al, 2009).

Snow covered area depletion

Spatial variation in snow water equivalent (SWE) distribution and melt energetics between slopes due to variations in elevation, slope, aspect, topography and vegetation leads to complex patterns for snow-covered area depletion. The fraction of snow-covered area (SCA) remaining as snowcover ablates in the spring exerts a strong influence on surface energy fluxes through albedo and temperature effects, and controls the contributing area for runoff generation. The use of a relatively new technique – oblique terrestrial photography – derives daily measurements of SCA in alpine environments, where persistent cloud cover makes conventional remote sensing methods unfeasible (DeBeer and Pomeroy, 2009).

Blowing snow

Meteorological stations situated in subalpine shrubland and alpine tundra collect data for parameterization and prediction of open environment snow cover redistribution and ablation at Wolf Creek, a 200 km^2 basin on the interior edge of the Coast Mountains in the Yukon Territory, Canada. Snow accumulation over complex terrain is highly variable due to blowing snow redistribution. This redistribution is dependant on snowfall, topography, vegetation and wind direction. Researchers at the University of Saskatchewan use a physically based blowing snow model (PBSM) for testing blowing snow redistribution and sublimation by wind over a small mountainous sub-Arctic catchment, with snow accumulation best represented using clear descriptions of landscape vegetation height and density, and topography (MacDonald et al, 2009). Investigation into the role of blowing snow in glacier mass balance is ongoing in the Cariboo Mountains (northern extension of the Columbia Mountains in British Columbia) to estimate blowing snow frequency, transport and sublimation fluxes. Data analyzed from a network of high elevation meteorological stations monitored by researchers at the University of Northern British Columbia (WC2N network participants) suggest that blowing snow significantly contributes mass to glaciers in this region (Clifton et al, 2009).

Groundwater pathways in alpine headwaters (IP3)

Research at Lake O'Hara (a wet alpine 14 km^2 watershed in south-eastern British Columbia) is focused on determining the data needed for snowmelt runoff models to accurately describe melt and thaw depths in groundwater movement. Late spring snow surveys characterized snow depth and density, while geophysical surveys conducted during the summer season delineated potential pathways of groundwater in moraine and talus fields using electrical resistivity imaging, ground penetrating radar, seismic refractions, and nuclear magnetic resonance imaging. A research team from the University of Calgary used data from hydrometeorological monitoring conducted during the entire melt season along with the snow survey and geophysical data to evaluate storage and flow parameters of talus slopes using techniques such as tracer-based hydrograph separation, water balance, recession analysis and time-series analysis. Two important hydrological response units have been identified in terms of storage and pathways – specifically moraines and talus fields (Hood et al, 2007) (Roy and Hayashi, 2007).

Future Activities

IP3 and WC2N are holding a joint Cold Regions workshop in October 2009 in Lake Louise, Alberta, Canada. Over 50 investigators and collaborators from both networks will be taking part as well as key partners including water resource managers and user groups.

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Weblinks

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Valuing the Arc – a Programme to Map and Value Ecosystem Services in Tanzania

Ecosystem Services in the Eastern Arc Mountains

The Eastern Arc Mountains of Tanzania are part of a globally important biodiversity hotspot. In addition, this region is economically significant, not only for the natural products such as building poles that are provided to the wider economy of Tanzania, but also for its provision of water and climate stabilization services. In particular the Eastern Arc Mountains are vital in the provision of water to hydroelectrical power generation plants, and also as drinking water to the coastal cities of eastern Tanzania. The trees of the Arc forests are also important stores of carbon, and if the forests are cut they release CO_2, which is an important contributor to climate change. Water flow regulation, carbon storage, and other processes such as support for nature-based tourism and provision of timber and non-timber forest products, and even pollination, are collectively known as ecosystem services.

The *Millennium Ecosystem Assessment* described in detail a wide range of ecosystem services, and outlined what they contribute to human well-being. This groundbreaking work, sponsored by the United Nations and involving over 1300 scientists, changed the way that many conservation and human development agencies saw their work, and made it evident that human development in many countries is dependent on natural resources and the services that nature provides freely for human use.

Ecosystem services are provided for free by natural habitats, but also provide a benefit to people, and these benefits can (in most cases) be ascribed an economic value. The stored stock of natural resources is known as 'natural capital', and the ecosystem services for people flow from this stock. As habitats are destroyed, this natural capital is depleted and the benefits provided – such as clean drinking water or carbon storage – may be lost.

The Valuing the Arc Programme

The Valuing the Arc Programme is a collaboration between Cambridge, York, Leeds and Cranfield Universities and University of East Anglia in the UK, University of Dar es Salaam and Sokoine University of Agriculture in Tanzania and the WWF network, in the form of WWF USA and WWF Tanzania. Valuing the Arc aims to map ecosystem services derived from the Eastern Arc Mountains and surrounding areas, work out where these services are used, and place a value on each service to local people, to people living elsewhere in Tanzania, and in some cases to people in other countries. By comparing this information with estimates of the costs of conserving the remaining forests of the Eastern Arc we will calculate whether conservation makes economic sense overall, and more specifically work out who would be the net winners and net losers.

The programme focuses on the following ecosystem services: carbon storage and sequestration, flow regulation and provision of clean water, provision of timber and non-timber forest products, opportunities for nature-based tourism, pollination of crops by wild bees and other insects. More detail is provided on www.valuingthearc.org.

The broad questions we hope that this project can address are:

- Who benefits from each of the different ecosystem services?
- Where are these beneficiaries located?
- What is the size of the benefits they receive (both in biophysical units and economic values)?
- How might these service benefits change in future, depending on plausible policy alternatives?
- How much would it cost to maintain each flow of services, and how do these costs compare with the overall value of the benefits provided?
- How could the costs of conservation be equitably shared, by the net winners of forest conservation paying the net losers?
- How much overlap exists between priority areas for conserving ecosystem services and biodiversity?

Progress so far

The Valuing the Arc programme lasts for 5 years, and has been working in Tanzania since January 2007. Over the first 2 years of the programme some important results have been generated. Our early focus has been on producing preliminary maps of our focal ecosystem services and of biodiversity patterns. We have used a simple mapping tool called InVEST (Integrated Valuation of Ecosystem Services and Trade-offs) developed by the Natural Capital

Sali Forest Reserve in the Mahenge Massif (photo by Frontier-Tanzania)

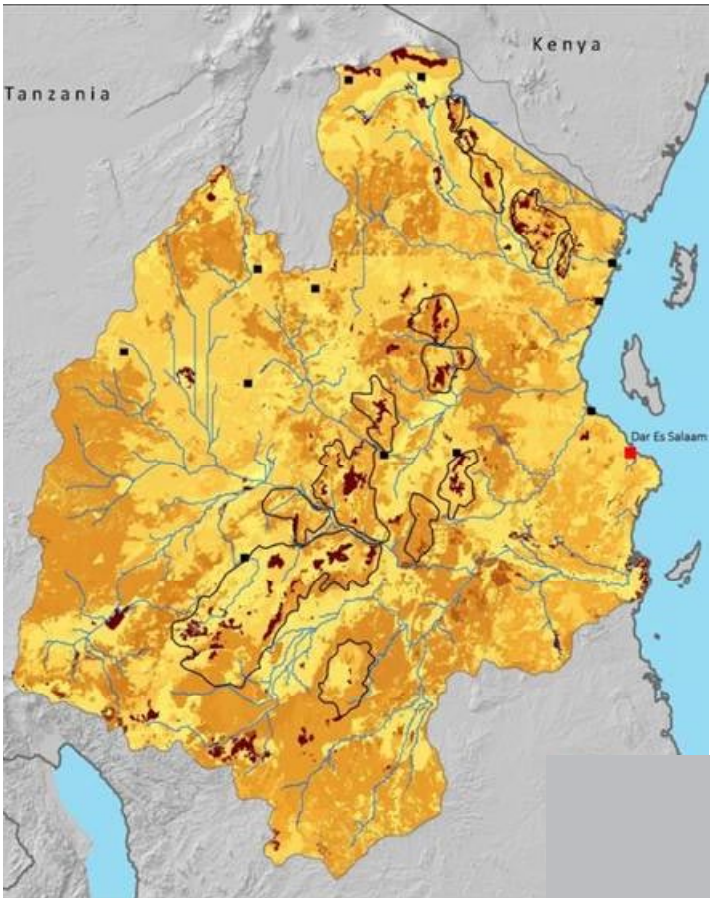

Figure 1: Map of carbon storage in eastern Tanzania. The darker the brown color of an area the greater the amount of stored carbon. Outlines of the main Eastern Arc Mountains are also shown, extending from the North and South Pare Mountains in the North west, to the Udzungwa and Mahenge Mountains in the south.

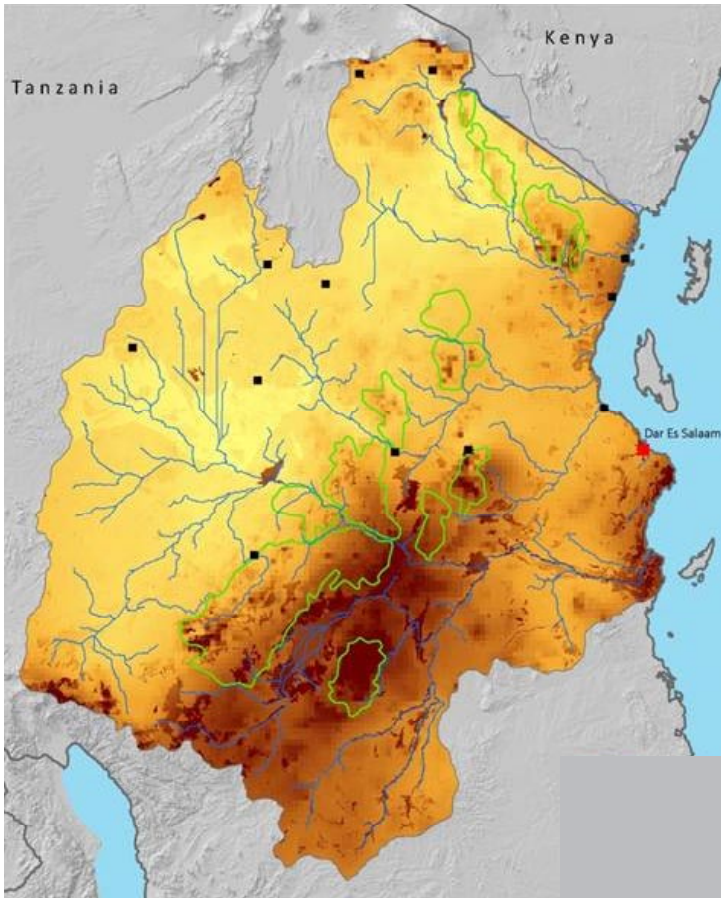

Figure 2: Map of water yield in Eastern Tanzania produced with the InVEST mapping software. The darker the brown color the higher the annual yield of water from that area. Eastern Arc Mountain blocks are marked in green outlines.

Project – a wide collaboration of universities and NGOs – and are now seeing how these results compare with using more sophisticated but data-demanding models. Another focus has been the development of plausible future scenarios for how landcover might change in Tanzania by 2050.

Some of the initial results we have obtained address the questions outlined below:

How much carbon is stored in eastern Tanzania?

We have used the InVEST tool to develop preliminary maps (see Figure 1) of the amount of carbon stored in eastern Tanzania. Lowland swamps and mangroves contain the highest density of stored carbon (over 600 tones carbon per hectare, mainly in the soil), followed by forest habitats in the Eastern Arc Mountains (up to ~300 tons carbon per hectare, mainly above ground). Around 35% of the carbon is stored within protected areas, with the highest density of carbon found in Forest Reserves and Nature Reserves managed by the Forestry and Beekeeping Division. The largest unprotected carbon stores are found in wetlands, and in unprotected forest habitats, the latter mainly on the Eastern Arc Mountains.

Where are the most important areas for water supply?

Our initial maps of water runoff indicate that two different sorts of areas are especially important for water provision (Figure 2). The first and most important areas are the large wetlands – for example the Kilombero Valley to the south of the Udzungwa Mountains, and the Mkata wetlands to the north of the Mikumi National Park – which are seasonally inundated swamp areas. Secondly the Eastern Arc Mountain peaks are also significant sources of water, especially those peaks closest to the Indian Ocean – such as the Ulugurus, East Usambara and Udzungwa ranges. Inland of the Eastern Arc Mountain range the water yield is particularly low and these areas experience water shortages for large parts of the year.

How do priority areas for conserving ecosystem services map onto priority areas for biodiversity conservation?

An initial map of the biological importance of eastern Tanzania has been developed using maps of the distribution of forest birds across the country (Figure 3). This map shows the high importance of the Eastern Arc Mountains in terms of forest birds. An initial analysis shows that these priority areas for forest birds fall in the same mountains that contain high carbon value forests and areas that are important for water runoff. Valuing the Arc will be further exploring these correlations in coming years, and will also investigate the best management regimes for conserving both ecosystem services and biodiversity value.

What is likely to change in future? We have developed two main scenarios for the Eastern Arc Mountains, using a framework of 'rules' derived from stakeholder consultations about how the effective implementation of government policies on poverty and sustainability might change agricultural land, forests, woodlands, and so on. These rules define land cover changes over time, which have important consequences for ecosystem service delivery and value.

Plans for the coming years

The Valuing the Arc programme aims to complete its mapping of ecosystem services in the coming year. At the same time as mapping the distribution and flow of services, there will be an analysis of the values of the various services. This provisional analysis will be refined in 2010, leading to the main outputs by 2011. It is hoped that this work will provide guidance for policy development in Tanzania and be an example of the kinds of work that might be possible, and useful, in other developing countries with limited data but considerable need for state-of-the-art information on ecosystem services and their sensitivity to alternative policy interventions.

In conclusion, our hope is to develop best practice science on biodiversity and ecosystem services, and use this science to inform the policy debate in Tanzania. There are two and a bit more years left to run on the programme and significant progress has been made in the first nearly three years. As such we hope that the programme will deliver final products in a couple of years and also produce scientific papers for a number more years to come.

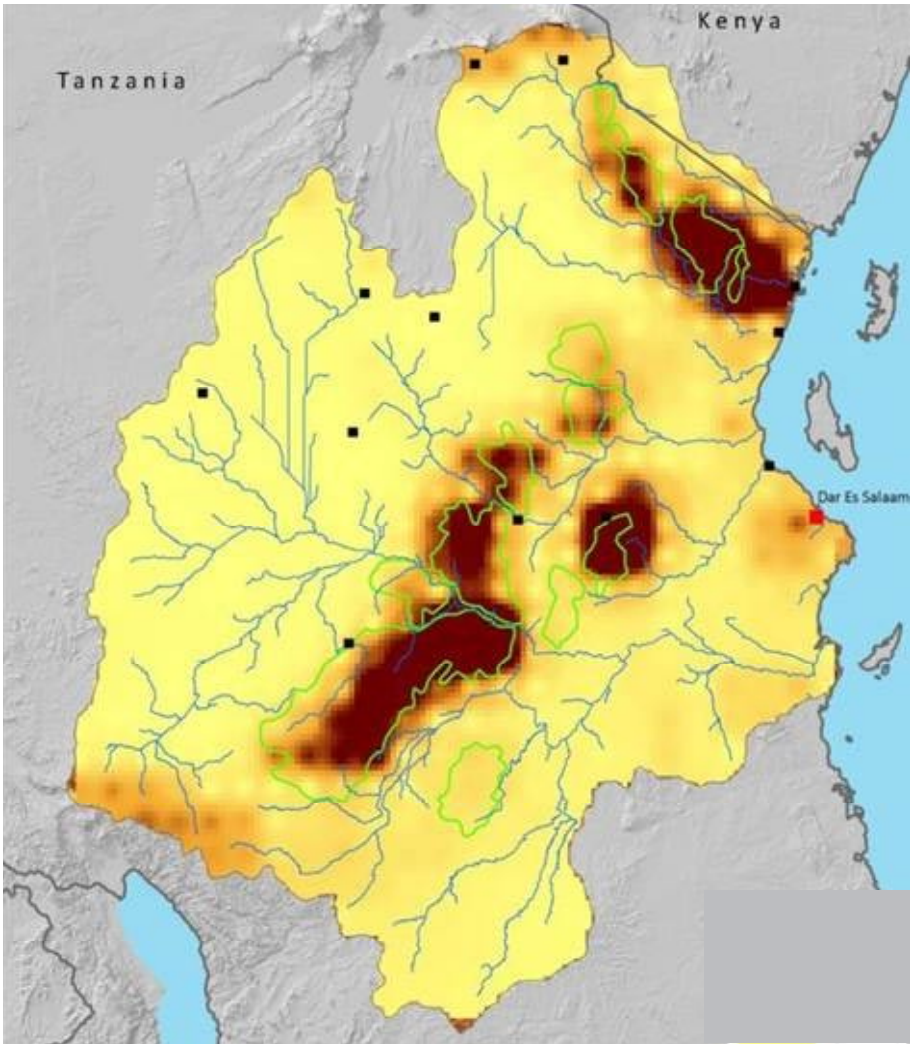

Figure 3: Important areas for forest birds. Darker brown areas have the highest concentrations of rare forest birds. Outlines of the Eastern Arc Mountain blocks are shown in green. The underlying bird distribution data was provided by Jon Fjeldså in Denmark.

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Weblinks

Millennium Ecosystem Assessment: http://www.millenniumassessment.org

Valuing the Arc: http://www.valuingthearc.org

Recent Environmental Changes in the Tatra National Park in Poland

The Tatra National Park was established under a Regulation of the Council of Ministers on 30 October 1954 and started its activities on 1 January 1955 as the third national park in Poland. With 212 km2 it covers just 0.56% of the country and protects the alpine high mountain landscape of the highest massif of the Carpathians. The Park abuts the Slovak Tatras National Park and the Polish and Slovakian national parks were jointly designated a transboundary biosphere reserve by UNESCO in 1993.

The Tatras were first explored by semi-nomadic herdsmen and gold prospectors in the Middle Ages, but the negative human impact on the environment was insignificant until the end of the 17th century (Fig. 1). Over time, human pressure on the environment grew. Increasing sheep herding in the 18th century needed more pasture, leading to extensive clearing of forests . At the same time hunting depleted wildlife populations, especially of goats, marmots and bears. Unrestrained development of mining and iron industry in the 19th century required huge amounts of wood and charcoal, thus causing more timber harvesting in the Tatra forests (Photo 1). The deforestation and overgrazing intensified erosion of mountain slopes and changed the timing and intensity of runoff. Artificial spruce monocultures replaced natural beech and fir communities in the late 19th and 20th centuries. The establishment of the national park stopped most of these processes with the exception of sheep farming, which is maintained on a few Tatra clearings as a traditional practice ("cultural shepherding") (Siarzewski 2006).

At present, mass tourism (Photo 2) and air pollution threaten Tatra National Park. The accessibility, beauty and uniqueness of this area make it an important tourist destination. The Tatra National Park is available for hiking, climbing, cave exploration, para-gliding, hang-gliding, sledging, skiing, and snowboarding. A rapid increase of tourist traffic started after World War II and lasted till the end of the 20th century. In the period from 1993 to 2007 about 2.5 million tourists visited the Park each year. In later years tourism has stagnated and is not expected to grow in the near future because of competition from the great variety of tourist destinations now available after Poland's accession to the EU (Baścik, Czubernat, Pociask-Karteczka 2007). Over 50% of tourist traffic is concentrated in July and August (Fig. 2). The heavy traffic in summer is three times

Photo 1: Differences in forests in 1915 (Photo by W. Goetel) and 2009 (Photo by J. Pociask-Karteczka)

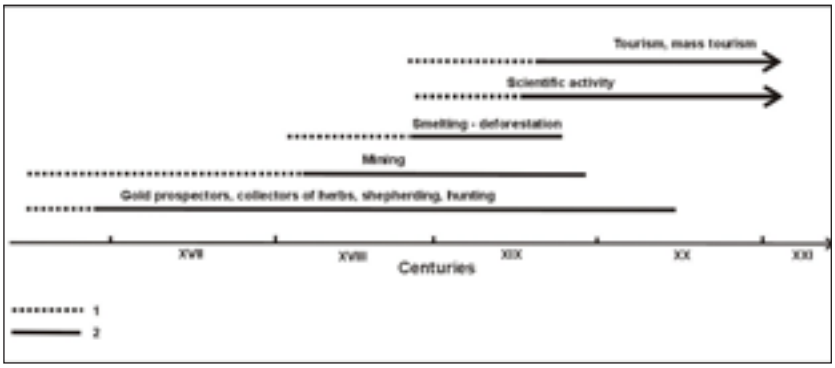

Figure 1: Human activities influenced changes in the nature of Tatra National Park over centuries (1 – poor activity, 2 – strong activity)

Photo 2: A queue by the entrance gate to the Jaworzynka Valley in the Tatra National Park (Photo by J. Chowaniec)

Name of the national park	Location	Area [km2]	Length of trails [km]	Density of trails [km/km2]	Average number of visitors [th./year]
Cévennes	Massif Central	9138*	-	-	1000
Pyrenees	Pyrenees	457*	350	0.77	2000
Écrins	Alps	917*	714	0.78	600
Mercantour	Alps	685*	600	0.88	800
Vanoise	Alps	528*	600	1.14	800
Tatra	Carpathians	212	245	1.16	2036**

* without buffer zone ** except tourists who entered the park by cable railway

Table 1: Selected mountain national parks in Europe (after Kurek 2004)

greater than the tourist capacity of the Park (Baranowska-Janota et al. 2000). While the Tatra National Park is among the smaller parks in Europe, the density of trails and the number of tourists are among the highest, indicating the strong pressure from tourism (Table 1).

Mass tourism has caused environmental degradation in the Tatra National Park. Almost 52% of annual tourist traffic is concentrated on two routes and environmental degradation is the strongest along these trails (Photo 3).

The great number of people on hiking trails causes significant trampling of the ground, destroying the vegetative cover and accelerating erosion (Fidelus 2007). Trash, waste, and food scraps left along the trails attract animals. Noise as well as transgressions of the park's protected zones (for instance by para-gliders, hang-gliders) disturb and frighten animals in their habitats. Vegetation becomes synanthropic, especially in the vicinity of the most frequented mountain trails and shelters with restaurants. New invasive species are dangerous for

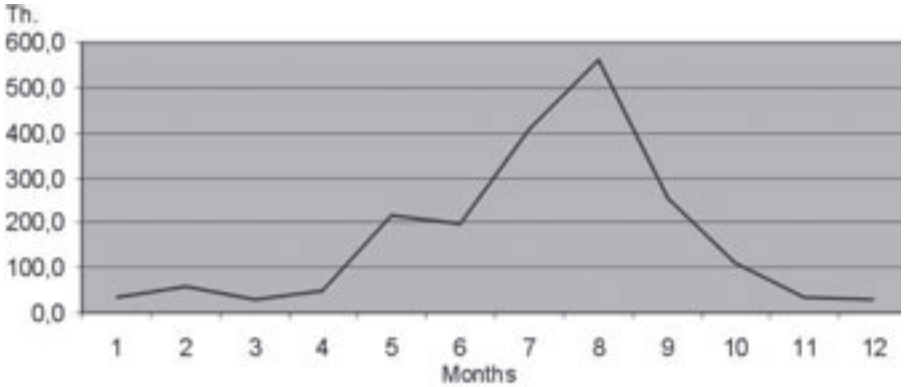

Figure 2: Tourists traffic in particular months in the Tatra National Park (1993-2005)

Photo 3: Linear erosion gutter near the Rakoń (Photo by J. Fidelus)

the biodiversity of natural habitats. The shelters contributed to the contamination of surface waters until the 1990's. Algal communities of high mountain streams changed as a consequence (Kawecka 1977). Nowadays, most shelters have well operated sewage treatment plants. However the park is not sufficiently equipped in portable toilets, so linear contamination along the trails is common in forest and dwarf mountain pine areas.

The natural environment of the Tatra National Park is also affected through precipitation. Acidification of the High Tatra surface waters was detected in the early 1990's. Sulphur and nitrogen loads exceeded thresholds throughout most of the year. This concentration caused changes in the soil chemistry, and the death of single and even entire stands of trees (Kot at al. 1993). The sulphate concentration in precipitation in the period 1992-2005 decreased significantly due to a national reduction of sulphur oxide emissions. No significant change in nitrate, ammonium or total nitrogen deposition was observed. The chemical composition of surface water showed signs of chemical recovery with decreases in sulphate concentration and increases in acid neutralizing capacity. This increase in buffering capacity probably resulted from decreasing acidification and global warming which prolongs the vegetative period, changes plant species composition and increases the microbiological activity of soil (Rzychoń, Worsztynowicz 2007).

The changes in the Tatra National Park caused by human activities add to those of arising from natural environmental changes. Climate change is the most important factor influencing changes in vegetation, fauna and geomorphological processes. Reconstructed and observed summer temperatures in the Tatras from 1550 to 2004 indicate that the last cool period was observed in 1960-1990. Warm summers have dominated since 1991 and the number of extreme events has increased (Niedźwiedź 2005). Ice cover analysis on Lake Morskie Oko located in the eastern part of the Park also indicate recent climate warming: the length of the period with ice cover on Lake Morskie Oko has diminished at a rate of 11 days per decade (Photo 4). In the period 1995-2005, ice cover duration was 32 days shorter than in the period 1971-1982. These changes correspond with a positive statistically significant air temperature trend in the April-May period (Fig. 3); Pociask-Karteczka, Choiński 2009). Climate changes will probably contribute to raise the treeline level and other vegetation zones.

National and international snow sport events and increasing urbanization on the periphery are creating new conservation challenges in the Park It remains to be seen if Park management will rise to the challenge. It is possible that t he participation of the Polish and Slovak Tatra National Parks in the international Man and the Biosphere (MAB) programme will promote more effective nature protection.

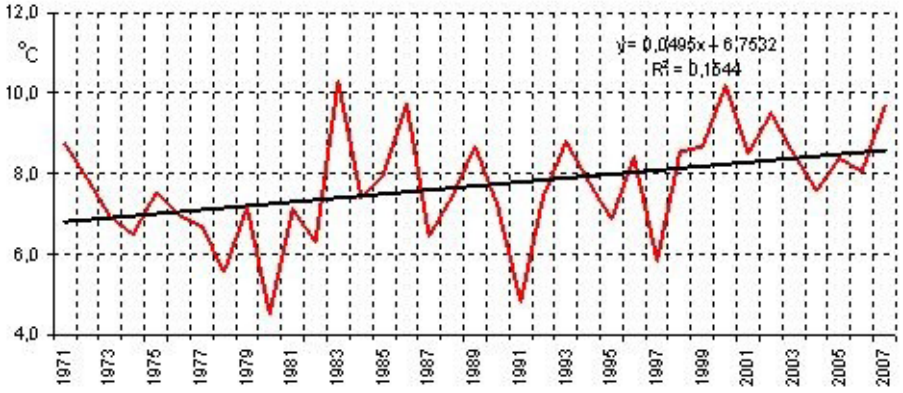

Figure 3: The air temperature in the period April-May in 1971-2007 (Zakopane station located near the northern border of the Park)

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Photo 4: Drilling ice cover in the Lake Morskie Oko (April 2007) (Photo by J. Pociask-Karteczka)

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Mountains as Model Systems for Understanding Drivers of Plant Invasion

The introduction and spread of non-native species is considered a major threat to biodiversity and ecosystem services (MA 2005). They can potentially lead to the replacement of native species, and affect ecosystem structure and functioning, for example affecting slope protection or disrupting food webs (e.g. by replacing food sources or affecting pollinators). The spread of non-native plants can be limited by a number of factors, including the availability of seeds (termed "propagule pressure"), the availability of suitable (especially disturbed) habitat, competition with native species and their ability to adapt genetically to new conditions.

Until now, mountain systems have been thought to be less at risk of invasion by non-native plants (MA 2003). Human activities, and therefore the introduction of these species and the presence of disturbed habitat, are generally thought to be less pronounced at higher altitudes. Furthermore there may have been insufficient time for many non-native plants to become adapted to high-altitude environments, particularly to low temperatures (Fig. 1). However, because of changes in land-use patterns, decreasing isolation of mountain areas e.g. by increased tourism, introduction of non-native ornamental species directly to high altitude areas and climate change, mountains are expected to become increasingly threatened by non-native plants in the future (Pauchard et al. 2009). Research into invasion processes in mountains might therefore contribute to preventing the damage potentially caused by non-native plants. At the same time, understanding derived from mountains, especially processes operating along altitudinal gradients, can be extrapolated more generally to lowland systems (e.g. to latitudinal gradients).

Mountains as model systems

The introduction of non-native plant species into mountain regions around the world represents a replicated experiment in species distributions (Pauchard et al. 2009). Often the same species is present in multiple regions, where it might be either native or introduced. By comparing plants in both their native and introduced ranges it is possible to determine how they differ (for example in their traits and patterns of distribution in response to the environment) and so elucidate the factors limiting their spread. By reciprocating the study in multiple regions it is also possible to determine the importance of regional factors on more general invasion processes. Mountains, with their steep environmental gradients across relatively short distances, present ideal model systems to implement these approaches. All plants reach ecological limits along altitudinal gradients, particularly due to climatic factors. But the anthropogenic activities often associated with high propagule pressure (e.g. unintended

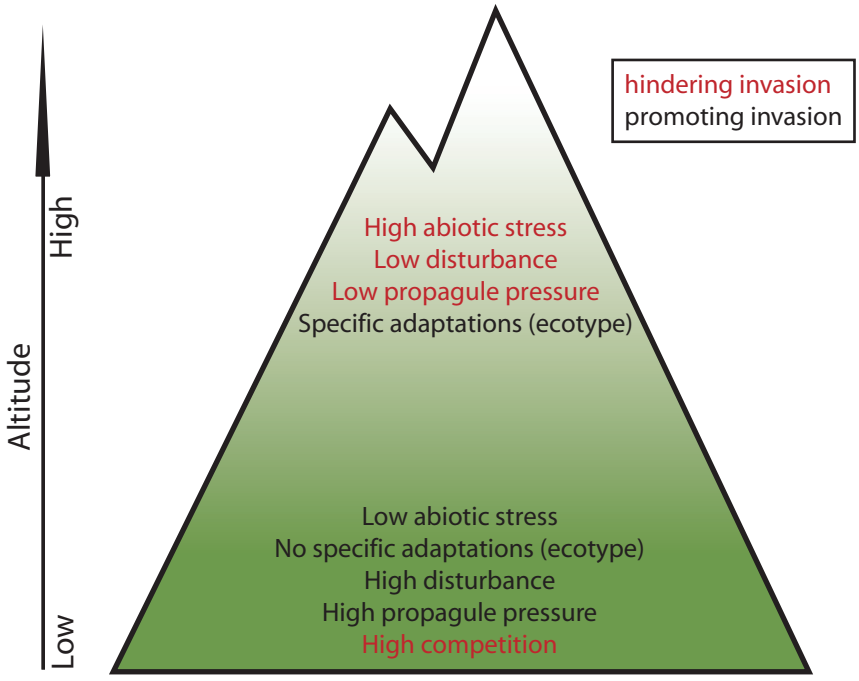

Figure 1: Factors affecting plant invasion along altitudinal gradients in mountains. At low altitude low abiotic stress (e.g. benign temperatures), high anthropogenic disturbance levels and high propagule availability (propagule pressure) promote plant invasion. No specific adaptations are expected to be needed under these benign conditions. At high altitudes abiotic stress increases, whereas disturbance and propagule pressure decreases, hindering plant invasions into mountains. Specific adaptations (ecotypes) might overcome abiotic constraints and promote plant invasions at high altitudes. Higher invasion into mountain areas can also be expected if constraining factors are alleviated, e.g. through increased disturbance at high elevations, increased anthropogenic transport and direct introductions of ornamentals adapted high altitude conditions.

spread of seed along roads by traffic) and disturbance (e.g. road works, building activities) are also much reduced at higher altitudes. Investigating which factors determine the altitudinal limit of non-native plants can therefore reveal which factors are most important for limiting their spread.

A reciprocal analysis of ecological and genetic factors of non-native plant invasions along altitudinal gradients in the Swiss Alps and Wallowa Mountains (OR, USA), 2004-2007

We present a completed research project that illustrates the use of mountain invasions as a model for invasive species research. The project was part of the Mountain Invasion Research Network (MIREN), which researches invasive plants and supports their management in mountains worldwide (see also MRI Newsletter no.1, Sept. 2008). In our study, we focused on the following main questions:

1. Are the distributional patterns and growth characteristics similar in the native and the introduced range of the species – if not, which factors cause these differences?
2. Does high phenotypic plasticity allow successful invasions into higher mountain areas or is there a need for selection or presence of high mountain ecotypes?
3. In what respect are biotic interactions with the native community or the release from such interactions, e.g. through disturbance, the main determinants of the altitudinal limits of non-native species?

To investigate these questions on factors influencing the distribution of non-native plants in mountains along altitudinal gradients, we compared eight forb species from the Asteraceae (daisy family) in two temperate mountain ranges. We chose the Wallowa Mountains (Oregon) in the US and the Canton Valais in Switzerland, as they are climatically similar and harbor species

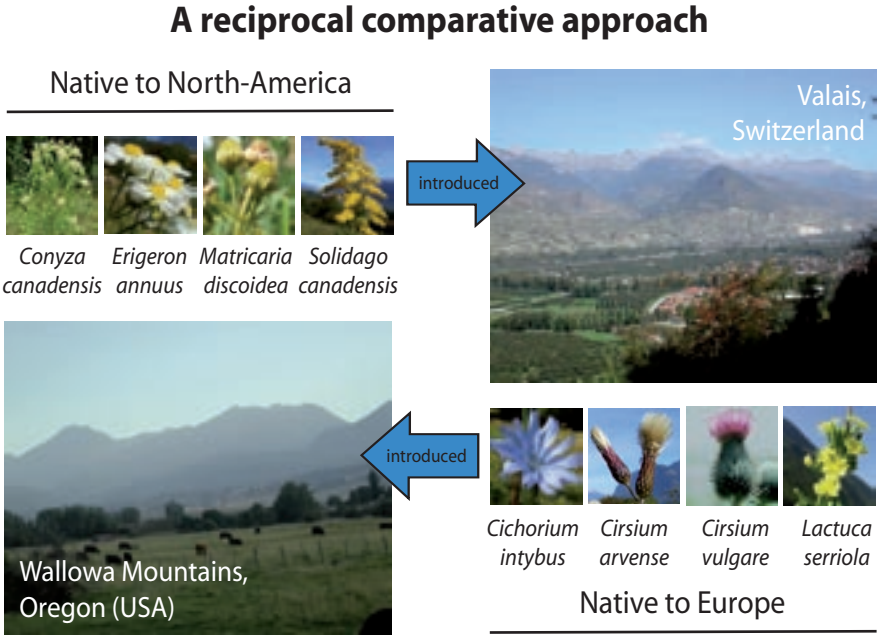

Figure 2: A reciprocal comparative approach was used to investigate the importance of factors driving mountain invasions. Species native to the North-America and introduced in Europe were compared with species native to Europe and introduced in North America in a reciprocal design in two mountain systems - the Wallowa Mountains, Oregon (USA) and the Valais in Switzerland (photos: J. Alexander, M. Poll)

that are native in the one and non-native in the other region, and vice versa. This offered the possibility of a reciprocal study design, i.e. we compared species native to Oregon with species native to Switzerland in both their respective native and introduced ranges (Fig. 2). We integrated results from surveys of species distribution in the field, plant trait and genetic analyses and experimental approaches.

1. Plants exhibit similar altitudinal distributions and growth characteristics in their native and introduced ranges

An important question in current invasion biology is whether a species generally grows and reproduces under the same environmental conditions, e.g. climate, in the native and introduced ranges. If so, it is said that the niche, i.e. the ecological conditions where a species can grow and reproduce, is conserved. If niches are generally not conserved then it is not possible to use the abiotic conditions under which a particular species is found in the native range to predict the areas where it might occur in an introduced range. Steep altitudinal gradients are suitable to study the climatic niche, especially of temperature, of a species.

We hypothesized that the eight species would occur over a narrower altitudinal range in the introduced than native range (i.e. that their climatic niches would be narrower in the introduced range), based on two considerations. First, introduced populations typically represent only a subset of the genetic diversity of native populations, and genotypes adapted to extreme abiotic conditions, especially low temperature at high elevations, may be missing. Second, at the margins of species distributions populations are often maintained by high influx of propagules (e.g. seeds) from populations near the centre, but this effect might be limited in the introduced range if populations are actively spreading and not yet in equilibrium with their climatic limits.

However, our surveys of species distribution showed that most species actually reached very similar altitudes in both the native and introduced region (Alexander et al. 2009-a). This pattern was corroborated when plant performance, measured as seed size and plant height, was measured. Plant size decreased and seed size increased along the altitudinal gradient in a similar way in the native and introduced regions (Alexander et al. 2009-b). Seedling recruitment was not restricted to relatively lower altitudes in the introduced than native range (Poll et al. 2009) indicating no evidence of restriction on recruitment to lower elevations in the introduced range.

2. Altitudinal distribution of non-native species is mainly determined by phenotypic flexibility

While no important differences in the behavior of the study species between the native and introduced ranges were found, the performance and traits of plants differed along altitudinal gradients within regions. Such ecological variation within species may be due to genetic adaptation (different genotypes) or phenotypic flexibility (i.e. the ability to grow under wide ranges of conditions). The relative contribution of these factors can be distinguished using common garden experiments, where individuals from different elevations and regions are grown under the same environmental conditions.

We established common garden experiments at three elevations – at low, intermediate and high altitude – and compared plants of native and non-native status and of high and low altitude origin. We found genetic differentiation in both native and non-native plants between plants of low and high altitude origin. Plants of high altitude origin tended to flower earlier, remained smaller and produced less biomass in the common garden at low altitude, indicating an adaptation to high altitude conditions. However, plants of low altitude origin were not found to be disadvantaged under the harsher conditions when grown in the highest common garden, thus not showing specific adaptations to their altitude of origin. This result indicates that the species distribution along altitudinal gradients in the native as well as the introduced range is rather determined by their ability to grow under a wide range of conditions (phenotypic flexibility) than by being adapted to conditions at specific altitudes.

With molecular genetics techniques we further evaluated the genetic differentiation of populations between native and introduced ranges and along altitudinal gradients within ranges. We expected that introduced populations would have low genetic variability because they stem from only a few source populations. This was the case for one species, *Solidago canadensis* (Canada goldenrod, native to Oregon). However another species, *Lactuca serriola* (Prickly lettuce, native to Switzerland), was actually more variable in the introduced region, perhaps due to the mixing of genetically distinct native populations, where it also reached a higher altitudinal limit (Alexander et al. 2009-c). Genetic variability might have influenced the wide ecological range of this species in the introduced range, but even the genetically depauperate goldenrod was not prevented from reaching high altitudes. Overall these results suggest that again phenotypic flexibility may be more important than genetic variation in the studied species in enabling them to cover a broad altitudinal gradient.

3. Habitat disturbance facilitates invasion of ruderal non-native plants in mountains

One reason that has been proposed to explain the low degree of invasion in mountains is the reduced habitat disturbance at higher elevation. Our data confirm the importance of habitat disturbance in facilitating invasion of non-native plants adapted to ruderal habitat conditions. Establishment of non-native plants was positively correlated with disturbance, and in some cases an intact native vegetation cover completely excluded non-native plants. Disturbance intensity differed markedly between regions, with the Wallowa Mountains being characterized by more open and disturbed vegetation. This factor might partly account for the much higher density of non-native species that was found there than in the Valais. However, we also found that species performance along altitudinal gradients was consistently poorer in the Wallowa Mountains, and other regional specific factors may also play a role.

Drivers of plant invasions in mountains: insights from the integrative comparative approach

Our comparison of populations in both native and introduced mountain regions indicated that non-native plant populations do differ genetically from native populations and along altitudinal gradients. However, the remarkable similarity in patterns indicates that the need to adapt to environmental conditions does not prevent a species from reaching its full ecological potential in the new range, i.e. even small non-native plant populations with a small genetic variability seem to be able to grow along the same altitudinal range as the genetically more diverse native populations. This finding suggests that species' ecological niches are conserved when they are introduced to a new range, despite differences in genetic variability. Furthermore, low propagule pressure is unlikely to prevent a species from reaching its ecological limits once it is present in a region. However, region-specific factors, such as broad climatic characteristics, do affect species performance independently of whether they are native or non-native. These might confound the interpretation of comparisons between a species' performance in the native and introduced ranges, and region-specific factors can be identified using a reciprocal design. Disturbance emerged as the most important correlate of invasion success, and our results therefore suggest that this and associated patterns of human land-use exert a much stronger influence on the spread of non-native plants along environmental gradients than changing climatic conditions.

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Notes from the Global Change Research Network for African Mountains

The Global Change Research Network (GCRN_AM) has made two large steps since the last edition of the MRI News.

First, the Swiss National Science Foundation and the South Africa National Research Foundation agreed to fund the joint Swiss-South African scientific seminar „Toward Sustainable Fine Resolution Hydro-Ecological Observatories in Southern African Mountains" proposed by Dr. Hannes Rautenbach of the University of Pretoria and Dr. Michael Lehning of the Swiss Institute for Snow and Avalanche Research (SLF).

The seminar itself will run from 2 to 6 November 2009 at the Swiss National Park in Zernez, at the Federal Office for the Environment in Bern, and at the University of Lausanne. The program covers observing systems related to climate, hydrology, and biodiversity, and will benefit from the participation of researchers at the Swiss National Park, at MeteoSwiss, from two programs within the Federal Office of Hydrology, from all four entities of the ETH domain, and the Universities of Basel, Bern and Lausanne. The visiting delegations will include researchers from the South African Environmental Observing Network (SAEON), the KwaZulu-Natal Wildlife Service, the Sneeuberg Nature Reserve, and the Universities of Pretoria, Witwatersrand, KwaZulu-Natal, Stellenbosh and Lesotho.

The seminar will initiate international collaboration around a nascent effort to establish a network of permanent hydro-ecological observatories in southern African mountains. Switzerland has a long experience with mountain monitoring and as such, Swiss knowledge, skills and expertise will help South African scientists to establish a world-class observational network. In exchange, Swiss scientists will glean experience in data collection and interpretation of long-range climate, biodiversity and ecological data in an environment quite different from the Alps. Another aim is to show the benefits of geo-referenced biodiversity data, for integrated analysis and spatial visualization of biodiversity information in relation to climate, land use, physiography and other important parameters.

One of the hopes of the effort is that a good example of an interdisciplinary mountain observatory system in southern Africa could serve not just as an example but also as a kernel for a broader observatory system throughout African mountains.

Second, the network has seized the opportunity offered by a call by the EU FP7 to develop a proposal focusing on the integrated management of water and natural resources in Africa. The call focuses on building long-term lasting human and social capacity for integrated natural resources management, particularly a toolbox for the evaluation of future scenarios as well as of proposed policies and programs. While this effort is just beginning, MRI hopes to create a consortium with researchers from both Europe and Africa to develop an applied coupled human-earth system science approach to this problem.

When the next MRI News comes around, I hope to be able to present both the results of the Swiss-South African scientific seminar and the nature of the proposal to FP7.

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GCRN_AM:
http://mri.scnatweb.ch/networks/mri-africa/

Scientific Seminar „Toward Sustainable Fine Resolution Hydro-Ecological Observatories in Southern African Mountains": http://mri.scnatweb.ch/index.php?option=com_docman&task=cat_view&gid=157&Itemid=43

The Americas Cordillera Transect for Global Change Research

During 2009 the activities of the ACT network have concentrated on

- networking to produce collective outputs,
- maintaining the flow of information with the Newsflash,
- preparing a proposal for future work.

ACT coordinator Dr. Fausto Sarmiento has been in contact with several scientists in order to prepare workshops and sessions to present research done in the Americas Cordillera. The principal target is the Global Change and the World's Mountains Conference, taking place in Perth, UK, from 27 September to 1 October 2010. Researchers from the ACT network will present current social science research projects to understand global change in the mountains of the Americas. Dr. Sarmiento is also organizing a special session on the ACT network's activities on mountain landscape transformation under global environmental change at the yearly meeting of the American Association of Geographers (AAG) to be held in Washington, DC in April 2010.

Dr. Sarmiento collected and edited information for distribution in the bilingual newsflash produced bimonthly. The news items include information from ACT members sent either to MRI in Switzerland or to Fausto Sarmiento in the USA, news from other list servers and information the network coordinator collected by other means.

The topic of "Farmscape Transformation and Global Change in the Tropical Mountains of the Americas" (see Publications) continues to attract interest and prospective collaborators. Fausto Sarmiento (UGA), Ricardo Russo (EARTH) and Jeffrey Jones (CATIE) are developing a research proposal on mountain agriculture and livelihood strategies for adaptation to change with a seed grant from the Exposition Foundation of Atlanta. The envisioned project will include nodes in Mexico, Guatemala, Costa Rica, Panama, Colombia, Ecuador and Venezuela, with the participation of ACT members Gerardo Bocco, David Ortega-Pacheco, Luis Ortega, Juan Gonzalez and Alejandro Leon. The goal is to receive funding from NSF for regional work on coupled human-natural systems.

Dr. Sarmiento with the participation of Dr. Carol Harden from the University of Tennessee Knoxville is planning the resubmission of a funding proposal for a regional workshop on the state of the art in global change science in the Americas cordillera. This workshop should also serve as an occasion to improve the ACT network's functioning and membership basis. The work presented there will either be published in a peer-reviewed publication or in an edited book .

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

Global Change and the World's Mountains, 27 September -1 October 2010, Perth, UK: http://www.perth.uhi.ac.uk/mountainstudies/2010

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MRI Europe Progress Report

Editorial

It has been more than six years since I started working in global change research coordination in mountain regions. The longer I deal with this specific field, the more I am convinced that the European mountain science community generates more data and information than anybody can ever get hold of, let alone read and comprehend. New books, conference proceedings and workshop reports on mountain issues are published almost daily. Many products are available online and every institution starts its own communication tool tailored to the specific needs of their target group. No doubt, information has become an ample and accessible good.

A closer look reveals that the amount of English-written scientific information published on mountain issues differs vastly between countries. Using the Web of Science®, Prof. Christian Körner (2009) conducted a bibliographic analysis of the worldwide research activities associated with mountains by country, institution, and subject. His analysis identified the United States, Switzerland, France and Italy as the leading countries in terms of the absolute numbers of „alpine" publications. Counting the „alpine" publications per capita per country, the list starts with Switzerland followed by New Zealand, Austria, Norway, and Sweden. Using „mountain" as search term, the picture differs only slightly. In brief, Körner's analysis not only identifies clusters of high research activities but similarly shows gaps, i.e. mountain research communities that were hitherto rarely publishing in English peer-reviewed journals.

A similar picture can be gained from the georeferenced maps pinpointing the geographical coverage of the peer-reviewed research articles published in *Mountain Research and Development* (1991-2008). While a large number of publications is dedicated to the Alpine bow and a cluster of case studies has been published for the Pyrenees, mountain systems of Central, Eastern and Southeastern Europe are barely represented (Figure 1).

In conclusion, despite the bustling scientific writing on mountain topics, be it in English or in other languages, there is no reason to sit back and take things easy. There is still a high demand for conducting high quality scientific studies on mountains themes at a regional scale and to intensify international research collaborations that not only contribute to the wider publication of research results in English language but also to capacity building. The MRI-Europe Programme will support this process and facilitate the generation of high-quality research papers.

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Figure 1: The MRD "article mapper" shows the spatial scope of peer-reviewed research articles published in Mountain Research and Development (1991-2008).

MRI Europe

The integration of the MRI-Europe Programme into the Institute for Mountain Research: Man and Environment (IGF) of the Austrian Academy of Sciences, coincided with institutional changes. On April 1st 2009 the IGF was transformed from a Research Unit to an Institute of the Austrian Academy. Prof. Axel Borsdorf was confirmed as its Director, with Prof. Georg Grabherr and Prof. Johann Stötter as Vice-Directors. In response to the insecure financial support for the MRI-Europe Programme, Drs. Borsdorf and Björnsen Gurung visited the members of the new presidency of the Austrian Academy of Sciences in Vienna in July 2009 to discuss future directions and financial support of the MRI-Europe network. Prof. Dr. Weingartner, MRI's President, also addressed requests to the Swiss National Science Foundation and the Swiss Academy for Natural Sciences for additional funding for MRI-Europe.

Science for the Carpathians

The Science for the Carpathians (S4C) initiative made a big step forward during the 2-days meeting held in Bratislava on 9-10 of June 2009.

The first day targeted the topic „Securing the provision of ecosystem services in the Alps and the Carpathians". Gathering 37 experts from both mountain regions, the event not only promoted knowledge and information exchange between these two regions but explicitly aimed at the development of joint project proposals (see workshop report page 46). Prof. Patrick Hostert, Geomatics Lab, Geography Department, Humboldt-Universität zu Berlin and Prof. Adrienne Grêt-Regamey, Planning of Landscape and Urban Systems, ETH Zurich initiated and co-organized the first day of this event.

The second day was devoted to the institutional setup and planning of the S4C network. It was organized by the Institute of Landscape Ecology of the Slovak Academy of Sciences in cooperation with MRI-Europe/IGF, the Jagiellonian University, the International Scientific Committee on Research in the Alps (ISCAR), the Swiss and Austrian Academies of Sciences, with the support of IGF, EURAC and the Interim Secretariat for the Carpathian Convention-UNEP. Specifically, the meeting lead to the nomination of 14 members of an S4C Interim Scientific Steering Committee chaired by Prof. Jacek Kozak, Institute of Geography and Spatial Management, Jagiellonian University, Kraków, Poland. The Committee has been elected for the time until the 1st Forum Carpaticum (15-17 September 2010, Kraków). Tasks and responsibilities are described in a Draft Memorandum.

An important milestone was set by the 13 representatives of the Carpathian Academies of Sciences (CAS) (Czech Republic, Hungary, Poland, Romania, Ukraine and Slovakia), who accepted the invitation of the presidents of the Swiss and Austrian Academies to participate in the workshop. The representatives expressed a high interest in the S4C activities and its further development. They defined 5 fields in which the Academies could contribute to foster research cooperation in the Carpathian region. Although a direct financial support seems unlikely in the period of the current financial crisis, it is possible to use existing mechanisms, especially the framework of existing bilateral agreements. Annual Meetings of CAS members having special interest in mountain research will be held. The Academies will contribute to the organization of the Forum Carpaticum 2010, and are planning their next meeting as a side-event of the Forum.

This first Forum Carpaticum in 2010 will focus on "Integrating Nature and Society towards Sustainability" (15-17 September 2010, Kraków).

South Eastern European Mountain Research Network

The South Eastern European Mountain Research (SEEmore) network was launched in April 2009 in Borovets, Bulgaria. The SEEmore network was created to facilitate scientific networking, research coordination and collaboration in the mountain regions of Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Macedonia, Montenegro, Romania, Serbia, Slovenia, and Turkey.

The intensified dialogue between global change scientists of different countries and disciplines will allow a prioritization of themes and the development of joint research strategies ultimately leading to more consistent research proposals, a higher number of international research collaborations and thus more funding for relevant regional research. The research findings generated from SEEmore projects should help decision-makers to address the most pressing problems of the SEEmore region, thereby fostering sustainable development and conservation in the Balkan mountains. Prof. Mariyana Nikolova, Director of the Institute of Geography, Bulgarian Academy of Sciences, has been the main driving force behind the new network and several follow-up activities have been outlined for 2010.

In 2009 and 2010, the MRI-Europe Programme will certainly continue its activities in the regions of Central, Eastern and Southeastern Europe, and hopefully contribute to the filling of the „white spots" on the European mountain research map. The MRI-Europe Programme will facilitate the publication of English articles by organizing scientific events yielding in scientific products, by facilitating research collaborations and by supporting the development of relevant research proposals at a regional or European scale. The recently published synthesis paper on „Global Change Research in the Carpathian Mountain Region" (see Box) is certainly one stepping stone in this process.

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

MRI Carpathians: http://mri.scnatweb.ch/networks/mricarpathians/

MRI South Eastern Europe: http://mri.scnatweb.ch/networks/mri-europe/south-eastern-europe/

Mountain Research and Development Google Mapper: http://www.mrd-journal.org/map/

An Introduction to the Institute of Tibetan Plateau Research, the Chinese Academy of Sciences

The Chinese Academy of Sciences (CAS) founded the Institute of Tibetan Plateau Research (ITP) in December, 2003 to coordinate research activities of Chinese and foreign organizations that focus on the environment of the Tibetan Plateau. The ITP research focuses on the uplift of the Plateau and its impact on climate and environment in Asia and the northern hemisphere.

The ITP has three campuses in, respectively Lhasa, Beijing, and Kunming. The Beijing campus is for management, laboratory analysis, sample storage, and international cooperation. The Lhasa campus is mainly for field work, field data collection and support of international joint expeditions. The Kunming campus, managed by the Kunming Institute of Botany of CAS, focuses on biological genetic resources from extreme environments such as those on the Plateau. The ITP has so far attracted 120 scientific staff and 37 technicians. Among them are one CAS academician (Prof. Tandong Yao), twenty-five professors, and thirty-four associate professors. The Institute also holds open positions for international researchers, having so far employed eight guest experts, one visiting scholar and two interns from abroad. In addition the Institute hosted 129 graduate students (including 61 PhD and 68 master's candidates majoring in physical geography, structural geology, atmospheric sciences or geophysics) and 18 post-docs pursuing topics in physical geography at the Institute.

The ITP continues to invest in its laboratories and field stations. Two laboratories now up and running in the Institute are the CAS Key Laboratory of Tibetan Environmental Changes and Land Surface Processes (TEL) and Laboratory of Continental Collision and Plateau Uplift (LCPU), each of which has a branch in Beijing and another at Lhasa. The TEL laboratory includes sophisticated apparatus such as an isotope ratio mass spectrometer, inductively-coupled plasma spectrometer, total organic carbon/nitride analyzer, Gamma ray detector, cold storeroom and ultra-clean room. The LCPU laboratory houses a large variety of equipment, including HELIX, one of the most advanced inert-gas mass spectrographs worldwide.

The network of field stations on the Tibetan Plateau, the Tibetan Observation and Research Platform (TORP), focuses on data collections relevant to

- interaction between geological processes and climate,
- high-resolution records and modern environmental processes, and
- land surface processes and plateau atmospherics.

Five monitoring bases exist or are under construction in the North, South, Central, East, and West of the Tibetan Plateau. Three field stations, including Nam Co Multi-sphere Observation and Research Station (NAMORS), Southeast Tibet Observation and Research Station for the Alpine Environment (SETORS) and Qomolangma Atmospheric and Environmental Observation and Research Station (QOMORS), have already hosted several international joint expeditions and field experiments, producing voluminous data annually and inviting more collaborations. Two more stations are under construction, the Ngari Desert Observation and Research Station (NADORS) and Muztagh Ata Westerly Observation and Research Station (MAWORS). The TORP network lives by the "3-high" principles: getting high precision monitoring data, obtaining high resolution environmental records, and making high level scientific contributions.

The ITP is currently involved in nearly a hundred research projects. These projects revolve around geospheric structure and uplifting mechanism, impacts of the uplift on environment in East Asia, high resolution paleo-environment change reconstruction, land surface system and processes, atmospheric

The Lhasa Campus of ITP (photo by ITPCAS)

Snow at Nam Tso station on the shore of Lake Nam Tso at the border between Damxung County of Lhasa Prefecture and Baingoin County of Nagqu Prefecture in the Tibet Autonomous Region of China, approximately 112 km [70 miles] NNW of Lhasa (photo by ITPCAS)

processes on the Plateau and biological adaptability and genetic resources in an extreme environment.

With respect to paleo-environmental reconstructions ITP researchers have succeeded in constructing quantitatively interactive models between paleo-environmental proxies and modern climate/environmental parameters through the study of stable isotopes in atmospheric precipitation, spore and pollen in ground surface over different regions, and the assemblages of microscopic-biological species in lakes. With these quantitative models, paleo-environment over the past 20,000 years, especially during the last 2,000 years has been reconstructed.

The studies of ice cores, lake cores, and tree-rings reveal the common presence of particular climatic events on the plateau, and show their own specific temporal and spatial scale, and magnitude. Aerosols monitoring on the Plateau indicates a close relationship between atmospheric methane density and climate change, confirming the significant effects of human activity on climate in high-altitudes. As additional evidence of the impact of human activity, the accumulation of black carbon over the ice/snow surface severely affects the latter's heat absorption and albedo, thus accelerating glacial melt on the plateau.

ITP geological researchers have discovered from the studies of continental suture and lava that the collision between Indian and Eurasian plates occurred at the middle part of the suture as early as 65Ma BP, and then gradually extended to the East and West Himalayan Syntaxis. Variations of the Cenozoic lava petrology on the Plateau around 65Ma BP showed the transition from oceanic crustal subduction to continental crustal subduction in the Tibetan areas, leading to crust shortening as large as 3000 km, far larger than 2000 km from previous understanding. In addition, the collision of the Yarlung Zangbo suture also suggests a similar geological setting in the foreland sediment basin as that of Zagros foreland oil basin in the Middle East gulf region. Thus with the foreland sediment covering the Indian passive continental margin sediment, the Yarlung Zangbo foreland basin presents a benign condition for oil gas production, storage and coverage.

In the past decades, scientists from around the world have proposed all kinds of scientific hypotheses centering around the forming mechanism of the Plateau, its evolution and its impact on climate and environment. Aware of the importance for international academic communication, the ITP takes the initiative in reaching out to German, American, Japanese, French colleagues to promote mutually beneficial collaborations.

For instance, the ITP is the lead agency in China for the Sino-German project, Evolution of the Tibetan Plateau and its Environmental Processes and Ecosystems (TiP), generously funded by the German Research Foundation.

In August 2009 under the auspices of the CAS and National Natural Science Foundation of China (NSFC), the ITP organized the inaugural Third Pole Environment (TPE) workshop in Beijing, inviting internationally acknowledged scientists and active program managers to promote this multi-national project focused on the Third Pole, that is, the Tibetan-Qinghai plateaus and all the associated mountain ranges in China and adjacent countries. Nearly seventy representatives from eleven countries are involved in the project, which aims to advance the study of regional environment of the Third Pole, the water cycle, and the geological hazards likely to be caused by global climate changes.

In addition, ITP is the lead Chinese partner in a study funded by the EU's Seventh Framework Program of hydrometeorological processes on the Tibe-

tan plateau and Asian monsoon systems through the combination of long-term observation with remote sensing and numerical simulation The international links and the scope of established ITP research projects will further the accomplishments of the Institute and form the basis for leading scientific research into the 21st century in this important

TORP stations by Chinese Academy of Sciences further strengthened the academic forces in the Third Pole environmental study.

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http://www.itpcas.ac.cn/

Snow, Ice and Water in the Alpine Region: The System is Undergoing Radical Change

Conference: Snow, Ice and Water in the Alpine Region – more topical than ever
Swiss Hydrological Commission CHy, 5 June 2009

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Climate change will dramatically modify the water cycle in the Alpine region. At a recent conference of the Hydrological Commission (CHy), scientists discussed what the future might hold in store for us.

When the river Aare flooded the Matte quarter of the city of Bern in May 1999, this event was considered a once-in-a-century event. The last time a similar flood had happened was before World War I. The next century lasted 6 years and 3 months: in the late summer of 2006, the Matte area was under water once again. The Aare's uncanny repeat messed up long-term flood statistics. Similarly, the river Lütschine in the Bernese Oberland has had four „once-in-a-century" events in the nine years since 2000.

Is this accumulation cyclical or does it follow a trend? Petra Schmocker-Fackel, of the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), explored this question in Bern on 5 June 2009, in her paper given at the conference entitled "Snow, Ice and Water in the Alpine Region – more topical than ever". The event was co-organized by the Swiss Hydrological Commission CHy (see page 37) the Swiss Snow, Ice and Permafrost Society (SEP/SIP), the Swiss Society of Hydrology and Limnology (SCHL/SSHL), and the Swiss Cryospheric Commission. A common thread ran through all the papers presented: the climate is changing and this change will have enormous impacts on the water cycle in Switzerland and neighbouring countries.

Among the most serious impacts is a possible increase of floods. There have always been periods of more frequent flood events of the kind we have been observing in the past 30 years: the last one began in the early 19th century and lasted nearly 100 years. But in between, there were always quieter times, as in the mid-20th century. A new trend might now be interfering with this cycle. Predictions show that climate warming will lead to a higher frequency of intense rainfall events. Such events will have dramatic consequences if the storage capacity of a river's catchment is filled by prior rainfall. "This can lead to discharge amounts that exceed any amounts previously measured," said Petra Schmocker-Fackel. In order to predict future flood risks, she pointed out, the dynamics of the system need to be taken into account in addition to climatic change. "It is important to know what the maximum amount of precipitation is beyond which water is no longer held back in a catchment."

Today Alpine rivers are regulated by glacial regimes, but by the end of the 21st century, glaciers will consist of only meagre leftovers. The Laboratory of Hydraulics, Hydrology and Glaciology (VAW) of the ETH Zurich has developed models of the future of glaciers and of their influence on Alpine rivers. Those models predict that discharge will increase at first, because of glacial melting. Depending on the size of glaciers, peak flows will be reached after 20 to 60 years. After this peak, seasonal peak flows as well as the annual flow will decrease. Andreas Bauder and

The entire melt water of the Morteratsch Glacier (Switzerland) comes to light through the mouth of the glacier. The water will flow through the Inn River to the Danube and finally enter into the Black Sea. At the end of Little Ice Age at around 1860 the Morteratsch Glaciers achieved its maximum extension. Since then it regressed by 2500 meters of length. One fifth of its surface and more than a third of its volume disappeared. The reason for this is climate warming which amounts to 1.5 deg for this time period; this is double compared to the mean global warming. (photo by Bruno Schädler, 2008)

Matthias Huss of the VAW concluded: "at the end of the 21st century we have to expect water shortages that will have an influence on the management of water resources beyond the region."

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The supra-regional character of the theme was also clear in Bettina Schaefli's presentation of research results. Schaefli is a hydrologist at the University of Delft in the Netherlands who is working on the influence of climate change on Alpine rivers. From a hydrological point of view, what is happening in the Alps is also influencing the estuary of the Rhine. The climate in the future will probably lead to a reduction of annual precipitation; the slight increase expected in the winter will not compensate for the marked decrease expected in the summer. This decrease in precipitation is not the only reason why rivers will carry less water. More precipitation will evaporate on those areas exposed by glaciers retreat than was the case when they were covered with ice. Consequent, discharge amounts are likely to decrease more than precipitation amounts. Some scenarios show that we must expect an up to 7% decrease in productivity of hydropower plants by 2050.

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With an increase in debris flows and rockfalls, the consequences of thawing in the Alpine areas covered by ice until now will be just as dramatic, although only local. Glacier retreat and thawing of the permafrost are increasing the volume of loose sediment that can start moving. The debris flow in Guttannen in 2005, totalling a volume of 500,000 m^3, was the result of such a development. The numerous rockfalls that have taken place in the past few years are also probably due to changes in surface ice and permafrost. "However, the processes that lead to a fall are not yet understood well enough," concluded Christian Huggel of the Department of Geography, University of Zurich, summarizing research results on this topic. Natural hazard management is therefore facing a complex situation and can rely far less on past experience.

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Another trend is of lesser consequence: complete freezing of lakes is increasingly rare. The older generations will remember the 1st of February 1963, when the authorities declared the Lake of Zurich fit for ice-skating. H.J. Hendricks Franssen of the ETH Zurich's Institute of Environmental Engineering, who is a passionate ice-skater, reviewed all available sources on the freezing of eleven lakes in the Swiss Mittelland in the period between 1901 and 2009. The development of a complete ice cover on a lake depends mainly on the number of days during which the air temperature remains below the freezing point and on how many degrees Celsius below zero there are; but the threshold for the sum of the negative degree days is different for each lake. The decisive factor is depth: with its maximum depth of 260 m the Lake of Brienz never froze, although it is quite cold in the area. But the Lake of Morat, which lies in a milder climate area but is only 45 m deep, froze 28 times in the 20th century.

In the past 40 years Swiss lakes in the lowlands froze much less often than before; in the past two decades this trend has increased. In the case of lakes that freeze rarely, this is particularly striking. Climate scenarios for the Alpine area predict an increase in winter temperatures by 2070 that will range between 1.2 and 4.5 °C above those of 1990. It is likely to be too warm for lakes to freeze completely in future. In the coming decades, it will at least still be possible to skate occasionally on natural ice of smaller, shallower lakes.

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The technical term for the sudden emptying of a glacial lake is "jökulhlaup". The term comes from Iceland, where the phenomenon often occurs. We had better practice this tongue-twister, since jökulhlaups are happening more frequently in the Alps as well. The best known example in Switzerland is the lake that has regularly formed at the Unterer Grindelwaldgletscher.

Meanwhile the glacier has become the scene of an summer spectacle that displays the whole gamut of consequences resulting from ice melting in the Alps. The glacier is currently losing 10 million m^3 of ice per year. In the area where the lake forms, its surface is 200 m lower than it was 150 years ago. The sides of the mountain that had been supported by the glacier have become unstable, leading to several major earthslides. A spectacular one was the slide on the right-hand flank of the valley in the early summer of 2005, which brought the Stieregghütte – a mountain farm and hut – literally to the edge of a cliff; or, on the other side of the glacier, the collapse of the "Schlossplatten", where an area with a volume of 2 million m^3 of rock fell on the glacier in 2006.

A jökulhlaup also occurred in the area when at the end of May 2008, 800,000 m^3 of water drained into the Lütschine river. The lake is becoming larger every year. At the beginning of June 2009 it already contained 2.5 million m^3 of water. Hansruedi Keusen, who works for Geotest and is meticulously monitoring the events related to the Grindelwaldgletscher dynamics, estimates that the volume of the lake could increase to 10 million m^3 in 2011. This must not happen, as an outbreak with this volume

of water would have catastrophic consequences right down to Interlaken. To avoid this catastrophe, a gallery is being built to allow water to be discharged as soon as the lake reaches a volume of 300,000 m^3. This artificial outlet will be ready by the spring of 2010.

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A variety of causes can lead to sudden emptying of glacial lakes. Meltwater mostly flows out through channels in the ice, which become larger as a result of warming. The VAW of the ETH Zurich explored the mechanisms of the Gornersee above Zermatt (VS), a lake that forms regularly and then breaks out – though always in a different manner. "It is difficult, if not impossible, to predict when a glacial lake will empty and how high the discharge will be," concluded Martin Funk, a glaciologist at the Laboratory of Hydraulics, Hydrology and Glaciology, VAW.

But glacial lake outbursts are not a new hazard in the Alps. They have occurred before, at times with catastrophic impacts. What has changed are the causes. In the past it was usually glacier growth that led to dams and glacial lakes. Today these lakes are created by the thawing of ice masses.

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Although obscured by major problems that climate changes and consequent changes in the hydrological cycle will cause in relation to natural hazards, hydropower or agriculture, changes in aquatic biotic communities also merit attention. Beat Oertli and his team at the Institute Terre-Nature-Paysage (ITNP) of the University of Applied Sciences in Western Switzerland (HES) predicted future colonization of Swiss ponds, pools and small lakes by water plants, larger invertebrates (macroinvertebrates) and amphibians. Calculations for their model are based on biodiversity data collected in 120 small water bodies in Switzerland. Modelling showed that there will be a marked increase in biodiversity as a result of climate warming. This increase will be particularly striking in alpine water bodies, which are currently still cold and therefore species-poor. As soon as they become warmer, they will become attractive for numerous species that now live in lowland ponds and pools. For example dragonflies, of which at present, 58 species have been counted in Switzerland, are expected to spread upward into higher habitats in the coming years. In addition, we can expect that Mediterranean species will migrate northwards. This has already been observed: the heat-loving scarlet dragonfly (*Crocothemis erythraea*) is a recent newcomer in Switzerland.

But there will also be losers: for the azure hawker (*Aeshna caerula*) and all other species that require cold water, the habitat will become too small. Seven species of dragonflies that live in Switzerland today are endangered by climate change.

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Weblink

Tagung „Schnee, Eis und Wasser im Alpenraum – aktueller denn je!"
http://chy.scnatweb.ch/d/Aktuell/Veranstaltungen/vergangene_Veranstaltungen.php

Surface melt water of the Morteratsch Glacier (Switzerland) disappears in a vertical swirl that ends at the glaciers bed. There, a moulin might develop; the water moves a piece of stone that circularly spins into the bedrock like a millstone. At the end of Little Ice Age at around 1860 the Morteratsch Glaciers achieved its maximum extension. Since then it regressed by 2500 meters of length. One fifth of its surface and more than a third of its volume disappeared. The reason for this is climate warming which amounts to 1.5 deg for this time period; this is double compared to the mean global warming (photo by Bruno Schädler, 2008).

Climate Change and Water in the Andes

Conference held at the Hemispheric Institute of the Americas at the University of California, Davis, USA on 15 April 2009

The Conference "Climate Change and Water in the Andes" brought together engineers, geographers, historians and anthropologists to discuss the dramatic disappearance of tropical glaciers. The talks emphasized the advance in scientific understanding of glacier retreat and its impacts, especially on water resources. They described the adaptation programs that are beginning to address this significant problem.

Ben Orlove (UCDavis) discussed glacier retreat in the Peruvian Andes. Worldwide, this process impacts physical and social systems in multiple ways. These impacts include the reduction in water resources, increases in geohazards, and the loss or deterioration of culturally significant landscapes. It is a great challenge for societies to adapt to this retreat, because the impacts are very different in nature and in scale, and because they are distributed unevenly in space and time.

A study in Cusco, Peru demonstrates the difficulties of adaptation efforts. Interviews with indigenous livestock herders shows that they live at fairly small social and spatial scales, concentrating on their own village and nearby villages. At the same time the herders dispose of a variety of temporal scales, looking at both the near and distant future, and are concerned about both economic impacts (principally water availability) and cultural impacts, since they hold mountains in great reverence. Interviews with NGOs, by contrast, indicate that they address broad social and spatial scales of entire regions, but focus on the near future of project cycles, and address only economic impacts. This mismatch of scale is a severe impediment to the cooperation that is necessary to both if they are to adapt to climate change.

http://www.des.ucdavis.edu/faculty/orlove/orlove.htm

Geoff Schladow (UCDavis) discussed the water resources of Chilean Patagonia under a changing climate. This region is unique because the principal anthropogenic stress on inland waters is the result of atmospheric deposition of global contaminants, and climate change. This makes the region important on a global scale for studying these impacts, free of the confounding local effects that dominate water resources in most countries. The impacts of climate change can be explored through analysis of stream flow records, sediment records, and archived satellite data and through the establishment of new monitoring programs. The impacts of climate change may already be evident, with GLOF (Glacial Lake Outflow Flood) events increasing in frequency in recent years. There is particular urgency to addressing these issues, as new anthropogenic stresses such as hydroelectric development may soon start having an impact on lakes in Patagonia. Water resources in Chile are distributed very heterogeneously, with the bulk of the water present in Patagonia, and the demand for both water and hydroelectricity largely in the central and northern parts of the country.

http://www.terc.ucdavis.edu

Mark Carey (Washington and Lee University) noted that future climate change and glacier retreat will likely produce dramatic impacts on water supplies for people worldwide, especially in the Peruvian Andes. Although most research on this topic in the Andes focuses primarily on the science of environmental processes influencing water supplies, over the last half century the most influential factors affecting water use have been social, cultural, political, and economic. Water use on Peru's glacier-fed Río Santa has increased substantially since 1950 due to construction of a large hydroelectric facility and major irrigation projects. National and international government policies, such as neoliberal reforms and

Research at Glacial Lake Palcacocha, Cordillera Blanca, Peru (2003) (photo by Mark Carey)

Ritual pilgrimage to the snow-capped Andes in Cusco (photo by anthroplogist Zoila Mendoza)

authoritarian politics, drove the development of these projects. Cultural beliefs and social relations, on the other hand, have compelled some communities to successfully challenge new reservoir construction. Human variables including government policies, technology, social relations, and cultural beliefs must be acknowledged to avoid simplistic or deterministic projections about future climate-glacier-water dynamics.

http://home.wlu.edu/~careym/

Walter Vergara (World Bank) noted that since 1970, glaciers in the Andes (Colombia, Ecuador, Peru, Bolivia, Chile, and Argentina) have lost 20% of their volume with serious immediate implications for water, power supply and ecosystem integrity in the region. The World Bank and many partner organizations are coordinating their strategies to address this problem. Key components include institutional strengthening, particularly in the area of supporting access to information and linking science to development; promoting carbon finance to maximize the value and synergies of carbon revenues by tightening the linkage between these resources and local environmental and social priorities; and supporting adaptation.

A regional project on Adaptation to Rapid Glacier Retreat in the Tropical Andes (Bolivia, Ecuador and Peru) addresses water supply (through the development of alternative sources, demand management and engineered storage), energy supply (through diversification of supply from hydropower sources), and agriculture (through promotion of alternative crops and advanced irrigation systems). Also, under the Colombia Integrated National Adaptation Project, the World Bank supports the monitoring of glaciers and associated moorlands in Colombia, in order to characterize water and carbon cycle in moorlands (páramos), to estimate loss of water regulation function and carbon release caused by warming.

In cooperation with NOAA and the Japanese Space Agency, the World Bank also supports a regional effort for remote and field monitoring of the hydrology and climate in glaciated areas.

http://beta.worldbank.org/people/vergara

Jeffrey Bury (UC Santa Cruz) discussed some of the findings from his new interdisciplinary research focusing on glacier recession, hydrological change and human vulnerability in the Cordillera Blanca, Peru. Preliminary findings from the project, which includes glaciologists from Ohio State University and hydrogeochemists from McGill University, illustrate that rapid glacier recession in the Cordillera Blanca of Peru is significantly affecting hydrological processes in the region and generating new vectors of human vulnerability for inhabitants of the region. His presentation illustrated the ways in which glacier recession has begun to limit local household access to water, a crucial access for agricultural, livestock and tourism related livelihoods.

He argued that these recent changes and the risks that rapidly receding glaciers pose for new natural hazards events highlight the need for new planning and preparedness efforts in the region. Finally, he suggested that the complex nature of shifts in vulnerability taking place along multiple vectors and across several scales of natural resource governance point to the need for new forms of adaptive governance that are flexible, responsive, transparent, and that enhance human capacity and resilience.

http://people.ucsc.edu/~jbury/CurrentResearchProjects.htm

Marisa Escobar and David Purkey (Stockholm Environment Institute) discussed a project that seeks to develop, test and demonstrate the utility of a glacier module in hydrological models that can investigate climate change impacts on water management regimes in Peru. Flows in glacierized basins are critical for Peru's hydropower production, the source of 71.6% of the country's total electricity supply. They presented a newly developed glacier module coupled to the WEAP (Water Evaluation and Planning System) hydrologic model to assess the relationship between climate and hydrologic change in the Río Santa basin in Peru. Their current effort seeks to understand the threat climate change poses to water managers in the Andes considering potential climate futures, the implications of these climate scenarios on the hydrology of the high Andes, and finally the ramifications of these changes on the productivity of current and future water management regimes. This chain of analysis permits the formation and evaluation of potential adaptations.

http://sei-international.org/?p=staff&staffid=163
http://sei-international.org/?p=staff&staffid=118

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http://Darkeningpeaks.blogspot.com

http://glaciers.wlu.edu/

http://home.wlu.edu/~careym/

Northern Eurasia High Mountain Ecosystems NEESPI-HE International Workshop 2009

Bishkek, Kyrgyzstan, 9 - 15 September 2009

The Northern Eurasia Earth Science Partnership Initiative (NEESPI), together with the University of Idaho, the German Research Centre for Geosciences, the Central Asia Institute for Applied Geosciences, and the Institute of Geography of the Russian Academy of Sciences held a scientific and educational workshop on the Northern Eurasia Mountain Ecosystems and Regional High Elevation NEESPI projects in Bishkek, Kyrgyzstan on 9 - 15 September 2009. The workshop provided a venue for researchers to discuss their investigations in the mountains of Northern Eurasia, to improve coordination of ongoing studies, and to maximize the use of funding resources by avoiding duplication of efforts.

The NEESPI research initiative has a strong focus on high elevation mountain regions of Northern Eurasia. Since 2004 about 30 projects have been funded through and/or joined the NEESP initiative to study mountainous regions of Northern Eurasia, including Khibiny, Alps, Carpathians, Caucasus, Ural, eastern and central Siberia, Altai-Sayan, Tien Shan, and Pamir. The ongoing projects study potential consequences of human activity, climate variability, and global change on the very sensitive mountainous ecosystems and water resources, and on land degradation in Northern Eurasia. The results of these projects provide a basis to establish environmental guidelines for a future sustainable development of this region.

One of the priority issues addressed by the workshop was the much-needed coordination of research and capacity building in the NEESPI High Elevation (HE) domain. The interest in high elevation research has risen considerably among the global scientific community. The Cryosphere and Climate Project (CliC) of the World Climate Research Programme (WCRP) includes a focus on high elevations. One of the four major research themes of the Monsoon Asia Integrated Regional Study (MAIRS), is "Multiple stresses on ecosystems and biophysical resources in high Mountain Zones". The Coordinated Energy and Water Cycle Observation Project High Elevation (CEOP-HE) component has a regional focus in Eurasia and studies physical and dynamic processes in high elevations. It contributes to global climate and water cycle studies by providing rare but crucial information from high elevations.

At the workshop several institutions in the NEESPI domain manifested their interest to coordinate high elevation research in central Asia (see box "NEESPI Participants").

The workshop's particular attention was on the coordination of the current and planned activities in the framework of the NEESPI, MAIRS, CliC and CEOP-HE programs in Central Asia. During the discussion sessions, participants defined the key scientific questions that should be studied in coordinated efforts in the future:

- How did climate, water resources and other environmental parameters change in the past during the period of instrumental records and earlier in the mountainous regions, and what can they tell use regarding earth system response to global change?

- What is the interaction between water cycle components in alpine regions and the surrounding lowlands? In particular,
  - how do alpine permafrost distribution and changes in the area and volume of snow and glacier cover affect the hydrological regime of the mountain rivers and their water chemistry?
  - how do changes in the alpine cryosphere contribute to geo-hazards such as catastrophic floods, landslides, mudflows, and to land degradation/desertification, overgrazing and deforestation?
  - what is the role of large mountain glacierized massifs on the local and regional climate?

- How well can we predict when and where critical thresholds will be crossed and what the ecological consequences and potential societal impacts will be?

- How can we promote adaptation strategies to absorb the negative impacts of geo-hazards?

- How can we integrate and assimilate the NASA remote sensing data on changes in mountain areas and surrounding plains with extensive in situ environmental and socio-economic data sets available in the Asian national archives and individual databases?

As the NEESPI and CEOP-HE initiatives depend on financing agencies, this list of research questions will be adapted according to the interests and focus of the national funding agencies in US, Europe and Asian countries.

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http://neespi.org/science/

CEOP NEESPI and HE Participants

Central Asia Institute for Applied Geo-Sciences (Bishkek, Germany-Kyrgyzstan)

Central Asia Institute of Hydrometeorology (Tashkent, Uzbekistan)

German Research Center for Geosciences (Potsdam, Germany)

Geographic Information Science, Austrian Academy of Sciences (Austria)

Cold and Arid Regions Environmental Engineering Research Institute (Lanzhou, China)

Commission for Glaciology at the Bavarian Academy of Sciences (Munich, Germany)

Government Post Graduate College, Madhya Pradesh, Kumaon University Nainital (Uttarakhand, India)

Institute of Atmospheric Science and Climate (Bologna, Italy)

Institute of Geography Kazakhstan National Academy of Sciences (Almaty, Kazakhstan)

Institute of Geography Russian Academy of Sciences (Moscow, Russia)

Institute of Geography Johannes Gutenberg University (Germany)

Institute of Tibetan Plateau Research (Beijing, China)

Kyrgyz-Russian Slavic University (Bishkek, Kyrgyzstan)

Moscow and Tomsk State Universities (Russia)

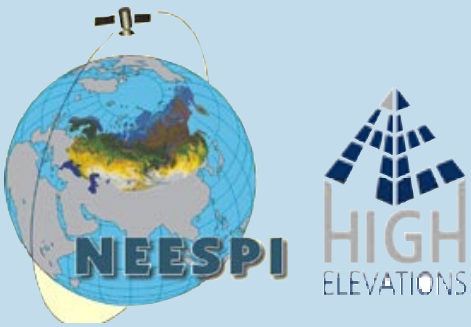
Nagoya University (Japan)

National Departments of Hydrometeorology (Bishkek, Kyrgyzstan)

National Department of Hydrometeorology (Dushanbe, Tajikistan)

Research Institute for Humanity and Nature (Kyoto, Japan)

St. Peresburg State University (St. Petersburg, Russia)



Meeting Report

Ecosystem Services in the Alps and the Carpathians

Securing the Sustainable Provision of Ecosystem Services in the Alps and the Carpathians. Proposal Development Workshop, Bratislava, 9 June 2009

On June 9th, 2009, ETH Zürich, Switzerland, Humbold University zu Berlin, Germany, the Slovak Academy of Sciences, Bratislava, and the Mountain Research Initiative held a Proposal Development Workshop on "Sustainable Provision of Ecosystem Services in the Alps and the Carpathians", an event of the research network S4C, Science for the Carpathians.

Scientists from Germany, Austria, Switzerland, Denmark, Sweden, France, Italy, Czech Republic, Slovakia, Hungary, Poland and the Ukraine presented research results and identified urgent research questions related to ecosystem services (ESS). Following the presentations and discussions, the participants sketched out joint proposals in response to three international calls for project proposals targeting changes in land use management, integrated resource management and biodiversity.

MRI has recorded all presentations and made them accessible via the MRI website (see box).

The following notes are derived from the presentations listed in parenthesis at the end of each section. Please watch the webcasts to find out more about each topic.

ESS are defined as services of the ecosystem relevant to human economy and wellbeing, as e.g. production of food, fiber and wood, or water filtration. The global Millennium Ecosystem Assessment of the UNO (2001-2005) classified ESS into the following categories: supporting (e.g. nutrient cycle), regulating (e.g. water purification), provisioning (e.g. food), and cultural (e.g. recreation). Even though single ESS can be identified, they are all interconnected within and between ecosystems.

While humans depend on the proper functioning of these systems, they also affect them through their actions. Main pressures include land use change, climate change, exploitation of natural resources, pollution, and population growth. Among these, land use management can most effectively be changed to secure the provision of ESS. Studies on this topic presented at the workshop often investigated stakeholders' attitudes towards their dependency on ESS (for example the ATEAM study, presented by Dagmar Schröter, Austrian Federal Office for the Environment).
Other studies dealt with the consequences of climate and socio-economic change on ESS in the Alps, as for example the MOUNTLAND project on sustainable land use in three alpine regions in Switzerland. Its goal is to develop methods for a sustainable provision of ESS through the development of adaptation mechanisms. MOUNTLAND is a positive example of the high degree of interdisciplinarity and the intensive dialogue between science and stakeholders characteristic of the research on ESS. The project also investigates methods of pricing ESS to facilitate the connection between ecology and economy (see presentations by Marek Degorsky, Polish Academy of Sciences; Ihor Soloviy, Institute of Ecological Economics, Ukraine; and Ybele Hoogeveen, European Environment Agency).

Sustainable forest management is a priority in the Carpathians, especially in the Ukraine. In scientific workshops with participants from various disciplines, ESS were identified and evaluated through a problem-based approach in the region of interest. Patterns of land use change and laws of ownership were then identified with the local community. This approach was based on the assumption that a collaboration with the government, local stakeholders and economists are crucial to the development of successful adaptation mechanisms (see presentation by Ihor Soloviy).

Spiš castle and Spišské Podhradie, E Slovakia (by Tatiana Hrnciarová); Erlenbach, Switzerland (MRI); Exkursion of the Forest Ecology Group, ETH Zürich, Switzerland (MRI); Chocskévrchy Mts. (N Slovakia) (by Luboš Halada)

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http://mri.scnatweb.ch/events/mri-events/proposal-development-on-ecosystem-services-in-the-alps-and-carpathians-9-june-2009-bratislava-sk.html

Swiss Hydrological Commission CHy: Opening of the commission's office

Bern, 5 June 2009

The Hydrological Commission (CHy) of the Swiss Academy of Sciences (SCNAT) can look back on a varied history. Its precursor was first established in 1863, only to be dissolved in 1915 (Perret, 2001). After having been re-established in 1947, the Hydrological Commission went through a time of prosperity that came to a provisional end in 1991 with the integration of the Commission into the new Swiss Society of Hydrology and Limnology (SGHL/SSHL; Schram, 1994). After the Commission re-emerged as an independent commission of SCNAT in 1998, it spent many years re-defining itself and searching for a new orientation. This re-definition has now led to the creation of a professionally operated office for CHy, inaugurated on 5 June 2009 on the occasion of a conference entitled "Snow, Ice and Water in the Alpine Region – more topical than ever".

At the inauguration, the current president of CHy, Rolf Weingartner, affirmed the goal of giving "Swiss Hydrology" a firmer basis in research and higher education as a transdisciplinary science. The Commission will improve the position of Swiss hydrology at the national and international levels, promoting innovative projects and offering a first port of call for practitioners. CHy will carry out basic duties assigned by the Swiss Academy of Sciences SCNAT such as the promotion of scientific foresight and integrity, and the exchange of opinion between science and society. Together with other hydrological organizations CHy organizes symposia and workshops and publishes new findings of national relevance in its series "Beiträge zur Hydrologie der Schweiz". The Commission also gives it's recommendations to current hydrological questions. In addition, it will play a strong role as the National Committee of the International Association of Hydrological Sciences (IAHS). CHy is supported by SCNAT and by the institutions which delegate members. In addition it is crucial to find sponsors who support CHy financially.

To underline the support of the IAHS, the President, Arthur Askew, sent a welcome address (read with authenticity in his absence by Anne Zimmermann, CDE) that wished CHy and its new office the best of success. He asked the audience to keep in mind that a commission's success depends entirely on the continual commitment of each of its members.

CHy's new office is its "conscience" and thus the port of call for all activities in the field of hydrology in Switzerland, emphasized Heinz Wanner, President of the Oeschger Centre for Climate Change Research. He summarized his experience as president of numerous scientific commissions in four clear wishes for the new Executive Director, Bruno Schädler:

- A lot of spirit and creativity;
- Only a little time spent on paper work and meetings;
- Tenacity in asking for requested contributions and dealing with financial matters;
- A lot of joy and satisfaction!

Helmut Weissert, President of SCNAT's Platform Geosciences, gave the concluding speech. He asserted that hydrology is the link between the different geosciences: it leaves a mark even in geological formations such as fossil raindrops and wavelets in marine deposits. Based on experience with Earth's history, the Hydrological Commission is undoubtedly predestined to look with a sharp eye into the future.

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Research Strategy on Global Change in Mountain Biosphere Reserves: Follow-up of the GLOCHAMORE project

The GLOCHAMORE „Global Change in Mountain Regions“ project has been supported by the European Commission‘s Sixth Framework Programme on „Sustainable Development, Global Change and Ecosystems“ as well as by the Man and the Biosphere (MAB) Programme of UNESCO. From 2003 to 2005, GLOCHAMORE aimed at the development of a state-of-the art integrated and implementable research strategy to gain a better understanding of the causes and consequences of global change impacts on some 25 UNESCO Mountain Biosphere Reserves (MBRs) around the world.

In the years 2005 to 2008 the Mountain Research Initiative – as one of the project partners of the original project – used the GLOCHAMORE Research Strategy as guideline and reference in its regional research networks. UNESCO’s MAB Programme, another lead partner, submitted the proposal “GLOCHAMOST” to a private foundation in 2007. The proposal focused on Biospheres Reserves outside of Europe, but, unfortunately, did not get funded.

In 2008 UNESCO-MAB again took the lead in developing GLOCHAMORE follow-up activities. Following the “International Mountain Biodiversity Conference” held from 16 – 18 November 2008 at the premises of ICIMOD in Kathmandu (Nepal), an international post-conference workshop entitled “Research Strategy on Global Change in Mountain Biosphere Reserves” was organized by UNESCO and ICIMOD on 19 November 2009.

The purpose of the workshop was to discuss the future implementation of the GLOCHAMORE Research Strategy in mountain biosphere reserves and other mountain protected areas. Some 45 participants attended the workshop, amongst them the representatives of Changbaishan, Nanda Devi, and Katunskiy Biosphere Reserves.

Under the lead of Thomas Schaaf (senior officer of the UNESCO-MAB Programme, Martin Price (Director of the Centre for Mountain Studies at Perth College), and Yuri Badenkov (representing the Russian MAB National Committee), participants discussed the future research along the lines of the GLOCHAMORE Research Strategy. It was agreed to narrow down from the original ten GLOCHAMORE research themes to a future set of four themes, which would facilitate the implementation of the GLOCHAMORE Research Strategy at the operational level.

The four themes provide a minimal set of research and monitoring requirements to study global change impacts in mountain biosphere reserves the world over, with the goal to obtain relevant and comparable data.

The themes are:
- biodiversity,
- land use changes,
- water availability, and
- mountain economies.

The workshop participants further decided that in order to accomplish synergy effects with the on-going “Global Observation Research Initiative in Alpine Environments (GLORIA)” co-ordinated by the University of Vienna to study changes of floral species composition in alpine areas, the following GLOCHAMORE biosphere reserves (which are also GLORIA sites) should be the main sites for the second phase of GLOCHAMORE (now called GLOCHAMOST):

- Swiss National Park and Biosphere Reserve (Switzerland),
- Berchtesgaden Biosphere Reserve (Germany),
- Glacier National Park, Biosphere Reserve and World Heritage site (USA),
- Huascaran Biosphere Reserve and World Heritage site (Peru),
- Sierra Nevada Biosphere Reserve (Spain),
- Nanda Devi Biosphere Reserve (India),
- Changbaishan Biosphere Reserve (China),
- Katunskiy Biosphere Reserve (Russian Federation), and
- Teberda (Russian Federation).

The November 2008 workshop had very concrete outcome for these Biosphere Reserves. In early 2009 they signed contracts with UNESCO: UNESCO MAB supports the MBRs with seed-money, so that the research directors of these MBRs can design a research strategy centered around the four topics mentioned above, and to start implementing such research. By the end of 2009, they should be able to deliver a report detailing implementation steps and first results.

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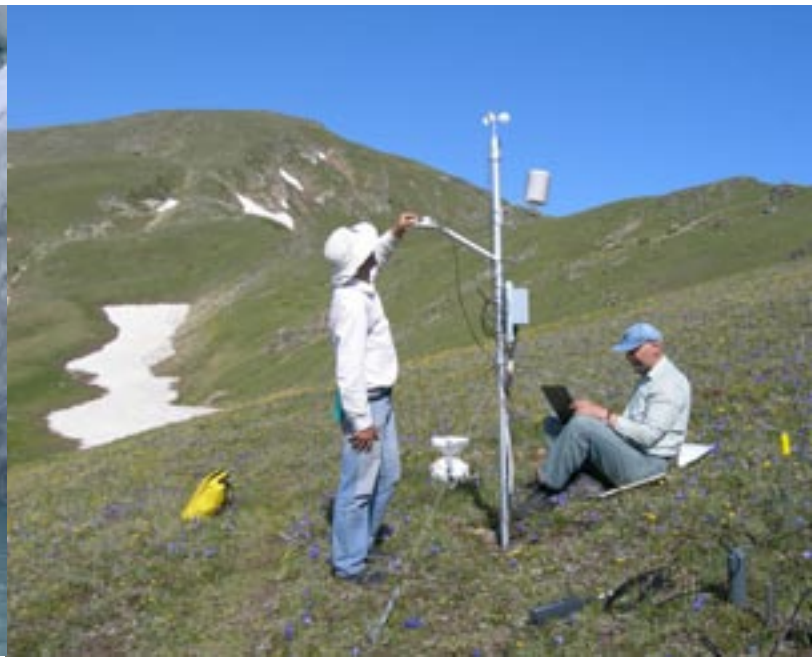
http://mri.scnatweb.ch/projects/glochamore/

Glacier National Part, USA: Karen Holzer records the margin of Grinnell Glacier with GPS (photo by Lisa McKeon)



Teberda State Biosphere Reserve: The scientuific group from the Biology and Soil Science Departments of Moscow State University realizes long-term monitoring activities (climate, vegetation, soil) at typical set of alpine communities in the Northwest Caucasus at an altitude of about 2800 m a.s.l. (photo by Tatiana Malysheva)

Changing Water Resources in the Alps

Spanning the centre of continental Europe, the Alps play a crucial role in capturing and supplying water to the continent. As such, they deliver vital ecosystem services both within and beyond the region, underpinning social and economic wellbeing in vast lowland areas.

The alpine climate has changed significantly during the past century, with temperatures increasing more than twice the global average (EEA 2008). This warming, and attendant reductions in snow and glacier cover, will change the hydrologic cycle in the Alps. Economic sectors, including households, agriculture, energy production, forestry, tourism, and river navigation, are already vulnerable to water shortages. Global climate change threatens to alter the alpine hydrological system drastically, leading to more droughts in summer, floods and landslides in winter and higher inter-annual variability.

Drawing on the most recent knowledge of climate change impacts in the Alps and experiences across the region, **the European Environment Agency** analyzed the risks that climate change presents to the region's water supply and quality and identified needs, constraints, opportunities, policy levers and options for adaptation. The EEA report entitled *Regional climate change and adaptation - The Alps facing the challenge of changing water resources* extracts policy guidance on adaptation practice and aims to assist regional and local stakeholders in developing robust adaptation strategies. The report presents six case studies that illustrate experiences of regional adaptation to key water resource issues related to climate change in Austria, France, Italy, Slovenia and Switzerland. They can provide governments and citizens in other areas guidance on which approaches are likely to be successful and which less so, and also provide a preview of the challenges ahead.

The focus of the report is on water resources and related adaptation, rather than water-related extreme events like floods, avalanches, landslides or mudflows, which are already well covered by existing studies of climate change impacts in the Alps. By providing the climate change and water-related components, this report contributes to EEA *Integrated assessment of Europe's mountains areas* (to be released in 2010) which will cover a wide range of interconnected issues (e.g. demographic shifts, ecosystem services and biodiversity, land cover) from a territorial and regional analytical framework.

The regional case studies and literature review contained in this report provide valuable insights into the forces that promote or obstruct adaptation.

Success factors

With regard to success factors, political support is a key catalyst for initiating, driving and coordinating adaptation to climate change, as it provides a strategic framework for effective action. Policies have generally been responses to extreme events or natural hazards that motivate demand for action by public authorities. Once initiated, adaptation measures rely on a broad variety of factors for their success, relating primarily to institutional and governance structures, as well as organizational settings:

- Measures are generally more accepted and successful when they promote other goals, including economic gains.
- A sound legal framework is a crucial complement to political support.
- Technological measures play a major part in adaptation measures.
- An increasing number of initiatives consider complementary ‚soft' actions on the demand management side (e.g. behavioral adaptation, full participation of stakeholders).
- Introducing market-based economic incentives and financial support is also helpful in encouraging proactive and innovative adaptation measures.
- Raising stakeholder awareness about the need for anticipatory adaptation actions is vital, especially in sectors with long lead times (e.g. forestry and

Artificial snow making and the related water management can put significant additional pressures on the environment and conflict with mitigation objectives (photo by EEA)

power generation).
- Other social factors, in particular local practices and social networks, are also key.

Barriers to adaptation

Barriers have mainly to do with:
- limited scientific knowledge and uncertainty about future climate change's local impacts on water availability, quality and demand,
- a lack of long-term planning strategies, coordination and use of management tools that consider climate change at regional, river basins and cross-sectoral levels, and
- the absence of explicit consideration of climate change in water supply or demand management plans.

Policy options

With regard to potential policy options, the regional case studies and broader empirical research contained in this report generate a variety of insights into developing effective policies for adapting to climate change and water resource issues. Besides making the case for a regional approach to climate change adaptation and pointing out the need to properly consider cross-sectoral water competition, the report stresses how the European Union should provide the overall policy frameworks, particularly in connection with the Adaptation White Paper and the Water Framework Directive (WFD).

Finally the report highlights how adaptation experiences are not easily transferrable to other mountain regions. Nonetheless, many lessons learned from adaptation in the Alps are of a generic nature and practical experience in the Alps provides guidance for designing regional strategies to adapt to climate change impacts and water resource issues.

The alpine tourism industry is highly vulnerable to changes in water cycle regimes (photo by EEA)

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Weblinks

European Environment Agency: http://www.eea.europa.eu

Download the full report:
http://www.eea.europa.eu/publications/alps-climate-change-and-adaptation-2009/

EEA reports and articles:
Impacts of Europe's changing climate - 2008 indicator-based assessment
http://www.eea.europa.eu/publications/eea_report_2008_4
http://www.eea.europa.eu/publications/briefing_2008_3

Climate change and water adaptation issues:
http://www.eea.europa.eu/publications/technical_report_2007_2
http://www.eea.europa.eu/publications/briefing_2007_1

If the well runs dry - climate change adaptation and water
http://www.eea.europa.eu/articles/climate-change-adaptation-and-water

The water we eat - irrigated agriculture's heavy toll
http://www.eea.europa.eu/articles/the-water-we-eat

Climate change: diverse threats call for a united response: http://www.eea.europa.eu/articles/adaptation-to-climate-change-2014-a-regional-and-territorial-challenge

Information on climate change has improved - but not enough
http://www.eea.europa.eu/articles/more-and-better-knowledge-needed-to-help-find-the-best-possible-climate-change-adaptation-options

EU strives for a system-wide response to climate change: http://www.eea.europa.eu/articles/adapting-to-climate-change-policy-context-and-perspectives

Other links:
Progress towards national adaptation strategies (NAS):
http://www.eea.europa.eu/themes/climate/national-adaptation-strategies

EC Adaptation White Paper (DG ENV's web site „Living with climate change in Europe"): http://ec.europa.eu/environment/climat/adaptation/index_en.htm

EU Water Framework Directive (WFD):
http://ec.europa.eu/environment/water/water-framework/index_en.html

The Alpine Convention:
http://www.alpconv.org/index_en

European Environment Agency

Orte Guten Lebens. Die Alpen jenseits von Übernutzung und Idyll

or freely translated, "A place for the good life. The Alps beyond over-exploitation or idyll"

Reinhold Messner writes in his foreword that it was Werner Bätzing, who drew his attention, focused on the peaks, to the mountains' lower realms. What is it about Werner Bätzing's work that draws even Messner's attention from the Alpine peaks to their inhabited realms? Is it Bätzing's stirring personal passion for the Alpine cultures and their achievements? Is it his analysis that goes beyond facile interpretations, or his pointed political statements that demand a greater administrative and political coherence between Alpine regions? This book, edited by Evelyn Hanzing-Bätzing in 2009, has all these attributes and draws attention to the Alps as a cultural landscape.

The origins

The recurrent theme of Bätzing's work are the "Orte des guten Lebens" - places that allow a satisfying and sustainable life. Exploring the Alps of southern Piemonte as a young teacher in the 1970s Bätzing caught a glimpse of an old Alpine culture on the verge of disappearance, a culture which had developed over centuries and allowed human persistence in an adverse Alpine nature. A question arose in the hiker's mind: might this culture hold clues as to how one creates a "place of the good life"?

This perception pushed the teacher to become a cultural geographer, and set the foundation of a whole life-time of field-studies, theoretical concepts, publications and courses. He developed his understanding of the nature of the Alps as we have come to know it as inseparable from the culture of mountain farmers. He realized that we perceive as nature is a cultural landscape which has developed over thousands of years of human use of the Alpine environment. The thesis that the Alps are first and foremost a cultural and economic region is the theoretical basis of Bätzing's analysis of current development of and threats to the Alpine economy, culture, and environment.

Two extremes of alpine development

The two study areas to which Bätzing returned repeatedly to develop his understanding and his theoretical concepts are examples of the two extremes of alpine development:

Valle Stura di Demonte in Piemonte, Italy, is a valley with a weak economic and social structure, as neither tourism nor industry have ever come into the valley. The valley's agriculture has never seen any major innovations, and has not been able to compete against that of the Italian lowlands. Today the valley has no economic basis, and its populations has dwindled from around 22'000 in the 1880's to less than 5'000 in the 1990's. Bätzing describes the underlying social condition of Valle Stura as "cultural torpidity" – caused by the constellation of specific family values, clan structures, and the larger economic development in Italy. Based on earlier anthropological studies in Valle Stura Bätzing describes a tradition of "family egoism" preventing any innovations of communal property and activities, which still play an important role in the valley. On each level – hamlet, village, community, valley – he furthermore finds two opposing clans or parties, locked in an opposition that makes any movement impossible. The emigration of the most innovative individuals further reinforces the torpid structures.

In combination with a national economy in which Alpine valleys are disadvantaged fringe regions this constellation of forces lead to a "torpidity" which can finally destroy the culture, the economy, and the environment formerly stabilized through agriculture. The valley thus loses the options for "the good life".

Bad Hofgastein, 858 m asl, in the Hohen Tauern, Austria (photo by Werner Bätzing)

In contrast, the population in the Gasteinertal of the Salzburg region, Austria, has tripled in the last 100 years thanks to the development of tourism. Many of the development's promoters were, until the 1950's, local people,. Development remained sustainable as long the traditional agricultural knowledge was transferred to questions of, for example, where and when to build. In the last 40 years, however, development has been driven increasingly by outside forces. With the multitude of opposing interests one of the basics of a sustainable economy has been lost: a shared responsibility for the environment. Bätzing describes this state as "cultural replacement", leading to the over-exploitation and finally the destruction of the environment though by a route quite different than that of "cultural torpidity" and the destruction caused by abandonment he found in Valle Stura. He concludes that it is above all the social realm that defines environmental sustainability, and that sustainability can be destroyed by under- as well as by over-exploitation. It is the Alpine culture on which the future of the Alps depends!

In both cases Bätzing sees the loss of opportunities to make these valleys "a place for the good life". In his quest for "the good life" Bätzing is far from prejudicial assessments of the modern world or illusions of an Edenic past. He maintains that "cultural vitality" is the basis for such a good and sustainable life, a culture that combines hard-won knowledge about the sustainable balance of production and maintenance in the mountains with an economy that plays a clearly defined role in a larger regional and even European context.

The Alps in the time of globalization. Precursor and touchstone of a sustainable regional development

Werner Bätzing's foremost postulate is that the Alps must be understood as its own economic and social region, and not as the dependent "Hinterland" of the metropoles along the Alpine bow. The status and "belonging" of the Alpine regions should be re-negotiated: the numerous small and often unconnected regions should be combined to reach a critical mass. The Alps from Slovenia to Italy and France must become an European Greater Region if their specific history and reality is to be recognized, and their specific future to remain viable.

Bätzing maintains that the use and marketing of the numerous direct resources of this economic region, such as water, timber, and natural resources should be the basis of the Alps as a distinct economic region. It is through the use of direct resources that people will keep working on the land, building on the long-standing knowledge about how to maintain environmental stability. Without this mountain culture the landscape reverts to "Disneyland". These direct resources could be financially viable if they are marketed as high quality regional products.

The use of the region's indirect resources, such as attractive landscapes and outdoor attractions, must thus remain in balance with the use of the direct resources, and should not prevent natural resource use as often happens today. Development and innovations have to be endogenous, combined with a common environmental responsibility if they are not to lead to an over-exploitation and destruction of the environment. Traditional experiences should be combined with new challenges. A viable "double economy" can thus develop: the Alps that perform economic functions for the whole of Europe, but at the same time use certain economic resources – agriculture, crafts – for regional economic production.

Such are the conditions needed for the Alps to continue to exist as cultural and economic region, and to provide the possibility of "the good life".

Conclusions

For Werner Bätzing the Alps matter. In European cultural history the Alps have always been the symbol of an adverse and threatening nature. More than any other region they can now demonstrate what a sustainable development in Europe could look like, sustainable development that combines a local economy with cultural vibrancy in an difficult environment. Bätzing's scenarios for a sustainable future of the Alps contain starting points useful for a discussion of sustainable development on the European or even global level.

Book review by Claudia Drexler, MRI

Neraissa Superiore, 1520 m asl, in a tributary of Valle Stura di Demonte, Italy (photo by Werner Bätzing)

Werner Bätzing
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