Mountain Forum Bulletin

July 2007

Melting Mountains

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Mountain Forum
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Cover photographs (clockwise from right)
Glacier Gruashraju (4,500 m), Cordillera Blanca, Peru. Holding Alcides Ames' 1986 photo in gloved hand, straining to find the landmarks 15 years later. Photo: Gary Braasch
Sierra Nevada, USA. Photo: Sierra Nevada Alliance
Glacier melting away, Bolivia. Photo: Dirk Hoffmann
Irrigated agriculture in Gyamtse, Tibet. Photo: Walter W. Immerzeel

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Editorial

Dear Mountain Forum,

We have great joy in introducing the July 2007 issue of the Bulletin. We are extremely grateful to the generosity of our valued members from around the world for their wonderful contributions. Your assistance and feedback are what makes it possible for us to continue to build the Bulletin into an even better source of information on mountain issues. Mountain Forum invites all members to continue to send ideas and contributions.

Climate change is perhaps the greatest environmental challenge facing the world today. This year the World Environment Day theme slogan was "Melting Ice - a Hot Topic?" The July issue features contributions on the theme of Melting Mountains in order to highlight promising models, and to build partnerships at all levels to enhance political attention and action towards climate change. It is up to each one of us to address the common tasks and challenges of preserving and restoring mountain environments.

In 2007, the Intergovernmental Panel on Climate Change (IPCC) said temperatures were probably going to increase by 1.8 - 4°C (3.2 - 7.2°F) by the end of this century. Mountains are one of the ecosystems most threatened by climate change. As climates warm, mountain species are forced to move higher up, glaciers disappear at an alarming pace, and fresh water resources are dramatically affected.

Connections between mountain ecosystems are needed to mitigate climate change impacts. We hope this bulletin will assist in your efforts to connect with mountain colleagues. We are confident that this issue will provide you with some helpful stories and case studies concerning climate change and its impact and future consequences on local traditions and environments in mountain regions around the world.

We all need to step up our action to tackle climate change, building on our considerable progress so far. Public awareness and engagement is vital. Time is not on our side... melting mountains deserve your attention before it is too late!

Sincerely,

Elizabeth Fox

Your feedback is precious to us. Please write in with your comments to *bulletin@mtnforum.org*. You can also write to us by regular post at the address provided on the back of the Bulletin.

Dear Mountain Forum members,

On behalf of the Mountain Forum Secretariat, hosted in the heart of the Himalayas in Kathmandu, I am pleased to introduce this edition of the Mountain Forum Bulletin. It includes contributions submitted by specialists associated with Mountain Forum from five continents working in their respective regions to address the issue of climatic change and its impacts on mountain environments.

For decades now, it has been observed by experts that a majority of mountains are melting around the globe. Growing scarcity of water has been forecast, which will continue to be an important cause of conflict for future generations. The affected mountain people will require additional support from local, national and international stakeholders to adapt to fallouts from climate change.

The exact causes of climate change are being researched by renowned scientists and programmes all over the world. Its effects are devastating for mountain communities, accentuating their vulnerability to disasters, conflicts, migration and poverty. To address climate change, it is crucial to develop innovative joint research programmes and participatory approaches combined with efficient communication platforms to raise public awareness about its impacts in mountains.

Mountain Forum was founded a decade ago with support from the Swiss Agency for Development and Cooperation (SDC) to facilitate awareness raising and advocacy regarding sustainable mountain development (SMD) issues. Since its inception, Mountain Forum has facilitated participatory dialogue platforms among stakeholders to shape SMD policies at both regional and global levels. These dialogues around issues affecting mountain environments were conducted to support the demand and efforts of the international community and will carry on.

I take this opportunity to express my heartfelt gratitude to the Mountain Forum Bulletin team and our Mountain Forum friends and experts who have enriched the content of this issue with their valuable contributions from all over the world. My special thanks goes out to my colleague, Elizabeth Fox, for her efforts and commitment to enhance the quality of content in the Bulletin.

In recognition of the International Polar Year 2007 and World Environment Day which was commemorated on 5 June 2007 and whose slogan was "Melting Ice - a Hot Topic?", this edition focuses on melting mountains. Mountain Forum will continue to offer its platform to advocate for safer and peaceful mountain environments and prosperity for future generations. We thank you very much for your continued support!

Sincerely yours,

Dr. Ana Maria Ponce
Executive Secretary
Mountain Forum

Agro-ecological Evidence of Climate Change in the Lebialem Highlands of Cameroon

Alexander Fomin Legwengoh

Farming on steep slopes, Lebialem Highlands, South West Province, Cameroon. Photo: Arend de Haas

"In the beginning, as the story is told, God was making his final touches to the creation of the world when he arrived tired and weary to Nsoko, a Bangwa village just over the river that separates the Bayang and Bangwa countries. By this time, it was getting dark. He asked the people for a lamp, so he might see what he was doing. Somewhat wary of a stranger in the night who wanted to borrow their possessions, they refused. God's tired labours in the darkness, spiced perhaps with a hint of revenge, resulted in a landscape that looks hastily made, magnificently uneven and difficult to inhabit."

There is hardly any region in the world where there is no fret about environmental changes, especially the issue of climate change. The Lebialem highlands have experienced a fair bit of environmental changes. What is distressing is that these changes could be attributed to climatic changes and they have a vital impact on rural livelihoods. For a community with very little to fall back on in the event of a drought, there is need for concern as well as to make an appeal for more local actions following large global talks.

Located in the north-eastern part of the South West province in Cameroon, Lebialem is composed of Nweh (Bangwa) and Mundani clans and is a hilly region that covers a surface of about 617 km^2 with an estimated 144,560 inhabitants. Lebialem is one of six administrative divisions in the South West Province. It is made up of three subdivisions: Alou, Menji and Wabane. The Lebialem highlands rise to about 8,000 ft forming part of the Banboutous highlands in Western Cameroon. The area is inhabited by the Bangwa, Mock and Mundani peoples who have rich and unique cultures, which result from their highland savannah and lowland forest environment. The alternating landscape fascinated early European explorers. It was described by Gustav Conrau, a German trader and colonial plantation labour recruiting agent in 1898, to be "an awe-inspiring mountain scenery with its accompanying steep, sometimes perilous paths, crossed by rushing torrents even in the dry season; high tumbling waterfalls with isolated compounds behind plantain groves and hedges". In this small geographic region that is inhabited by several ethnic groups with only a few hours climb you suddenly find a change in altitude, accompanied by a complete change in topography, ecological and climate change. The climatic condition varies from a moist and warm lowland forest to a cold, open country highland.

Agro-ecology of the Lebialem highlands

Due to the fact that climate and ecology vary from lowland forest to grassy highland, agricultural changes are visible in the different crops grown in these regions. Earlier accounts, such as those from Robert Brain in the 1960s or even oral accounts from the plus fifty year old generations are interesting portrayals of vast changes, not only in the society, but also in the environment. Agriculture is the central element in the socio-economic life of the Lebialem people and each region complements the other. While the lowlands produce cocoa as the main export crop and other forest goods - such as palm oil, dried fish and bush meat - the highlands main export crop produced is coffee and other products like groundnuts, maize, potatoes and raffia palm wine. Other permanent crops - none of which is of special commercial interest - are kola, avocado pears, plums, Indian bamboo, the date palms and raffia palms.

Two seasons determine farming activities: the wet season from April to November - December with maximum rainfall in September and October; followed by a short dry season from December to April, which is never completely rain free. Maximum rainfall in the region - noted as little above 900 mm - were recorded in August 1982 falling to slightly above 500 mm in August 1992. In the highlands, lesser dense forests have been cleared for intensive agriculture and some areas of grassland provide grazing land for cattle and horses. Often farms were cultivated from three to four years and then left to revert to bush for up to ten years. However, with population growth and increasing emphasises on the economic importance of agriculture, crop rotation was established, which also helps alleviate the poor soil condition, particularly in the upper region.

It would be impossible to discuss agriculture in the Lebialem region without mentioning the staple crop, cocoyam. Until a few years ago, this remained the main staple of the region. Yet, there has been wide spread complaint of the decline and, in some areas, complete disappearance of this crop. The decline in cocoyam production has been gradually replaced by cassava cultivation. Cassava, which was actually near to non-existent as recently back as the 1970s, was hardly consumed by the Labialem people. People recall that early traders brought cassava products, especially 'garri' (cassava flour) to Lebialem from the Bayang country (neighbours to the west). Vincent Lockhar, a Catholic priest in the area from 1982 to 1993, notes in his writing that cassava cultivation took place along side that of the cocoyam. This means that a few decades were required for a dramatic agro-ecological change to take place.

The cassava is generally associated with poor farmers who live in marginal areas that have adverse climatic and soil conditions. The crop has an exceptional tolerance to drought and to acid, infertile soils. Therefore, cassava is often grown on sloping land, which is a result of its minimal requirement for land preparation and its ability to produce reasonably good yields on eroded and degraded soils, where other crops would fail. It is easy to visualise the changes that have taken place here in the last few decades. With other crops failing and the savannah land encroaching into what was originally a rain forest land, there has been a significant shift from the water loving cocoyam plants to the highly resilient cassava.

Funeral celebrations, Lebialem Highlands, South West Province, Cameroon. Photo: Arend de Haas

Some other significant changes have been noticed in the Lebialem region. Towards the beginning of the dry season, the women form parties to hunt for tadpoles and frogs, because there are no fish in most Bangwa rivers. However, in recent years tadpoles and frogs - which have remained a delicacy - are increasingly difficult to find. Perhaps these occurrences are due to the fact that the rivers and larger streams have become warmer and have an increased amount of fish; an area they never inhabited before. Undulating landscape of the highlands was once crossed by rushing torrents even in the dry season. Now this is an occurrence that can only be rarely witnessed and several of these rushing streams are simply non existent. Due to climate change and human activities, the rivers Bechuo, Bejie, Efrue, Begeu, Ntchembe along with other upland streams have lost much of their water and vitality. Moreover, in the lowlands many fast flowing streams once required cane bridges, yet today it is safe cross these even during the raining season, which is previously when water levels were frightful and prohibitive.

On a positive note some lowland areas in Essoh (Attah and Lebang chiefdoms) in the past too cold for cocoa pods to ripen - are now warm enough to enjoy the benefits of cocoa trade. Also in the region as a whole there has been a noticeable increase in palm oil, with noticeable increase in beans, carrots and garlic cultivation in the highlands of the Alou and Wabane areas. Additionally, there has been an increase in the production of potatoes, beans and cabbage in the Mock highland regions although there is an increasing need for irrigation in order to cope with the fast recession of water in what were once highland farming communities, such as Mock Ngie and Mock Letegh.

Fortunately, the difficult terrain of the Lebialem highlands has meant that the forest can not be exploited rapidly due to the fact that in some places it has remained inaccessible. The tradition of chiefs owning sacred forests, called 'lefem', means that even in high grounds - where most forests were replaced by farms - patches of intact forests still remain containing the region's original biodiversity. Hunting and bush fires have pushed back most primates, elephants and other animals that were common some fifty years ago. However, people still report sightings of these animals or have evidence of them causing crop destruction in farmlands near large forest tracts, such as the Mark forest. Changes are obviously occurring and the changes in climatic conditions most probably play a huge role. The main concern and Lebialem people's prayer is that these changes will not cause the entire system to become a permanent drought stricken area. In a predominantly low-income population having a high dependence on agriculture there are very few safety nets for people to resort to. Often, in the area, changes have resulted in high emigration trends. Most families, therefore, currently rely highly on remittance from families who have moved to more agriculturally favourable areas, such as large Lebialem communities based in the fertile volcanic regions of Muea, Muyuka, Muyenge, Mbanga and Kumba.

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Forest encroachment, Lebialem Highlands, South West Province, Cameroon. Photo: Arend de Haas

Melting Glaciers in the Himalaya

Samjwal Ratna Bajracharya and Pradeep Kumar Mool

Melting glaciers in the Annapurna Region, Western Nepal.
Photo: Kamal Adhikari

Global climate change in the history of earth is a natural phenomenon due to continental drift, earth axis and orbital variations, variants in solar energy output and frequent volcanic activity. With the end of Little Ice Age (15th to 18th centuries), the behaviour of average surface temperature on earth depicts an increasing trend. Over the past few decades, since industrialisation human activities have resulted in steady increased concentrations of greenhouse gases in the atmosphere, which lead to the enhanced greenhouse effects, and thereby cause global warming.

Over the past hundred years, the world's average surface temperature has increased between 0.3°C and 0.6°C. Ten warm years have already been recorded in this century. The 1990s were likely to be the warmest decade of the millennium in the Northern Hemisphere, and the year 1998 was the warmest year, followed by the second warmest year 2005. According to the Intergovernmental Panel on Climate Change (IPCC 2001), and its assessments based on climate models, the increase in global temperature will continue to rise during the 21st century. The mean global temperature is the average from 1961 – 1990, assumed as normal period. The increase in the global mean temperatures from 1990 to 2100 could amount to anything from 1.4°C to 5.8°C, depending on the climate model and greenhouse gases emission scenario. On the Indian sub-continent temperatures are predicted to rise above an average between 3.5°C and 5.5°C by 2100.

Glaciers are one of the key indicators for exploring quaternary climate changes; as they remain sensitive to global temperature conditions; this is indicated by the continuous retreating and shrinkage of glaciers. For example, with temperatures rising by 1°C, Alpine glaciers have shrunk by 40 percent in area and by more than 50 percent in volume. One forecast suggests that up to a quarter of the global mountain glacier mass could disappear by 2050, and up to half could be lost by 2100.

This is anticipated from a study of glaciers in the Himalaya by the satellite images, which are complemented by field verifications and historical data. Nearly all of the glaciers are shrinking and retreating at different rates in different basins. A long-term study entitled, 'The Chinese Glacier Inventory', by the Chinese Academy of Sciences reported that during the last 24 years there has been a 5.5 percent shrinkage in volume of China's 46,928 glaciers; equivalent to the loss of more than 3,000 km^2 of ice. The study predicts that if the climate continues to change at the present rate, two-thirds of China's glaciers will disappear by 2050, and almost all will be gone by 2100. A study by the International Centre for Integrated Mountain Development (ICIMOD) carried out in the Poiqu basin of Tibet Autonomous Region (TAR) of the People's Republic (PR) of China revealed that the glaciers area had decreased by over 5 percent within 12 years from 1988 to 2000 and some valley glaciers have retreated by up to 68 m per year.

Similarly, the position of the Gangotri Glacier snout in Indian Himalaya has shifted about 2 km upwards from 1780 to 2001. Its retreat is continuing at an alarming rate. In Bhutan, glacier retreat was approximately eight percent in 66 glaciers that were studied in a topographic map from 1963 and a satellite image taken in 1993. Some small glaciers from 0.1 to 0.2 km^2 in area have disappeared completely in Bhutan. In some cases, glacier retreated areas are replaced by glacial lakes. A study of such lakes in Nepal reveals startling results. From 1962 to 2000, the retreat of the Imja glacier has been by about 41 m per year and this increased drastically to 74 m per year from 2000 to 2006. The Imja glacier's retreat is found to be one of the highest in the Himalaya amongst those studied as shown in Figure 1. Observations of individual glaciers indicate that annual retreat rates vary from basin to basin and in some instances, with a doubling of the rate in recent years compared to the early seventies.

Some of the retreating glaciers result in the formation of glacial lakes at the toe of glaciers dammed by the loose moraine. Consequently, increased rate of glacier retreat results in rapid accumulation of water in lakes, which may lead to sudden breaches of their unstable moraine dams. The resultant discharges of huge amounts of water and debris – glacial lake outburst flood (GLOF) – often have catastrophic effects downstream. A number of GLOF events have been reported in the region in the last few decades, particularly from the eastern sector of the region. These changes in climate will inevitably interact with changes in glaciers and glacial lakes and, due to GLOFs, will pose increasing threats. Such changes in climate will have effects ultimately on life and property of mountain people living in remote areas.

A study conducted by ICIMOD in partnership with the United Nations Environment Programme (UNEP), Asia-Pacific Network for Global Change Research (APN) and in close collaboration with national partner organisations generated an important baseline information of approximately 15,000 glaciers, which cover a total area of 33,400 km^2 and include 9,000 glacial lakes, of which 200 are potentially dangerous glacial lakes in Pakistan, Nepal and Bhutan and some selected basins from India and TAR PR China. The study also revealed 21 GLOF events from the Hindu Kush Himalayan region. Records of past GLOF events illustrate that once every three to ten years a GLOF has occurred in the region of Nepal, Bhutan and China causing varying degrees of socio-economic impacts.

The baseline information of glacial lakes prepared by ICIMOD formed an important basis to monitor accelerating global warming. Most of the lakes mapped at the toe of the glacier moraine are growing and new lakes have appeared in recent decades. If lake growth continues, then it has to breach out eventually. This will create devastating effects to downstream environments, livelihoods and property.

The unprecedented global warming, melting and retreating of glaciers give rise to the formation and growth of moraine dammed lakes and increased threats of GLOF. Monitoring these lakes, by means of remote sensing, and verifications in the field are important to identify mitigation work in order to install early warning systems to reduce the GLOF risks.

Glaciers and freshwater reserves of the Himalaya are an inherent part of the life support system; since half of world's population depend on these vital resources. In the face of accelerating global warming, retreating and shrinking glaciers in the Himalaya are clear indicators of climate change. There are several predictions of glaciers melting that are accompanied by impacts on millions of people whose survival depends directly or indirectly on these fresh water reservoirs. In addition, the increase of lakes dammed by the moraine will augment the frequency of GLOF in near future. It is difficult to speculate or to predict just how glaciers will retreat in the Himalaya, but now is the time for rigorous attempt to monitor glaciers environment and to initiate mitigation measures of GLOFs.

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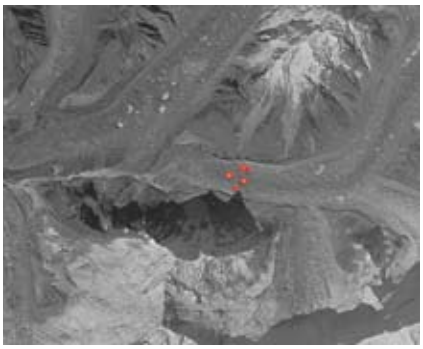
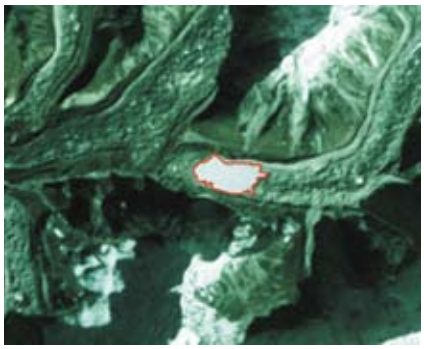


December 1962. Photo: Corona



December 1983. Photo: Sp. Shuttle

January 2006. Photo: Google Earth

Figure 1. *Growth of Imja Tsho seen in satellite images from 1962 to 2006 and field photo show the active calving on the Imja glacier snout (15 October 2006).* Photo: ICIMOD

The Effects of Global Warming on the Brahmaputra River Basin

Walter W. Immerzeel

Irrigated agriculture in Gyamtse, Tibet. Photo: Walter W. Immerzeel

The recently published fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC 2007) concludes that warming of the global climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. The report concludes that the average global temperature is very likely to increase between 1.8ºC and 4.0ºC by the year 2100. Warming is expected to be greatest over land and at most high northern latitudes, snow cover is projected to contract and that it is very likely for hot extremes, heat waves, and heavy precipitation events will continue to become more frequent.

The spatial variation in observed and projected climate change is large and mountain ranges and their downstream areas are particularly vulnerable for several reasons. Firstly, the rate of warming in the lower troposphere increases with altitude, that is temperatures will rise more in high mountains than at low altitudes. Secondly, there is a large high natural variation in climates because of the large difference in altitudes over small horizontal distances. This renders mountain areas more susceptible to climate change. Thirdly, and probably most importantly, is the role mountains play in the water supply to downstream areas. More than one sixth of the global population depends on water supplied by mountains and changes in hydrology and water availability are expected to be large in mountain basins. Climate change is expected to intensify the hydrological cycle, for example more precipitation and more evaporation. While snow and ice accumulation in mountain areas determine a large part of surface hydrology and temporal distribution of water availability will change significantly when surface air temperatures rise.

Despite its relevance, few studies have been conducted on the hydrological effects of climate change at basin scale in the Himalayas. Barnett et al, 2005 in a global assessment of the impact of global warming on snow dominated regions indicates that the Hindu Kush Himalaya area is perhaps the most critical area, where vanishing glaciers will negatively affect water supply in the next few decades because of the region's huge population. The ice mass over this mountainous region is the third largest on earth, after the Arctic/Greenland and Antarctic regions. The hydrological cycle of the region is complicated by the Asian monsoons, but there is little doubt that melting glaciers provide a key source of water for the region in the summer months.

A recent study provided insight of historical trends in precipitation and temperature, analysed possible future scenarios and evaluated the potential impact of climate change on the hydrology of the Brahmaputra river basin. This large Himalayan basin (530,000 km^2) covers parts of China, Bhutan, India and Bangladesh.

Based on a monthly observational global dataset an assessment was made of temperature and precipitation patterns from 1900 - 2002 in three physiographic zones of the basin: the Tibetan plateau, the Himalayas, and the floodplains. Warming was in general consistent with global warming patterns for the northern hemisphere (0.006ºC/year), with the largest increase in all three zones in spring. Notably, this is a critical period concerning snow and ice melt. Monsoons dynamics govern precipitation and no obvious trends may be identified. However, regression analysis between precipitation and the air temperature differences between the plateau and the floodplains showed that monsoons precipitation is significantly related to this temperature gradient. In turn, for a large part, precipitation is governed by the extent and depth of snow cover on the Tibetan plateau, and, therefore, extremely sensitive to temperature increases.

By statistical downscaling, outputs from 2000 - 2100 in six different General Circulations Model (GCM) a basin wide assessment of two different scenarios for anticipated changes in precipitation and temperature was made. The analysis showed that the warming rate in this century will increase and that the temperature increase will be largest in the Tibetan plateau (3.3ºC in the year 2100). Contradictory to the historical analysis precipitation, clear positive future trends in precipitation are anticipated (15 percent in the year 2100).

Yarlung river near Samye monastery, Tibet. Photo: Walter W. Immerzeel

A rainfall runoff model was calibrated using a monthly stream flow data set for the period 1956 - 1993. The model was fed by the downscaled GCM projection to provide insight in future changes in average and extreme stream flow per season. Average summer discharge is expected to show the largest increase (20 - 30 percent in 2100), which will likely have a similar effect on peak discharges.

The study concludes by foreseeing that in the floodplains, the main threat of climate change therefore lies in the increase of extreme precipitation in the monsoons and associated flooding. In combination with anticipated sea level rise the effects for Bangladesh will be devastating. It is not all negative, as climate change will provide important opportunities on the Tibetan plateau for intensifying agriculture and increasing yields. The increase in temperature will extend the growing season whereas increased precipitation in spring and autumn will reduce water scarcity. In the Himalayas, climate change will also provide opportunities for mountain agriculture; however the anticipated increased in temperature will further accelerate glacial melt. In the short run, the glacier melt may increase water availability, but major waterborne disasters are also likely. Rapid accumulation of water in glacial lakes can lead to a sudden breaching of the unstable 'dam' behind which they have formed. The resultant discharges of huge amounts of water and debris often have catastrophic effects on people, both upstream and downstream. In the long-term, climate will modify the timing and availability of water.

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Melting Mountains: Focus on the European Alps and Beyond

Carmen de Jong

Climbers on Mt. Blanc, France. Photo: Martin Gray - www.sacredsites.com/europe/france/mtblanc.html

The notion of "melting mountains" is very appropriate as a metaphor for mountain regions since it may concern water in both its solid and liquid state and links these to current trends in climate and human-induced global change. In this statement, "melting" can also be considered as a metaphor for "loss" in the sense of melting, sublimation or evaporation of snow, ice, glaciers and permafrost. The melting, sublimation and evaporation of natural snow and ice is apparent and includes the decay of glaciers, snow, firn or permafrost. Current climate change scenarios indicate the rapid acceleration of glacier retreat, which will initially augment river discharge but will considerably reduce discharge once a minimum threshold in glacier volume is attained.

Parallel to this, the scenarios predict that snowfall will decrease over space and time so

that snowmelt discharge will also decrease, but seasonality will change. To compensate for the decreases in winter precipitation, especially snowfall, professionals have resorted to produce their own artificial snow to sustain winter ski tourism in many regions of the globe. As such, the loss of artificial snow and ice through evaporation and melting is less evident. Since the production of artificial snow and ice is derived from existing or man-made surface and subsurface water resources in the highest and most vulnerable regions, the water lost by evaporation from a combination of sources (estimated at 30 percent) cannot be transformed into discharge and cause an increasing deficit for groundwater as well as surface resources. The loss of water through artificial snow production exasperates the problem of available water resources and climate change in the precipitation-poor periods. This affects areas in the European Alps as well as Mediterranean mountain regions, even in Turkey, and in the Rockies.

This contribution will, therefore, focus on glacier, permafrost, natural and artificial snow.

Glaciers

Climate change scenarios according to the Intergovernmental Panel on Climate Change (IPCC) indicate that on the one hand precipitation should increase by 25 percent, but that on the other hand temperatures are to increase by between 2 - 4°C depending on the scenario. Temperature increases are expected to be even more severe in the mountains and in winter. This does not mean that we are on the safe side of precipitation, because an increase in precipitation will not compensate for a temperature increase. Under the mildest temperature increase scenarios, the snow season will be menaced, since warmer temperatures will cause more rainfall at the cost of snowfall and a faster decay of any existing snow cover. Under the highest temperature increase scenarios it is expected that the winter season can be shortened by two months in the mountains. This all has important repercussions for glaciers and snow volume. Less snow-rich and warmer winters will mean that glaciers will simultaneously experience a deficit in their accumulation areas and faster melting in their ablation zone as well as increased evaporation and sublimation.

Left: *Pasterze glacier, Austria around 1900.* Right: *Pasterze dam reservoir in 2000*
Photos: Gesellschaft für ökologische Forschung

The fact that glaciers are retreating at the fastest rate recorded over the last 100 years is unprecedented and has been investigated by numerous glaciologists. This retreat is now a global phenomena, although some few regions still exist with glacier advance, for example Calderone glacier in the Apennines and the Franz Joseph glacier in New Zealand. However, glacier retreat, whether recorded in the Alps, Greenland or Antarctica, is faster than predicted by the majority of climate change models as demonstrated at the European Geosciences Union (EGU) Cryospheric Sciences sessions in Vienna this year.

An important effect of glacier retreat is the relation between meltwater discharge and dam reservoir filling. In the first few years during rapid glacier retreat, there will be an increase in discharge and dam reservoirs will be well filled. However, dams will not only be filled by water but also by sediments as large masses of loose sediments are released from glacier moraines as well as destabilised valley slopes. This will rapidly reduce dam capacity. To make matters worse, as glacier volumes shrink, less and less meltwater discharge will be available for decreased dam reservoirs and they will thus have to depend more on summer precipitation. Dam reservoirs may benefit in those areas under snowfall influence, yet climate predictions indicate that snow duration and extent will be reduced in mountain areas. In the long term this deficit will considerably reduce reservoir volumes and cause a risk for hydroelectric production.

Permafrost

Permafrost decay due to sub-surface ice melt associated with global warming is of concern for many mountain areas since it can increase the frequency and magnitude of natural hazards such as rockfalls, landslides and subsurface differential movements. Ice in rock fissures normally has a stabilising effect - when it melts, weathered material is released more easily and together with the in - and exfiltration of water, large rockfalls in and landslides can be triggered. At present the permafrost limit is at 2,500 m in the European Alps, with climate change this limit is expected to increase and so is the region of impact of natural hazards. Another phenomenon that requires investigation is the destabilising impact of rapidly retreating glaciers. Where glaciers at one time physically stabilised the valley walls, their lacking support after retreat together with the exposure to large fluctuations in temperature and air can significantly accelerate rock mechanical processes (such as stress release, lack of cohesion, new hydrodynamic pressures and weathering). This causes major risks for infrastructure and frequented by tourists.

Other concerns are the direct effects of permafrost melting threatening the stability of infrastructure such as railways. A recent study of the Qinghai - Tibet railway with an average altitude of 4,000 m shows that rapid permafrost decay is already menacing the railways foundations in many places. Such examples are not unique and will affect other regions in Europe that are under higher human pressure like the Narvik railway in Norway and the Glacier Express in Grisonia/Switzerland.

Snow

Climate change scenarios prognoses important effects on snowfall (as mentioned in the glacier section) so that less snowfall is expected at higher altitudes. This will have important impacts on river discharge as well as snow-related economy such as winter tourism. Since the actual trend in the European Alps shows a decrease in the total winter precipitation including snowfall, the ski industry is depending more and more on the production of artificial snow over approximately 25 percent of its pistes. This has major effects on the cryosphere. In contrast to natural snow ablation that originates from snowfall, artificial snow ablation concerns artificial snow that originates from water reserves that have not been replenished by snowfall. Natural snow ablates by a combination of processes that depend on a combination of meteorological and snow physical factors, while artificial snow instead is directly lost to a large extent via evaporation during the production of snow. The remaining snow is lost from stagnating snowmelt water on highly impervious surfaces or from high altitude reservoirs constructed to store water for snow production. The deficit in available discharge is slowly becoming a reality. In some regions in the French Alps, conflicts between drinking water uptakes and uptakes for artificial snow production exist. Also, the winter discharge of

alpine torrents has been reduced by between 40 – 70 percent due to this water abstraction and will not re-enter the water cycle in its full amount due to high probable losses en route.

In summary: much more monitoring and measurements are required to better understand the current situation, and together with reconstructions from the past, projections for the future can be ameliorated. In the short term, prognoses can be based on monitoring, for example on a monthly or seasonal basis but for longer term strategic decisions, reconstructions of the past are necessary. Depending on the data available(e.g. based on air photos, moraine stages, paintings and chronics), the reconstruction of glacier variability will be easier than the reconstruction of snow cover and snow depth which is temporarily and spatially much more variable and difficult to capture in the pre-remote sensing era. Human influences based on population projections or developments in tourism, hydro-electricity, industry and agriculture in mountain areas need to be considered.

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Changes in the European Mountains

Europe's mountains are affected by many forces of change that influence their people and the environments which they and millions more depend on. Until recently, it was generally felt that changes in economic and political structures would be the main driving forces of change for the foreseeable future. Today, we recognise that climate change - particularly changes in snowfall and in the frequency of extreme events such as major storms, floods, avalanches and, in some regions, droughts and fires - adds greatly to the complexity of making decisions for the future. Policy responses to climate change, such as increases in prices of fossil fuels, may also have major impacts on tourism, a major economic force in many European mountain areas. The future looks ever more uncertain, and we need flexible approaches to ensure that these areas can continue both to provide places for people to live and to deliver the ecosystem services which are so vital to Europe's citizens.

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The Oberaarsee, Switzerland, with the (melting) Oberaargletchser behind. The dam is used to produce hydroelectricity for the lowland cities of Basel, Bern and Zürich. Photo: Martin Price

Shrinking Glaciers: the Case of the Gepatschferner

Axel Thomas

Aletsch Glacier, longest in the Alps, seen from the Sphinx Observatory near the Eiger, Bernese Oberland, Switzerland. Photo: Gary Braasch

The decrease in extent and volume of mountain glaciers represents one of the most visible consequences of climate change in mountains. Mountain glaciers are commonly regarded as a sensitive instrument to observe the combined effects of the changes of a number of climatic variables such as temperature, solar radiation, evaporation and precipitation. With the exception of some maritime regions, glaciers are retreating worldwide. Glaciers in the European Alps are no exception with smaller glaciers disappearing at an alarming rate and larger glaciers shrinking visibly in extent.

Glacier variability alone, however, does not present a clear sign of human-induced global warming. Since the end of the last ice age in Europe (ca. 8000 B.C.) the Alps have seen several alternating phases of glaciations and near ice-free conditions. The last large deglaciation occurred during the Middle Ages, which can be easily traced by the records of high-altitude mines that have long since disappeared under advancing glaciers. The last period of glacier advance, in the so-called 'Little Ice Age', reached its maximum during the middle of the 18th century. From 1850 to 1980, glaciers in the European Alps lost approximately one third of their area and one half of their mass. Since 1980, another 20 - 30 percent of the remaining ice has been lost. With about 50 percent of the observed temperature increase in the 20th century estimated to come from variations in solar energy output a large part of the observed glacier retreat appears to be 'natural' deglaciation at the beginning of a warm period after a minor cold fluctuation.

Even if human-induced global warming may not be the only source contributing to glacier variations the effects of shrinking glaciers have to be considered as a serious problem for many countries. Glaciers provide crucial water storage, particularly in arid and semi-arid climates where winter precipitation is released in summer coinciding with the season of maximum water demand, both by households and irrigated agriculture. However, even in Europe under temperate climates glaciers provide an important, if not even critical source of water. In addition to a vital source of drinking water, glacier and snow pack melt water feed rivers that provide energy, both by powering hydroelectric power stations or as coolant for thermal and nuclear power plants. Pumped storage power plants built in mountains use hydro energy even more directly, benefiting both from the relief energy and the direct supply of glacier melt water into high altitude reservoirs. Austria supplies a considerable amount of peak-load energy into the European power distribution grid that is mostly generated from such glacier-fed hydroelectric power stations. With shrinking glaciers, the question regarding whether water supplies for these power stations are in peril is of obvious importance. In an intense discussion on the proposed expansion of alpine power stations estimates of future glacier-fed run-off are a fundamental piece of information.

With an area of about 22 km^2 the Gepatschferner, situated in Northern Tyrol (Austria), is one of the largest glaciers of the eastern Alps. It extends over an altitude range of nearly 1500 m draining into a reservoir above the Feichten power station, which generates an average 600 GWh per year. The historical glacier variation is dramatically visible by comparing two images of the glacier that span nearly a century from 1904 to 2000. Even more evident than the reduction in length is the reduced volume of the glacier. Variations in glacier volume are, however, not measured by the standard surveying method that simply observes length variations and the displacement of markers placed on the glacier surface. To estimate mass loss or gain surveys in glacier surface elevation over the entire glacier are needed. Precise surface elevations are obtained by photogram metric surveys that derive surface elevations from aerial stereo photos. Satellite data are only a useful tool to provide medium-resolution surveys over large areas but lack the resolution required to estimate glacier surface elevation with the necessary precision. Generating Digital Elevation Models (DEMs) from the stereo models and comparing DEMs from different observation periods can calculate mass changes directly.

A comparison of DEMs from 1971 and 1990 reveals that changes in surface elevations varies considerably over the glacier and that both localised increases and decreases have occurred. Perhaps the most intriguing feature is a bulge of more than 20 m high that developed at the terminus of the glacier indicating that glacier ice accumulated during a short period of positive mass balance in the 1970s at higher altitudes has been carried down. Over the entire glacier a mass loss of 26 x 106 m^3 (corresponding to about 0.9 percent of the entire glacier volume) has occurred during the two decades between 1971 and 1990.

While a glacier mass loss of less than 0.5 percent per decade seems not to be remarkable the observation period of 1971 to 1990 is not a typical example of the climatic conditions encountered over the last decades. Glacier mass loss (negative mass balance) is the consequence of a combination of warm summers and a lack of precipitation, both in winter as (at higher altitudes) in summer where fresh snow acts as an effective insulator of glaciers. During the observation period of 20 years, nine years indicated a positive mass balance indicating climatic conditions typical for the constant increase in summer temperatures encountered in the last century. Based on the visual impression of Gepatschferner in 1904 ablation rates and run-off must have been considerably higher during much of the last century than during the observation period in order to melt such a large glacier. Historic high summer temperatures during the last decade have led to considerable higher mass losses: of the remaining ice volume an estimated total glacier-volume of 5 – 10 percent was lost in the Alps in 2003 alone. Similar high ablation rates in the years to come might pose a problem for the continuing service of power stations.

To put recent results in perspective, historical glacier variation data and climatological records need to be collected and analysed in order to understand the interaction between climate and glacier ablation at Gepatschferner. Since Gepatschferner is among the first glaciers in the Alps that has been mapped with modern methods a number of topographical maps have been published from 1888, which will allow establishing a series of DEMs in order to evaluate the temporal evolution of the glacier mass loss. Correlation of climate and glacier variation may allow predicting run-off under future climate change scenarios and even provide arguments in the discussion of the future development of the hydroelectric power plant in Feichten.

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A useful web site showing time lapse shots of glacial retreat (in German) is *http://gletsherarchiv.de*.

Overview of Climate Change Impacts in the European Alps

Guillaume Prudent

Val Thorens, France. Photo: G. Mirande

The industrial development provoked huge greenhouse gases to release into the atmosphere. This greenhouse effect enhancing, combined with natural climatic variability, led to the so-called "global warming". Even if the Intergovernmental Panel on Climate Change (IPCC) reports giving more and more details about the possible impacts and the observed climatic variations, many uncertainties remain, especially at the regional scale. Only few Regional Climatic Models (RCMs) have been developed at this stage and the downscaling methods are not unequivocal. Furthermore, the climatic models, both global and regional, do not represent all of the existing interactions. For example, vegetation cover, cloud cover or orographic features are poorly integrated in the calculations.

The further you go into impact assessment, the greater are the uncertainties as presented in the following scheme. This overview is not exhaustive, but proposes some observed and possible impacts of climate change in the Alps.

Atmospheric parameters

Alpine temperatures

The reconstructions of the past climate show that the second half of the 20th century was the warmest 50 year period of the last 1300 years on the global scale. The last 15 years rank among the warmest for the last 500 years in the Alps. The four warmest years have all been observed after 1990 and the 2003 summer was the warmest summer of the last 500 years. During the 20th century, the Alps experienced a warming of temperatures comprised between 1°C and 2°C. This warming trend seems to have accelerated in the last decades.

The mean winter temperature increased more than the mean temperature for the other seasons; this is even more marked for the minimum temperature increase. However, some contrasts appear, depending on the location and elevation of the observation sites. According to the results proposed by the regional and global climatic models, temperatures will certainly continue to rise. This evolution should be more significant in the Alpine arc than in the rest of Europe. This warming should also be much important for minimum temperatures.

Alpine precipitations

The precipitation variability is very important in the alpine range. Thus, no general trend can be found concerning precipitation trends. However, in some specific massifs, a winter precipitation increase and a summer precipitation decrease have been found. Climatic models predict an increase of winter, autumn and spring precipitations, whereas the summer precipitations should decrease. In winter, precipitations should increasingly fall as liquid precipitations (and so less as solid precipitations). This is especially true for medium altitude areas. However, it is still difficult to include the specific orographic parameters in the climatic models. Indeed, simulation results show great variability depending on the site observed, the scenarios chosen and the model used.

Alpine natural systems

Snow cover, glaciers and permafrosts

A decrease of the snow cover duration and snow volume in the Alps has been observed since the 1960s. Nevertheless, strong differences appear, depending on the site elevation. It seems that this decrease is especially marked for low and medium elevation sites, but is still unequivocal for high elevation sites where the results are in contradiction. For each degree of warming, the snow line should rise by 150 m in altitude and the snow cover duration should decrease by 15 to 20 days, especially towards the end of the snow cover season.

The alpine permafrost has experienced important changes in the last 100 years, because of rising temperatures. Despite the fact that the evolution of permafrost is complex and less documented than that of glaciers, it may follow similar degradation.

The lower limit of permafrost potentially rose from 200 m during the twentieth century and the temperature in frozen ground has increased significantly since 1980. The inertia of permafrost to changing climatic conditions is quite strong and the reaction of this ground takes place over long time. Studies and observations of this frozen ground are recent and all the patterns are not well understood. It is also important to differentiate between cliff permafrost and medium slope permafrost (>30°C).

Since 1850, the European alpine glaciers have lost about 30 to 40 percent in icy surface area and around 50 percent in ice volume. During the decade 1980 - 1990, glacier mass losses further increased by more than 50 percent with respect to the

Glacier du Géant, France. Photo: C. Vincent, LGGE

secular average for the 20th century. The extent of Alpine ice is probably more reduced today than ever before during the past 5,000 years. The Alpine glaciers mass balances show an ablation increase while the accumulation during winter can not compensate for these losses. The glaciers' mass losses have tended to increase since the 1980s. The smaller is the glacier the stronger is its reaction to climate change. The glacier's mass and volume losses should continue and even accelerate as global warming continues. Some glaciers may even disappear toward the end of the 21st century.

Vegetation, forest and fauna

Climate change leads to a longer vegetative period (with an earlier bud blooming and later leaf falling in the season) and an increase of the vegetation indication. In a general manner, there is a delay in the physiological need period to climatic factors for the species (for example: need for heat or cold).

The most vulnerable species to climate change are ones with the least dissemination possibilities, especially the old forests (linked to long-term forest conditions, independent of the age of the population), with migration speeds not above a dozen meters per century. Climate change may have impacts on tree diseases and on parasitic insects by affecting their biology and their repartition or indirectly by affecting the biology of their host or their enemies and competitors.

Alpine ecosystems constitute important biodiversity stocks showing a wide range of species in small area. The altitude ecosystems are already under constant stress because of pollution, agriculture, alien species, etc. Climate change would come on the top of these existing problems and induce further loss of biodiversity in the Alps. The most spreading and adapting species may "steal" the weaker species ecological niches.

Erosion, river hydrological pattern

The flow of rivers seems to be evolving in a heterogeneous manner. However, nival rivers and those fed by glacier have encountered a modification in the intensity and temporality of their flow. Therefore, it is mainly the melting of glaciers and rainfall rather than snow fall which affects rivers' regimes within the context of global warming.

The rivers of nival regimes will be the most affected, the peak water level rise will take place approximately one month earlier

Val Thorens, France. Photo: G. Mirande

than at present and the average annual flow should decrease with strong seasonal contrasts. Summer and spring flow would decrease whereas winter flow would increase.

Regarding many factors, erosion should increase in mountainous area. Freezing and defreezing cycles, running water, decrease in snow cover and vegetation cover may enhance erosion in the Alpine slopes, which one already showing important erosion rate.

Alpine natural events

The consequences of climate change on natural events and, thus, on the evolution of the natural hazards and natural catastrophes are really hard to assess. The crises situations usually correspond to extreme characteristic of the events (considering the intensity, frequency or localisation of the events), while the climate studying concerns especially the mean values. Thus, the link between a global and mean phenomenon with local and extreme events is quite hard to provide.

The floods in the Alps do not show significant trends in the past. An increase in flood damage is mainly the consequence of human development rather than from any changes in precipitation and river patterns. For the future, rivers should have reduced nival and glacial pattern in the Alps, leading to earlier flood peaks in spring and stronger drought during summer.

Debris flow in the Alps may be strongly influenced by glacier retreat and permafrost degradation. It is mainly sediment and detritus materials availability that may change with climate change.

Avalanches show no trends at all in the Alps. Considering the importance of human development and the increase in extreme sports, avalanche damage still remains low. Perhaps, this could mainly be explained through protection measures and emergency services efficiency. Avalanche evolution is really hard to appreciate, but in the future hazards should be the same or even reduced.

The mass movements (landslides, rock falls and mud flows) should experience changes due to fluctuation in extreme and mean precipitations, shortening of the cold season (during which most water falls as snow or freezes), melting of permafrost on rock faces, etc. Once again, climate change mainly enhances dangerous situations that already exist (due to land use, lost of forest and vegetation cover) and sometimes creates new hazardous situations, potentially within the vicinity of glaciers.

Glacial hazards are very complicated phenomena and, presently, some triggering factors are still unknown (such as glacial water pocket burst). However, it seems possible that a stronger glacier retreat may lead to more glacial lakes and a limited stability for the hanging glaciers.

Forest fires will be influenced by climate change, because there will be more frequent drought situations during the summer, and new vegetation cover will lead to greater fire hazards. Yet, forest fire hazards are mainly traced back to humans. Forestry workers, farmers, tourists and inhabitants need to provide efforts to reduce fire triggering events.

Climate change may have many consequences on natural events, but it is rather human development which is already threatening mountainous areas. The human factor will be a crucial issue for future management of natural hazards.

Climate change will induce climatic vulnerabilities and climatic opportunities. Unfortunately, it seems that climatic vulnerability will be greater than climatic opportunities. Climate change impacts on human activities are numerous. We still underestimate all of the possible impacts society will face. However, this does not mean that we must view climate change as being the “devil” behind each extreme catastrophic event or winter without snow.

Nonetheless, today we need to assess impacts and propose adaptation measures. Currently, hydro-power production, winter tourism, agriculture and natural hazards managements already face difficulties in the Alps. If we do not prepare for climate change and its impacts, these sectors may face even stronger difficulties. Reactions must be both private and public, both local and national, both individual and collective, everyone has a rule to play.

Get a grip on climate change!!!

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The Central Mediterranean Cryosphere in a Changing Mountain Environment

Massimo Pecci

Figure 1. *Sampling snow layer for pH and conductivity determination in Arabba site, Dolomites, Italy.* Photo: M. Pecci

The summit area of the Apennines is quickly changing. The mid latitude cryosphere is shrinking and degrading due to global warming. The Calderone glacier - the only glacier in the Apennine belt - is experiencing general reduction of the cryosphere. This is causing many impacts such as: inducing permafrost degradation; variation in time and spatial distribution of snow cover; instability involving both ice, snow and rock debris; changes in the rhythms of precipitation and of melting, as well as of run-off; concentration, dilution, and distribution of chemical pollutant compounds.

Moreover, environmental changes seem to promote direct transition from the native and genuine glacial (periglacial to paraglacial) processes on a relatively reduced spatial and temporal scale.

This is a synthetic state of the art study and research is presented that takes into account three different cryospheric components in the Gran Sasso d'Italia massif.

Snow and snow cover

Snow cover assumes a central role in the assessment of the climate change effects on mid latitude mountain regions. Different amounts of precipitation and time dependant distribution produce effects both on tourist economic activities (namely ski resorts) and risks (snow avalanche risks and emerging snow cover risks). Until a few years ago, the risk due to snow was limited to mountainous areas and to the probability of eventual avalanches. Since the new millennium, emerging and new snow risks have been directly linked to climate change. These consist of the huge amounts of low altitude snow precipitation and coverage, as well as related effects of intensity and spatial or time-dependant concentrations on vehicles circulation, mobility and lifelines (energy supply and distribution, telecommunications, water supply and its distribution).

It is important to highlight that the entire Italian peninsula was once familiar - at least from 1921 to 1960 - to constant and prolonged snow coverage, with the exception of the Tyrrhenian, Ionic and insular shores. This snow abundance also promoted development of new and vast ski resorts, which always brought on increasing problems of mitigation for avalanche risks in the valleys as well on summits.

With global warming and different patterns of snow precipitation (concentration in premature or delayed periods of the winter season), the geography of snow-covered ski resorts is quickly changing. Moreover, based on the Intergovernmental Panel on Climate Change (IPCC) scenarios, snow limits will move to higher altitudes for periods and permanence times will be shorter than now.

In the future in particular, we could face several factors such as an increase of the average air temperature between 1.5°C and 3°C; a rise of snow limit up to 500 m in altitude both in the Apennines and in Mediterranean massifs; a decline, during the spring season, of snow precipitation also in high altitude (up to 2,500 m); an absence of snow precipitation beyond the winter season in the Apennines; a reduction in snow coverage of up to 80 percent at an altitude of 1,500 m in the Apennines.

Consequently, the mountains of the Mediterranean will begin to face substantially different winter seasons, having different patterns of snow-melted waters from springs and torrent water discharges. This will mean different territorial usage and different human presence in high altitudes. Finally, snow and even ice coverage have been caused by concentration and cold condensation (trapping) processes of inorganic, organic and radioactive pollutants.

During the winter season of 2005 – 2006, in several sample sites of the Italian territory a research program was promoted with focus on quick in situ control of chemical features for snow cover, in terms of pH, electrical conductivity and radioactivity. Activities were carried out within routine surveys of snow pack profile for avalanche risk mitigation. The quick surveys (Figure 1) were performed by three initial operative units IMONT in Gran Sasso d'Italia, CVA-ARPA Veneto in the Dolomiti Bellunesi and Centro Nivometeo di Bormio at 3,000 m, followed by two more carried out by MeteoSvizzera for the Basodino glacier area and by the Ufficio Neve e Valanghe, Università di Torino in the Valle d'Aosta site of Fontainemore.

The experimental goal for the first year was to verify the feasibility of new quick environmental snowpack profiles. Furthermore, field sites, measure features, a standardised and shared methodology were experimented and chosen. The problems found during the first year were discussed in order to perform an operative test in the winter season 2006 – 2007. The test aimed to standardise procedures and tools to introduce in routine surveys. In this way, a new tool for pre-monitoring of quality of water resources, coming directly from the cryosphere, could be proposed.

The ice

The Calderone glacier, located just behind the top of the Corno Grande d'Italia, has had strong reduction in volume (Figure 2) between 2,650 and 2,830 m. During the 20th century, altitudinal development was estimated at about 2,000,000 m^3, which makes for an approximate total of 4,000,000 m^3 since the Little Ice Age. This also produces an estimated reduction of ice thickness for an average of about 30 m or an average of about 36 m since the end of Little Ice Age and is very evident during last ten years (Figure 2). The principal effect of tensional release on the rocky edges and walls is the development of gravitational phenomena. A further feature of rapid evolution of the glacier's area is evident in glacial

Figure 2. *The lower section of the Calderone glacier (Central Apennines, Italy) - a time comparison showing reduction of ice thickness.* Photo: M. Pecci

debris coverage, which constitutes the left (hydrographical) arch of the frontal-lateral moraine and includes superficial movements and displacements. Both evidences highlight the hypothesised deglaciation phase and could suggest development of paraglacial environment and processes that are also linked to possible degradation of the rock and debris permafrost.

The Calderone glacier shows characteristic behaviour with a substantially stationary mass balance over the last years (if the two ice aprons are considered as unique apparatus) although in reduction and subdivided actually into two small glaciers since the year 2000. Debris coverage, morpho-topographic and exceptional winter snow accumulation, of more than 10 m, seem to be the principal causes for these actions, which are opposite to that of the general trend in most Alpine glaciers.

Permafrost

The activity of periglacial processes in relation to the presence of active permafrost in the area is only hypothesised. There is positive feedback from debris movements and evolutionary patterns, as well as from gravitational movements due to tensional release following ice reduction.

The most severe and recent phenomenon was the rock fall from the "paretone" (big wall) of the Corno Grande d'Italia. This occurred during the summer of 2006 on 22 August. Fortunately there were no victims, nor any grave damages. Since then, a detailed study and mountaineering monitoring of the area have been carried out in order to further evaluate the phenomena of rock instability. Monitoring of the permafrost presence and distribution of two thermal in situ stations also began in a comparable site at almost the same altitude in order to detect the hypothesised presence of permafrost and to survey its evolution.

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Gloria-Worldwide

The Global Observation Research Initiative in Alpine Environments (GLORIA) was created to establish and maintain a world-wide long-term observation network in alpine environments. Vegetation and temperature data collected at the GLORIA sites will be used for discerning trends in species diversity and temperature. The data will be used to assess and predict losses in biodiversity and other threats to these fragile alpine ecosystems which are under accelerating climate change pressures.

Source: *http://www.gloria.ac.at*

Socio-Economic Impacts of Glacier Retreat in Bolivia

Dirk Hoffmann

Glacier melting away, Bolivia. Photo: Dirk Hoffmann

Throughout the Holocene epoch glaciers have proven to be excellent indicators of climate variations. There are a number of studies on the recent trend of Bolivian glacier disappearance, which analyse complicated interactions of geo-meteorological conditions of the sub-tropical high mountains. Currently, practically no research has been carried out on the consequences of melting and eventual disappearance of the country's glaciers or on impacts on the economic and social situation. Thus, given the present rate of small glaciers' melting in the Bolivian Cordillera, this country study on the socio-economic impacts of glacier retreat is the first approach. It provides an overview of future scenarios.

Bolivian glaciers represent around 20 percent of the world's tropical glacier area. The increased melting and disappearance of Bolivian glaciers began at the beginning of the 1980s and has been followed by another increase over the last 5 to 10 years. As in other regions, smaller glaciers, which make up around 80 percent of all glaciers, are more sensitive to climate change and, in turn, retreat at higher rates than larger glaciers. Therefore, it is probable that most of those that have not already vanished will completely disappear within the next 10 to 20 years.

Due to the fact that Bolivia is home to only a very small part of Latin American glaciers, there will probably not be any large scale consequences on the country's social or economic systems. Based on settlement patterns and a general lack of valuable infrastructure in glacier watershed regions, there seem to be relatively small risk of damage as a consequence of melting glaciers. Impacts of glacier retreat are most likely to be local, in some cases regional, which means that local authorities (municipios) must play a vital role in this context. From all that we can gather, the supply of potable water for the growing urban conglomeration in La Paz – El Alto metropolitan region is probably the main area of concern for shrinking glaciers in Bolivia.

For the past 15 years or more, a group of French and Bolivian scientists have been studying the behaviour of some smaller Andean glaciers. In developing countries like Bolivia, there is little research capacity for topics that are not directly related to questions of development or the well-being of the people.

Bolivian glacier retreat since 1900

According to data supplied by the World Glacier Monitoring Service (WGMS), South America holds 25,908 km² of the world's total glacier area (15,861,766 km²), which is less than 0.2 percent. Of this amount, some 566 km² belong to the Bolivian Andes and account for a little more than 2 percent of the overall Latin American glacier surface area.

On a different count, Bolivian glaciers represent around 20 percent of the world's tropical glacier area. Based on data from 1975, the maximum area of Bolivian glaciers during the Little Ice Age maximum was 50 percent larger with regards to present day. During the last 50 years, the glacier area has decreased by only about 10 percent. Around 80 percent of Bolivia's 1,830 glaciers are smaller than 0.5 km² in size.

Methodological aspects

No evidence has been found throughout Bolivia, written or in the form of oral testimony, indicating that the melting of glaciers up to now has had any significant impact on human activities. In addition, the lack of reliable data or other research on this thematic topic makes it necessary, as a first step, to analyse evidence of socio-economic impacts in other countries and regions of the Andes, Rocky Mountains, Alps and Himalayas in order to identify the types of potential impacts.

On the basis of a matrix, by listing all possible socio-economic impacts and then in a second step by crossing details with information about Bolivian glacier regions we were able to conclude a first draft; a rough but systematic estimate of the magnitude of socio-economic impacts will have on the country. This first overview will allow us to indicate further research needs and elements for a responsive strategy aimed at mitigating impacts.

Public awareness and political response

Random interviews, as well as an intensive press and media scan show, were carried out to prove that to date there is virtually no evidence of public awareness of possible impacts melting glaciers will cause. On the political and institutional levels, the only exception was mentioned in the National Climate Change Program (PNCC) of the Ministry for Planning, which finances a primary study on glacier melting and water availability for the 1.5 million inhabitants in La Paz – El Alto metropolitan region. The study was carried out by the Institute of Hydraulics and Hydrology of La Paz UMSA University. Preliminary results indicate there will be a severe shortage in the drinking water supply within only a few years.

In October 2006, a regional conference was held in Quito, Ecuador that involved scientists, representatives of industry and NGOs as well as political decision makers from Colombia, Ecuador, Peru and Bolivia. It convened to discuss "The impact of glacier retreat and hydrological resources". Fortunately, this event triggered further activities in most of the participating countries. However, the Bolivian government as a whole, however, has still not laid out a strategy for pre-emptive measures or created mitigation plans for climate change induced glacier shrinkage.

Further research

Impacts on the economy and social structures will be largely felt at the local scale and - in some cases perhaps even at the regional scale - therefore more detailed local studies, with straightforward definitions potential impact areas, will be needed. Thinking about the construction of an Andean vision, one important element would be the development of a uniform methodology, which could be used in all Andean countries. The establishment of such an overview on the percentage of glacier melt water compared to total runoff constitutes a key element. A second task would be a more detailed glacier hazard analysis, correlating main glacier watersheds with human settlements and relevant infrastructures.

An updated glacier inventory of Bolivia and the central Andean region, including updates on mass balance data, would be greatly helpful. The countrywide data that is currently available is out of date (1970s and 1980s). Initiatives moving in this direction are already under way in Peru. Apart from detailed research needed at national and local levels, more research would be needed to assess future water availability in the Andean watersheds on a regional scale.

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Melting Glaciers in Himachal Pradesh

Baspa River, Himachal Pradesh, India. Photo: Nitin Chauhan

The Kinnaur Valley is a tribal region in Himachla Pradesh, India surrounded by the Kinner Kailash range and has three high mountains: Kinner Kailash (6,050 m), Jorkendaen and Raldang; both are approximately the same height as the Kinner Kailash Glacier. These mountains are the source for the Baspa River that flows along the Baspa valley. This river is the villager's only water source for irrigation and other water purposes. According to present statistics, the glacier has receded up to 3 km each year, which will further lead to water shortage. Based on a survey done in the region, the glacier will vanish by 2022.

If the glacier disappears, then there will be no other source of water for the people of the valley. Although the government is worried about the receding of the glacier, nothing much can be done. The state is required to develop more hydropower plants in order to produce around 2,000 MW of electricity. The entire valley suffers severe weather conditions. Plus, due to projects based in the area, there are many vehicles employed in this region emitting carbon dioxide; another cause for warming and glacier melting.

Similarly in the desert mountain region of Lahaul and Spiti the change in climate due to global warming has caused rain in the desert during the monsoons months. Yet, this effect of climate change is beneficial. Since the desert region never received rain before, the people were not able to cultivate many crops. Since the rains started a few years ago, the villagers have begun to cultivate apples adding to their agriculture income.

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Sierra Climate Change Toolkit: Planning Ahead

Joan Clayburgh

Sierra Nevada, USA. Photo: Sierra Nevada Alliance

From Al Gore's movie "An Inconvenient Truth" to Tom Brokaw's special on global warming, the attention placed on global warming and the need to take action to reduce emissions has been significant over the last two years. Thankfully, the debate on how to reduce emissions, by how much and when, is finally getting the attention it critically deserves.

While there are many organisations promoting emission reductions, the Sierra Nevada Alliance has found few who focus on the additional actions we need to take to adapt to climate change. Global warming has already impacted our environment and even with aggressive emission reductions, impacts to water, wildlife, and communities will be significant. For example, in the Sierra Nevada, even with aggressive reductions in emissions, scientists are modelling a decline of about 25 – 40 percent of the Sierra snow pack by mid-century.

The toolkit

The Sierra Nevada Alliance's mission is to protect and restore the natural environment of the Sierra Nevada for future generations. We have a network of over 80 conservation groups who see climate change as one of the greatest challenges our natural environment has ever faced.

In response to these concerns, the Alliance developed a resource for conservation leaders titled "Sierra Climate Change Toolkit: Planning ahead to protect Sierra natural resources and communities".

The "Sierra Nevada Alliance Climate Change Toolkit" reviews:

- The science of climate change and its impacts on the global, national, state and Sierra regional levels;
- The effects of greenhouse gas emissions and actions you can take to reduce them;
- Information about climate change impacts and specific actions to plan ahead for:
  - hydropower relicensing
  - watershed assessment, restoration and protection
  - fish restoration
  - forestry
  - flooding
  - land use planning
- Messages and Messengers;
- Resources, reading, websites, and a CD with PowerPoint presentations for you to educate your group and community.

Resource planning for global warming

Currently, there are hundreds of resource-planning processes occurring in the Sierra and thousands more around the country. To date, few of these plans take climate change into account. These plans traditionally look to the weather, habitat, and hydrology of the past as the backdrop against which they plan.

Planning how to adapt to climate change now will be easier and cheaper than waiting for changes to create a crisis. If we can plan how to adapt to a range of scenarios the scientists are predicting, we can come up with win-win solutions that protect our environment and local economies.

The Sierra Nevada Alliance encourages all groups to use these six guiding principles to protect our natural resources in the face of climate change:

1. Educate yourself and others regarding global, national, state-wide, and regional impacts of climate change;
2. Model and forecast a range of potential impacts from climate change on your target area/community/watershed;
3. Base all plans on an adaptive management model;
4. Monitor and track changes in weather, hydrology, and ecosystems in your target community;
5. Prioritise projects that will succeed under multiple scenarios for the future;
6. Promote healthy ecosystems that are better equipped to adapt.

Education

The first step is educating your group and others on climate change. Initial research by the Sierra Nevada Alliance into how local community members perceive climate change and the need to adapt identified common misperceptions and concerns. For example, some people are busy with their own work and fear adapting to climate change will add more work and take more resources than they have. Many feel that global warming is an issue that can only be addressed at the federal and international level. These and other concerns can be addressed through basic messaging, education and discussion. Key messages we have found to be effective are:

- Scientists agree that the Sierra and other regions are warming up now and snow is decreasing;
- Even under the best emission reduction scenarios, the warming trend will continue due to past emissions remaining in the environment;
- Reducing emissions now is a must and adapt to the changes already set in motion;
- Planning how to adapt to climate change now will be easier and cheaper than waiting for a crisis;
- Adapting to climate change can be part of existing planning processes and will not add on separate planning efforts;
- Elected officials, agencies and other funders will reward efforts that address how to adapt to climate change – this gives your effort a competitive edge;

Sierra Nevada, USA. Photo: Sierra Nevada Alliance

> There is scientific information and resources available to help you plan at the local level.

Modelling and forecasting

Modelling a range of impacts is also important. When folks see how different the future could be in their own backyard, they are much quicker to truly understand the importance of local action. Many resource planning efforts already use models in their planning. In these cases it is a matter of requiring the modellers to go beyond using only data from the last 100 years. The best consultants and modellers are already incorporating information from climate scientists.

Adaptive management and monitoring

Adaptive management is important because while the scientists agree that the climate is warming and there will be less snow, there are still a range of possible scenarios on how much precipitation will fall and when. Most global and local models are still evolving. Consequently, ensuring your plan includes ongoing assessment and tracking and then adjusting that plan accordingly, which is critical for success. Adaptive management can be a structured decision-making process with pre-defined management responses when goals are not being met. However, static plans that wait until the end of a process to gauge success are likely to fail in a changing climate.

And as noted above, tracking changes will be critical to guiding on-going management. Ongoing monitoring of weather, hydrology, and local ecosystems is more important than ever in a changing climate.

Prioritise for success

Finally, prioritising projects that succeed under multiple scenarios ensures your investments are not literally thrown down the drain. If a restoration project or operating procedure only succeeds under a limited scenario and another project succeeds under a range of different climates, better to place your resources on the more robust project or invest only a limited amount in the project that succeeds in only one scenario. One key principle is that the healthier an ecosystem is, the more able the system is to adjust to changes.

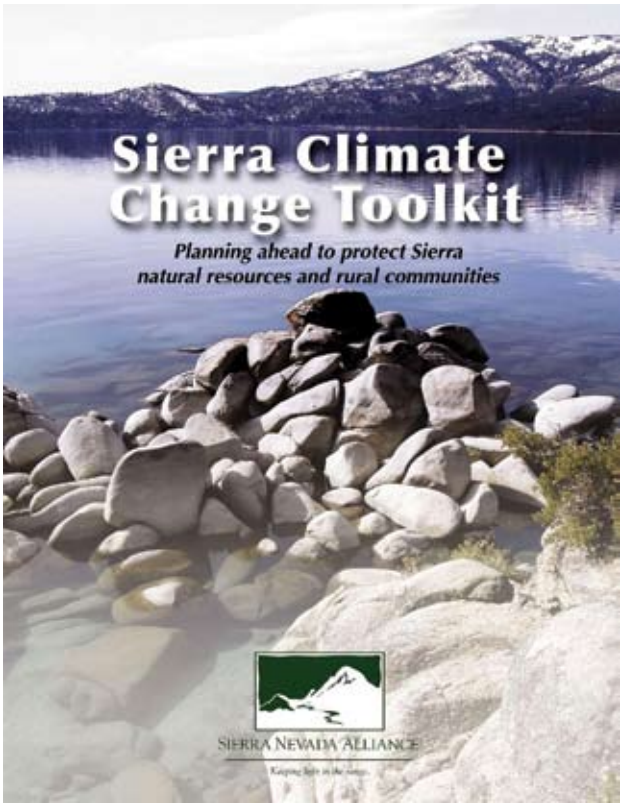
Positive action

Climate change impacts are being seen now. Significant impacts are already in motion according to most scientists. Planning only based on the past is doomed for failure. Our ability to protect our natural resources through smart planning relies on local leadership insisting climate change be on the table today. We have seen that thoughtful planning can produce win-win solutions, and this is always easier to do outside of a crisis. There has never been a time in our history when the need for action today was so paramount to the quality of life in the future. So reduce emissions and adapt – and together we can make a difference for which future generations will be grateful.

You can download the Sierra Climate Change Toolkit at: *http://www.sierranevadaalliance.org/publications/db/pics/1133215571_14593.f_pdf.pdf*.

Joan Clayburgh is the Executive Director of the Sierra Nevada Alliance. For further information about the Sierra Nevada visit: *http://www.sierranevadaalliance.org*.

A special thanks is extended to Helena Rodriguez of the Sierra Nevada Alliance for her assistance in preparing this article. She can be reached at *helena@sierranevadaalliance.org*.



Climate Change in Mountains - Interview with Dr. Gregory B. Greenwood

Ujol Sherchan

Dr. Gregory B. Greenwood. Photo: C. Perey

Dr. Gregory B. Greenwood is Director of the Mountain Research Initiative (MRI). Prior to MRI, he served as Science Advisor to the Resources Secretary of California and Climate and Bioenergy Advisor for the California Department of Forestry. The issues Dr. Greenwood has dealt with most over the past several years are climate change, especially policy development for both mitigation and adaptation, and natural resource management. During this time, he represented the state on the Sierra Nevada Ecosystem Project, a major interdisciplinary assessment of the mountain range for the US Congress. Prior to 1990, he worked in international natural resource management, principally in Africa and South Asia.

Mountain Forum (MF): Can you tell us about the Mountain Research Initiative (MRI), with reference to its global change focus?

Dr. Gregory B. Greenwood (GBG): MRI is a programme with a mission to promote and coordinate global change research in mountain regions around the world. It has been funded by Swiss National Science Foundation. That has allowed us to set up an office and seriously take on our mission.

"Global change" is not just climate change. Climate change is clearly important, but it is not the only form of global change; that is, it is not the only form of change that goes beyond what you think of as a kind of a regional or local problem. There are issues such as population growth. There are issues of significant changes in economic systems, not just the collapse of communism in different parts of the world, but also trade liberalisation under the World Trade Organisation. A lot of these things go beyond regional or local issues. One must understand how these larger global drivers affect what we call the coupled human-earth system in mountains. “Coupled human-earth system” is a compact phrase: it is not just about the geophysical, or the economic; it is a word about how human beings deploy economic systems with biogeophysical settings in mountain regions around the world.

MF: ... and about the GLOCHAMORE project in which you were involved?

GBG: GLOCHAMORE stands for Global Change in Mountain Regions. It is a project that was funded by the European Commission's Sixth Framework programme. It ran from 2002 to 2005. Its goal was to create a kind of standard "science plan" for studying global change in mountain regions around the world.

GLOCHAMORE allowed us to really dig in and figure out exactly what kind of topics that the community of global change researchers in mountain regions thought were important. If you look at the GLOCHAMORE Research Strategy[1], which is a product of the GLOCHAMORE project, you will see about 28 different topics that were seen by the community of mountain researchers as being key to investigate.

There is a commitment in the GLOCHAMORE Research Strategy to study global change in an interdisciplinary and transdisciplinary way. "Interdisciplinary" means that you try to look at relationship between those 28 different research topics. You do not look at each research topic as a stand alone topic, you try to get a better sense of how they are linked. So you have climatologists working with hydrologists working with economists working with sociologists.

“Transdisciplinary” means that the science community conducts its work in the context of stakeholders. It means that global change researchers investigate how the human-earth system works, but they can do that best if they at least understand the concerns and perspectives of stakeholders who are living and working within the systems they are studying.

MF: What have been the initial findings, if any, of the climate change component of the GLOCHAMORE project?

GBG: I have to set you straight on this. The GLOCHAMORE project set a research framework. It did not conduct the research. What it set is the Research Strategy. Since 2005 we have been implementing that strategy which means getting people in different parts of the world to focus on these issues, and develop the observational systems, models and scenarios. We do not have research results yet.

I think there are plenty of results that have already come out of other studies that do not have their origins in the GLOCHAMORE project - that show the impact of climate change in mountain regions. There is extensive literature on glacial recession. In most mountain regions of the world that have glaciers, most of the glaciers are losing mass. But not every glacier is retreating; not every glacier is losing mass but a majority of them are.

We can see other examples of climate impacts in mountains. In the Sierra Nevada of California, there is a very clear trend toward less snow and more rain during winter, and this has a big impact on the timing of the water release out of the mountains to agricultural areas downstream.

MF: Media have too often focused on retreating glaciers to highlight impacts of climate change. What other less visible changes are occurring in mountains that perhaps need more attention?

GBG: Just in the cryosphere field, one of the most important things is melting permafrost. Permafrost is frozen ground water. You do not see it as you would

Sierra Nevada, USA. Photo: Sierra Nevada Alliance

a glacier. Permafrost is often what holds together very steep mountain slopes. There have been a number of instances in the Alps recently where very steep north-facing slopes have collapsed we think largely because the frozen water that held them together has melted. We are learning more and more about how permafrost will be affected by climate change. This issue is very important for public safety in mountain regions.

MF: What are the implications of climate change for the farmer or agro-pastoralist living in, say, the high Himalaya or the Andes?

GBG: Changes in the water regime are going to be very important for any mountain dweller who works with irrigation systems. Changes in the timing of water release could have very large impacts on mountain farming.

Any shift in precipitation and temperature that is likely to change the floristic composition of mountain pastures will surely affect anyone that depends on grazing animals for a living. This is a subject about which we know very little. Grazing is the principal economic land use in most mountain regions around the world. Yet we know very little about how pastures and rangelands will change with future climate change scenarios.

MF: How can mountain people brace themselves for fallouts from climate change?

GBG: The best thing is to continue to make their cause known to the representatives in governments. The mountain people are dispersed and have poor means of communication, are farther from the levels of power. They must continue to work on the representatives in governments to ensure that their voices are heard. This is not that much different from any other of the local development issues that we've had.

There is a very interesting example of this that doesn't involve mountains. In Alaska, several years ago, some relatively conservative Republican senators became very concerned about climate change because a small group of their constituents, the Inuits living on the coastline of Alaska, were experiencing climate change first hand. Icepacks were much thinner than that they used to be and permafrost was melting under their villages. The villages were threatened by storm tides. It became very clear that a couple of hundred people who were suffering disproportionately from climate change made noise to their representatives. These representatives who normally would not have been well disposed to climate change as an issue became quite sensitised to it because the effect was very clear. Mountain people must, therefore, call attention to specific issues such as their villages are threatened by rock fall because of permafrost melting and their agriculture is threatened because they are unable to get the amount of water that they used to get out of streams. All these acute impacts need to be made clear to decision makers in the capital.

MF: In the face of growing evidence that deforestation is one of the main causes of climate change, we see mountain top removal in the Appalachian region continuing unabated to make way for coal extraction - a "double whammy", if you will. As a US citizen, what is your take on this?

GBG: It is not an issue I have studied. Deforestation impacts of mountain top removal in Appalachia seem to me to be relatively small compared to the change in forests associated with deforestation in the Amazon, Argentina and Paraguay.

Millions of hectares of forests have been converted in other parts of the world. I think that that deforestation is several orders of magnitudes bigger than any deforestation that's happening in Appalachia. I do not think that that level of deforestation in Appalachia is particularly serious as a global change issue. You have to understand that I do not have data available to back up what I just said. I am giving you my impressions. My impression is the impact of mountain top removal in Appalachia is still very severe, and it has to do mostly with, I think, water quality in that region. I am not saying this is not important issue, it is particularly important to the people who live there.

I am personally very concerned with the growing interest in USA with use of coal. That I think is very problematic. That is a global change issue. Putting more carbon dioxide into the atmosphere is not the right direction to go.

MF: How do you see climate change affecting the aid, development, and research patterns in mountain areas?

GBG: We are beginning to see the interest in climate change incorporated into the development agenda. For instance, The Global Environmental Facility (GEF), which brings together the World Bank, United Naitons Development Programme (UNDP) and United Nations Environment Programme (UNEP), was created to augment funding for development projects in order to gain additional benefits under three Conventions, those of Biodiversity, Desertification, and Climate Change. It is a recognition on the part of the donor community that there were these key environmental issues that needed to be addressed in development programmes. I know that GEF has over the last few years focused on climate change and developed programmes that addressed green house gas emissions and has begun to focus on projects related to adaptation to climate change. Adaptation is a very valuable addition to the programme. In the tropical Andes there is a World Bank GEF project focusing squarely on how climate change will affect mountain communities. I think this is a very good sign. Bringing climate change into development decision making increases the amount of information that you need to have about local impacts. We do not yet have a lot of detailed information related to climate scenarios and their impacts in specific mountain ranges. Climatologists are currently taking results from global circulation models to drive regional climate models. We need more of the kind of research if were going to design adaptation projects that make sense for different mountain regions.

MF: What role should governments and development agencies play vis-à-vis adaptation to climate change?

GBG: The first thing is that none of this happens without money. Governments must fund the research necessary to make better adaptation decisions.

What may be required is a kind of deep discussion between the research funding community and development funding community about fundamental interdependence. In the context of US, National Science Foundation, and the Agency for International Development are having an ongoing conversation about the fact that one side needs money to do research, the other side needs information to make wise decisions. It is this better dialogue that needs to happen between those two communities.

MF: Do you think it is too early to formulate mitigation or adaptation strategy as there is still so much we do not know about the workings of climate change in mountains?

GBG: Mitigation focuses on reductions in green house gas emissions. I do not think there is any question that the world as a whole needs to start doing that now. How to reduce emissions while minimising economic impacts is the focus of current research.

Adaptation is different and means dealing with unavoidable future climate change. Regardless of what we do with mitigation, we're going to have climate change for the next 50 - 100 years due to past emissions. If we are to adapt to that climate change, we need more knowledge about how climate will likely change in a given area. Local investments will be made in irrigation systems, water supply hydropower, and roads. These relatively detailed engineered strategies which cost a lot of money must be developed with a fuller understanding of climate change.

I am not saying we need to do nothing until we have more knowledge. You start doing things that are "no regrets" kinds of things and you learn as you go along.

MF: How can organisations or networks such as Mountain Forum, MRI and other mountain stakeholders draw the attention of policy makers to the issue of climate change in mountains?

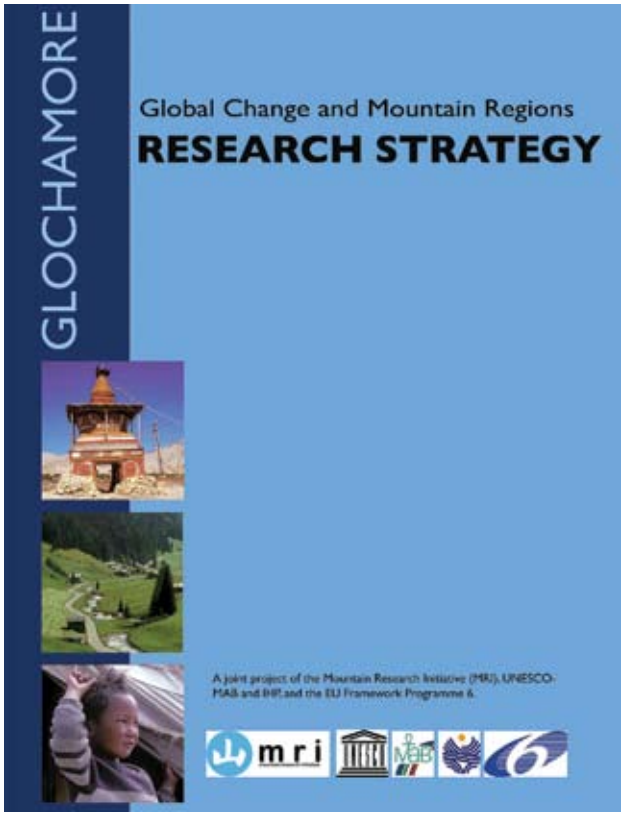
GBG: For any kind of issue, there has always been a problem of attracting policy makers' attention. Policy makers have thousands of issues in front of them. We are always competing with other issues. The mountain community needs to manifest its sense of community by working together to make sure that its big issues are presented compellingly and, more importantly, continuously.

Climate change has been a long twilight struggle. It has always been difficult making this issue tangible to policy makers. It is not a question of being "scientifically correct". Our problem is that we compete with War on Terror, with the latest disaster for people's attention.

Nonetheless we are at a very good time. We should thank Al Gore for making climate change one of the top five or seven issues that the public thinks about at any one time. We need to keep that pressure up. We need as well to say what we want to do. We need to have a response, so that when policy makers finally say "Ah, OK I get it. Climate change in mountain regions - that is a big deal. So what are we going do about it?", we can give them something concrete and fundable.

We need to incorporate a non-static climate into all our government agencies' strategic planning. We have a giant state water project in California that moves mountain water all over the state. It has planned its operations up until now on the basis of a static climate. That is, planners assumed variations from year to year but around a stationary mean. Now we know that the mean is not stationary, that the future will be different and our planning has to incorporate that observation. The same with Highway Departments. We cannot afford to build large infrastructure projects on an erroneous understanding of climate.

I cannot speak for Nepal. I can easily imagine however that in drier parts of the Himalaya, irrigation is very important. There has to be some serious thoughts put into the water supply, and ensure that irrigation systems work or that economies work with less water. Some years ago the Karakoram in Northern Pakistan saw a real shift from wheat to potato as the main crop. The potato is much more demanding of water than wheat. Perhaps people will find that potato is no longer a sustainable crop in that area. So what are the new options? What are the agricultural solutions to provide to farmers in terms of crops and cultural techniques that are adapted to new climate regime? It is high time we got serious about the details of climate change in mountains.



[1] The GLOCHAMORE Research Strategy incorporates the knowledge and inputs of several hundreds scientists working on global change in mountain regions worldwide. The strategy can be downloaded at *http://mri.scnatweb.ch/content/view/74/31/*.

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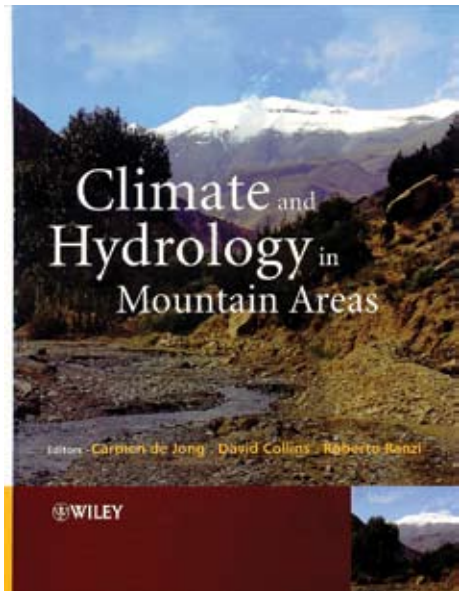
Climate and Hydrology in Mountain Areas

Ellen Wohl



The characteristics of climate and hydrology in mountain areas remain poorly understood relative to lowland areas. High spatial and temporal variability in precipitation, runoff and subsurface flow processes, and stream flow, as well as sparse instrumentation networks and limited historical records of climate and hydrology, contribute to limited understanding of the distribution and movement of water in mountain environments. As the editors of this volume note, mountain regions play an extremely important role as "water towers" to the world, perturbing climatic circulation patterns and storing water for gradual release to adjacent lowlands. The papers collected in this book make an important contribution to advancing our understanding of climate and hydrology in mountain areas because they present pioneering work that, in many cases, represents the first application of existing measurement techniques to mountain regions. These applications demonstrate the utility and limitations of existing techniques in mountain areas, at the same time providing detailed information about the specific regions to which they are applied.

The volume is divided into five sections. Section one, on snow and ice melt, includes "Use of positive degree-day methods for calculating snow and ice melting and discharge in glacierised basins in the Langtang Valley, central Nepal" by Rijan Kayastha and others; "Surface energy balance of high altitude glaciers in the central Andes: The effect of snow penitentes" by Javier Corripio and Ross Purves; "Using subgrid parameterisation and a forest canopy climate model for improving forecasts of snowmelt runoff" by Ulrich Strasser and Pierre Etchevers; and "Assessment of snow-covered areas using air temperatures during melt in a mountainous basin" by Pratap Singh and Lars Bengtsson. Section two, on soil water and permafrost, includes "Permafrost monitoring in high mountain areas using a coupled geophysical and meteorological approach" by Christian Hauck and others; "Effects of frozen soil on the groundwater recharge in alpine areas" by Daniel Bayard and Manfred Stähli; "Water balance in surface soil: Analytical solutions of flow equations and measurements in the Alpine Toce Valley" by Marilena Menziani and others; and "Saturated hydraulic conductivity and water retention relationships for alpine mountain soils" by Stefano Barontini and others. Section three, on evapotranspiration and water balance, includes "Water balance modeling with fuzzy parameterisations: Application to an alpine catchment" by Gerald Eder and others; "Water relations of an old-growth Douglas fir stand" by Timothy Link and others; "Comparison of evapotranspiration and condensation measurements between the Giant Mountains and the Alps" by Carmen de Jong and others; and "Climatologic and hydrologic coupling in the ecology of Norwegian high mountain catchments" by Jörg Löffler and Ole Rössler. Section four, on coupling meteorology and hydrology, includes "Runoff and floods in the Alps: An overview" by Baldassare Bacchi and Vigilio Villi; "The use of coupled meteorological and hydrological models for flash flood simulation" by Charles Lin and others; "Operational weather radar assessment of convective precipitation as an input to flood modeling in mountainous basins" by Stefan Uhlenbrook and Doerthe Tetzlaff; and "Geomorphological zoning: An improvement to coupling alpine hydrology and meteorology?" by Carmen de Jong and others. Section five, on climate change impact and mountain hydrology, includes "The influence of glacier retreat on water yield from high mountain areas: Comparison of Alps and central Asia" by Wilfried Hagg and Ludwig Braun; "Snowmelt under different temperature increase scenarios in the Swiss Alps" by Franziska Keller and Stéphane Goyette; and "Climate variability, water resources, and hydrologic extremes – modeling the water and energy budgets" by Osman Yildiz and Ana Barros.

Except for very short review papers on alpine climate change and cryospheric responses by Roger Barry and the paper on runoff and floods in the Alps by Bacchi and Villi, the papers present detailed case studies. Although each contribution includes an introductory section that provides a brief overview of the topic it discusses, it would have been nice to include more state-of-the-science review papers in this collection. The different aspects of climate and hydrology are well covered. The papers deal primarily with physical processes, with relatively little attention given to chemical or ecological interactions. Discussions of climate change generally do not include changes in land use in mountain environments. Taken together, the collection of papers provides a useful guide to (i) areas of active research and the state of knowledge of climate and hydrology in mountains, and (ii) geographic (e.g. very low and high latitudes, very high altitudes) and topical (for example effects of land use, ecohydrology) gaps in existing knowledge.

The volume is well produced. Although the papers do not include abstracts, each has an introductory and concluding discussion. The text is easy to read and grammatically correct, even though many of the authors do not have English as their first language. The book contains a series of colour plates, along with numerous black and white figures. Even the latter are easy to interpret, although a few do include indistinguishable shadings of gray. The volume is enhanced by a comprehensive index and a list of symbols and abbreviations. Although the content of this volume does have some overlap with various IAHS publications, the papers in this book tend to be longer and more consistently written and edited. This volume should provide a useful guide to those interested in learning more about climate and hydrology in mountains, and a reference for those already working in the field.

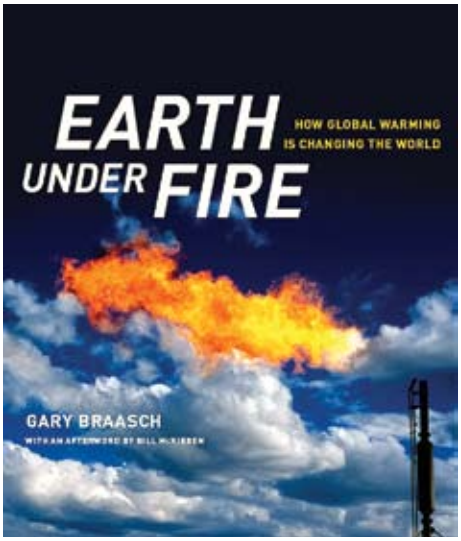
Climate and Hydrology in Mountain Areas
Edited by Carmen de Jong, David Collins, and Roberto Ranzi. Chichester, United Kingdom: John Wiley and Sons Ltd, 2005. xii + 315 pp. €149. ISBN 0-470-85814-1.

This book review by Ellen Wohl was first published in MRD 26.1.

Ellen Wohl works at Colorado State University, Department of Geosciences. She may be reached at *ellenw@cnr.colostate.edu*.

Tracking the Loss of Glaciers in the Andes: An Excerpt from the New Book

Gary Braasch



My photo-documentation "World View of Global Warming" began in 1999, after I learned of climate changes in Alaska. Many other places I was familiar with as an environmental and natural history photographer were also threatened by rising atmospheric temperatures. I set out to record the changes and the science of global warming.

The importance of glaciers to so much of the world and the drama of their settings called me to trek into some of the great mountains of the world to try to document what has been lost. In particular, I set out to re-photograph glaciers that had been captured on film years or decades ago. To find my locations, I researched old books and bins of vintage postcards. I pored over topo maps, trying to locate potentially dramatic views of glacier tongues that would now, I guessed, be shriveled and drawn far up their valleys. In some cases I found out about particular glaciers from scientists or local mountaineers, or ran across photos on the internet. Often, all I had to do was drive to a national park, where old photos of huge glaciers often hang in visitor centers. Still, it is difficult to find a past photographer's viewpoint even in a park, where roads and trails have been rebuilt and former clearings are now filled in with fifty-year old trees.

In the Andes, which contains the largest concentration of glaciers in the tropics, melting has been accelerating; driven by a sixty-year temperature increase that is almost twice the world average. I met glaciologist and mountaineer Alcides Ames at his home in Huaraz, Peru, in July 1999, where he handed me a copy of his study on shrinking ice along with two pictures of glaciers to re-photograph. Not able to guide me himself, he then entrusted me to his American assistant, Bryan Mark. Bryan led me up into the Cordillera Blanca, through snow and knifing winds, to Glacier Uruashraju, at about 15,000 ft (4,500 m). We held Ames's 1986 photo in gloved hands (see cover photo), straining to find the landmarks he described for repeating the view. Even though only fifteen years had passed, it looked like a totally different place - the glacier terminus in the photo was totally gone. I scrambled around to take pictures from a number of viewpoints, worried that after the grueling trek I would not get the matched photos. Only after inspecting the transparencies back home did I realise that the glacier had retreated more than a quarter of a mile (0.5 km) in those few years and was just a smudge of white in my photos. Bryan and I had been standing in Ames's footprints, but the glacier was nearly gone.

A few days later, I trekked alone through the Llanhanuco Valley past Mount Huascarán and up onto the shoulder of Huandoy. I held up an old photo again and again against the mountain landscape endeavoring to find the photo spot on the ridge. This one was taken by the Austrian Hans Kinzl during a 1933 expedition. Across the valley, where in Kinzl's image the fat lobe of Broggi Glacier filled a small basin, I could see only twin tarns where the ice had been. This glacier had receded about half a mile (1 km) in sixty-seven years and was now almost invisible among patches of seasonal snow.

Returning to the Callejón de Huaylas valley gave me new appreciation for the deep connection these people have with their highlands. The villagers here, descendants of the Inca, have suffered greatly from these mountains, even as they derive all their water and sustenance from them. In 1970, an earthquake shook loose a portion of the Huascarán glacier, which fell into a steep valley and became a monstrous mud flow, a slurry of slush and ice chunks and dirt and stone. It then jumped a ridge without warning and completely buried the village of Yungay right up to the church steeple, killing twenty thousand. Thousands more died in Huaraz from the quake. The towns were rebuilt - Yungay was moved a few miles away - and life has gone on. But I was struck by the irony, knowing that today, a new, slow-motion disaster is bearing down on this valley again, one that will inexorably choke off these people's summer supply of water, threatening them again. Forty percent of the water in the Rio Santa, which drains the cordillera, is from melting glaciers. On the Pacific side of Peru, 80 percent of water resources originate from snow and ice. Andean glaciers that had held their own in the mid-twentieth century have been persistently losing mass since about 1976. The flow of glacier water in the Andes will soon be merely a tickle into the many reservoirs and hydroelectric power stations that serve large cities of the Andes, such as Lima, Quito, and La Paz.

I am grateful to those whose assistance and information made this trip to the Andes, and a subsequent one to Quelccaya Ice Cap, possible: Alcides Ames, Edwin Bernbaum, Nilda Callañaupa, Bryan Mark, Celso Jaimes Quispe, Jorge Recharte, Lonnie Thompson, Ankur Tohan, and Miriam Torres. I also thank Alton Byers, who wrote an essay for Earth Under Fire.

EARTH UNDER FIRE: How Global Warming is Changing the World will be published in September 2007 by University of California Press, and will be available on line and at major bookstores.

Gary Braasch's World View of Global Warming project is a dedicated photo documentation of the effects of rapid climate change at *http://www.worldviewofglobalwarming.org*.

Gary Braasch photographs environmental issues and conservation, nature, biodiversity, ecosystems, field science and climate change in stock photos and assignments. He may be reached at *gary@braaschphotography.com*.

Asia-Pacific Mountain Network

An old Chepang man from Dhading, Nepal. Photo: Udayan Mishra

APMN Bulletin

The spring issue of the Asia-Pacific Mountain Network (APMN) bulletin has been published. The bulletin is especially intended for off-line members of the network. It highlights recent activities of APMN as well as critical and emerging mountain issues, plus focuses on mountain-related events and activities taking place in the Asia-Pacific region. Distribution of the bulletin was focused on members with lower internet capability and is part of the drive to keep offline members active and informed as well as online members. Copies are available at: *http://apmn.icimod.org/publications/APMN-bulletin_vol_7_no_2.pdf*

The summer and latest issue of the APMN Bulletin from the Asia Pacific Mountain Network is now available online. The bulletin covers the period from January to June 2007 and focuses on issues of climate change and its impact on biodiversity of the region. The bulletin is available for download from: *http://apmn.icimod.org/publications/APMN-bulletin_vol_8_no_1.pdf*

UN-FAO/ICIMOD Agreement

APMN is carrying out three different tasks for the Mountain Partnership Secretariat (MPS) and Mountain Forum Secretariat led UN-FAO/ICIMOD agreement. In the first, APMN is carrying out a brief assessment of potential of broadband communications to contribute to socioeconomic development in areas of low connectivity in mountain areas (in Nepal). The second activity is developing communication tools to support information exchange and activities of the Biodiversity Conservation Initiative. The third activity APMN is performing is a communication needs assessment and looking at partner linkages in the Central Asia region.

New staff at APMN office

Ms. Sapana Lohani joined APMN/ICIMOD in January 2007 as an Intern. She works primarily on the publication of the APMN Bulletin as well as facilitating other daily activities of APMN. She has a Master's degree in Environmental Science from Tribhuvan University. Prior to joining ICIMOD, she worked as treasurer for the NGO 'Environment Protection Campaign, Nepal' and also coordinated the publication of an Environmental Magazine 'The Earth Preservation' published by 'Environment Protection Campaign, Nepal'.

APMN membership status

As of May 2007, there are 144 organisational members from 21 countries and 978 individual members from 35 countries who are registered with APMN. This accounts for about 35 percent of the total members of Mountain Forum.

Upcoming events

E-India 2007: India's premier ICT4D event
31 July - 03 August 2007. Hotel Taj Palace, New Delhi, India
Contact: sulakshana@eindia.net.in
Web: *http://www.eindia.net.in/*

Call for Essays: Ethics in Science and Environmental Politics, Ethics of Climate Change
Deadline: 2 September 2007
Contact: *esep-submissions@int-res.com*
Web: *http://www.int-res.com/journals/esep/esep-essay-contest/*

International Conference: Natural Hazards and Natural Disturbances in Mountain Forests
18 - 21 September 2007
Conference Centre Panorama (Trento - Italy)
Web: *http://www.sisef.it/sisef/iufro.php?action=page&n=1*

The Future of Forests in Asia and the Pacific: Outlook for2020
16 - 18 October 2007. Chiang Mai, Thailand
Contact: *patrick.durst@fao.org*
Web: *http://www.fao.org/forestry/site/39701/en/*

The 2nd Asia CliC Symposium: The State and Fate of Asian Cryosphere
22 - 26 October 2007
Contact: *qinxiang@lzb.ac.cn/xieaih@lzb.ac.cn*
Web: *http://www.casnw.net/clic/Asia_clic.html*

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European Mountain Forum

Grindelwald Valley, Switzerland. Photo: Martin Price

Project updates

Agrom-Ro Association in partnership with European Mountain Forum (EMF) is running a project called "Project for broadband communication in mountain areas". It aims to assess and increase awareness of the potential for broadband communications to contribute to socioeconomic development in areas of low connectivity through the reduction of the digital divide between mountain and lowland areas.

Its main outcome will be an improved knowledge about the connectivity situation in selected mountain areas and better understanding of the potential needs and interest of mountain communities toward broadband and its relevance for promoting socioeconomic development. The final output will be a document with the main findings of two surveys, their analysis and proposals for follow-up actions.

The targeted area is in the mountains of Mures county, Romania, with 83 villages and one town (Sovata), situated along the valleys of Mures, Gurghiu, Beica, Niraj, and Sacadat rivers (total: 2,203.92 km^2). Total population counts for 63,868 from which 51,515 live in rural areas, while 12,353 reside in urban areas. The elevation varies between 600 and 2,100 m.

For further details please visit the Agrom-Ro project's webpage at: *http://www.mtnforum.org/europe/carpathians/projects/broadband/* and *http://www.agromro.ro/*

Please note: Romanian EMF members and Romanian visitors are encouraged to fill in the online questionnaire in order to help make a rough comparison between the areas this project implementation and other mountain areas in the Romanian Carpathians.

To learn more, you may contact the Agrom-Ro team at *agromro@gmail.com* or the European Mountain Forum at *emf@mtnforum.org*.

Contact

European Mountain Forum

Email: *emf@mtnforum.org*
Web: *http://www.mtnforum.org/europe*

Mountain Tsunami in the Land of the Thunder Dragon

Punakha Dzong along the Pho Chuu and Mo Chuu - the area damaged by the 1994 partial glacial lake outburst flood of Luggye Tso, Bhutan. Photo: Kelzang Rinchen

Nestled high in the Himalayas, the isolated mountain kingdom of Bhutan has done more to protect its environment than almost any other country. But with more than 87 percent population of farmers and hydropower being the backbone of Bhutan's economy, climate change could have a detrimental impact on the lives of the Bhutanese people. The most dramatic threat is posed by glacial lake outburst floods (GLOFs). As the Himalaya's glaciers recede, these lakes form and fill with melt water all along the mountain range, dammed by the rocks of glacial moraine. Of Bhutan's 677 glaciers, some are believed to be retreating at 20 to 30 m a year. And as glacial melt accelerates, 24 of Bhutan's 2,674 glacial lakes are in danger of bursting. Some studies predict the wall separating two lakes in central Bhutan could burst as early as 2010, unleashing 53 million m^3 of water, twice the volume of the 1994 outburst (see caption). The result would be similar to a mountain tsunami, which can wipe out anything in its path.

Source: Reuters *http://www.alertnet.org/thenews/newsdesk/DEL156416.htm*

InfoAndina - Latin American Mountain Forum

New CONDESAN Coordinator
The Steering Committee of Consortium for Sustainable Development of the Andean Ecoregion (CONDESAN) and the Directors of the International Potato Center has announced the appointment of Miguel Saravia as CONDESAN Coordinator, starting May 2007.

Miguel served as an Interim Coordinator since October 2005. During that period, Miguel showed a clear vision in the implementation of the Road Map of the Consortium, led the strengthening of some research projects and the development of funding proposals, and cooperated actively with CONDESAN Partners and Initiatives to meet some of their demands.

Miguel is a librarian by training (Pontificia Universidad Católica del Perú - PUCP, Peru), with a major in management of information and communication technologies (ICTs) for development and graduate studies in management of non-governmental organisations (Open University, UK). He was a member of the Steering Committee of Red Científica Peruana and is currently associated with TIC.pe, an initiative of Peruvian organisations for the application of ICTs from a social perspective; he is a member of the Steering Committee of ASOCAM, a network of regional entities and projects seeking to further reflection on, and sharing and capitalisation of knowledge on local development in rural areas; and is the Mountain Forum representative to Latin America.

In August 2005, Miguel was appointed InfoAndina Leader. From this position, he contributed to the development of Mountain Forum in Latin America, cooperated with the expansion of the Mountain Partnership, and has helped align CONDESAN with its new road map.

RAMP Peru workshop in Cajamarca, Peru. Photo: InfoAndina

RAMP Peru workshop in Cajamarca, Peru. Photo: InfoAndina

Related articles:

- Thinking in ICT – Conversation with Miguel Saravia: *http://lac.derechos.apc.org/?apc=ie_1&x=5058002*
- InfoAndina Leader: *http://www.infoandina.org/infonota-ampliado.shtml?x=5040&cmd%5B58%5D=i-58- 8e77320963a7a9426e80b19d0476bf60*

Project updates

Communication and dissemination support to the RAMP PERU Project
CONDESAN proposes to develop "The Lemelson Recognition and Mentoring Project - RAMP PERU". This project is designed to further social development by promoting and developing technological innovation in less favored sectors of society. RAMP PERU is a project that, through competitive processes, identifies, accompanies and supports any creative individual or group (inventors and innovators), for them to develop proposals with a view to improving the satisfaction of basic needs of less favoured populations. The project also seeks its sustainability by entrepreneurial – social strategies and the creation of a regional and nationwide institutional social network.

The project seeks to further an increase in the number of inventors and innovators in Peru; to promote sustainable social enterprises; to generate employment as a result of the development of new technologies and, lastly, to increase support by the public and private sectors to invention, innovation and enterprise development. To accomplish these objectives, the RAMP PERU project has support from the Lemelson Foundation, which has been lending support to invention and technological innovation to contribute to sustainable economic and social development in countries such as Peru. At present, the Foundation has provided more than 100 million dollars for such purposes in different countries in the world and aims to involve women and youth in technological innovation.

The project is implemented by a National Consortium of three institutions that have been strategically articulated by their skills. GRUPO - Grupo de Apoyo al Sector Rural, as a unit of the Engineering Department of Pontificia Universidad Católica del Perú engaged in research, dissemination and transfer of appropriate technologies for the rural population will provide technical support to innovators and inventors, to make their innovation ideas into technological prototypes; NESST (the Nonprofit Enterprise and Self-Sustainability Team), an international nonprofit organisation with expertise in the development of civil society organisations, will provide advisory and mentoring in the forming of social enterprises; and CONDESAN will provide its solid knowledge of the social problems of Peruvian communities and its expertise in innovation and technology transfer.

The RAMP PERU project is being implemented in three regions of Peru: Cajamarca, Puno and Cusco. The project has two regional counterparts: CEDEPAS NORTE in Cajamarca and CIRNMA in Puno. Choice of these three work areas for the first stage of the project was based on the socio-economic and viability conditions of the regions.

The project started in January 2007 and will operate for five years. The first stage will focus on three regions: Cajamarca, Puno and Cusco, and subsequently expand to other regions in Peru.

The project consists of three stages: preparation, first competitive process, and second competitive process. We are currently in the preparation stage, in which research on the "Technological Innovation System in Peru: Technology Needs and Demands," that basically includes information on the same subject in the three regions, has been completed. Research is in its editing stage, and will be subsequently distributed to all stakeholders. We are also preparing the Strategic Plan for the Project, for five years, and the policy guidelines of the project.

The RAMP PERU project is expected to launch, at the end of the five years, 12 social enterprises and to have at least 12 technological products.

The entire process will be systematically documented by preparing documents on the lessons learned, recommendations, social policies, case studies, as part of the building of knowledge to be disseminated to and shared with the partner institutions and public interested in it, through InfoAndina, that is providing communication and dissemination support to the RAMP PERU project. For further information visit *http://www.infoandina.org* or contact *a.r.ramirez@cgiar.org*.

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North American Mountain Forum

A Yezidis woman in the Sin Jar Mountain Range, Iraq. "Women of the Mountains" was the focus of a global conference held in Utah, USA.
Photo: Russell Lee Klika

Project updates

Women of the Mountains Conference
The "Women of the Mountains" conference took place in Orem, Utah, USA in March 2007. The conference was organised jointly by Utah Valley State College (now Utah Valley University) and the Kyrgyz National Centre for the Development of Mountain Regions as a follow up to the "Celebrating Mountain Women" conference held in Bhutan in 2002. Mountain Forum was represented in Utah by elected Board Members, Sonia Salas (Latin America) and Moses Duku (Africa) and by node manager, Amy Krause (North America).

The Orem Declaration of Mountain Women – an outcome of the conference – was published after extensive editing by conference participants and is now available at Mountain Forum Online Library at *http://www.mtnforum.org/oldocs/579.pdf*. Both Mountain Forum and Mountain Partnership have been invited to be involved in follow-up activities.

Bow Valley Mountain Forum
The Bow Valley Mountain Forum is now one year old with 164 local members and 70 subscribers to the Bow Valley Update bi-weekly newsletter. This local website publicises opportunities for nearby residents and visitors to get more involved in Bow Valley communities. The site focuses on community events and activities that affect economic, social and environmental sustainability in the region. If successful, we hope the idea will be replicated in other mountain communities.

Mexican landscape, Mexico. Photo: Carolina Lopez

The local calendar and homepage on the Bow Valley Mountain Forum are updated on an ongoing basis. However, the rest of the site is also changing and growing as site organisers are still working to meet grant commitments.

Upcoming events

Sierra Nevada Alliance Annual Conference - Sustainable Sierra
Kings Beach, CA, USA. 3 - 5 August 2007
Contact: *sna@sierranevadaalliance.org*
Web: *http://www.sierranevadaalliance.org/conference/*

Parks, Peace and Partnerships Conference
Alberta, Canada. 9 – 12 September 2007
Contact: *info@peaceparks2007.org*
Web: *http://www.peaceparks2007.org*

Banff Mountain Festivals
Banff, Alberta, Canada. 27 October – 4 November 2007
Contact: *mountainculture@banffcentre.ca*
Web: *http://www.banffmountainfestivals.ca/*

On the web

Mexican Climate Change Network
http://www.nottingham.ac.uk/geography/network-mexico/

Many of you may not know that there is a research network for climate change in Mexican mountain regions – surprisingly, based out of Nottingham, England. The Mexican Climate Change Network focuses on drought in Mexico including impacts, responses, and spatial distribution over time. The network fosters dialogue between people working on these issues as they relate to climate change, and encourages integrated research and research development particularly among dendroclimatologists, palaeolimnologists, climate historians and modern climatologists.

Eight Minutes on Mountaintop Removal – YouTube

http://www.youtube.com/watch?v=RPixjCneseE

This volatile issue divides communities in mountainous Appalachia. Mountaintop removal is a form of strip mining that removes the tops of mountains to access coal seams. Permits allow the disposal of rock in valley bottoms below and the storage of slurry on mountain-top sites. Proponents of the practice argue that it supports local economies and provides energy to consumers. Opponents argue that the economic benefits are outweighed by the risks of disrupting valley watersheds and storing coal slurry above communities and watercourses. This video opposes mountain-top removal mining. More neutral information is difficult to find, although the West Virginia Geological and Economic Survey does provide information here: *http://www.wvgs.wvnet.edu/www/mtrm/fa02mtrm.htm*.

Contact

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Did you know?

Earthwatch Expeditions: Volunteer Mountain Field Work

Several volunteer Earthwatch Expeditions travel to mountain places for projects ranging from anthropological and archaeological field work to wildlife conservation. This year alone, expeditions are planned for mountainous regions of Peru, Canada, Japan, China, Australia, Iceland, Mongolia, Mexico, New Zealand, Puerto Rico, and the Czech Republic. The Earthwatch Institute 'engages people worldwide in scientific field research and education to promote the understanding and action necessary for a sustainable environment'. The Institute's extensive volunteer program caters to solo-travellers and groups, teens and families interested in hands-on fieldwork.

Source: *http://www.earthwatch.org/*

Mountain Forum Secretariat

Biodiversity conservation at the Mountain Forum Open House in Kathmandu

The Mountain Forum Secretariat (MFS) and the Asia-Pacific Mountain Network (APMN) co-organised an Open House for Mountain Forum members on 18 January 2007. The focus of the Open House was Biodiversity Conservation, theme of the International Mountain Day celebrated on 11 December 2006. Mountain Forum members, delegates from different organisations, staff from MFS and from the International Centre for Integrated Mountain Development (ICIMOD), and other individuals interested in learning about and joining the network participated in the programme. More than 50 participants were present at the half day event.

The Open House programme was opened by Dr. Ana Maria Ponce, Executive Secretary of Mountain Forum Secretariat. The programme was then followed by welcome remarks from Dr. Madhav Karki, Deputy Director General-Programmes, ICIMOD, and from Dr. A. Beatrice Murray, Acting APMN Coordinator, ICIMOD.

The programme featured two guest speakers. The first presentation on the agenda was "Biodiversity conservation beyond boundaries: A landscape approach through partnership" by the invited speaker Dr. Nakul Chettri, Community Biodiversity Specialist, ICIMOD. The paper was co-authored with Ms. Bandana Shakya, Research Associate, Transboundary Biodiversity Management, ICIMOD. The selected commentator for the presentation was Dr. Eklabya Sharma, Programme manager, Natural Resource Management, ICIMOD; and the plenary discussion thereafter was moderated by Dr. Ana Maria Ponce. The second presentation was on "Community-based biodiversity conservation in Annapurna Conservation Area" by Dr. Siddartha Bajracharya, Member Secretary, National Trust for Nature Conservation (NTNC). Dr. Ekalabya Sharma commented on the paper and the plenary discussion thereafter was moderated by Dr. Madhav Karki. The former presentation highlighted the role of transboundary cooperation through partnerships to help countries meet their conservation goals, while the second presentation focused on the importance of community-based approaches in biodiversity conservation. Both sessions of discussion were active and well represented by the participating Mountain Forum members and guests.

In addition to the talk program, the participants were familiarised with Mountain Forum services, which include publications, online library, website, and e-conferences. "Certificates of Memberships" were distributed to the participating Mountain Forum members.

The Mountain Forum Open House had wide coverage in local newsletters from stakeholders such as FIT-Nepal and EV-K2-CNR.

Abstracts of both papers can be accessed from:
http://www.mtnforum.org/apmn/mfoh2007/1-AbstractPaper-session1.pdf
http://www.mtnforum.org/apmn/mfoh2007/2-AbstractPaper-Session2.pdf

MFS participation at international, regional, and local events

Ujol Sherchan from MFS attended the KM4Dev (Knowledge Management for Development) Forum 2007, in Manila, Philippines during 8 - 9 February. The event was organised by the KM4Dev Secretariat of the Asian Development Bank based in Manila.

Sushil Pandey from ICIMOD also attended the meeting. Mountain Forum and ICIMOD's mission was to provide input in the KM4Dev sessions from the mountain perspective and increase the visibility of Mountain Forum and ICIMOD. Mountain Forum brochures and other Mountain Forum communication material were disseminated at the event.

One World South Asia (OWSA)'s Annual Regional Meeting (ARM) held in Dhulikhel, Nepal. Photo: Mountain Forum

Celine Curi from MFS participated in One World South Asia (OWSA)'s Annual Regional Meeting (ARM) held in Dhulikhel, Nepal on 27 - 28 February 2007. This event was a platform for various agencies and individuals, partners and non-partners engaged in advocacy of developmental issues in order to congregate to pool knowledge and explore new opportunities provided by ICTs so to amplify the voices of the voiceless, and to empower them to participate in processes for sustainable and equitable development in the region. This year's ARM focused on the Millennium Development Goals with a view to review progress, identify key learning and concerns, chart out mid-course corrections, and upscale strategies that work.

Ms. Curi also took part in an Idealist.org initiated meeting (see *http://tinyurl.com/ys6jfn*) at the Pragya English School in Koteswor, Kathmandu, Nepal on 11 February 2007. The meeting revolved around discussions of potential collaborations between Mountain Forum and the School.

New website launched

Mountain Forum launched a new and improved website in March 2007. The new website, among others, features:

- New design
- New section on Mountain News
- Aggregated content on specific themes each month

- Individual webpages for each member, including facility to add photographs and documents
- Real time profile updating systems
- Improved membership systems which allow for city specific networking
- New Features

E-conference report

The e-conference report on "Mountain to Mountain Cooperation: Sustainable Use of Biodiversity, including Genetic Resources, in the Andes and the Himalaya" was released at the end of February 2007. The e-conference, which was held during 12 - 30 June 2006, was organised by the Mountain Forum Secretariat in association with the Mountain Partnership Secretariat, the HimalAndes Initiative, the International Centre for Integrated Mountain Development (ICIMOD), and the Asia-Pacific and Latin American nodes of Mountain Forum.

Participants at the Virtual Innovation Marketplace workshop at Nagdaha, Dhapakhel, Nepal. Photo: Mountain Forum

Virtual Innovation Marketplace Workshop

A two-day workshop on the Virtual Innovation Marketplace was organised by the Mountain Forum Secretariat (MFS) and the Global Mountain Program at Kathmandu over 31 May – 1 June 2007. The workshop aimed to present the concept of an 'innovation and information marketplace' as an innovative way to approach the issue of connecting information supplies with information demands in mountainous regions.

Thirteen participants attended representing the Global Mountain Program (GMP), CONDESAN, the Mountain Forum Secretariat (MFS), the Food and Agriculture Organization of the United Nations (FAO), Bellanet, Himanchal Foundation, ICIMOD, and the Internet Service Providers Association of Nepal as well as an external consultant.

Mountain Forum Annual Board and Node Managers' Meetings

Mountain Forum Board Members, staff from all Regional Nodes and from MFS met during 3 - 10 June 2007 in Kathmandu, Nepal, on the occasion of Mountain Forum's Annual Board and Node Managers' Meetings. Representatives from Mountain Forum's partner organisations - FAO, GMP, UNEP, and TMI, and from main donor SDC - also joined the Board Meeting, which was held at ICIMOD during 5 - 7 June. Discussions mainly revolved around ways to strengthen the network and its collaboration with key stakeholders in the Mountain Agenda.

Participants at the Mountain Forum annual meetings in Kathmandu, Nepal. Photo: Mountain Forum

Executive Secretary vacancy announcement

A vacancy announcement for the position of Executive Secretary at the Mountain Forum Secretariat was recently issued and publicised. Deadline for applications is 10 August 2007. Read the full vacancy at *http://www.mtnforum.org/rs/mfnews.cfm?newsid=5*.

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Dr. Andreas Schild nominated as New Chair of the Mountain Forum Board of Directors

We are very pleased and honoured to announce that Dr. Andreas Schild, a Swiss national, was nominated as the new Chair of Mountain Forum during the Board Meeting held in Kathmandu from 4 – 7 June 2007.

Dr. Schild is a development specialist with over 30 years of experience in designing, planning, implementing, and monitoring cooperation programmes, mainly in the field of sustainable natural resources management. He acquired important management experience through a number of positions that he has held, including Country Director of Swiss Development Cooperation in Nepal and Rwanda/Burundi, Executive Director of Inter-cooperation, a major Swiss NGO, and Chief Technical Advisor in North Korea for the UNDP financed aid coordination program. He has worked long-term in Afghanistan, Bangladesh, and Nepal, and has headed or participated in multiple missions to all of the ICIMOD member countries. Dr. Schild has a PhD in History and Sociology from the University of Berne in Switzerland.

Dr. Schild is not new to the mountains - they are within him - but he is new in his function as Director General of the International Centre for Integrated Mountain Development (ICIMOD), which has been his principle activity since April 2007. Now we are happy to have him as the Chair of the Mountain Forum Board.

We asked Dr. Schild as current Chair of the Mountain Forum Board, how do you see Mountain Forum evolving?

"Concerning the contents and direction for Mountain Forum, I would like to mention two concerns: as a mountain man I do not believe in strong centralised solutions. Local (here regional) ownership is the key for lasting solutions. I will therefore opt basically for decentralised subsidiary approaches," said Dr. Schild.

He continued by saying, "As a simple mind working in a complicated environment, I feel the necessity for more clarity in the cooperation of the different programs, initiatives and partnerships around the Mountain Agenda. The tendency for me will be to look for more clarity among the different actors and to favour the cutting back of redundancies". In closing, Dr. Andreas Schild said, "I look forward to your full support and cooperation in order to be a constructive Chairman".

Using Clean Energy to Reduce Melting Ice in Ghana

Jacob Kow Mensah

Cleaning wood in Ghana. Photo: Jacob Kow Mensah

Wood fuels, including charcoal, account for over 80 percent of Ghana's average total energy consumption each year. Much of the wood fuels, however, are used in households for cooking and heating. A study conducted by Energy Research Group - Ghana, in 1998, on charcoal production and its use in Ghana indicates that over 500,000 metric tons of charcoal is consumed annually in Ghana. This amount means more than 3.6 million tons of wood extracted each year from the forests of Ghana for charcoal production, which is mainly for use in urban centres.

Corresponding estimates of firewood consumption, based predominantly on rural areas, indicate an annual total of 5.83 million tons of wood is cleared annually. If we add up the total amount of wood that is cleared each year to meet our annual wood fuel needs, then the equivalent comes to over 650,000 ha.

The growing pressure on the country's forest resources has also led to increased distances between fuel wood production areas and consumption centres. Charcoal, for example, is produced in the transitional zones of Kintampo, in Dunkwa and in the Ashanti Highlands and is then transported to the major centres of consumption in Accra and Kumasi ranging; distances which range from 100 to 500 km.

The continued use of inefficient traditional earth mound kilns to produce charcoal, coupled with inefficient methods of burning both charcoal - in the traditional coal pot - and firewood - in the three stone pots – combined with the emission of greenhouse gases have all merged with the increasing transportation costs. As a result, charcoal and firewood usage contribute to the depletion of the ozone layer and therefore to global warming. Firewood is currently the most expensive domestic energy source in comparison to kerosene and liquefied

Source: Energy Research Group, Ghana

petroleum gas (LPG). Not only does hybrid solar, LPG, electric cooker (an improved solar cooker) all reduce overdependence on wood fuels, but they also decrease emissions of greenhouse gases into the atmosphere, which in turn reduces global warming and the melting of ice of the mountains.

For more information on the Energy Research Group, Ghana, please contact Jacob Kow Mensah at *jacobkowmensah@yahoo.co.uk*.

Mountain quote

Ampato (6,288 m) in the Andes of southern Peru. Photo: Alton Byers

"On the mountains of truth you can never climb in vain: either you will reach a point higher up today, or you will be training your powers so that you will be able to climb higher tomorrow."

- Friedrich Nietzsche

More Water from Fast Melting Glaciers in the Tien Shan: A Blessing or a Curse for Agriculture?

Daniel Maselli

Tuz Lake. Photo: Andreas Goetz

Glaciers play an important role in agricultural production in the semi-arid areas of Central Asia. This importance is based on the fact that river flow is considerably supplied by glacier and snowmelt in summer when water demand for irrigation is at its peak. Scientific material for the present contribution stems from an article titled "Tracing Glacier Wastage in the Northern Tien Shan (Kyrgyzstan/Central Asia) Over the Last 40 Years", which was recently accepted by the international journal "Climatic Change". The article was written by Peter Niederer, Viktor Bilenko, Natasha Ershova, Hans Hurni, Sergeji Yerokhin, and Daniel Maselli. Studies were carried out on a representative watershed in the Northern Tien Shan mountain range in Kyrgyzstan (Figure 1, page 35) for the period 1963 to 2000 and show a clear trend in glacier retreat. During this short timeframe, glaciers lost 28 percent of their area with an apparent acceleration of wastage since the 1980s. The most affected glaciers are those smaller than half a square kilometre; while they decreased by only 9.1 percent from 1963 to 1986, they lost 41.5 percent of their surface between 1986 and 2000.

Glacier water and agriculture

Freshwater and agriculture are closely interlinked in Kyrgyzstan where 94 percent of the available freshwater is used for agricultural purposes. While glacier melting has been pervasive on a global scale during the last century, Central Asia has been suffering from a particularly large retreat of glacial ice.

It seems evident, that the high mountain glaciers in Central Asia are very sensitive to the

process of global warming and that this is a serious threat for the 'permanent' fresh water resources of the entire region. If the current annual rate of decrease is maintained, the glaciers in the region investigated may well shrink to half of their current surface by the middle of the 21st century. Given the rapid glacier melting and given the importance of the agricultural sector for the national economies, this retreat could become a serious socio-political challenge in the near future for Central Asia. The rapid decrease is an alarming fact, especially in small glaciers, which indicate warming trends more clearly than large ones. The main reason for the melting is a constant increase in mean annual and summer air temperatures as well as a decrease in summer precipitation. Since summer precipitation in Central Asia plays a crucial role in annual glacier mass balance, this combined effect amplifies the negative impact on glaciers.

Paradox of melting glaciers and political responsibility

Freshwater scarcity could become a growing concern in the region that was once a glacier mass, which will have diminished under a critical threshold leading to rapid river flow reduction. This is particularly true during the dry summer period when glacier water plays a vital role for agricultural production in many areas where irrigation is essential. Moreover, the increased need of water for the growing highly populated urban and peri-urban areas may soon add to the (future) competition over scarce water resources and challenge the highland - lowland relationship by further marginalising remote rural areas.

Currently, the fast melting glaciers contribute to a continued increase in river flow, which creates a paradox for many users who do not automatically establish a link between more water and less glaciers. For most of those living in the vicinity of mountains such as the Chu Valley, the amount of river water presently increases or remains stable at a high level. Therefore, it is no surprise that little or no efforts are made to effectively reduce water consumption or to save or harvest water. Simultaneously investing in irrigated agriculture appears to be economically promising. The surface areas requiring irrigation water, in turn, continuously increase while water may become a contested and scarce resource. While this increase in water flow may appear as a blessing for today's users, it may turn out to be a curse for the next generation if no appropriate measures are taken. This alarming fact calls for a rapid political response and challenges the social responsibility of current leaders in Kyrgyzstan and neighbouring countries. It would be meaningful and wise to develop mechanisms to save and harvest water while resources are still abundant; especially to avoid major shortcomings, which may trigger both hardships for people as well as all sorts of tensions and conflicts.

Figure 1. *Subdivision of the Tien Shan mountain range in Western (W), Inner (I), Northern (N), and Central Tien Shan (dotted lines). Study area as black rectangle.* Photo: CAMP / NCCR

Acknowledgements

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You can learn more about CAMP/NCCR at *http://www.cde.unibe.ch, http://www.camp.kg, http://www.nccr-centralasia.org* and / or *http://www.nccr-north-south.unibe.ch.*

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Climate Change Impacts on Freshwater Ecosystems in the Himalayas

Anne-Marie Singh

Golyo Lake, Nepal. Photo: WWF Nepal

The regional programme on Climate Change Impacts on Freshwater Ecosystems in the Himalayas (CCIFEH) is a follow up initiative to an earlier two year Himalayan Glaciers and Rivers Project, which was carried out from 2004 to 2006. It documented impacts of climate change on glacier melt in the Himalayas. Through this project, the World Wildlife Fund (WWF) aims to study and to mitigate climate change impacts on freshwater ecosystems, livelihoods and economy. The project will also research "glacier tipping points", develop a "two degree" scenario model of rise in temperature for India and Nepal, study environmental flows and identify threatened freshwater species and ecosystems. During this research, WWF aims to raise awareness on the issue among local communities and to suggest implementation for adaptation strategies.

About the CCIFEH project

Recently, WWF and other studies have proven that climate change and increased temperatures impact glacier melt as well as the fresh water flow into the rivers of the Himalayan region. These changes highly affect the livelihoods and regional biodiversity in India and Nepal that are extremely dependent on these river systems and basins.

In six sites across India and Nepal the regional programme aims to implement adaptation strategies and climate witness components in order to help deal with changes brought about by climate change. It also intends to generate a better understanding of climate change impacts on fresh water ecosystems by researching glacial melt and discharge patterns of glaciers in the Himalayas, and through the establishment of correlation between glacier retreat and river run off by means of a "two degree" model scenario. The "two degree" model scenario is a global temperature rise model, accepted by WWF, utilised to ascertain the impacts on the environment in the event of two degrees global mean surface temperature increase, as well as to develop mitigation strategies to deal with and, perhaps, reverse these impacts.

Climate change impacts in the Himalaya cause glaciers to melt more rapidly, which, in turn, lead to river flooding and glacier lake outburst floods (GLOF). The Gokyo Lake and the Imja Lake, in Nepal are partially fed by glaciers. A rise in water level affects its species and neighbouring communities in adverse ways. The project seeks to improve its understanding of GLOF events and to develop, as well as initiate subsequent community-based site level adaptation measures in consultation with local stakeholders.

Ladakh, in the state of Jammu and Kashmir, India is home to some of the world's highest wetlands. At this altitude, any change in the size and area of the wetlands and water flow in the rivers could possibly be related to climate change as most of them are glacier-fed. WWF, through this project, executes community consultations and, along with raising awareness on impacts of climate change, documents local community's perceptions of climate change.

The Ganga River is directly fed by the Himalayan glaciers and sustains the livelihoods of several local communities. Changes in the river flow directly impacts population, migration, and habitats, for example of fresh, water dolphins, turtles and crocodiles and so on.

The programme will study seasonal migration rates of these aquatic species to collect primary and secondary data from local communities. Hydrological studies, changing crop patterns, and environmental flows are also linked to the project, in addition to the development of adaptation strategies for aquatic species conservation.

The Kosi basin lies in the eastern part of Nepal. It includes three national parks and one conservation area. The Kosi is the third largest Himalayan river. The threats to its natural diversity in these ecological zones are being accelerated as a result of climate change, brought about in the form of flooding, droughts, landslides and forest fires.

The project aims at assessing the vulnerability of the wildlife reserves in the area and developing community level site adaptations as well as documenting climate witness stories from local communities.

Climate witnesses, Ladakh, India. Photo: Phuntsog Tashi, WWF India

Embankment on Mousini Island, Sundarbans, India. Photo: Anurag Danda, WWF India

The Sundarbans, located in the eastern part of India are the world's largest mangrove forests, and climate change impacts have been partially responsible for rising sea levels, which has resulted in the destruction of local habitats on these low-lying islands. The Regional Programme aims at raising awareness amongst local communities, in the island of Mousuni, with regard to climate change and developing long term livelihood adaptation strategies for local governments to adopt based on scientific validation and existing studies. It also aims at initiating community plantations to strengthen mangrove ecosystems.

For further information, visit *http://www.ccifeh.org* or write to Anne-Marie Singh, Regional Communication Officer of WWF - India at *apsingh@wwfindia.net*.

Tajikistan and the Pamir Mountains

Geoff Hathaway

Jirgitol girls, Tajikistan. Photo: Stephen Fuller

On 23 March 2007 SEEDS (Social Enterprise and Environmental Development System) became the first ecologically based Tajik National NGO. Its work is focused on issues of sustainable land management, ecological preservation, and improved economic stability for local populations.

SEEDS mission

The mission of SEEDS is to continuously and consistently identify unused, misused, mismanaged or overlooked natural and human resources that are available to the Tajik people. Then it aims to develop enterprise, projects or other mechanisms that will realign and utilise these resources in a manner that will assist to create positive and long term economic growth and ecological stability.

SEEDS seeks to create cooperative systems based on community interests and cooperative participatory efforts from the government, as well as boost enterprise development. This can be accomplished by attempting to balance humans with their resources and environment in order to create continuous and stable economic growth, which should be based on appropriate stewardship of locally available natural and renewable recourses.

Ecological overview

Heavily subsidised Soviet energy inputs ceased abruptly in 1992 in part contributing to the civil war, but also creating an environmental disaster. Approximately 90 percent of forests were quickly cut as a fuel source for rural communities.

This situation has not subsided and many mountain communities are on the verge of complete environmental collapse and

decertification of their land resources. Some communities have denuded the land and must travel as much as 16 km to find fuel sources.

Climate change in the Pamir Mountains

Issues and problems related to climate change are already well understood by Tajik mountain communities. For example weather, precipitation and seasons continue to create concern and confusion for local agricultural activities. An underlying theme of SEEDS work is to assist in the development of systems for change and adaptation, as well as much needed survival mechanisms for local populations.

Communities and change

SEEDS understands there is a strong connection between people and their economies and environments. Reinforcing these connections to be visible within communities is a primary goal of SEEDS work.

Currently, SEEDS is seeking partners, supporters, and operational funding towards specific project support and/or through donations.

SEEDS is pleased to join the Mountain Forum family and looks forward to a long and interesting relationship.

You can learn more about SEED at *http://www.tajikseeds.org*.

Geoff Hathaway, Founder of SEEDS, may be reached at *geoff@tajikseeds.org*.

7/7/07 – Concerts for a Climate in Crisis

Live Earth, a 24-hour, 7-continent concert series, will use the global reach of music to engage people on a mass scale to combat our climate crisis. Live Earth will bring together more than 100 music artists, featuring such artists as the Police, Madonna, and the Red Hot Chili Peppers, and two billion people to trigger a global movement to solve climate crisis. Madonna has written a new song for the 7 July Live Earth concerts and the first million downloads will result in a donation to the Alliance for Climate Protection.

Live Earth will be transmitted worldwide, from eight cities (New York, London, Johannesburg, Rio de Janeiro, Shanghai, Tokyo, Sydney, and Hamburg) by Intelsat (http://www.intelsat.com) using its industry-leading network of satellite and terrestrial facilities in standard and high definition, across multiple media channels - TV, radio, internet and wireless channels. Live Earth concerts will be broadcast to a live worldwide audience by MSN at *http://www.LiveEarth.MSN.com*.

Source: *http://www.liveearth.org*

Building Partnerships for the HKKH Region

Emanuele Cuccillato

Sagarmatha (Everest) National Park, Ama Dablam Peak (6,812 m) and a stupa on the trail towards Pengboche. Finding the balance between tourism growth and cultural heritage preservation is becoming a key challenge in SNP. Photo: Emanuele Cuccillato, IUCN

The project "Institutional Consolidation for the Coordinated and the Integrated Monitoring of Natural Resources towards Sustainable Development and Environmental Conservation in the Hindu Kush - Karakoram - Himalaya Mountain Complex" (HKKH Partnership Project) is a regional initiative aimed at consolidating institutional capacity for systemic planning and management of socio-ecosystems at the local, national and regional levels in the HKKH region. The project, supported by the Italian Cooperation, is implemented by The World Conservation Union (IUCN) in partnership with CESVI, Ev-K2-CNR and the International Centre for Integrated Mountain Development (ICIMOD).

The project was presented by Italy and approved by the UN as a Type II outcome of the World Summit on Sustainable Development (WSSD) and is part of the Global Mountain Partnership. This multi-scale initiative is active at regional, national and local levels with a special focus on three protected areas: Sagarmatha (Everest) National Park (SNP) in Nepal, Central Karakoram National Park (CKNP) in Pakistan and Qomolongma Nature Preserve (QNP) in Tibet Autonomous Region of China. Currently, activities have started in Nepal and Pakistan while are planned to begin in China. The intervention will be calibrated on the

specificities of each site and of each country, so that the benefits will be most tangible and effective for the beneficiaries.

A systemic approach for managing complex ecosystems

In high mountain regions of developing countries, several ecosystems are fragile. The communities depend for their livelihoods on the services provided by the same ecosystems, exercising a constant pressure on the resources, but at the same time shaping the ecosystem though long standing traditional management practices. The complex nature of the interactions occurring within these socio-ecosystems render conventional management approaches based on command and control ineffective in achieving long term sustainability. While new approaches and methodologies have emerged to address these issues, few of them have been applied for operational management. Building on the systemic paradigm, the project aims to implement adaptive management and resilience theory to operationally support the planning, management and monitoring processes at local, national and regional scales. Participatory methodologies and science - soft and hard system approaches - will be integrated in a process supporting collaborative management and contributing to fill knowledge gaps on key ecosystem dynamics.

Bridging research and management

Using sound scientific knowledge to support the management process of mountain ecosystems is one of the conditions to achieve sustainability together with the effective participation of the stakeholders directly depending on and managing those ecosystems. Presently, major gaps exist in the knowledge of crucial socio-ecosystem dynamics of the HKKH mountain complex and no clear mechanism is established linking research with management priorities. At the same time, results of past international research are often not available to national institutions and communities directly involved in the management process. Strategies and tools will be developed to bridge research and management through the development of "Research Gateways", platforms dedicated to foster the sharing of existing knowledge and data, as well as to bring together management and research communities with a common goal: sustainable ecosystem management.

Sagarmatha (Everest) National Park. Illegal fuelwood collection linked to trekking and mountaineering expeditions exerts critical pressure on the alpine juniper shrubland.
Photo: Emanuele Cuccillato, IUCN

Tools and methodologies

Building on the most advanced experiences in ecosystem management, the project will develop and test tools to support ecosystem management processes at different spatial and temporal scales. These tools will address the needs of key stakeholders and will be developed through their direct involvement. The tools will gradually evolve into a Decision Support Toolbox for ecosystem management (DST) comprising both participatory and science based modules.

Application examples

The project is conducting several activities, starting with a focus on the local and national levels. Examples of ongoing experiences and applications are:

- Qualitative and quantitative modeling of the dynamics of Sagarmatha National Park (SNP) socio-ecosystem to simulate possible responses to management interventions;
- Scenario Planning with Tourism Operators, Government, NGOs and local communities to develop a common vision for the future of SNP;
- GIS databases and 3-D simulations to support resource use zoning, biodiversity conservation, tourism management and marketing;
- Development of visitor registration systems;
- Support the development of Central Karakoram National Park (CKNP) management plan;
- Baseline studies on biophysical and socio-economic aspects as references for future monitoring;
- One of the most comprehensive online knowledge base focused on SNP, CKNP and CKNP with more than 1,000 entries, including articles, reports, books, maps, etc.;
- Online integrated web portal featuring insights on the project, a searchable knowledge base, interactive web mapping *http://www.hkkhpartnership.org;*
- National workshops on System Dynamics modeling and land cover mapping;
- Exchange visits and cross learning for communities and Park staff.

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ClimChAlp: Climate Change, Impacts and Adaptation Strategies in the Alpine Space

Guillaume Prudent

The Climate Change, Impacts and Adaptation Strategies in the Alpine Space (ClimChAlp), an Interreg III B, is part of the Alpine Space Program. This strategic project was launched in March 2006 and will be carried out until April 2008. Twenty two partners work closely under the leadership of the Land of Bavaria (Bayerisches Staatsministerium für Umwelt, Gesundheit und Verbraucherschutz, Referat Klimaschutz).

The aims of the project are to:

- Strengthen the alpine institutions partnerships;
- Synthesise existing knowledge;
- Provide strategic analysis and recommendations;
- Prepare the future strategic alpine cooperation for 2008 - 2013.

The project is divided into nine working packages (WP):

- WP 1, 2, 3: administrative issues;
- WP 4: information and publicity activities;
- WP 5: climate change and resulting natural hazards;
- WP 6: monitoring, prevention and management of specific effects of climate change on nature;
- WP 7: impacts of climate change on spatial development and economy;
- WP 8: flexible response network;
- WP 9: synthesis and processing.

The WP 5 will be further explained in detail as it is the one in which the author plays an active role. At the French level, the WP 5 is divided into two modules. The first module task is to list the available climatic simulations for the Alps and to provide knowledge on the regional scenarios concerning the Alpine region. The second module task is to provide feedback on the observations and possible impact of climate change on natural hazards.

The Observatoire National sur les Effets du Changement Climatique (ONERC), a service of the French Ministry of Ecology and Sustainable Development, is in charge of module one. The Rhône Alpes Région gave mandate to Pôle Grenoblois Risques Grenoble (PGRN) to responsible for module two.

Both institutions are working very closely to build up the ClimChAlp base. This framework presents a state of the art for future scenarios, while it also observes climate modifications and its consequences on the alpine arc.

An assessment on the three levels of changes and impacts has been provided. The first level concerns the changes in atmospheric parameters, climate change in itself. Temperature, precipitation, air pressure and winds patterns are all detailed in this first level. Then the consequences of the so-called "natural systems pattern" are proposed as a second level of impacts. Eight different "natural systems" have been analysed: surface water runoff, snow cover, underground water runoff, permafrost, glacier, rivers, forest/vegetation cover and erosion. The third level of impacts deals with natural events (floods, torrential events, avalanches, mass movements, glacial hazards, tempests and forest fires). To provide the most objective state of the art study, only information concerning each hazard has been considered. Thus, evolution of damages has not been taken into account since several other factors may blur the development of natural events under changing climatic conditions (population vulnerability, crisis management, insurance cover, stake values increase, and so on).

During the assessment, 91 publications were analysed all of which deal with climate change and climate variability in the Alps. The results provided by the scientific and administrative publications have been classified into four categories of information in order to give a critical analysis of the overall impacts. Each are described below:

Paleo-environmental reconstitutions
This kind of information has been obtained through methods used to reconstitute the climate and activity of past events, including hazards. Direct and indirect methods may provide this type of information (dendrochronology, lichenometry, historical chronicles, ect.).

Observations
This form consists of instrumental measures and their observation methods. These measures are mostly available after the year 1850 and then mainly concerned with the 20th and 21st centuries. Instrumental observations have been carried out by using several methods (thermometer, radar, satellite data, and so on).

Modelling
These results are calculated by modelling. The climatic models can be global (global climatic model) or regional (regional climatic model). This also includes modelling hazards, such as avalanches or debris flow models.

Conjectures
Under this generic term, the work hypothesis and intellectual extrapolations from the observed and modelled changes are proposed.

For each level of impacts, this classification method has been used, leading to a 130 page document called "Analysis". In this document information for each level and origin have been conglomerate. Experts groups have been built for each topic. These experts groups provided a critical point of view of the results proposed and the analysis methods used.

Finally, we are currently working on a synthesis for policy makers. This synthesis aims to give a critical point of view on the actual state of knowledge that could be useful for both local and national policy makers in their decisions concerning climate change vulnerability in the Alps and adaptation measures for natural hazard management.

To learn more you are visit the PGRN website to navigate the ClimChAlp base at *http://www.risknat.org*. You can also have a look on the ONERC website, which presents some of the ONERC publications and climate change indicators in France at http://*www.ecologie.gouv.fr/-ONERC-.html*.

For further details please contact Guillaume Prudent at *gprudent@polarfoundation.org*.

Contributing to Sustainable Development of Mountain Regions in Bolivia

Jorge Choquehuanca

The Bolivian Mountain Institute (BMI – Instituto Boliviano de la Montaña) is a La Paz based scientific foundation with a handful of projects in implementation and ambitious plans for the years ahead. Inspired by the International Year of Mountains (IYM 2002), the BMI was founded the same year and officially set up its own modest offices, which have functioned since 2004.

In accordance with the UN Agenda 21, the mission of BMI - as established in its founding charter - is to contribute to sustainable development of mountain regions in Bolivia through scientific investigation, capacity building and technical assistance, exchange of experience and by carrying out projects.

BMI's work is organised along the following program areas: research for development and conservation of mountain areas; global change in the high Andes; capacity building and technical assistance; sustainable mountain projects; and public debate and awareness.

International Mountain Day 2006

In commemoration of the International Mountain Day (IMD) 2006 BMI, in cooperation with German InWEnt, organised a national forum and debate on climate change titled "Shrinking glaciers and hydrological resources in Bolivia – from research to action". The aim of this important event was to promote discussions on the impacts of glacier retreat and its consequences on hydrological resources and water supply, as well as to highlight future actions.

The central presentations were given by Dirk Hoffmann (BMI) depicting the main findings of InWEnt's Andean Regional Conference Climate Change, retreating glaciers and hydrological resources, which was held in Quito in October 2006. Carlos Laruta from the Ministry of Water presented the new Bolivian government's policies on water resources and watershed management, followed by a presentation from Edson Ramírez (Hydraulic and Hydrological Institute of UMSA University) on future predictions of glacier retreat and impacts on water availability for the La Paz - El Alto metropolitan region. Subsequently, Oscar Paz, coordinator of Bolivia's National Climate Change Program (PNCC), presented the country's adaptation program on climate change.

Presentations can be downloaded from BMI's web site at: *http://www.bolivian-mountains.org/_spaprivate/forodic06.htm*.

Shrinking glacier, Huayana Potosi (west face) in the Cordillera Real, Bolivia. Photo: Dirk Hoffmann

Projects and activities

Country study "Socio-economic impacts of glacier retreat in the Bolivian Andes"
Since practically no relevant research has been carried out on socio-economic impacts of glacier retreat in Bolivia, this country study is the first approach to attain an overview of future scenarios related to the melting of small glaciers in the Bolivian Andes. (For further details, please refer to the article on page 17).

Glacier Archive project
At regular intervals trips are taken to visit different glaciers of the Bolivian Andes, wherein photographs of glaciers are taken. Exact geographical location and dates are recorded, which over time makes glacial retreat visible through a photographic time series.

Mountain Waste project
Excursions are taken to mountain areas. Participants bring trash bags to collect wastes along the way. Upon return, the wastes are photographed and classified. Objects retrieved thus far include pottery, coins and airplane parts, among others. The aim is twofold to help clean up high mountain areas, while at the same time to raise public awareness about problems waste creates in mountainous areas.

Initiative to found the "Chacaltaya Glacier and Ski Slope Museum"
Although accelerated melting of the glacier has now made skiing impossible, the Chacaltaya Glacier is still renowned as "the world's highest ski slope with a lift". Scientific predictions foresee a period of not even five years, before the glacier will completely disappear. Thus, this museum intends not only to recall international skiing competitions held here up to the 1970s, but to also serve as a reminder of human induced climate change effects.

Mountain Protected Areas
This project, launched in 2006, aims to identify and to promote sites for high mountain protected areas. It takes into account aspects of biodiversity conservation, the different possible classes of protection possible under Bolivian legislation, as well as social acceptance and participation of local populations. Currently, BMI concentrates efforts on the Tuni - Condoriri National Park in the Cordillera Real where efforts are underway to install a permanent park administration.

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Climate Change and Patagonian Glaciers

Agustina Barros, Ricardo Villalba, Mariano H. Masiokas

Mountain glaciers are critical sources of fresh water, which contribute to the sustainability of socio economic activities such as hydroelectric power generation, agriculture and tourism. Glaciers are also considered to be key indicators for the early detection of global climate change.

The Patagonian Andes (Figure 1) encompass a series of environmental conditions that make them extremely suitable for the study of natural climatic variability. These mountain systems are highly sensitive to climate variations and are one of the areas less affected by anthropogenic activity (for example acid rain and nitrogen fertilizer). This region is by far the largest glacierised area in South America, covering over 20,000 km², mostly concentrated south of 45ºS. Although glaciers between 35ºS and 45ºS cover much less of an area than the ones located South, only 300 km², they constitute a valuable source of information for the study of climatic change, as their relatively small size make them particularly sensitive to synoptic changes. Also, these areas have been less studied in comparison to the Southern areas.

For a better understanding of glacier and climate change, different studies have been undertaken using aerial photographs, satellite images, historical documents, tree-ring records and field measurements. The present study focuses on the documentation of glacier recession in the North Patagonian Andes through paired photographs over the past 110 years. In addition, it analyses climate records from 1912 to 2002 for stations between 39ºS and 45ºS to develop a simple climatic index. The use of historical images for studying glacier fluctuations are a valuable tool as they can provide precise information about past glacier volumes and frontal positions. The comparison of these historical pictures with recent ones shows the impact of recent climate change on fragile environments like Patagonia. With regards to this, the Argentinean Institute for Snow, Ice and Environmental Sciences (IANIGLIA) has a significant database containing several hundred historical pictures and sets of paired photographs showing glacier change over the last century.

For this study, different glaciers from the North Patagonian Andes, with good quality pictures, were selected. Figures 2, 3, and 4, show three of these mountain glaciers including, Lanin, Torrecillas and Frías respectively, where marked glacier recession can be observed. These comparisons reveal that over the past century the climate conditions in the region have clearly favoured ablation over accumulation in the mass balance glaciers. Regarding the climate index, there is a high tendency towards drier and warmer conditions over the period from 1912 to 2002. During this interval, average warm season (October – March) temperatures have increased by 0.056ºC per decade, whereas cold season (April – September) precipitation records have declined at a rate of 4.89 percent per decade. The climate index is correlated with the regional stream flow records derived from the seven longest and most complete records from the North Patagonian Andes, which confirms the validity of the index. Also, the correlation with precipitation and temperature, demonstrates a strong regional pattern of discharge controlled by precipitation variability over the last century. These findings have a considerable implication for the evaluation of the importance of possible future changes in precipitation and temperature in the Patagonian region. Other results from atmosphere-ocean general circulation models suggest that the temperature and precipitation trends observed in Northwestern Patagonia will continue into the 21st Century.

This information and the continuity of global warming studies are of crucial importance for future water resource management programs and regional development initiatives that are adapted to the new conditions of climate change and glacier recession.

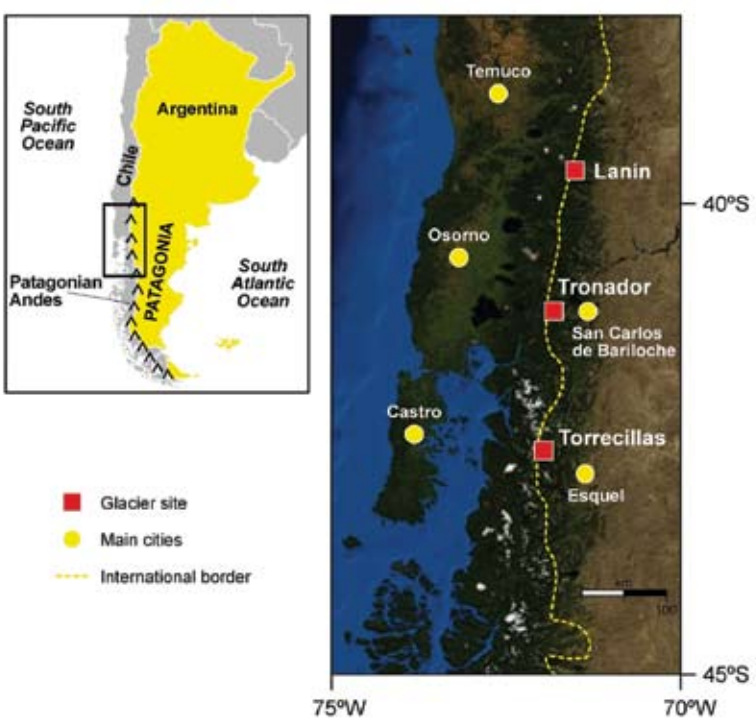

Figure 1. *Location of Northwestern Patagonia glacier sites and main cities. Lanin Norte Glacier (39º 39'S, 71º 30'W).* Source: IANIGLIA

Figure 2. *Changes in the Lanin Norte Glacier front in 1896 and in 2001.* Photo: Moreno (left), Villalba (right)

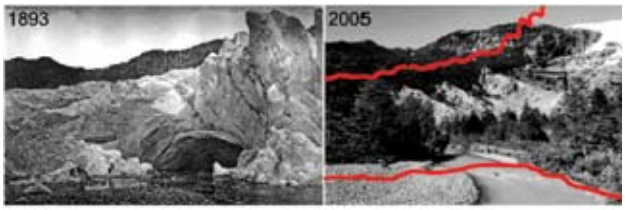

Figure 3. *Recession of Frías Glacier in the Tronador area receded between 1893 and 2005.* Photo: Stephen (left), Masiokas (right)

Figure 4. *Glaciar Torrecillas in Los Alerces National Park shows significant recession between 1937 and 2007.* Photo: Parques Nacionales (left), Villalba (right)

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To learn more about IANIGLIA visit: *http://www.cricyt.edu.ar/?g=mostrar&i=ianigla* or write to *ianigla@lab.cricyt.edu.ar*

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Argentina. Photo: Agustina Barros

The Mountain Research Initiative

Claudia Drexler

The Mountain Market at the February 2007 workshop of the Global Change Research Network in European Mountains (GCRN_EM). Photo: MRI

The Mountain Research Initiative (MRI) promotes and coordinates research on global change in mountain regions around the world. It is funded by the Swiss National Science Foundation (SNSF) and the Swiss Federal Institute of Technology (ETH Zürich) and has offices at the ETH and the University of Lausanne, Switzerland.

Like Mountain Forum, MRI is concerned with sustainable development of mountain environments under economic and climatic global change. MRI concentrates on the research section of this community. MRI's goal, as enunciated in the International Geosphere-Biosphere Programme (IGBP) Report 49, is to foster research that detects the signals of global changes, assesses the impacts of these changes for natural ecosystems as well as for human societies, and contributes to the sustainable management of mountain resources. As MRI is a promotion and coordination initiative, it seeks to achieve these goals through three strategic activities: framing research approaches, influencing funding, and developing cohesion in the research community through communication.

The GLOCHAMORE (Global Change in Mountain Regions) project laid out strategic foundation for MRI's present activities. It was funded by the Sixth Framework Programme of the European Union (EU) from 2003 to 2005, and framed a global change research agenda for mountain regions worldwide. The output was an integrated and implemental research strategy to understand the causes and consequences of global change in mountains. Critical to the development of the strategy was the participation of 28 UNESCO Mountain Biosphere Reserves (MBRs) and the integration of activities and knowledge from both natural and social sciences. In 2005, the publication of the GLOCHAMORE Research Strategy capped a two year effort consisting of four thematic workshops and a final Open Science Conference. The strategy not only lays out the rationale, research goals and actions for twelve disciplinary themes, but also advocates an integrated approach both across disciplines (interdisciplinary) and between science and stakeholders (transdisciplinary).

In 2006, MRI broadened its focus from strategy development on a global level to the initiation and support of regional networks of global change researchers. With the GLOCHAMORE Research Strategy, MRI not only produced a framework for research, but also - principally through regional networks – gave tangibility to the strategy. MRI started several regional initiatives to tackle this translation. Following the April 2006 conference 'Climate Change: Organizing the Science in the American Cordillera' held in Mendoza, Argentina, MRI facilitated the launch of the American Cordillera Transect.

The advent in December 2006 of a call in the EU Seventh Framework Programme (FP7) for research on climate change impacts on vulnerable mountains regions galvanised MRI's European community and greatly accelerated the formation of a Global Change Research Network in European Mountains (GCRN_EM). MRI launched the network at a workshop on 1 and 2 February 2007 in Zürich, Switzerland titled "Developing a Global Change Research Network in European Mountains: Going Beyond FP7". The workshop attracted a large audience of over 90 scientists from 21 countries, including the Eastern European countries, and Turkey. MRI structured the workshop in light of the FP7 call. Coordinators of consortium responding to the call were invited to describe their projects. Participants interested in adding a proposal had the opportunity to describe their research.

MRI is currently working with the Monsoons Asia Integrated Research Study and with the Consultative Group on International Agricultural Research (CGIAR) and a host of African institutions to develop networks in Monsoons Asia and Africa, respectively.

The regional networks initiated and supported by MRI have several purposes:

- Exchange between global change scientists;
- Coordination of scientific information;
- Initiation of integrative and comparative studies.

Further information about

- GLOCHAMORE *http://mri.scnatweb.ch/content/category/3/10/31/*
- The American Cordillera Transect for Global Change Research h*ttp://mri.scnatweb.ch/content/category/3/45/67/*

Participants define priority themes of the Global Change Research Network in European Mountains (GCRN_EM). Photo: MRI

- Global Change Research Network in European Mountains *http://mri.scnatweb.ch/content/category/3/47/30/*
- Global Change Research Network in African Mountains *http://mri.scnatweb.ch/content/view/170/80/*

If you are interested in the MRI's activities please visit *http://www.mri.scnatweb.ch/* and subscribe to the MRI Newsletter.

If you are looking for experts on global change in mountain topics (or if you want to enter your data into the MRI database) visit the MRI Experts Database at *http://mri.scnatweb.ch/index.php/content/view/40/44/*.

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Glacier National Park without glaciers?

View of Grinnell Glacier taken from the summit of Mount Grould (2,133 m), Glacier Natural Park, Montana, USA. Photo: Karen Holzer, USGS

A century ago there were 150 glaciers in Glacier National Park. Today, 27 glaciers remain; 90 percent of the ice volume is gone since then. At the present rate within 25 years we will see disappearance of the last glacier in Glacier National Park.

Source: Dan Fagre, a Research Ecologist and Global Change Research Coordinator for the Northern Rocky Mountain Science Center of the U. S. Geological Survey. He has been stationed at Glacier National Park, Montana for the past 15 years. *http://nrmsc.usgs.gov/research/global.htm.*

Climate Change and Mountain Biodiversity

Jeffrey A. McNeely

Mount Makalu (8,462 m), Nepal. Photo: Jeffrey A. McNeely, IUCN

Mountains have long been a calm, cool refuge from the busy steaminess of the lowlands far below. Walking through mountain forests, pastures, and snowfields gives one a sense of peace and solitude, and make it easy to forget, at least for a few fleeting hours, the problems of the world. But the biggest environmental problem in the world is now posing an existential threat to the biodiversity of the mountains.

For despite their lofty aloofness, mountains, too, are suffering from climate change. Their habitats are changing, and their biodiversity increasingly is in danger of extinction: more than half of Europe's mountain birds are threatened, according to Bird Life International. The snows of Kilimanjaro are now a light dusting on the highest peaks; glaciers are in rapid retreat in the Alps, the Rockies, the Himalayas, and the Andes; lowland species are inexorably moving up the mountains as climates warm, driving before them the species that have already been confined to the higher elevations.

The World Heritage Centre and UNESCO have recently released a series of case studies on Climate Change and World Heritage, pointing out the profound influence on World Heritage properties such as Sagarmatha National Park (Nepal), Huascaran National Park (Peru), Kilimanjaro National Park (Tanzania), and Jungfrau-Altsch-Bietschhorn (Switzerland). All of these sites, selected on the basis of their outstanding universal value, are being profoundly influenced by the retreat of their glaciers and the colonisation of new plant communities inexorably moving uphill. In Kilimanjaro for example, the area covered by

snow and ice has shrunk by 80 percent since 1900, and may disappear altogether by the year 2020; and over the past three decades, the glaciers of Peru have lost almost a quarter of their 3,170 km^2 surface. Since these tropical glaciers are very sensitive to global warming, projected climate changes could imply the total melting of Peru's glaciers in the next several decades.

These mountain treasures, like many other mountains throughout the world, contain plants and animals that are unique to the high elevations, adapted to bitterly cold winter temperatures, short growing seasons, seasonal migrants from lower elevations, and various other physiological and behavioural adaptations. Mountains can be seen as sort of terrestrial islands, with their unique biodiversity evolving in splendid isolation from the sea of human influence below. Many have high levels of endemism. For example, in 2005, a new monkey was discovered in the southern highlands of southwest Tanzania, the first monkey to be discovered in Africa since 1984. The highland mangabey was found in a part of Tanzania that is noted for its endemic species, the Udzungwa Mountains. A new genus and species of conifer, named *Xanthocyparis vietnamensis*, was described in 2002. It apparently is confined to one limestone mountain massif on the border between Vietnam and China. Whereas in the Great Smoky Mountains National Park in Tennessee, USA, a recent weekend of active inventory work yielded 850 species of moths and butterflies, of which 53 of them are new to science.

However, global warming and other aspects of climate change are now driving many of the mountain species higher up the mountains as the sea of lowland vegetation continues to rise until no suitable habitat remains, leaving extinction as the ultimate fate of too many species. Scientists have found that the recent mass extinction of amphibians is associated with pathogen outbreaks tied to global warming. In 1989, in the mountains of Costa Rica, the Monte Verde harlequin frog vanished along with the golden toad. An estimated 67 percent of the 110 or so species of Atelopus, a genus of frogs endemic to the American tropics, have met the same fate, probably due to a pathogenic fungus. Analysing the timing of the losses in relation to changes in sea surface and air temperatures indicates that large-scale warming is a key factor in the disappearances; temperatures at many highland localities are shifting towards the growth optimum of the deadly fungus, thus encouraging outbreaks.

As just one more example, nine of the twenty-five historically described populations of the Great Basin Pika (*Ochotona princes*) have become extinct, primarily due to climate warming that has forced them to higher elevations. For the populations that have become extinct, they had no higher habitats to which to climb. The remaining populations are retreating higher up in mountains; for example, in Yosemite National Park in the Sierra Nevada Mountains of California, pikas have moved over 500 m upwards over the past 90 years. Another part of the reason for these population extinctions is that the pikas are isolated on mountains with no easy way of moving to adjacent mountains, an example of the "island effect" found on the mainland.

Climate change is also likely to bring about changes in disturbance regimes, including more frequent fires, more spectacular floods, and even disastrous draining of mountain lakes formed behind glaciers. At least 20 glacial lakes are at risk of bursting in Nepal, with even more in neighbouring Himalayan countries. The lakes are formed behind moraines, but the amount of water in the lakes increases as glaciers melt, so the pressure on the natural dams increases until they burst, freeing huge volumes of water to rush down the mountainside and wash away villages built too close to stream beds. Nepal's glaciers are now receding at a rate of 30 to 60 m per decade. In Tibet, some 95 percent of the glaciers are retreating; temperatures are rising and water availability is declining, thereby undermining agriculture on the Tibetan plateau. Already, wells are running dry and small rivers are disappearing.

Adapting to climate change in mountains is no simple matter. Mountain farmers need to consider changing planting dates, use different species and mixes of species they plant, and improve the efficiency with which they use water. For biodiversity conservation more generally, some species-specific conservation measures may be required, and more active intervention in habitat management may need to be considered. Management techniques such as prescribed burning may be required to manage forest density and maintain some of the threatened alpine species. Protected areas may need to be expanded or adjusted so that they incorporate greater landscape diversity that will allow shifts in species distributions; protected areas might also be usefully linked with other protected areas by corridors of suitable habitats, providing substantial north-south landscapes such as the Yellowstone to Yukon Biological Corridor, the Andean Biological Corridor, and the Meso-American Biological Corridor. All of these approaches will need stronger science to support their implementation, calling for greater investment in monitoring the changing climates and their implications for mountain biodiversity.

People are very much part of the adaptation picture. For example, preserving plant species diversity at the landscape level in the Alps requires the maintenance of a high diversity of land use types. In the Alps, species diversity in mountain grasslands depends on old cultural traditions, with significant variation among these. Maintaining cultural adaptations to mountain living will be part of adapting to changing conditions

The mountains of the world have been an important refuge for numerous species, seeking sanctuary from climatic and other conditions to which they were not well adapted. The rapid climate changes that mountains are experiencing today are having profound influences on mountain habitats, the species that occupy them, and the humans with whom they share the rugged heights. Increased efforts are required to slow the rate of climate change, maintain both montane forests and the lowland forests that provide moisture to the uplands, and link mountain refuge in larger landscapes that will enable biodiversity to adapt to the environmental changes that are sure to come in the coming decades.

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Tackling Climate Change in Partnership

Jane Ross

Canada. Photo: Aris Michich, FAO

Mountains host sensitive indicators of global climate change. As the world heats up, mountain glaciers - the source of water for many of the world's river systems and people - are melting at unprecedented rates, while rare plants and animals struggle to survive over ever diminishing areas, and mountain people, already among the world's most disadvantaged, face greater hardships.

We cannot reverse the effects of climate change. However, understanding how climate change affects mountains and working to mitigate its effects is vital for us all - wherever we live.

There are an array of debatable issues and predictions related to climate change. Nonetheless, it is a fact that extremes of climate are becoming more and more common in mountain areas. As global climate change threatens to disrupt mountain environments, life for mountain people in particular - already amongst the world's poorest and most vulnerable - may only get harder. Just as warming trends are forcing many species to migrate uphill in search of habitat, mountain people too may have to adapt to changes - or leave their homes, as traditional sources of food and fuel grow scarce. At the same time, mountains could become more dangerous as the melting of glaciers compromises water storage and melted permafrost increases the likelihood of hazards such as falling rocks, landslides, floods and avalanches. Many mountain people depend upon agriculture for their livelihoods, but climate change could have a significant adverse impact on farming. Irrigation could be affected, first by floods and then by drought, making survival harder for subsistence farmers as well as those who grow cash crops. Nearly all economic activities such as tourism would decline as mountain ecosystems changed irrevocably. One of the indirect consequences of global warming in mountain regions is the increasing risk of infectious diseases. Scientists have reported that the mosquitoes that carry malaria, dengue and yellow fever are spreading to higher altitudes as temperatures warm. Ticks are proliferating northwards and to higher altitudes, causing disease, and insect pests are predicted to spread causing damage to crops. With few resources to ward off infectious diseases, mountain people could be among global warming's greatest victims.

The implications of climate change for specific mountain ecosystems and regions are as yet unknown and under discussion. However, for the sake of mountain environments, mountain people and all of us who depend on mountains - for water, energy, food and medicine - it is vital that we study and monitor the biological, physical and environmental health of mountains so that we can better understand, manage and mitigate the effects of climate change.

Over the last few years, there has been increasing recognition by the international community of the need to rise to the challenge of climate change in high-altitude areas. For example, the last World Conservation Union's World Conservation Congress (WCC) (Bangkok, 17 - 25 November 2004) explored the effects of climate change on the world's mountain ecosystems. Experts attending the event warned that little was being done to monitor the state of glaciers in the Himalayas, which were melting due to global warming and thereby increasing the risk of major floods. The WCC included a workshop on conservation and sustainable development in mountain areas and adopted several resolutions and recommendations directly relating to mountains. Since then, many organisations have been working towards these goals through advocacy, research, education and action on the ground.

- Around the world, the Mountain Research Initiative (MRI) is working at the interface between climate change and mountains. It conducts a scientific programme that detects signals of global environmental change in mountain environments, defines the consequences of global environmental change for mountain regions as well as lowland systems dependent on mountain resources, and informs sustainable land, water, and resource management for mountain regions at local to regional scales. Among its numerous activities, MRI produced the influential study 'Global Change and Mountain Regions – an overview of current knowledge', managed the recent EU-funded GLOCHAMORE (Global Change and Mountain Regions) project, which convened the international Open Science Conference, and produced the GLOCHAMORE Research Strategy. This is a significant step in furthering our understanding and knowledge of the causes and consequences of global change research, including climate change, and generating collaborative efforts to address the challenges at all levels.
- In the Himalayas, the Ev-K²-CNR Committee oversees the Ev-K²-CNR Project, which has become one of the main international cornerstones of high-altitude and remote-area scientific research in the world. It manages the Pyramid International Laboratory - Observatory at the base of the Nepali side of Mount Everest. This monitoring tool helps us better understand mountain ecosystems, their processes and interactions with the human component, and the effects of global changes at the local level.
- In Central Asia, the Regional Environmental Centre for Central Asia (CAREC) in Kazakhstan recently completed an exemplary project to further environmental awareness and education in the sub-region of climate change, through the production and dissemination of new educational resources (textbooks, posters and video) for secondary schools. There are now clear indications that this Kazakhstani experience is being replicated in other countries in the Central Asia region.
- In Africa, the International Development Research Centre (IDRC) and UK's Department for International Development (DFID) launched a multimillion dollar research programme that will help the poorest in the region cope with the increasing impact of climate change, which is already making them vulnerable to flooding, soil erosion, drought, and crop failure. The programme is expected to strengthen adaptation in a range of ways, such as assisting communities plan and take water conservation measures to make

Arun river, Nepal. Photo: Jeffrey A. McNeely, IUCN

them less vulnerable to drought and improving agricultural production and food distribution practices to ensure secure food supplies during extremes of climate.

- In the European Alps, the annual symposium of the International Commission for the Protection of the Alps (CIPRA) (Bad Hindelang, Germany, 18 - 20 May 2006) focused on the growing threat to Alpine regions posed by natural hazards and the impact of climate change on Alpine tourism. A key outcome of the event was the adoption of the CIPRA Resolution on 'Climate Protection and Climate Change Adaptation Strategies'. This calls upon the European Union, the bodies of the Alpine Convention, the Alpine states and all governmental and non-governmental authorities to intensify their climate protection efforts and to draw up sustainable strategies for dealing with the growing repercussions of climate change.

All of these organisations are working individually and with partners at the local, national and regional level to create awareness, exchange information, generate knowledge and promote concrete action on the ground. However, there is even greater scope to work together in partnership to strengthen and consolidate efforts within and across regions. And that is the Mountain Partnership. 'We can do better and achieve more by working together than working alone' this is the core rationale behind the Mountain Partnership, a global alliance of countries and organisations committed to improving the lives of mountain people and protecting mountain environments around the world. As of today, a total of 142 members in five regions have joined the Mountain Partnership: 47 countries, 15 intergovernmental organisations and 80 major groups (civil society, NGOs and the private sector).

All of the above organisations are coincidentally members of the Mountain Partnership. Indeed work has recently begun between some of them to use their collective energies and commitment to focus on climate change issues within the framework of the Mountain Partnership. A special side event, 'Climate change and sustainable development in high altitude and remote areas' took place during the 15th Session of the United Nation Commission on Sustainable Development (CSD-15) (UN Headquarters, New York, 9 May 2007). The event was organised by Mountain Partnership members, the Government of Italy and the Ev-K^2-CNR Committee, in collaboration with other members such as the Interim Secretariat of the Carpathian Convention (UNEP-Vienna ISCC) and the European Academy of Bolzano (EURAC), as well as the 'Friends of the Mountains' Group of the Italian Parliament. It focused on the links between science, sustainable development and cooperation, highlighted specific project examples from the European Alps, the Carpathians and the Himalayas, and discussed the role of the private sector in achieving sustainable mountain development.

We cannot undo the harm already inflicted by climate change. But we can reduce and mitigate the effects and plan for the future by working individually and in partnership. There is clear potential for us to use the framework of the Mountain Partnership to tap into the wealth and diversity of resources, knowledge, information and expertise, from and between one another, to catalyse our collective efforts in order to tackle climate change in mountains.

For further information, contact Jane Ross, Communications Officer, Mountain Partnership Secretariat at: *jane.ross@fao.org* or visit the Mountain Partnership website at *http://www.mountainpartnership.org*.

Earth Day 2007: Climate Change in Nepal and the Consequences for South Asia

Forum on climate change at the American Center in Kathmandu, Nepal. Photo: Sudhir Mahat

The US mission in Kathmandu actively supports efforts to increase awareness of environmental conservation in Nepal. The American Center designated April as "Environment Month." On 18 April 2007, the American Center held a forum on Global Climate Change. Basanta Shrestha, Division Head of Mountain Environment and Natural Resources Information Systems (MENRIS) of ICIMOD gave a talk on "The Impact of Climate Change on the Himalayan Glaciers" while Sandeep Chamling Rai, Program Manager, Climate Change and Energy of WWF Nepal spoke on "Perspectives and Challenges of Climate Change in Nepal".

The need for governments and civil society to collectively work toward better environmental practices was discussed and the importance of individual consciousness and action was stressed. Nepal is blessed with a magnificent landscape with its Himalaya Mountains serving as a water source to nearly half of the world's population. In order to protect Nepal's precious environment and ensure a healthier planet, we must continue to work together to promote conservation.

Visit the embassy website at *http://nepal.usembassy.gov*

World Environment Day 2007 in Indian Himalayas

Rashmi Gangwar

WED celebrations in Baramulla, India. Photo: CEE Himalaya

The Centre for Environment Education (CEE) Himalaya celebrated World Environment Day (WED) on 5 June 2007 with students from Reckong Peo. Remote, but picturesque, Reckong Peo is located in Kinnaur, the south eastern district of Himachal Pradesh. It has magnificent views of Kinner Kailash (6050 m). Approximately 500 students from eight schools in and around Reckong Peo participated in WED celebrations, which included a poster competition, showing of a film and awareness talks on this year's theme and related local concerns. The celebration was organised in collaboration with the Departments of Education and Forest, the Government of Himachal Pradesh and Mahila Kalyan Parishad, a local NGO.

Through colours and crayons the children beautifully expressed their perceptions and concerns about the theme "Melting Ice - a Hot Topic?". The poster making competition was conducted in two categories – 'group A' for students from standards nine to twelve years old and 'group B' for children ages six to eight. 'The Last Show on Earth', a film by Philip Cayford - a story about extinction on a global scale as well as hope and the work of those struggling to save endangered species and our planet - was screened on this occasion.

Since the 1970s, an average air temperature increase of 1°C in the Himalayas has been recorded. Sixty seven percent of the Himalayan glaciers are retreating at a startling rate and this is mainly attributed to climate change. During the period from 2001 to 2004 in the Baspa basin of the Kinnaur district the glacial area has decreased from 173 km^2 to 140 km^2. The average temperature recorded in Kinnaur from 1991 to 1995 was 19.8°C; from 1996 to 2000 it was 20.1°C and between 2001 and 2004 was 21.6°C. The increase is notably much higher during for the last five years.

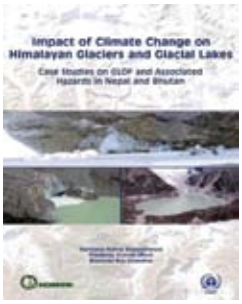
WED 2007 poster competition held in Rekong Peo, Kinnaur, India. Photo: CEE Himalaya

Celebrations in Baramulla, Jammu and Kashmir

Celebrations for WED 2007 were also organised in Baramulla, Jammu and Kashmir. Approximately 90 students and ten teachers representing four public schools from Baramulla participated in the day long celebrations. Students from Guru Nanak Dev Model High School, Noor ul lslam High school, Baramulla Public School and Hanfia Higher Secondary School participated in these events. Participants discussed global concerns about climate change. Events such as an inter-school quiz and extempore competition were organised. Students participating in these events presented their views in extremely effective and enthusiastic manners.

Rashmi Gangwar is Coordinator of CEE Himalaya and may be contacted at *rashmi.gangwar@ceeindia.org*. For further details see *http://www.ceehimalaya.org*.

New Book Launched



On the occasion of World Environment Day 5 June 2007, the book "Impact of Climate Change on Himalayan Glaciers and Glacial Lakes: Case Studies on GLOF and Associated Hazards in Nepal and Bhutan" by Samjwal Ratna Bajracharya, Pradeep Kumar Mool and Basanta Raj Shrestha was launched. It is published by the International Centre for Integrated Mountain Development (ICIMOD) in cooperation with the United Nations Environment Programme Regional Office Asia and the Pacific (UNEP/ROAP).

You can download the full document at *http:// books.icimod.org/index.php/search/publication/169*.

Why "Melting Ice" is a Hot Topic for the World Environment Day?

Excerpt from the speech given by Achim Steiner, Executive Director of UNEP, on World Environment Day in Tromsø, Norway on 4 June 2007 related to the recent publication "Impact of Climate Change on Himalayan Glaciers and Glacial Lakes: Case Studies on GLOF and Associated Hazards in Nepal and Bhutan".

"I sat down and, in fact, I was handed another report, which we are producing together with ICIMOD in Nepal. It is another one of these reports attempting to point out a fundamental reality. In this one the issues are Glacial Lake Outburst Floods (GLOFs). If you want to understand what it means to somebody in Bhutan or in Nepal to talk about climate change today, then you need to look at this report.

GLOFs are a simple change and a series of chain events: global warming results in melting ice, which builds up into new lakes in areas where traditionally no water was stored. One day the lake's natural wall will simply give way. Within seconds we have a flood bursting down the valley at a speed higher than a missile. The reason why I am mentioning this issue is because the Bhutanese have richly established their agriculture and their livelihoods in these valleys for hundreds of years. Today, Bhutan must either invest hundreds of millions in stabilising these new lakes or move thousands of people somewhere else. Because the risk of leaving them live downstream from potential disastrous events simply can not be done by the Government.

This issue takes the best of science and brings it into public policy. It also underlines why, when we talk about climate change, we must mention the equity dimension so that a country such as Bhutan will not be asked to underwrite the bill for a series of natural phenomena that are unfolding (there) for which it has no responsibility. We may justly point out actions from another part of the world which result in having used our environment and our natural resources in a way that now put millions of other people at high risk."

To learn more about WED 2007 visit *http://www.unep.org/wed/2007*.

We Need Trees: Biking Around the World

Mohammad Tajeran at the Mountain Forum Secretariat, Kathmandu, Nepal.
Photo: Mountain Forum Secretariat

In March 2007, Mohammad Tajeran of Iran stopped by to visit us at the Mountain Forum Secretariat while planting trees in Kathmandu. He is on a global tour called "We Need Trees". Mohammad came to us seeking cooperation from the Mountain Forum family and others. His personal campaign for the well being of our planet and all mankind began with a dream and then grew out of his heartfelt determination. Now, Mohammad is cycling around the world planting trees along the way.

We asked Mohammad why do we need trees? He responded by saying, "Trees act as an air filter, trapping dust particles and absorbing gaseous pollutants. Trees also reduce greenhouse gases through photosynthesis as they absorb carbon dioxide and produce oxygen. In cities, trees moderate the effect of urban heat islands. Trees also shade us from the ultraviolet rays of the sun, which are becoming increasingly dangerous with the thinning of the ozone layer. Climate change and pollution have tragic effects on our planet and trees are precious sources needed to balance impacts. In the end, our life depends on the life of trees."

To achieve his goal, Mohammad has a small supporting team helping to put him in contact with organisations in hopes that they will inform others of his mission and message.

If you would like to sponsor "We Need Trees" or highlight Mohammad's journeys he may be reached at *malan1445@yahoo.com* or visit *http://www.weneedtrees.com*.

ClimateHimalaya: Change the World Campaign

ClimateHimalaya is an initiative of the Environmentalists' Association of Nepal, a professional forum of Nepalese Environment Experts, which aims to reduce ecological footprint of human society leading to a more sustainable and livable world.

To celebrate World Environment Day 2007 in Nepal an e-conference on climate change and the Himalayan Glaciers was held from 7 to 30 May 2007.

You may access a synthesis report of the e-conference at *http://www.freewebs.com/climatehimalaya/index.htm*.

Discussion archive: *http://groups.google.com/group/climatehimalaya*

Please inform your networks about this initiative to minimise the impact of climate change in the greater Himalayan region or better yet, become part of the Environmentalists' Association of Nepal's "ClimateHimalaya: Change the World Campaign". Be responsible and put moral pressure on others to be responsible!

For further information please contact Tek Jung Mahat at *tekjungmahat@gmail.com* or *climatehimalaya@gmail.com*.

The upcoming events listed below were brought to our attention by Mountain Forum members as well as events organisers. If you have information on a mountain related event, please send the information to the Mountain Calendar via the online submittal form at: *http://www.mountainpartnership.org/events/c-newevent.asp*

For many of these events, more detailed descriptions are available on the Mountain Partnership website: *http://www.mountainpartnership.org/events/default.asp*

Many thanks to all the contributors for sharing this information with the Mountain Forum community.

Mountain Forum is not responsible for any changes in the programmes of the listed events. Please contact the event organisers for the latest information.

July

3 - 6 July 2007
ANZSEE 2007 Conference: Reinventing Sustainability - A Climate for Change
Noosaville, Queensland, Australia
Contact: *anzsee@yahoo.com.au*
Web: *http://www.anzsee.org/2007conference/conference_pageholder.asp*

23 - 25 July 2007
Workshop: A Global Change Research Network in African Mountains
Kampala, Uganda
Contact: *greenwood@scnat.ch*
Web: *http://mri.scnatweb.ch/content/view/170/30/*

26 - 29 July 2007
Lao Ecotourism Forum: Bridging the Mekong Region
Vientiane, Laos
Contact: *pany@sayolaos.com*
Web: *http://www.ecotourismlaos.com/forum2007.htm*

23 - 29 July 2007
Environmental Hazards and Sustainable Development in Mountain Regions
7th International Summer School of
Patarlagele Research Station, Romania
Contact: *geoinst@rnc.ro*
Web: *http://www.mri.scnatweb.ch/dmdocuments/first_circular_2007.doc*

August

3 - 5 August 2007
Sierra Nevada Alliance Annual Conference - Sustainable Sierra
Kings Beach, CA, USA
Contact: *sna@sierranevadaalliance.org*
Web: *http://www.sierranevadaalliance.org/conference/*

September

3 - 7 September 2007
International Conference on Poverty Reduction and Forests
Bangkok, Thailand
Contact: *conference@recoftc.org*
Web: *http://conference.recoftc.org*

12 - 15 September 2007
International Training and Workshop for Alpine Protected Areas Managers
Matrei, Austria
Deadline for abstract: 15 July 2007
Contact: *info@alparc.org*
Web: *http://www.alparc.org*

27 - 30 September 2007
2007 Santa Fe Trail Symposium: Where the Mountain Branch Crosses the Purgatoire
Trinidad, Colorado
Contact: *trailassn@gbta.net*
Web: *http://www.santafetrail.org/symposium2007.htm*

24 September - 13 October 2007
International Seminar: Countdown 2010: People, Protected Areas and Biodiversity Conservation
Majella National Park, Italy
Contact: campus@istpangea.it
Web: *http://www.iucn.org/themes/wcpa/events/InternationalSeminar07.pdf*

30 September - 3 October 2007
A Global Vision of Forestry in the 21st Century Conference
Toronto, Canada
Contact: *a.veneziano@utoronto.ca*
Web: *http://www.forestry.utoronto.ca/centennial/congress.htm*

October

1 - 3 October 2007
Third Meeting of the Adelboden Group
Deadline for registration: 15 July
FAO headquarters, Rome, Italy
Contact: *angela.perez@fao.org*

3 - 7 October 2007
Mountain and Wilderness Medicine World Congress 2007
Aviemore, Scotland
Contact: *anna.barton@tiscali.co.uk*
Web: *http://www.worldcongress2007.org.uk/*

4 - 5 October 2007
Towards Integrated Mountain Area Development and Its Recognition in the Common Agricultural Policy: Shaping the New European Space
Piatra Neamt, Romania
Deadline for abstract: 21 September 2007
Contact: *conference@euromontana.org*
Web: *http://www.euromontana.org*

4 - 7 October 2007
25th Mustelid Colloquium
Trebon, Czech Republic
Contact: *mroche@vydry.org*
Web: *http://www.mustelid2007.org/*

15 - 17 October 2007
International Conference: Managing Alpine Future - Strategies for Sustainability in Times of Change
Innsbruck, Austria
Contact: *alpinefuture@alps-gmbh.com*
Web: *http://www.alps-gmbh.com*

Mountain Calendar 2007

18 - 19 October 2007
Global Change Research Network in European Mountains (GCRN_EM)
Networking Meeting: From Strategy to Project
Innsbruck, Austria
Contact: *bjoernsen@env.ethz.ch*
Web: *http://www.mri.scnatweb.ch/dmdocuments/GCRN_EM_Innsbruck07.v1.pdf*

19 - 20 October 2007
The Women of Appalachia: Their Heritage and Accomplishments
Zanesville, Ohio, USA
Deadline for abstract: 13 August 2007
Contact: *ouzconted@ohio.edu*
Web: *http://www.zanesville.ohiou.edu/ce/wac*

24 - 26 October 2007
International Agroforestry Education Conference on Integrating Conservation in Upland Agriculture in Southeast Asia
Chiang Mai, Thailand
Deadline for abstract: 30 June 2007
Contact: *Monton.j@ku.ac.th*
Web: *http://www.worldagroforestrycentre.org/sea/networks/Seanafe/Index.asp*

25 - 28 October 2007
III International Seminar on Mountain Tourism:
Sustainable Tourism in the Montane Protected Areas - Building Partnership between NGOs and Managers of Protected Areas
Sucha Beskidzka, Poland
Contact: *christian.baumgartner@nfi.at*

November

1 - 2 November 2007
Sustainable Solutions, Focus on Africa
Delft University of Technology, The Netherlands
Contact: *LustrumSymposium@TUDelft.nl*
Web: *http://www.lustrum.tudelft.nl/symposium*

7 - 8 November 2007
Managing Environmental Impacts of Linear Corridors and Infrastructure
Revelstoke, British Columbia, Canada
Contact: *office@cmiae.org*
Web: *http://www.cmiae.org/conferences.htm#Linear_Corridors*

7 - 10 November 2007
Conference on Less Favored Areas for Agriculture and Rural Areas
Jihlava, Czech Republic
Contact: *stolbova@vuze.cz*

26 - 30 November 2007
United Nations/Argentina/European Space Agency Workshop on Sustainable Development in Mountain Areas of Andean countries
Mendoza, Argentina
Contact: *victor.kotelnikov@unvienna.org*

Please update your contact information!

Dear Mountain Forum member,

Please update your contact information by visiting *http://www.mtnforum.org/mem/update.cfm* or by notifying the regional office nearest to you.

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Fax: +256-41-223 242

Email: *amf@mtnforum.org*
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To contact the European Mountain Forum by post, fax or phone, please contact the Mountain Forum Secretariat at the address provided on the back cover of this Bulletin.

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Mountain Culture at The Banff Centre
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Web: *http://www.mtnforum.org/rn/namf.cfm*

Supporting Institutions

Food and Agriculture Organization of the United Nations

Swiss Agency for Development and Cooperation

Aletsch Glacier, longest in the Alps, seen from the Sphinx Observatory near the Eiger, Bernese Oberland, Switzerland. Photo: Gary Braasch

Host Institutions and Partners

African Highlands Initiative

Bellanet

Consorcio para el Desarrollo Sostenible de la Ecorregión Andina

European Mountain Forum

Fundació Territori i Paisatge

International Centre for Integrated Mountain Development

International Potato Center

Mountain Research and Development

The Banff Centre

The Mountain Institute

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