



Australian Institute of Alpine Studies

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International Year of the Mountains



Some mountain facts

- ▶ About 500 million people, 10% of the world's population, live in uplands and mountains
- ▶ Mountain areas are the source of water for more than half the world's population
- ▶ All the world's major rivers originate in mountain areas, in the form of precipitation, rain and snow stored temporarily as ice, released in spring and summer melt periods
- ▶ In arid and semiarid areas mountains provide 70-95% of downstream freshwater
- ▶ In areas with higher rainfall the figure is 30-60%
- ▶ High elevation water flows power many hydro-electric plants
- ▶ Mining pollutes mountain water
- ▶ Mountains are fragile ecosystems. Their soil is thin, therefore unstable, which limits growth of plants and makes them more vulnerable to human disturbance. They take a long time to recover once damaged. They also have a long history of economic exploitation and political neglect.
- ▶ In mountainous areas of developing countries transport links may be scarce, access to markets poor, high population growth, limited employment possibilities
- ▶ Mountain populations in Nepal, Ethiopia, and Peru are among the world's poorest (FAO 1995)
- ▶ Mountains are storehouses for crop genes and much of remaining genetic diversity subsists there
- ▶ The International Potato Centre in Lima has the world's largest bank of potato germ plasm, with 5,000 distinct types
- ▶ In the tropics, mountain forests have the fastest rate of loss of diversity - about 1.1% a year
- ▶ The mountains of central Asia are home to over 5,500 species of flowering plants
- ▶ 10% of all bird species are found only or primarily in cloud forests in mountains
- ▶ Protection is given by 138 biosphere reserves, 150 parks and reserves above 1500m and 39 World Heritage sites
- ▶ Some 90% of mountains cloud forests have disappeared from the northern Andes - as a result of grazing, food production, wood, mining, road building, fires
- ▶ Mt Kinabalu is believed to contain one of the richest diversities of plants in the world
- ▶ Mountain tourism generates about 15-20% of global tourist industry
- ▶ There are 65-70 million downhill skiers worldwide (1999)
- ▶ In Switzerland - the tree-line is now 200-300m lower than its natural limit
- ▶ There were 29 landslides / avalanches in 2000, killing 1,099 people
- ▶ Avalanches and landslides caused over \$1.2 billion damage in the Americas in 1991-2000 and \$366 million in Asia

Abstracts from the AIAS meeting held at Jindabyne on 28 November 2002

The timing of Late Pleistocene periglacial activity in Australia

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Pleistocene periglacial landforms are far more widespread in Australia than glacial deposits. Despite more than a century of research describing Australian glaciation, periglacial landforms have received relatively little attention. Periglacial landforms are sensitive indicators of past climate change, usually forming within specific temperature limits. However, the vast majority of Australian deposits have no dating information and therefore their climatic importance is difficult to place in time. This paper describes the exposure dating of periglacial deposits from four mountainous locations in Australia (Barrows et al., ms). This is a similar approach to the one we used to date glacial deposits in Australia (Barrows et al., 2001, 2002). We selected sites from Ravine (north of Cabramurra), Mt Little Higginbotham (Victoria), Ben Lomond and Mt Wellington (both Tasmania). Nine exposure ages from the first three sites group within the range 17,000-24,000 yr. Seven of the ages fall within a weighted mean age of $22,600 \pm 800$ years. This age lies within the last glacial maximum and is similar to the timing of the maximum glacier advance in Australia during this period (Barrows et al., 2002). In further work, we are also radiocarbon dating two additional sites near Brindabella and Mt Hotham, and dating the timing of final glacier retreat on the Kosciuszko Massif.

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The Snowy & East Gippsland Rivers Institute

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A substantial effort has been invested into understanding the river ecosystems of the Snowy and related East Gippsland rivers over the last decade. Expert panel investigations have been followed up by more detailed investigations into the ecological health of the Snowy River, and related reference streams. The continued monitoring of these systems will be necessary to underpin adaptive management of environmental flows in the Snowy, and in some of the other montane rivers diverted by the Snowy Scheme. There is potential for knowledge generated by this and other processes to fuel a long-term research initiative, and to support an institute of learning for these rivers that brings together cultural, scientific and experiential knowledge. Such an institute could make knowledge more accessible (than e.g. unpublished government reports) and lead to its wider application in river management.

Estimating the number of bogong moths migrating annually to the Snowy Mountains

Ken Green

The key invertebrate species in the alpine/subalpine zones of the Snowy Mountains in terms of biomass and seasonal importance is the bogong moth *Agrotis infusa*. This moth migrates from lowlands in spring with 65% of its dry weight being fat. The moths, spend the summer gregariously aestivating in rock crevices and caves. They are impossible to count in this situation and moth light capture data (going back 15 years) give only a relative index of moth numbers. Bogong moths are the major food for the endangered mountain pygmy possum, and are important for foxes and ravens and are eaten by robins, pipits, skinks, fish, and invertebrates.

In addition to their importance as food, the moth debris on the cave floors, which can be up to 1.3m deep, supports a unique assemblage of invertebrates including two species of mermithid nematode parasites and two species of giant collembola not known from elsewhere.

The bogong moth is also of importance because it brings polluting agricultural arsenic with it on its annual migration (Green et al. 2001). Despite the importance of bogong moths, there is no measure of their numbers migrating annually into alpine Australia.

Numbers coming into the alpine ecosystem can be assessed from the equation

$$\text{migrants in} = \text{migrants out} + \text{total mortality}$$

If the distribution of mortality from various causes (predation, weather, parasitism) is known and if the proportional mortality is known, then calculation of one of these factors can be used to calculate the total mortality and hence a first-order estimate of moth numbers.

Total predation on bogong moths can be calculated from the known density of predators in different seasons, the proportion of their diet that is bogong moths in each season, the weight of a moth and the amount of food required per day in each season.

Taking all predators and causes of mortality into account it is estimated that 1.75 billion moths migrate into the Snowy Mountains each year.

The use of predators to sample invertebrates is useful because they sample continuously in all habitats, regardless of weather whenever the selected prey is available. (They are more committed to sampling because their life depends upon it). Their diet can be used to show inter-annual, seasonal and spatial variation in availability.

References:

Green, K., Broome, L., Heinze, D. and Johnston, S. (2001) Long distance transport of arsenic by migrating Bogong Moths from agricultural lowlands to mountain ecosystems. *Victorian Naturalist* 118, 112-116.

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Introduction

The Alps, as Australia's most efficient and high yielding catchments, are important for the supply of high quality water. Mosslands store large quantities of water and perform a critical role in alpine catchment hydrology. However, much of the detail of the hydrologic and ecological functioning of mosslands is poorly understood. We studied the physical and chemical properties and hydrological behaviour of the peat beneath an intact mossland to investigate how mosslands function, particularly the hypothesis that mosslands smooth streamflow by absorbing and later releasing large quantities of water after high rain.

The Australian high mountain mosslands are recognized as a threatened vegetation community. The extent of humified peat soils indicates that, previously, mosslands were more extensive than today. The degrading of intact mosslands to form humified peats is expected to have changed the quantity, quality and timing of water discharge from alpine catchments. We compared the physical and chemical properties and hydrological behaviour of peats from intact mosslands with those of partly humified peat to investigate the hypothesis that humified peats are a remnant of catotelm peats beneath intact mosslands.

Material and Methods

Site selection, field analyses and sample collection

The Wellington Plain mossland (map 8223-S (Tamboritha-Moroka) 50N85E) in the Gippsland Alps was selected as this area includes almost undisturbed areas containing the sequence of Sphagnum hummocks and hollows characteristic of intact mosslands. There are also extensive areas of partly humified and humified peat.

We measured saturated hydraulic conductivity in five wells using the recovery method. Watertable height was monitored manually from March 2001 and automatically from June 2002 in two Sphagnum hummocks and one partly humified peat site using equipment developed for this project. Rain was monitored from April 2001 using a tipping bucket raingauge and a Hobo event logger.

In Autumn 2001 we collected two types of samples for laboratory analysis: brass ring samples and bulk samples. Seven brass cores were collected from each of four layers beneath an intact hummock: 0, 35, 55 and 90 cm depth. Samples were saturated with water from an adjacent stream and stored at 4 °C until required for analysis. Three brass cores from the surface of the partly humified peat were collected in the same manner. Bulk samples were collected from the fibric, hemic and sapric layers of an intact hummock, and the surface of partly humified peat. Samples were sealed in plastic bags and stored at 4 °C until required for analysis.

Laboratory analyses

The concentration of 9 elements, Al, Ca, Fe, K, Na, Mg, Mn, P and S, were determined using ICPOES. Samples were oven dried and ground to 0.5 mm using a Retsch ZZ mill. Plant-available elements were extracted using 2.5 % acetic acid and total elements were extracted by nitric/perchloric acid digestion. The solutions were analysed using a GBC Integra XM ICPOES.

Solid-state ¹³C NMR was used to characterise the carbon chemistry of fibric, hemic, sapric and exposed peats, following the method described in Golchin et al. (1994). The ratio of alkyl to o-alkyl

carbon indicates the extent of decomposition of the sample (Baldock et al. 1997).

The EC1:5 and pH_{H2O} were measured on field moist samples, following the methods of Rayment and Higinson (1992). Loss on ignition was determined following the method described in Hesse (1971).

The saturated hydraulic conductivity was measured using a mini-disc permeameter following the method in Cook et al. (1993). The mini-disc permeameter applied a water potential of -0.1 kPa to the top of the soil core. The Buchner funnel was replaced with a saturated sand stand, which applied the same water potential to the base of the soil core. Timed measurements of water height allowed calculation of saturated hydraulic conductivity.

Water retention curves were determined on brass ring samples according to the method in Topp et al. (1993). We used sintered glass funnels (por 4) attached to hanging columns of water to apply suction of -5 and -10 kPa. Suctions of -30, -50 and -100 kPa were applied using presoaked 100 kPa pressure plates in sealed pressure vessels. This was done in triplicate. We applied a suction of -1.5 MPa to duplicate sub-samples using presoaked 1.5 MPa pressure plates in sealed pressure vessels. This suction was not applied to the exposed peat because the instrument malfunctioned. We weighed samples after equilibration to determine water loss at each suction. After 100 kPa, samples were oven dried at 105 °C over night, and weighed to determine bulk density.

Results and Discussion

Smoothing streamflow

The intact mosslands had little capacity to store additional water, which does not support the hypothesis that mosslands smooth streamflow by absorbing and later releasing large quantities of water after high rain. Water storage was investigated by monitoring the watertable and rain. Water below the minimum watertable is in permanent storage; it is not released under natural conditions. Between the minimum and maximum watertable levels, the mosslands have the capacity to store additional water: available storage. The maximum distance between the highest and lowest water levels, and thus the available storage, was 12.3 cm. The response of the watertable to rain depended on the initial watertable level. Rain raised the watertable when the initial level was low, but had little effect when the initial level was high. Hydraulic conductivity in the acrotelm was 1.4×10^{-3} m/s, decreasing to 6.5×10^{-6} m/s in the catotelm. Thus when the initial water level was high, incoming water rapidly moved through the acrotelm. Our water retention curves showed that the acrotelm released water most readily and the catotelm retained the most water under all but atmospheric pressure. The high surface hydraulic conductivity of the acrotelm, combined with the small available storage, meant that most rain rapidly passed through the mosslands into streams, even in dry periods.

Origin of humified peats

Our results suggest that partly humified peats are a remnant of catotelm peats, which have been exposed to aerobic decomposition by drainage and erosion of the acrotelm. The surface of the partly humified peat had some properties similar to each layer of peat beneath the intact mossland. Plant-available nutrients suggested that the partly humified peat most resembled the fibric layer. This contrasts with the ¹³C NMR results, which indicated that the partly humified peat most resembled the hemic layer. However the details of these two data sets support our hypothesis that humified peat is a remnant of catotelm peat from beneath an intact mossland. This supports the model of the genesis of humified peats proposed by Costin (1954) and detailed in Ashton and Williams (1989).

Conclusion

Intact mosslands remain close to fully saturated, thus while large quantities of water are permanently stored in the acrotelm, mosslands have little capacity to store additional water after high rain. The

characteristics of the partly humified peat suggests that they formed from catotelm peats, exposed to the atmosphere by erosion of the acrotelm.

Acronyms

¹³C Nuclear Magnetic Resonance: ¹³C NMR, Inductively Coupled Plasma Optical Emission Spectroscopy: ICPOES

References

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- An interim report on research into winter active small mammals in relation to snow cover in Kosciuszko National Park.*

An interim report on research into winter active small mammals in relation to snow cover
in Kosciuszko National Park

Glenn Sanecki, Centre for Resource and Environmental Studies, Australian National University

Snow is a significant component of the alpine and subalpine areas of Kosciuszko National Park. To date however our understanding of the role snow plays in the ecology of winter active small mammals has been drawn from overseas work and a few site-specific studies. Work undertaken this year investigated the distribution of small mammals in relation to snow cover conditions throughout the winter. Preliminary results suggest that although thermal stability of the subnivean space may be more suitable for small mammals where snow cover is better developed, the subnivean space at these sites is often poorly developed and small mammals are less likely to be detected. Small mammals are more likely to be detected at sites where snow cover development is poorer and thermal conditions are less stable. Although snow cover may stabilise the temperature of small mammal habitat it also appears to limit the use of otherwise suitable habitat by small mammals, whilst also permitting the use of otherwise unsuitable habitats.

Book Review

Structure and Function of an Alpine Ecosystem: Niwot Ridge, Colorado

William D. Bowman and Timothy Seastedt, eds. Oxford University Press, Oxford, UK and New York, NY. 337p., cloth. 2001. [ISBN 0-19-511728-X].U

Reviewed by:

Chris Norment, Dept of Environmental Science and Biology, SUNY Brockport, Brockport, NY USA

Structure and Function of an Alpine Ecosystem attempts to summarize almost five decades of research conducted at the alpine research site at Niwot Ridge in Colorado's Front Range, which is part of the Rocky Mountain system. The Niwot Ridge site is one of 24 Long-Term Ecological Research Sites (LTERs) in the United States (22) and Antarctica (2) supported by the National Science Foundation, established to study "ecological processes over long temporal and broad spatial scales". The Niwot Ridge site has been affiliated with the LTER program since 1980, but alpine research there extends back at least to the early 1950s, when scientists associated with the Institute of Arctic and Alpine Research (INSTAAR) at the University of Colorado in Boulder began working in the area; additional important work occurred there in the 1970s under the Tundra Biome portion of the International Biological Program. The book includes 15 chapters in four sections (Physical Environment, Ecosystem Structure, Ecosystem Function, Past and Future). There is also an introductory chapter describing the history and significance of research at Niwot Ridge. The goal of the book is to "provide a description of the Niwot Ridge/Green Lakes Valley alpine ecosystem... including the spatial and temporal patterns of animals, plants and microorganisms and associated ecosystem processes." The book focuses on the alpine site at Niwot Ridge,

although "the results can be extrapolated to much of the southern and central Rocky Mountains".

To my mind, the book's strongest chapters are found in the sections on Physical Environment and Ecosystem Function. In these sections the reader will find useful chapters on climatic, geomorphic, and hydrologic constraints on community structure and the interrelationships of the alpine biota, and primary production, plant nutrient relationships, decomposition, and nitrogen cycling. The book also contains a useful chapter on species-environment relationships of the Niwot Ridge alpine vegetation, which describes the vegetation primarily in relation to the snow gradient. However, no species list or taxonomic summary of the vascular plants is included in the chapter. The chapter on the vertebrates at Niwot Ridge includes information on composition, distribution, seasonal dynamics, and biotic and geomorphic influences. Additional information on vertebrates is contained in the chapter on plant-herbivore interactions, which includes information on the impact of the northern pocket gopher (*Thomomys talpoides*), pika (*Ochotona princeps*), yellow-bellied marmot (*Marmota flaviventris*), and voles (*Microtus* spp.) on the alpine vegetation.

Perhaps the most noticeable gap in this volume is the lack of detailed information on Niwot Ridge invertebrates, despite their diversity in alpine ecosystems and importance as herbivores and pollinators. There are relatively brief accounts of invertebrates in chapters on plant-herbivore interactions and decomposition processes, but nothing like the complete account that they deserve. Thus, published studies on springtails, benthic macroinvertebrates, distribution and biomass of tundra arthropods, life histories, focal-plant insect pollination, reproductive output in ants, and aeolian arthropods, all of which were

Poetry?

There once was a fellow called Ken
Who had a peculiar yen
He was very fond of frogs
Especially in bogs
And for a while he did hop to the fen

There once was a smooth talking student
Who liked going off in his tent
He'd ask 'Please go camping with me
It's for my PhD'
But who knows whether he's a real gent?

A tallish young chappie from Brazil
Said 'These point quadrats make me feel
quite ill.
I've done thousands and more
And what's it all for?
I'd rather be eating my fill

A supervisor by the name of CP
Conferenced with a child on her knee
The dribbling pair
Caused everyone to stare
And that's the end of any funding for me!

A researcher from Griffith U
Is a bit of a fitness guru
But she likes a good time
With a bottle of wine
And the yoga just helps her come to!

A shy retiring self-proclaimed poet submitted the above regarding the AIAS meeting. The said person asked to remain anonymous (but hasn't paid me yet).

Book Review cont. ...

conducted at or near Niwot Ridge, were mostly ignored in *Structure and Function of an Alpine Ecosystem*. Given the selective nature of several of the review chapters, I feel that the volume would have been enhanced by several appendices, including one listing all taxa found at the site, and one listing all theses, dissertations, and publications dealing with research conducted at or near Niwot Ridge.

Despite *Structure and Function of an Alpine Ecosystem's* selective focus on Niwot Ridge and nearby areas of Colorado's Front Range, Australian researchers interested in alpine ecology will find much useful information in the book. A careful reading will provide a valuable perspective for comparing alpine ecosystems of the Snowy Mountains, the high plains of Victoria, and Tasmania to those of the Niwot Ridge/Green Lakes site. In addition, the review chapters and the final chapter ("Environmental Change and Future Directions in Alpine Research") could provide a useful tool for thinking about the design and implementation of research projects in the Australian snow country. Although I reckon that the price (estimated at about \$AU 157)* might discourage purchase by all but the most dedicated AIAS members, at the very least I would suggest that *Structure and Function of an Alpine Ecosystem* is worth checking out from your local university library.

(*I paid >\$AU 200 – ed.)

Impact of Global Warming on Mountain Areas Confirmed By UNEP-Backed Mountaineers

GENEVA, 5 June 2002 - An expedition, dispatched to the Himalayas to chronicle the environmental health of one of the world's most famous mountain ranges, has gathered startling evidence of the impacts of climate change.

The team, backed by the United Nations Environment Programme (UNEP), has learnt that the glacier, from where Sir Edmund Hillary and Tenzing Norgay set out to conquer Everest nearly 50 years ago, has retreated by around five kilometres up the mountain.

Roger Payne, Sports and Development Director at the International Mountaineering and Climbing Federation (UIAA), and one of the expedition's leaders, said: "It is clear that global warming is emerging as one, if not the, biggest threat to mountain areas. The evidence of climate change was all around us, from huge scars gouged in the landscapes by sudden, glacial floods to the lakes swollen by melting glaciers. But it is the observations of some of the people we met, many of whom have lived in the area all their lives, that really hit home."

The seven-strong expedition, which set out from Kathmandu on 16 May, returned on 1 June after climbing on Island Peak, which is 6,189 metres (20,305 feet) above sea level in the Khumbu Region of Nepal. The expedition, whose findings are being released on World Environment Day, visited the famous Thyangboche Monastery and talked to experts including ones in the Sagarmatha (Everest) National Park.

It was in conversation with Tashi Janghu Sherpa, President of the Nepal Mountain Association, that the team first learnt of rising concern among local people over the impacts of global warming.

Ian McNaught-Davis, President of the UIAA and another of the expedition's leaders, said: "He told us that he had seen quite rapid and significant changes over the past 20 years in the ice fields and that these changes appeared to be accelerating. He told us that Hillary and Tenzing would now have to walk two hours to find the edge of the glacier which has close to their original base camp in 1953 which means that it has retreated by between four and six kilometres."

"He told us that around Island Peak, so called because it once resembled an island in a sea of ice, there were once a network of small ponds. Today they have merged into a big, several kilometre-long, lake, as a result of the glaciers melting. Mr. Janghu said he was worried, worried that glaciers would continue shrinking, and that the melt waters would trigger floods sending huge quantities of water, rubble and mud down the valley", said Mr. McNaught-Davis, a former businessman and television presenter of popular science series' on British television.

At the Thyangboche monastery, home to 60 Buddhist monks, they met with Lama Rinpoche who has lived there for over 30 years and witnessed two big floods, the result of melting glaciers causing local lakes to burst. One recent flood had washed away the old wooden bridges downstream. New, metal ones, have been built higher and 100 metres longer replacing the older, 50 metre ones to try and reduce the chances of similar damage from a future flood.

“It was the Lama’s impression that such events were becoming more frequent and a rising phenomenon of the past eight to nine years”, said Mr. McNaught-Davis, whose team’s findings come in the United Nations International Year of the Mountains and International Year of Ecotourism.

UNEP scientists, working with experts from the International Centre for Integrated Mountain Development (ICIMOD) based in Kathmandu, have used satellites and on-the-ground studies to pinpoint 44 glacial lakes in Nepal and Bhutan that are now so swollen, they could burst their banks in as little as five years.

There has been concern that rising numbers of tourists and climate change might also be having impacts on the vegetation of the area. Alton Byers of the US-based Mountain Institute told the World Ecotourism Summit in Quebec last month that an estimated 27,000 people a year visited the area, up from a handful in the early 1960s. Tourists now out-number the local sherpa population which totals 3,000 in the Khumbu region of Nepal’s Solu Khumbu District.

Julia-Ann Clyma, another member of the expedition from New Zealand, said that just below the village of Thyangboche, people were developing a medicinal herb garden in an attempt to preserve local, medicinal plants and knowledge.

“We saw a lot of impressive efforts by local people to make themselves less dependent on food imports including the development of greenhouse crops and fruit orchards”, she said.

The team was also impressed by the numerous reforestation schemes underway, aimed at balancing the fuel wood needs of local people and tourists with the need to maintain healthy forests.

This appears in line with the research of the Mountain Institute, which found that forest, cover below the snow and ice line “remains essentially unchanged from the 1950s. Natural forest regeneration appears

to be increasing in many areas, and tree growth in the vicinity of the Namche Bazaar and other villages has increased as a result of successful plantation efforts over the past 15 years”.

The Institute, however, concludes that above 4,000 metres over-harvesting of high altitude juniper shrubs and cushion plants for fuel, nearly all of which is tourist related, is having a serious impact on the environment. These impacts include erosion and loss of wildlife.

However, local community action groups are being developed to restore these degraded habitats. Plans include banning the harvesting of alpine shrubs and the development of subsidies to encourage the sustainable exploitation of trees such as the plentiful supplies of birch and rhododendron from lower down.

Building shelters for porters at major trekking villages is also under discussion. At the moment many porters sleep outside and burn wood to keep warm.

Pemba Geljen Sherpa, the expedition’s guide on the trip who has lived in the area all his life, said he had witnessed dramatic changes in his lifetime. He said traditional dress and customs were fast disappearing. But suggested this was an inevitable consequence of the modern world.

“It is all changing, you do not see the same traditional dancing or singing of my parents’ generation”, he said.

But the Sherpa guide rejected suggestions that tourism should be curtailed: “We need more, not less, tourism here to boost the economy and give people jobs, incomes and education. I think we can manage it so that it is the right kind of tourism that respects local people and local landscapes. What we cannot control is global warming, that is in the hands of others. We, here in Nepal, produce tiny amounts of the gases linked with global warming. It is up to the big, industrial countries of Europe, North America and Japan, to act to save our mountains and the environment upon which our livelihoods depend.”

Glacier Mass Balance and Regime: Data of Measurements and Analysis

by Mark Dyurgerov

Editors: Mark Meier and Richard Armstrong

This is the most complete data set of parameters of world glacier regimes that has ever been compiled. Data presented in three appendices include annual mass balances and related variables for mountain and subpolar glaciers outside the two major ice sheets (Greenland and Antarctica). All available sources of information, such as publications, archived data, and personal communications, have been collected for a time-series of about 280 glaciers. Observational data have been used from the beginning of measurements in 1945/46 until 1998. Data have been digitized, quality checked, and all errors found were eliminated. The information gathered in this report on modern glacier states reveals that:

1. The rate of annual melt-water production (ablation) by glaciers has been increasing, and is composed of about 1.7 m/yr in water equivalent for the period.
2. The annual accumulation (winter balance) rate has also been increasing with the average value of about 1.5 m/yr in water equivalent.
3. Annual volume change has been 90 km³/yr adding about 15–20% (0.25:1:0.11 m/yr) to sea-level rise over the period.
4. The equilibrium-line altitude has risen by 200 m (square root error is about 100).
5. Accumulation area ratio decreased from about 60% in 1968 to 50% in 1998 (square root error is about 5%).
6. The mass-balance sensitivity with respect to air temperature changed at the end of 1980's and reached -700 per °C.

The existing trend in glacier volume change shows that wastage of glaciers will accelerate in continental regions, North America, parts in South America, and Central Asia. Subpolar glaciers, outside the two major ice sheets, will contribute more to sea-level rise.

The price of this publication, including CD containing all the data, is \$30 plus \$5 shipping and handling. 264 pp. April 2002. Occasional Papers, University of Colorado, INSTAAR, UCB 450, Boulder, CO 80309-0450

More mountain facts

Top 10 highest towns and cities

- ▶ Wenchuan, China 5099 m
- ▶ Potosi, Bolivia 3976 m
- ▶ Oruro, Bolivia 3702 m
- ▶ Lhasa, Tibet (China) 3684 m
- ▶ La Paz, Bolivia 3632 m
- ▶ Cuzco, Peru 3399 m
- ▶ Huancayo, Peru 3249 m
- ▶ Sucre, Bolivia 2835 m
- ▶ Tunja, Colombia 2820 m
- ▶ Quito, Ecuador 2819 m

Nine of the ten highest mountain peaks in the world are all in the Himalayas.

- ▶ Everest Himalayas Nepal/Tibet 8,850 m
- ▶ K2 Karakoram Pakistan/China 8,611 m
- ▶ Kanchenjunga Himalayas India/Nepal 8,586 m
- ▶ Lhotse I Himalayas Nepal/Tibet 8,516 m
- ▶ Makalu I Himalayas Nepal/Tibet 8,463 m
- ▶ Cho Oyu Himalayas Nepal/Tibet 8,201 m
- ▶ Dhaulagiri Himalayas Nepal 8,167 m
- ▶ Manaslu I Himalayas Nepal 8,163 m
- ▶ Nanga Parbat Himalayas Pakistan 8,125 m
- ▶ Annapurna Himalayas Nepal 8,091 m

Global Change Monitoring Programme

Bishkek, October 28 - UNESCO's unique network of Biosphere Reserves is set to have a new role - monitoring global climate change. Out of the 408 biosphere reserves in 94 countries, 138 are in mountain areas. And mountains are proving to be extremely sensitive to global warming. Melting glaciers have recently unleashed deadly mudslides, rare ecosystems are threatened, and a lack of snow is crippling economies that depend on winter tourism. While the data from these sites will enable scientists to draw a more accurate picture of global climate change, they may also help to offset catastrophes when hazardous conditions develop.

In a partnership with the Mountain Research Initiative (MRI) based in Berne (Switzerland), the International Human Dimensions Programme on Global Environmental Change (IHDP), and the International Geosphere-Biosphere Programme (IGBP), UNESCO is selecting biosphere reserve sites from each of the major mountainous regions of the world as the focus for this new global climate change monitoring programme. And in addition to its assessment of environmental impacts, the study will also see how global change is affecting the socio-economic conditions of mountain people. UNESCO Director-General Koichiro Matsuura will announce this project when he addresses the Global Mountain Summit, due to open in Bishkek (Kyrgyzstan) on October 29, the culminating event in the International Year of the Mountain that comes to an end in December.

The sensitivity of mountains to global climate change has gradually emerged over the past few decades. But it first attracted wide public attention in 2001 when Professor Lonnie Thompson of Ohio State University forecast that Mount Kilimanjaro (Tanzania) will have lost its famous snow-capped peak by 2015 if current predictions on global warming are maintained. The mountain, he claimed, has already lost some 82% of its permafrost since 1912 - and 33% of this in the past two decades. And while the extra water from the melting glacier may be increasing the fertility of adjacent lowland areas in the short-term, water supplies would become critically low if it disappears.

A similar picture can be seen all over the world. In mid-September, the Kolka Glacier in the Caucasus

Mountains collapsed, submerging villages in the Republic of North Ossetia (Russian Federation) under thousands of tons of ice and rock, killing over 120 people. Meanwhile, all 37 named glaciers in the Glacier National Park in Montana (USA) have shrunk dramatically in the past 150 years, with the Sperry Glacier losing 11% of its volume between 1979-1993 and the Grinnell Glacier retreating by 63% between 1938-1993, according to the U.S. Geological Survey (see http://www.nrmcs.usgs.gov/research/glacier_retreat.htm). USGS predicts that all the glaciers will be gone by 2030 if present warming rates continue.

Europe's Alps are not spared either. In July, emergency workers pumped out a 16-hectare lake formed by the melting Belvedere Glacier on Monte Rosa in Italy, when it threatened to burst the dyke of boulders that had been containing it and flood the Italian village of Macugnaga. "From 1850 to 1980 Alpine glaciers lost half their volume, on average," says mountain expert Bruno Messerli of the University of Berne (Switzerland). "And in the 20 years from 1980-2000 a quarter of what was left was also lost. There will still be a bit of the 23km Aletsch glacier left at the end of the century, because it is 900m deep in places. But a lot of other areas will disappear."

The UN Environment Programme (UNEP) is currently monitoring lakes that have formed as glaciers melt. In the Himalayas alone, some 44 glacier lakes are filling so rapidly that they could burst their debris retaining walls in the next four or five years, in what are known as 'glacial lake outburst floods' (GLOFs). While GLOFs are not a new phenomenon, according to UNEP, there is evidence that they are becoming more common as glaciers retreat, putting in danger the towns and villages that lie beneath them.

Glaciers melt naturally during the summer and the phenomenon is not, in itself, a sign of global warming. Under stable climatic conditions, the ice lost through melting is replenished by winter precipitation in the form of snow. And the melt water forms an essential part of many of the world's major rivers. "But," adds Mel Reasoner, Director of the Mountain Research Initiative, "in many arid and semi-arid areas, people are dependent not only on the amount of glacier melt water, but on the timing of the water flow. The water has to be available at critical times for irrigation. Snow-pack and glaciers provide a buffer between when the precipitation falls as snow and when it is released as water. The melt season is often the warmest, driest time of the

year, providing large volumes of runoff for irrigation when it is most needed.”

But in many of the world’s mountains, there is less precipitation today in the form of snowfall, as winters have become shorter and warmer. Combined with warmer summer temperatures, this creates a net loss for the glacier, even if, in the short-term, the extra melt water is welcome in adjacent lowland areas. “But,” warns Mr Reasoner, “where agriculture has become dependent on the seasonal melt water, if you remove the glacier you no longer have a source of stored water that is available throughout the summer.”

The idea of using biosphere reserves in mountain areas for global change research would be an extension of the Global Observation Research Initiative in Alpine Environments (GLORIA) project, an international research network that is looking at the effects of global change on alpine vegetation by making standardized observations in parallel sites (see http://www.gloria.ac.at/res/gloria_home/). GLORIA has already launched research in mountain sites in Europe and is now looking to extend the work globally. “It is a unique opportunity to have access to biosphere reserves in all the big mountain areas of the world,” says Mr Messerli.

Mountain ecosystems are well suited for research to track global climate change. “The upper ecosystem from the upper vegetation limit to the glacier is essentially the same over all climatic zones from the North Pole to the Antarctic,” says Mr Messerli. “A glacier and the permafrost on Kilimanjaro is the same as in the Alps or the Himalayas.”

At the same time, mountain ecosystems change dramatically over very short distances, with just small changes in altitude. And this makes them particularly useful indicators. For example, at higher altitudes only certain plant and animal species can survive under long periods of snow and ice cover. But with global warming these areas are shrinking, so that plants adapted to the warmer, lower habitats slowly invade the higher elevations. The shifts in these ecosystem boundaries provide an index of global climate change, which can be observed and compared in all continents of the world, using standard sets of climatic measurements, such as precipitation and temperature. And other factors driving global change, like radiation, soil erosion, changing soil conditions and demographic pressures,

are also very noticeable in mountain regions.

Mountain biosphere reserves have another advantage for global comparisons. Their so-called “core” areas are relatively free of human activity. Outside these core areas, and at lower altitudes, the culture and farming practices of mountain people can have profound effects on local ecology, making the effects of climate change difficult to distinguish from those directly due to human activities. Even the German word ‘Alp’ refers to mountain pastures reclaimed from naturally forested areas. “And”, says Mr Reasoner, “the structure of mountain biosphere reserves makes them ideal natural laboratories for investigating highland-lowland interrelationships.”

Mountain people are also particularly vulnerable to other natural hazards, such as volcanic eruptions, avalanches, floods and earthquakes, even without the risk from GLOFs. Mountains are naturally high-energy environments, being formed by the collision of plates of the earth’s crust that, at least for ‘young’ ranges like the Alps, Andes, and Himalayas, are still moving. Global warming, coupled with changes in land use, such as deforestation, or extensive terracing, increases the risks. The heaviest rains for three decades brought floods and landslides to Nepal in July this year, killing some 187 people and cutting off the Kathmandu Valley from the rest of the country.

The sensitivity of mountains to global warming is also having an impact on local economies that depend on tourism. “Below 1500m the ski stations in the Alps can no longer continue,” says Mr Messerli. “The ski lifts are closing. The big banks will no longer give loans for new ski industry constructions.” Reasoner confirms this. “A lot of the low-elevation ski stations did not open this year and many are seeing a significant drop in revenue. If the winter snow-line moves up 1000m in the next 100 years the ski industry is going to look very different to the way it does now. Already, ski areas are eyeing expansion into higher undeveloped areas in the Alps, which is meeting stiff resistance from environmental groups. And this is creating conflict between interests that really should be working together.” Ski resorts in North America are reporting a similar decline (e.g. See www.socc.uwaterloo.ca/snow/snow_synopsis_e.cfm). According to the World Resources Institute, a lack of snow could also threaten the future of Winter Olympic Games. But it could simply mean that the Games move to northern venues, like Norway, where global warming has increased winter precipitation and where glaciers are growing - even if the winters are still getting shorter.

Mountain Wildernesses: Increasingly Threatened

New UNEP Report to be Key Contribution for Bishkek Mountain Summit LONDON/NAIROBI, 23 October 2002 - The world's mountain regions, considered indomitable and unchanging, are gradually being tamed as more and more land is converted to farming and grazing, a new survey shows.

Almost half of Africa's mountain regions are estimated to now be under the plough or the hoof, followed by South America. In Africa, an estimated ten per cent of mountain areas have been converted to cropland and 34% turned over to grazing, the survey shows.

Apart from Greenland, the region whose mountains appear to be the most pristine is North and Central America. Here only an estimated 14 per cent has been converted of which nine per cent is for cattle, sheep and other domestic livestock and five per cent for crops.

Klaus Toepfer, Executive Director of the United Nations Environment Programme (UNEP) said: "Mountains have been a source of wonder and inspiration for human societies and cultures since time immemorial. Mountains, from Mount Fuji in Japan to Mount Olympus in Greece, play key roles in many religions. Indeed they have often been seen as the homes of the Gods. Legends abound, from the fabled Yeti of the Himalayas, to Big Foot in the United States". [Editor's note - Bigfoot is now been exposed as an elaborate hoax -see Sydney Morning Herald 9/12/02]

"Our reverence for these unique, wilderness, areas has been partly

Australian Institute of Alpine Studies Newsletter, December 2002. 14

by Farms, Roads, Fires and Wars

based on their remoteness, their inaccessibility. But this new report highlights how, like so many parts of the world, some of these last wild areas are fast disappearing in the face of agriculture, infrastructure development and other creeping impacts. Behind all these is the spectre of climate change, which is already taking its toll on the glaciers and changing plant and animal communities in high altitude areas," he said.

"These impacts, these losses, are not just regrettable but threaten the health and well-being of us all. Mountains are the water towers of the world, from where the world's mighty rivers spring. We must act to conserve them for the benefit of mountain people, for the benefit of human-kind," he said.

The findings on agricultural intensification in mountain areas forms part of a unique report called Mountain Watch. It notes that traditional agricultural systems, such as terracing, can have a healthy impact on mountain areas by, for example, helping to stabilize soils. But the report, which will be presented to heads of state, ministers and other delegates attending the Global Mountain Summit in Bishkek, Kyrgyzstan, which runs from 29 October to 1 November, indicates that much of the conversion to crop or grazing land is leading to loss of forests and other land cover which can accelerate erosion and soil loss as well as have impacts on wildlife and water resources.

The report, the first map-based assessment of environmental change in mountain areas and the implications for sustainable development, has been compiled by the UNEP World Conservation Monitoring Centre (UNEP-

WCMC) as a contribution to the International Year of the Mountains.

Mark Collins, Director of UNEP-WCMC, said the report graphically illustrated seven pressures or causes of environmental change in mountains: natural hazards, fire, climate change, infrastructure growth, violent human conflict, changes in land cover and agricultural intensification. He added: "To identify the priority areas for global mountain conservation, maps of ecosystem and indicator species groups were overlaid with information about the various pressures. The result was stunning. We could clearly see which areas are suffering most due to a combination of pressures or impacts. So for the first time we have a global snapshot of the threats and vulnerability of different mountain regions".

"Mountain environments cover some 24 per cent of the world's land surface and deserve the level of concern afforded to other global ecosystems," said Andrei Iatsenia, UNEP's Mountain Programme Coordinator. "To this end, UNEP, with support from the Global Environment Facility (GEF), is promoting a more strategic approach to tackling mountain problems. The Mountain Watch process will provide accessible and accurate information for policy makers and all involved in mountain issues," he said.

Other highlights from the report.

- ▶ South America's mountain areas appear particularly vulnerable to "destructive earthquakes" with approximately 88 per cent of the mountain land area deemed at risk.
- ▶ Parts of the Caucasus, California and the North-West Andes, (in particular the forest ecosystems of the Magdalena

Valley in Colombia), are amongst the most threatened, bio-diversity rich, mountain areas in the world. They should be made conservation priorities.

- ▶ Almost a quarter of mountain areas globally could be "highly impacted" by infrastructure development including roads, mining and power and pipelines by 2035.
- ▶ The mountains of Greenland are likely to be the hardest hit by global warming. 98 per cent of its mountain areas could be suffering severe climate change by 2055.
- ▶ Africa's mountain regions are being hardest hit by multiple pressures including conversion of forests and other mountain terrain to grazing land, fire and violent human conflict.
- ▶ The risk of serious violent conflict is higher in mountain regions. The highest level of mountain land that has witnessed war is in Africa. Here 67 per cent has been impacted by "high intensity conflict".

Adrian Newton, lead author of the Mountain Watch report, said: The report shows that globally approximately 41 per cent of mountain land has fallen within the intensity human conflict between 1946 and 2001, compared with 26 per cent of non-mountain land".

The report shows that, despite the intensification of agriculture in mountain regions, these lands are less suitable for growing crops than more low land areas. This, said Mr Newton, allied to environmental degradation may play a role in increasing the risk of armed conflict in mountain regions.

HOUSE KEEPING

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AIAS website member information

The following do not have an entry on our website:

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So if you want to put something in, or if you want to update your entry, or send a picture of yourself email it to Jo Hooper at joanne@thebigbluec.com.au.

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WORKSHOPS

There are four mountain-related workshops coming up next year if anyone is interested:

Boulder Colorado 'Functional significance of mountain biodiversity' (organiser Prof. Bill Bowman)

LINKING MOUNTAIN DIVERSITY WITH FIRE, GRAZING AND EROSION, LA PAZ, 20.-23 AUGUST 2003

Diversification processes in the alpine: bridging the gap between population, phylogenetic and ecological approaches", Aussois, France, June 23-27, 2003, organized by Dr. Irène Till-Bottraud (Grenoble, France), Mary T. Kalin Arroyo (Chile) and Ragan Callaway (Montana, USA), see: http://www.unibas.ch/gmba/Workshop_Aussois.html

Mountain biodiversity and climate, Vienna, Austria, Winter 2003/4, organized in cooperation with Prof. Georg Grabherr, University of Vienna (GLORIA-network, see: <http://www.gloria.ac.at/>)