The Mountain Research Initiative

WORKSHOP ON GLOBAL CHANGE RESEARCH IN MOUNTAIN REGIONS

Catalogue of Research Summaries

9 am – 5 pm
Sunday, 12 December 2010
Faculty Club
University of California
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USA

mountain research initiative

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Keywords:
Botany, Phenology, Plant Physiology/Elevated CO_2, Mycorrhizae, GLORIA

1. What are your central research objectives?
The effects of climate change on alpine plants (GLORIA, Global Research Initiative in Alpine Environments), and the responses of plants to very high soil CO_2 (ZERT, Zero Emissions Research Technology)

a. On what phenomena do you take data?
GLORIA - Species presence, cover, and distribution according to the GLORIA research plan, and a time series of photographs to determine seasonal appearance and phenology of plants. ZERT - leaf physiology, plant distribution and mycorrhizae at very high soil CO_2.

b. What are you attempting to predict or characterize using those data?
GLORIA - long-term monitoring site of alpine plant species in the context of climate change, ZERT - detect and predict plant responses to elevated CO_2.

2. What is the geographic scope of your research?
a. Where do you gather data?
Montana – Northern Rocky Mountains and a field near Bozeman (ZERT).

b. Over what geographic domain do your conclusions hold?
Locally, and in the Rocky Mountains, with linkage to the GLORIA project.

3. What agencies and foundations fund your research?
DOE-EPSCoR (Department of Energy) – ZERT, GLORIA – unfunded
a. What are the time horizons for your funding?
Through 2011 with the possibility of extension through 2014

b. What kinds of resources does your funding provide for you?
Graduate and undergraduate students, lab facilities, equipment, and travel

4. How you would like to see your research program evolve over the next 5-10 years?
a. New methodologies for data acquisition?
In-situ, high-resolution cameras to study the phenology of alpine plants

b. New methodologies for data analysis?

Towards the use of new methods in analysis of alpine mycorrhizal samples

c. Incorporation of new disciplines into your program?

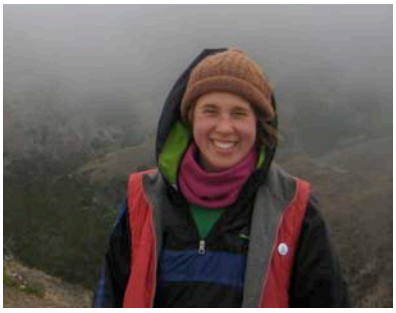
Research on plant functional traits

d. Expansion to new geographic areas?

Yes, with an emphasis on collaboration.

e. Other?

It would be most valuable to have a database of alpine mycorrhizal fungi.



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Keywords: Tree mortality, coastal ecosystem, plant-water relations, geomorphology, stable isotopes

1. What are your central research objectives?
The objective of my research is to advance our understanding of the spatial and temporal patterns and processes underlying drought-induced tree mortality in a coastal forest ecosystem. The focus of my research is threefold: 1) How does tree mortality relate to soil moisture determined by geomorphic attributes in the landscape?, 2) What are the physiological controls on plant water status that may directly determine tree mortality across age classes?, and 3) What is relative importance of seasonal water inputs (summertime fog and winter rain) on alleviating water-stress of trees?

a. On what phenomena do you take data?
I use remotely sensed imagery (aerial photographs, DEMs, and satellite images) to determine the spatial extent of tree mortality and how it relates to the geomorphology of the landscape. I measure the physiological response of trees to variation in seasonal water inputs to determine plant water status/stress and overall function throughout the year. Changes in the physical environment are monitored by meteorological stations at field sites. To source water-use by trees and to measure integrated stress, I collect tree stems and needles, respectively, for stable isotope analyses.

b. What are you attempting to predict or characterize using those data?
The outcomes of this study should contribute to a mechanistic understanding of how variation in plant-available soil water, in an already water-limited ecosystem, impact coastal forest structure and function. Therefore, this study has potential to inform models of the vulnerability of coastal forests to different climate change scenarios.

2. What is the geographic scope of your research?

a. Where do you gather data?
In the Bishop pine (Pinus muricata) forest on Santa Cruz Island--one of the northern Channel Islands off the coast of southern California.
b. Over what geographic domain do your conclusions hold?
Fog-influenced forests along the California coastline, and others located in a Mediterranean climate.

3. What agencies and foundations fund your research?

a. What are the time horizons for your funding?
2 years at present. Funding is pending for another 2-3 years.

b. What kinds of resources does your funding provide for you?
(graduate students, post-doc, lab facilities)
Salary, tuition, fees, field equipment, lab fees, travel for field research and conferences.

4. How you would like to see your research program evolve over the next 5-10 years?

a. New methodologies for data acquisition?
I would like to perform a pulse-chase field experiment using deuterated water to better understand how and when water resources are partitioned by plants in the soil environment throughout the year. I think that it will be important to include additional species in this experiment as recent studies suggest mycorrhizal fungi provide a pathway for water transport between species.

d. Expansion to new geographic areas?
I would like to expand my study to mainland populations of Bishop pine across its range.
e. Other?

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1. What are your central research objectives?
How is climate change affecting mountainous areas (among others)

a. On what phenomena do you take data?
I don't take data, I simulate climate change impacts so I gather as many datasets as I can to test the models. I use climate data as fine scale as I can depending on the science question asked and the area of interest.

b. What are you attempting to predict or characterize using those data?
Changes in vegetation and associated biogeochemical cycles and fire, eventually translating these into habitat characteristics or vulnerability indices to help land managers plan for a sustainable future

2. What is the geographic scope of your research?
Park. My PhD student is testing our model run at 800m resolution against data collected by Park scientists and from the Grinnell survey and resurvey. I am very interested in continuing this type of work in the Olympics (my backyard) and Yellowstone (good fire information). I am also collaborating on a NICR proposal looking at the Central Appalachians.

a. Where do you gather data?
From the literature, from colleagues.

b. Over what geographic domain do your conclusions hold?
Depending at what resolution we run the model: for Yosemite at 800m, it's a regional/local analysis but we have run the model globally at 50km, the central Appalachian project would be for the Appalachian trail, so a narrow corridor.

3. What agencies and foundations fund your research?
USFS has funded the work of the MAPSS team I have belonged to until 2006. The Park Service has funded my PhD student for the Yosemite project.

a. What are the time horizons for your funding?
Yosemite project is finished. I am looking for funding and grant writing opportunities in collaboration with colleagues.

b. What kinds of resources does your funding provide for you?
The funding I had paid my PhD student.

4. How you would like to see your research program evolve over the next 5-10 years?
Well established collaborative work with easy exchange of data/observations or model output between colleagues with multi-author publications
Synthesizing findings, creation of a central database with climate data easily accessible and formatted, creation of a modeler's platform with various modeling tools, user friendly, easily accessible with interchangeable parts.

a. New methodologies for data acquisition?
Working with climatologists like Daly who have strong reservations about the relevance of GCM projections in complex terrain: new climate dataset creation.
b. New methodologies for data analysis?
Better handle on uncertainties associated with climate inputs and hydrological features such as riparian corridors. Incorporating hydro features.

c. Incorporation of new disciplines into your program?
Close contacts with hydrologists, climatologists

d. Expansion to new geographic areas?
Yosemite and Olympics, maybe the central Appalachians

e. Other?
I have colleagues working in China who would really like to learn how to manage high elevation areas under climate change. I have colleagues in France working in European mountains who would welcome collaborative projects..

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Keywords: Tree rings, Tropical treeline, Great Basin, Dendrometers, Automated sensors

1. What are your central research objectives?
My long-term scientific goal is to understand how ecoclimatic factors control landscape patterns and processes in present, past, and possibly future environments. I pursue this goal using natural archives, especially tree rings, which I study at multiple spatial and temporal scales (for instance, I use either multi-century long tree-ring chronologies as well as half-hour stem size measurements).

a. On what phenomena do you take data?
Tree-ring data are used to quantify climatic change, wildfire regime, woodland species dynamics (at the lower and upper treelines), and biogeographic/ecoclimatic regions.

b. What are you attempting to predict or characterize using those data?
Data are used to define a baseline record of natural variability, to be used for the determination of ecological reference conditions, which in turn guide conservation and restoration of natural landscapes and ecosystems by providing a baseline for measuring the effects of past and present activities. Emphasis is placed on responses to regional climatic modes, such as the North American monsoon, and on the application of research results to watershed and natural resource management, particularly in terms of drought planning, fire use, and old growth conservation.

2. What is the geographic scope of your research?
Mountains in arid and semi-arid regions in the mid-latitudes, treeline sites in the tropics

a. Where do you gather data?
Great Basin, USA (see http://dendrolab.org/gb_climate.htm)
Central Mexico (see http://dendrolab.org/mexico.htm)
Italian Apennines and Alps

b. Over what geographic domain do your conclusions hold?

Western North America, Tropical North America (NAMS region), Mediterranean Basin

3. What agencies and foundations fund your research?
Mostly NSF

a. What are the time horizons for your funding?
Currently the next 2 years or so are covered

b. What kinds of resources does your funding provide for you?
(graduate students, post-doc, lab facilities)
Grad students, equipment, travel, lab technician

4. How you would like to see your research program evolve over the next 5-10 years?
More analysis of actual climate-tree growth relationships at multiple time and spatial scales. For example, the Mexico site risks being abandoned after having provided excellent, continuous data on atmospheric, soil, and tree parameters from 2001 to the present.

a. New methodologies for data acquisition?
Remote download of sensor data. Image analysis of tree-ring anatomical properties.

b. New methodologies for data analysis?
Expanded eco-physiological measurements. Process-based modeling of tree growth. Bayesian analysis.

c. Incorporation of new disciplines into your program?
Linking models of landscape change with actual observations of landscape-level climate, disturbance, and vegetation dynamics.

d. Expansion to new geographic areas?
Possibly.

e. Other?
More integration with existing large-scale efforts, hopefully through MRI.

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Keywords: Climate change, glacier recession, vulnerability, governance, Peru

1. What are your central research objectives?
My central research objectives are to evaluate the impacts of climate change and glacier recession on human vulnerability, adaptation and resilience. The research also examines how climate change affects environmental governance, particularly in relationship to hydrologic resources. Finally, my research is intended to provide insights into the implications of climate-change and glacier recession on future resource access and management.

2. What is the geographic scope of your research?
The research is currently located in the Peruvian Andes, in particular the Cordillera Blanca, Peru.

3. What agencies and foundations fund your research?
The research has been funded by research awards from the National Science Foundation, including a two year project from the Geography and Spatial Sciences Directorate and a three year (current) project from the Coupled Natural and Human Systems program. The funding provides resources for field research, student training and the dissemination of project findings.

4. How you would like to see your research program evolve over the next 5-10 years?
It would be superb if researchers could have access to the necessary geospatial data to establish higher levels of confidence in our findings. This includes better remotely sensed data on a regular basis, access to near orbit communications systems and new monitoring equipment.

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Keywords: plant community dynamics, plant-microbe interactions, mycorrhizae, competition, alpine tundra

1. What are your central research objectives?
My research focuses on understanding mechanisms behind plant species responses to climate change in alpine systems and studying the interactive effects of different aspects of climate change (nitrogen deposition, warming, changes in precipitation, woody encroachment) on alpine plant communities and ecosystem function.

a. On what phenomena do you take data?
Plant community composition, productivity, soil microbial biomass and composition, nitrogen cycling, soil organic matter

b. What are you attempting to predict or characterize using those data?
We are trying to understand and assess the impact of climate change factors on alpine communities and use the data to parameterize models to predict species changes in the future.

2. What is the geographic scope of your research?
a. Where do you gather data?
Niwot Ridge in the Front Range of the Rocky Mountains

b. Over what geographic domain do your conclusions hold?
The Rocky Mountains, but with implications for other alpine systems more generally

3. What agencies and foundations fund your research?
NSF, LTER

a. What are the time horizons for your funding?
3-4 years

b. What kinds of resources does your funding provide for you?
(graduate students, post-doc, lab facilities)
I am the post doc on this grant, there is also funding for a graduate student, a summer technician, lab and field equipment and analyses, travel to conferences.

4. How you would like to see your research program evolve over the next 5-10 years?

a. New methodologies for data acquisition?

We are working with one of the co-PIs on this grant to better characterize soil microbial (fungal and bacterial) communities with molecular techniques. We are also beginning 13C tracer experiments combined with PLFA analysis of fungal communities to measure carbon transfer from plants to their mycorrhizal and parasitic fungal symbionts.

b. New methodologies for data analysis?

We are planning to use hierarchical Bayesian modeling to model plant population dynamics incorporating the effects of climate factors as well as plant demography and competition, so that we can project the models into the future and simulate plant communities under different climate change scenarios.

c. Incorporation of new disciplines into your program?

We are currently working with and would like to expand our collaborations with microbiologists, molecular biologists, biogeochemists, and climatologists

d. Expansion to new geographic areas?

Possibly

e. Other?

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1. What are your central research objectives?
The central research objectives of Storm Peak Laboratory are to integrate climate research and education by advancing discovery and understanding within the scientific fields of air pollution, aerosol research and processes related to clouds and precipitation.

a. On what phenomena do you take data?
Continuous measurements are made of basic meteorological parameters, trace gas concentrations, aerosol concentration and size distribution, and cloud condensation nucleus (CCN) concentration. When the laboratory is immersed in cloud, measurements of cloud particle (i.e., droplets and snow crystals) size distributions are collected.

b. What are you attempting to predict or characterize using those data?

2. What is the geographic scope of your research?
a. Where do you gather data?
Storm Peak laboratory (SPL) is permanent mountain-top facility located in the Rocky Mountains of northwestern Colorado (3220 m M.S.L.; 40.455 deg N, -106.744 deg W).

b. Over what geographic domain do your conclusions hold?
Measurements at SPL are representative of the continental background atmosphere in the western U.S. Transport of air masses from as far away as Asia is routinely observed. SPL is frequently exposed to the free troposphere.

3. What agencies and foundations fund your research?
Much of our recent funding has been from agencies including the U.S. National Science Foundation (NSF), the U.S. Department of Energy Atmospheric Radiation Measurement Program (DOE ARM), and the Electric Power research Institute (EPRI).

a. What are the time horizons for your funding?
The funding period for most of our grants is on the order of 3 or more years.

b. What kinds of resources does your funding provide for you?
(graduate students, post-doc, lab facilities)
Funding is used to support the Storm Peak Laboratory staff, including the

director and site manager, graduate students and post doctoral researchers, provide for logistics to support research and educational activities, upgrade the physical plant, and acquire and maintain research equipment.

4. How you would like to see your research program evolve over the next 5-10 years?

a. New methodologies for data acquisition?
Because of the uniqueness of this research facility, we would like to see SPL incorporated into national and international research and monitoring programs such as the DOE ARM program and WMO GAW network. Such new programmatic focus would involve deployment of new instrumentation. We are currently working towards an on-line data base system to disseminate our research results.

b. New methodologies for data analysis?
SPL was recently awarded an equipment grant from NSF which will allow real-time, continuous measurements of trace gases, ultra-fine aerosol size distributions and atmospheric water vapor and isotopic composition. These will elucidate atmospheric processes involving aerosol nucleation and precipitation formation.

c. Incorporation of new disciplines into your program?
The role of biological activity on atmospheric processes, including air chemistry, aerosol formation and growth, and cloud nucleation.

d. Expansion to new geographic areas?
Some of our research activities, such as aerosol-cloud interactions, would benefit from similar studies at other mountain-top locations in the Sierra Nevada. There are several facilities where collaboration with SPL could be developed.

e. Other?

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Keywords (max. 5 terms): Speleothems, paleoclimate, Southeast Europe

1. What are your central research objectives?
My PhD research concerns the production of high-resolution terrestrial proxy paleorecords based on stable isotope analyses and uranium-series dating of speleothems from the Balkan Peninsula. Primarily, I aim at the regional differentiation of the climatic and environmental variability during the Holocene and late Pleistocene, starting with the maritime influenced Mediterranean regions to the continental-temperate regions of the Carpatho-Balkans.

a. On what phenomena do you take data?
I collect samples from speleothems for chemical and isotopic data…

b. What are you attempting to predict or characterize using those data?
… to facilitate the interpretation of key aspects of climate shifts and climate variability such as rainfall variability, mean annual temperature and vegetation response.

2. What is the geographic scope of your research?
Southeast Europe

a. Where do you gather data?
Currently in the Carpatho-Balkans (Serbia), with the intension to extend to the Dinarides (Western Balkan Peninsula)

b. Over what geographic domain do your conclusions hold?
Hopefully, the results will help to provide independent and reliable, high-resolution chronologies of terrestrial climate in the Balkan Area that in turn will help to refine and differentiate global chronologies of past climatic changes.

3. What agencies and foundations fund your research?
Currently, my research is funded by the Elsa-Neumann fellowship program of the Federal State of Berlin. Grants for conducting field work have been awarded by the German Academic Exchange Service (DAAD).

4. How you would like to see your research program evolve over the

next 5-10 years?
My mid-term research interest is the comparative assessment of past climate variability during the last and recent interglacial period. Comparing climate variability of the last and present interglacial period based on high-resolution paleorecords promises unequivocal information about the climate system of the Earth.

a. New methodologies for data acquisition?

- Implementation of speleothem growth- and cave atmosphere monitoring programs in appropriate cave environments to gain a better understanding of the "speleothem system" and in interpreting its environmental signals

b. New methodologies for data analysis?

- fluorescence spectroscopy and UV microscopy, X-ray fluorescence elemental analysis

c. Incorporation of new disciplines into your program?

- Hydrology, geomorphology

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Keywords:
Botany, inventory, diversity, vegetation, composition

1. What are your central research objectives?
For the last 10 years we have been collection data on the flora and the distribution of different vegetation formations along an elevational gradient spanning more than 5000 m vertically. The overall purpose has been to learn and understand the flora of the area. We have used a total of four methods to quantify the vegation: 1 ha tree forest plots where all individual with a DBH>10 were permanently tagged, 0.1 ha plots where all stems with a DBH>2.5 cm has been recorded, intercept line transect where the coverage of herbaceous vegetation was measured, and epiphyte plots where all epiphytes of 1–2 large trees were samples as well as all epiphytes on all stems up to about 2 m, were sampled. We have made 50 large plots and 380+ small plots, 120+ line transects, and 20 epiphyte inventories. We have as indicated estimations of *alpha* diversity from numerous sites, and because we use a single unified "taxonomic" system we can compare and reach conclusions on *beta* diversity as well. The total number of documented species surpasses 7,000, and we expect the area to contain no less than 12,000 species. In the context of climate change we have done little, but believe that a solid foundation in a high diverse area is imperative to be able to make any attempt on predicting change. We are ready to start.

2. What is the geographic scope of your research?
Our focus area is what we call the Madidi region in Northern Bolivia, it encompasses the protected areas of Madidi, Pilón Lajas and Apolobamba, which with the surrounding areas covers an area that is about 110,000 km^2. We cover areas from lowland tropical rainforest and savannas, through premontane forests, dryforest, montane forest to grassland vegetation at midlevels and high in the Andean mountains.

3. What agencies and foundations fund your research?
We have been funded by the National Science Foundation (2 grants), National Geographic Society (2 grants), the Taylor (1 grant) and Davidson famiies (4 grants). We have funding until Mar. 2012, but are constantly looking for more. We fund four professionals working in La Paz, one grad students in St. Louis, four undergraduates per year in La Paz (we have graduated 22 professionals in Bolivia, and 17 are working on their thesis). We are funded to internet connection in Bolivia, computers, servers, office space, herbarium access, field

work (travel and subsistence), travel to and from St. Louis for the professionals each year.

4. How you would like to see your research program evolve over the next 5-10 years?

We see ourselves as growing, if not in the amount of staff and projects then in the sophistication and complexity of our analysis of vegetation and flora. We are very interested in using our knowledge and documentation in climate change research, and believe that we are uniquely and well suited to move in that direction. Few Tropical areas boast a baseline study as ours.

We would like to modernize our data capturing to use PDAs directly in the field, but battery life has so far been prohibitive, but it has been a while since lst resarched. We would like to obtain funding for climatic monitoring at several elevational levels, we would use the TEAM protocols and standards. We would like to create a DNA barcoding library of as many species of trees as possible, we have so far collected more than 3000 DNA samples, but have no funds to get them analyzed. We see that technique as a very useful tool to monitoring of regeneration, as seedlings can be consistently correctly identified.

We are interested in establishing a server in St. Louis that could run R as a web package so that analysis could be submitted to the server and carried out there, with increased power of data crunching as well as memory. This would allow for al project member and student to run analysis in R. The problem here is training in the use of R, but we hope to overcome that with short course training of staff and students.

We would like to increase out outreach program, or rather establish a real program both in St. Louis and in La Paz. This would require funding or finding people in other branches that would be interested in taking on the challenge of communicating botanical science to the general public.

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Keywords (max. 5 terms): climate change, ice cores, geochemistry, Tibetan Plateau

1. What are your central research objectives?
To examine past climate and environmental changes using alpine ice cores. At the Institute of Tibetan Plateau Research, we are analyzing ice cores from in and around Tibet to better understand past temperature and accumulation variability, dust deposition, and atmospheric pollution. Monsoon dynamics are a key aspect of this research; we are trying to characterize monsoon dynamics in relation to snow deposition and chemistry.

a. On what phenomena do you take data?
We use mountain ice cores for chemical and isotopic analysis, with the underlying phenomena related to atmospheric moisture transport and composition.

b. What are you attempting to predict or characterize using those data?
Using geochemical records from ice cores, we are documenting past climate and environmental changes, including temperature and precipitation variability, dust transport and composition, and the impact of atmospheric pollution on snow chemistry.

2. What is the geographic scope of your research?

a. Where do you gather data?
Glaciers in Central Asia and Tibet.

b. Over what geographic domain do your conclusions hold?
Although ice core data represent point data, results are relevant at local, regional, and global levels, and are important for modeling at multiple scales.

3. What agencies and foundations fund your research?
Current funding is from the National Natural Science Foundation of China (NSFC), Chinese Academy of Sciences (CAS).

a. What are the time horizons for your funding?
Expected funding with CAS through 2011.

b. What kinds of resources does your funding provide for you?
(graduate students, post-doc, lab facilities)
Laboratory resources for geochemical analysis, support for graduate students and travel.

4. How you would like to see your research program evolve over the next 5-10 years?

I hope to see further collaboration and expansion of an observation network of high elevation precipitation chemistry in the coming years. I foresee this program being a valuable platform for training young scientists in field and laboratory research. Overall, I hope this program can evolve to incorporate more remote sensing aspects, work more closely with engineers for equipment development, and further develop related areas of atmospheric modeling. I am interested in expanding this research to other high mountain regions of the world beyond Asia.

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Keywords: ecosystem, social-ecological, climate change, pastoralism, Tibet

1. What are your central research objectives?

My central research objectives are to examine how climate and land use changes interact to affect the structure and function of high elevation ecosystems using multiple study approaches at different scales. I consider the effects of multiple drivers (e.g. climate warming, extreme weather events, grazing) on variables such as plant productivity/composition/quality, soil processes, and ecosystem carbon flux. I examine broader responses and also seek to identify the potential mechanisms driving these responses. My work elucidates both how high elevation systems may respond to on-going climate and land use drivers and also how these responses may feedback to land use and climate change. My work often involves experimental manipulations, but I also conduct observational sampling and use simulation models to address my research questions. My recent projects are highly interdisciplinary and focus on coupled human-natural systems. For example, I am leading a project that is examining Tibetan ecosystem and herder vulnerability to extreme weather events (so-called 'snow disasters') and climate warming in the context of on-going natural resource policies. Here, we are employing an ecological experiment in addition to semi-structured interviews, remote sensing and a coupled ecosystem-household decision making model. Our goal here is to identify how to enhance resilience of the pastoral social-ecological system under a suite of climate and natural resource policy scenarios.

2. What is the geographic scope of your research?

I work on the Tibetan Plateau in Asia and in the Rocky Mountain region of North America. My work involves experimental manipulations at the plot scale, observational sampling at the landscape scale and simulation modeling at the regional scale.

3. What agencies and foundations fund your research?

My work is primarily funded through the US National Science Foundation, but I have also received funding from other organizations, including NOAA and the Ford Foundation.

4. How you would like to see your research program evolve over the next 5-10 years?

I would like to see a stronger, more coordinated network of high elevation sites working together on similar climate change and ecosystem manipulations. I would also like to achieve greater integration of bio-physical and social science research using quantified methods and site specific, ground-based data.

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Keywords: Knowledge Platform, Snow Science, Snow – Atmosphere Interaction, Hydrology, Avalanche Warning

1. What are your central research objectives?
The research unit Snow and Permafrost of WSL / SLF Davos studies primarily the physical environment in mountain regions. Particular focus areas are snow - atmosphere interaction, snow climatology and mountain meteorology, snow physics, permafrost dynamics, avalanche formation and snow sports. These diverse fields are complemented by other SLF groups on snow hydrology, avalanche dynamics and high Alpine ecology (particularly protection forests and the effects of artificial snow). This combination of research activities allows the institute to have excellent core subject research as well as a unique program for the prediction, mitigation and management of Alpine natural hazards.
Core research subjects are snow microstructure, surface energy and mass exchange over snow (small scale) and in mountains (large scale), drifting snow, snow and permafrost climatology and snow mechanics (fracturing etc.). Applied research is on avalanche hazard prediction, flood prediction in Alpine catchments, snow sports, artificial snow production and snow/permafrost interactions with the man-made structures. Research and application are supported by a strong footing in IT data management and model expertise. Data acquisition, management and exploitation is addressed within the SwissEx (www.swiss-experiment.ch) program (centered at SLF) and state of the art numerical models on snow (SNOWPACK, Alpine3D) and avalanches (RAMMS) are developed in house.
The main research objectives are a better understanding of the complex environmental interactions in mountains in particular with respect to the cryosphere.

a. On what phenomena do you take data?
Data from both manual measurements and high Alpine snow/hydro/meteorological stations are collected on avalanches, snow distribution and re-distribution, snow variability and snow stability, snow-vegetation interactions and snow microstructure. In addition, snow microstructure is investigated with computer tomography and a wind tunnel produces data on drifting snow and soil as well as soil – plant – snow interactions.

b. What are you attempting to predict or characterize using those data?
Many of the observations are used in running the operational avalanche forecast and increasingly in running flood forecasting in Alpine catchments. The research data is used to understand snow and permafrost from its microstructure to its spatial distribution and long-term temporal development due to climate change.

2. What is the geographic scope of your research?
a. Where do you gather data?
The data collection areas reflect the scale of the phenomena being measured: Data over the Swiss Alps (200+ IMIS/ENET stations) provide measurements of large scale distribution/effects, small catchments (Wannengrat, landscape Davos, Valleé de la Sionne etc.) provide information on medium scale distributions/effects and for laboratory scale measurements, the snow microtomograph and wind tunnel are used. Some studies outside Switzerland are carried out.

b. Over what geographic domain do your conclusions hold?
See above, trend analyses for climate and hydrology are valid for the Swiss Alps but basic findings on snow and local meteorological phenomena are of general validity.

3. What agencies and foundations fund your research?
Major funding from ETH domain, SNF, private industry/KTI and EU. A few private foundations (Velux, Vontobel).

a. What are the time horizons for your funding?
Typically 3 to 4 years.

b. What kinds of resources does your funding provide for you?
(graduate students, post-doc, lab facilities)
Students, Post-Doc, Permanent Staff and Instrumentation.

4. How you would like to see your research program evolve over the next 5-10 years?
The basic research will focus on the formulation of a new theory of snow metamorphism and snow microstructure. This will be complemented by more rigorous assessments of climate change scenarios of the future cryosphere and associated hydrological consequences. A further focus will be the development of warning models for smaller avalanches. In general the resource aspect of snow will become more important.
The infrastructure development will go towards generating a knowledge platform based on technological development that has happened within the SwissEx project.

a. New methodologies for data acquisition?
Fast deployment of wireless sensor networks should find its way into operational hazard forecasting. Collaboration and reuse of measurement data should be facilitated by databases showing what has already been acquired by other institutions as well as enabling seamless data sharing.
Generic tools should be available to remove the acquisition and data management overhead from the project.

b. New methodologies for data analysis?
One aim of the knowledge platform discussed above is that a model toolbox will allow a fast analysis of datasets with customized numerical model systems. This should augment current possibilities, which are based on statistical analysis tools and pre-defined model systems.

c. Incorporation of new disciplines into your program?
The knowledge platform will not only treat cryosphere, hydrology and natural hazards but also extend into air pollution.

d. Expansion to new geographic areas?
South-America, South Africa, Himalayas.

e. Other?

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Keywords: Climate Fire Forest Treeline Adaptation

1. What are your central research objectives?
To understand the climatic and ecological controls on (1) fire regimes (severity, area, frequency); (2) forest ecosystems (distribution, hydrologic function, dynamics); and (3) upper and lower treeline processes.

a. On what phenomena do you take data?
Empirical data: Mountain temperature and snowpack, tree establishment, dendrochronology (tree growth)

Modeled data: climate and hydroclimate parameters (temperature, precipitation, snowpack, evapotranspiration, etc.)

b. What are you attempting to predict or characterize using those data?
I aim to characterize historical relationships between ecological dynamics and climatic (top-down) and local feedback (bottom up) processes, with the goal of predicting / projecting those phenomena into the future given a changing climate and global change in general. From a management standpoint, I am also interested in developing products useful to resource management problems related to these investigations, and the work therefore has a role in adaptation to climate change.

2. What is the geographic scope of your research?
Western North America, primarily western US

a. Where do you gather data?
United States: Washington, Oregon, Idaho, Montana, Wyoming, Colorado, California, New Mexico, Arizona, Nevada, Utah

b. Over what geographic domain do your conclusions hold?
Generally the western US and similar eco-climatic or biogeographic settings. We typically use climatic gradients as a basis for stratifying our sampling, so the conclusions can sometimes be applied more generally when climate can be considered the most important driving factor.

3. What agencies and foundations fund your research?
NOAA, USDA Forest Service, USDOI National Park Service, USDOE NICCR

a. What are the time horizons for your funding?
In 2-3 year increments; in the near term, funding is sparse

b. What kinds of resources does your funding provide for you?
(graduate students, post-doc, lab facilities)
I'm a research scientist, so the funding provides my salary. I have currently no lab facilities, and I cannot be a major supervisor for graduate students or post docs – I must rely on faculty for that.

4. How you would like to see your research program evolve over the next 5-10 years?
I would like to have most of my efforts to understand climatic controls on ecosystem processes transition to a more ecohydrological and phonological basis, rather than relying on temperature and precipitation as much. I would very much like to work to make our local observations of climate-ecosystem feedbacks part of larger networks of standardized observations to increase the scientific value – and ability to scale up – of our work. The International Tree Ring Data Bank, the Gloria project, etc. provide good examples. We should be doing the same thing for fire severity, post-disturbance response, seedling establishment.

a. New methodologies for data acquisition?
The combination of highly detailed field observation and scaling up via remote sensing is intriguing, but what we really need is more climatic observation in mountain systems, and also the ability to measure ecophysiological responses in networks.

b. New methodologies for data analysis?
Automation of generating climate fields from observations.

c. Incorporation of new disciplines into your program?
Ecophysiology is the number one priority for me in terms of new disciplines to incorporate. Second would be social sciences – who benefits, who makes decisions, and why for natural resources problems related to our work. That would help us ask better questions than those driven just by curiosity, and it might also have implications for funding.

d. Expansion to new geographic areas?
I would very much like to compare our results with others in semi-arid and very wet mountain ecosystems (like the Great Basin and Pacific Northwest of the US
e. Other?

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Keywords: Aeolian Dust, Loess, Past Atmospheric Circulation, Central Asia, SE Europe

1. What are your central research objectives?
The overarching aim of my research is the integration of paleoclimate and paleoenvironmental signals derived from high resolution sedimentary geologic records (primarily on Quaternary time scales) with findings of modern synoptical climatology in order to reconstruct past atmospheric circulation dynamics. Particularly I am interested in short- and long-term regional paleo- and modern climate changes and their intra-hemispheric linkages and teleconnections.

a. On what phenomena do you take data?
Sedimentary geologic records (e.g., loess & dust records) using physical and chemical analyses, supported by geochronological methods (e.g., amino acid geochronology and luminescence chronology)

b. What are you attempting to predict or characterize using those data?
Generate value of aeolian dust sedimentary records for reconstruction of past climate change, including the migration of major atmospheric frontal boundaries and regional and hemispheric atmospheric dynamics – on long- and short-term timescales.

2. What is the geographic scope of your research?
The geographic scope of my research covers mountain forelands throughout the mid-latitudes of Eurasia.

a. Where do you gather data?
My primary research areas are located in Central Asia (Kazakhstan & Uzbekistan, northern and western fringe of the Tien Shan) and in East Asia (China). I am also working quite extensively in the circumference of the Carpathians, particular in the middle and lower Danube basin (Serbia & Romania).

b. Over what geographic domain do your conclusions hold?
My conclusions hold generally over the continental interiors throughout Eurasia, but have wider implications for Northern Hemisphere paleoclimates.

3. What agencies and foundations fund your research?

a. What are the time horizons for your funding?
I am currently funded by a Visiting Fellowship of the Leverhulme Trust at Aberystwyth University, UK. During the past five years my research was and partly still is funded by the German Environmental Foundation (DBU), German Academic Exchange Service (DAAD), Bosch Foundation, and the Humboldt-Ritter-Penck Foundation. Two proposals to German funding bodies are in review, respectively in preparation and are expected to provide funding over the coming 3-4 years.

4. How you would like to see your research program evolve over the next 5-10 years?
I would like to complement my work that focuses mainly on geologic records in the forelands of mountainous regions in Eurasia through interaction with geoscientists working with paleoclimate records and/or data of contemporary changes in climate at high elevations in the area.

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Keywords (max. 5 terms):
Tropical glaciers, mountain geography, climate change, hydrology, hydrochemistry

1. What are your central research objectives?
I research the nature, extent, and biophysical impact of changes in glacier environments over time. My group focuses on modern glacier recession as well as Late-Glacial to Holocene variability, and we aim to develop transdisciplinary understanding of climate forcing, hydrologic impacts, social adaptation and vulnerability.

a. On what phenomena do you take data?
We measure glacier mass changes, landscape alteration, surface and subsurface hydrology, water quality, glacial geomorphology, climatic variability and lake sediments. Specific recent data acquisition efforts include: airborne laser swath mapping (ALSM) of glaciers and proglacial valleys; photogrammetry (aerial and terrestrial) of glacier changes; ground (ice) penetrating radar of glacier depth and proglacial valley stratigraphy; hydrochemistry to analyze hydrological sources and contributions to surface and groundwater; stream discharge logging; groundwater monitoring with piezometers and temperature loggers; hydrometeorological observations with vertically distributed instrument arrays; satellite image and altimetry analysis (ASTER, Landsat, SPOT, SRTM); moraine mapping with GPS; lake and wetland coring; and computer modeling, including GIS-based coupled glacier mass balance and ice flow, catchment scale hydrologic balance, and hydrochemical mixing models.

b. What are you attempting to predict or characterize using those data?
Tracing changes in mountain glacier mass over time elucidates dynamics of physical phenomena (climate change, erosion, sedimentation, hydrology) and informs the evaluation of impacts to human society (availability and quality of water). We desire to quantify these processes, better predict their future changes, and inform strategies of adaptation.

2. What is the geographic scope of your research?
While my research focuses primarily is on glaciers and mountain environments in the tropical Andes and Africa, I also work in Alaska and mid-latitude sites once occupied by glaciers, including Great Basin National Park and Central Ohio.

a. Where do you gather data?
We gather field data and maintain embedded sensor networks in a number of specific highland regions in Peru, Ecuador, Chile, Africa, Alaska and Nevada.

b. Over what geographic domain do your conclusions hold?
Our conclusions hold for different spatial regions, from tropical highlands globally (glacial-Holocene paleoclimate), to local mountain regions (as listed above).

3. What agencies and foundations fund your research?
We have been funded by NASA, NSF, National Geographic Society, Western National Parks Association, as well as the Climate, Water & Carbon initiative, Geography Department and Office of International Affairs at the Ohio State University. Funding has been in 1-5 year grants, and resources are used for supporting students, post-docs, field equipment, laboratory analyses, travel, and computing software and support.

4. How you would like to see your research program evolve over the next 5-10 years?
Ongoing and future developments over the next 5-10 year include new technologies and methods, new transdisciplinary integration with social scientists on coupled natural and human systems and dynamics of environmental change, and expansion into new regions of the Andes, Africa and Asia. We have acquired new instruments for nutrient and isotopic analyses of water to assist further work on water quality changes. We are expanding efforts to integrate our physical hydrological work with human geographic assessment of indigenous livelihood level impacts, adaptation schemes, and resilience to environmental change. We also have initiated new research into Andean paleoclimatic gradients throughout the Holocene and Late-Glacial using lake cores and moraine chronology, as well as processes of glacier change, water and biogeochemical cycling in Alaskan peatlands. In the Great Basin, Nevada, we are maintaining hydroclimatic observations and measuring heavy metal and contaminants in watershed sediments. Finally, we have collaborative efforts ongoing in Tibet to evaluate glacier change impacts to stream hydrology and macrobiology.

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Citizen Scientists: Linking science, sport, and tourism to protect mountain regions of the world
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Keywords: citizen scientists, public-private collaborations, climate change, invasive species, biodiversity monitoring

1. What are your central research objectives?
Linking mountain recreationists (such as rock climbers and mountaineers), tourists, and other mountain stakeholders with scientists and land managers to fill research gaps and protect mountains and vertical landscapes of the world.

a. On what phenomena do you take data?
Climate change impacts, human impacts, air and water pollution, pesticide impacts, tourism impacts, biome shifts, invasive species, altitudinal migration, threatened and endangered species in mountains and vertical landscapes (i.e., cliffs, crags, outcrops, etc.)

b. What are you attempting to predict or characterize using those data? Mountain regions of the world are being affected by a growing number of impacts. Citizen Scientists can help land managers, governments, scientists, and other mountain stakeholders understand and mitigate these impacts and develop collaborative adaptation strategies. Involvement in citizen scientist projects can also create in mountain stakeholders enhanced stewardship, environmental leadership, recreational experiences, educational benefits, and support of legislation and funding for mountain protection efforts.

2. What is the geographic scope of your research? It has global potential.

a. Where do you gather data? Yosemite National Park (as shown left at Vernal Falls during the 2008 Lichen Inventory Project), Great Smoky National Park (USA), HKH region (project being developed)

b. Over what geographic domain do your conclusions hold? Citizen Scientist projects can be valuable in all mountain regions of the world and areas with cliffs (sea cliffs and inland cliffs), crags, and outcrops.

3. What agencies and foundations fund your research?
The National Park Service (USA), NPS Centennial Challenge Initiative, The American Alpine Club.

a. What are the time horizons for your funding? Typically one or two years for specific species assessments. This includes planning, sampling, identification,

and cataloging results. Transects through mountain landscapes will need longer-term and repetitive (over time) funding.

b. What kinds of resources does your funding provide for you?
Logistical support for citizen scientists, meetings, training, equipment, species and subject experts, lab facilities, media and public relations, publication of results.

4. How you would like to see your research program evolve over the next 5-10 years?

a. New methodologies for data acquisition? Using small re-chargeable data loggers that can synch with digital cameras to precisely geotag images taken by citizen scientists during their projects. This would be especially useful for landscape transect projects that can be repeated over time. Using new cell phone applications (example at left) that help people correctly identify species, geotag their locations and images, and provide other important information about the species (why they are endangered, why they are invasive, how to protect or properly remove the species if they are invasives, etc.)

b. Expansion to new geographic areas? Rock climbers and mountaineers have the skills needed to access the very high, cold, and remote parts of mountain regions. They could help scientists to get important images and information from these "white spots on the map".

c. Other? Social media (Facebook, Twitter, YouTube, etc.) is now being used very effectively to publicize and promote citizen science projects, results, and the rewarding experiences of participants. This is particularly effective for connecting to the young generations, who will need to carry on the work to protect mountain regions of the world in the future.

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Keywords: mountain ecosystems; subalpine forest ecology; periglacial geomorphology; alpine mammals; Sierra Nevada-Great Basin-W North America

1. What are your central research objectives? To investigate fine-scale climate processes and mountain ecology: 1) understand the response of high-elevation pines to historic and present climates; 2) investigate interactions of alpine mammals (esp *Ochotona*) with their environment and climate; 3) explore decoupled thermal regimes of rock glaciers and related periglacial landforms (e.g., talus) as they relate to hydrologic reservoirs and alpine mammal habitat.

a. On what phenomena do you take data?
Climate
Vegetation: Diversity, composition, structure
Plant growth (coniferous trees primarily)
Small mammal population dynamics and behavior
Groundwater (in relation to rock glaciers and periglacial landforms)

b. What are you attempting to predict or characterize using those data?
See part 1 above

2. What is the geographic scope of your research?
a. Where do you gather data?
Sierra Nevada (CA) and Great Basin mountains of Nevada, S Oregon, and NE CA

b. Over what geographic domain do your conclusions hold?
~ Same as above

3. What agencies and foundations fund your research?
Primary base support through USDA Forest Service, augmented by funds from competitive grants

a. What are the time horizons for your funding?
Annual for base support; variable (1-3 yrs) for grants

b. What kinds of resources does your funding provide for you?
(graduate students, post-doc, lab facilities)
Salary for myself, my lab tech, and a statistician; office and laboratory; truck; some travel; minimal research supplies

4. How you would like to see your research program evolve over the next 5-10 years?

a. New methodologies for data acquisition?
I seek new methods for understanding climatic relationships at fine spatial and temporal scales and new methods for tracking thermal environments of the organisms (trees, alpine plants, mammals) and environments (rock glaciers, talus fields) I study

b. New methodologies for data analysis?
GIS; integration of models with empirical data and observations; analytic tools for comparisons of historic to current trends and to develop scenarios for future conditions at fine spatial scales; methods for detecting presence/abundance/ status of alpine mammal populations

c. Incorporation of new disciplines into your program?
Given that my focus is on high mountain ecosystems and the climates that impinge on these, all disciplines related to these environments are important to me. Hydrology would be the highest priority next, although my latest work focuses on mammal population dynamics and behavior, which is new to me.

d. Expansion to new geographic areas?
I have started to focus more intensively on the Great Basin ranges (NV, CA, OR) that support upper montane and alpine environments. Given that there are 315 of these in NV alone, I'll be busy enough with these for many years!

e. Other? Thanks for hosting this wonderful event!

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Keywords: Snowmelt discharge, Water Temperature, and Conductivity

1. What are your central research objectives?
Monitor and define hydroclimatic variaiability and change in the Sierra Nevada Mountains, California
a. On what phenomena do you take data?
Spring pulse, peak snowmelt discharge, base flow, stream water temperature, and conductivity

b. What are you attempting to predict or characterize using those data?
Their change and rate of change in a warming climate

2. What is the geographic scope of your research?
Sierra Nevada

a. Where do you gather data?
In mountain streams where flow is relatively unaltered

b. Over what geographic domain do your conclusions hold?
Do not know that (yet)

3. What agencies and foundations fund your research?
USGeological Survey

a. What are the time horizons for your funding?
Long-term

b. What kinds of resources does your funding provide for you?
(graduate students, post-doc, lab facilities)
Field equipment and field assistant (Fred Murphy)

4. How you would like to see your research program evolve over the next 5-10 years? Include remote sensing

a. New methodologies for data acquisition?
Someone else would need to define variability in the water table and ET(in selected watersheds)

b. New methodologies for data analysis? Use of numerical models would be new to us, were are largely obsevationaly based.

c. Incorporation of new disciplines into your program?

We have started including Chinook salmon

d. Expansion to new geographic areas?
Perhaps the West Coast Ranges, such as North (Washington State) and South Cascades ((Northern California)

e. Other?
Would like to know if any studies of mountain streams include hourly stream temperature and conductivity?

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Keywords: global environmental changes, alpine tundra, plant life history, phenology, nitrogen

1. What are your central research objectives?
My central research objective is to understand how global environmental changes affect
ecosystem function in seasonally snow-covered landscapes through understanding plant
responses to these changes.

a. On what phenomena do you take data?
Plant species responses, plant community life history, plant production, nitrogen cycling, microclimate, timing of snowmelt, surface greenness

b. What are you attempting to predict or characterize using those data?
Environmental cues that regulate plant species life cycles and plant community response to environmental changes that alter ecosystem functions

2. What is the geographic scope of your research?
The geographic scope of my research to date is North American temperate and arctic regions.

a. Where do you gather data?
I have been conducting research in the Colorado alpine tundra, Colorado montane forests, and in the Arctic tundra near the Brooks Range in Alaska. I have also worked in high plains ecosystems in Colorado and Wyoming.

b. Over what geographic domain do your conclusions hold?
Most of my research best describes plant and ecosystem responses to global environmental changes within a site. However, this year, I have established an experiment in the Arctic on the effects of early snowmelt on plant and ecosystem function that is similar to one I conducted in the Colorado alpine tundra. I would like to work with others to establish similar experiments across Arctic and alpine landscapes in other regions of the world.

3. What agencies and foundations fund your research?
The U.S. National Science Foundation Office of Polar Programs and Division of Environmental Biology, the United States Geological Survey, and the British Ecological Society

a. What are the time horizons for your funding?
I have funding for 2 more years of research in the Arctic and am regularly applying for funding for new projects.

b. What kinds of resources does your funding provide for you?
Research assistants, data manager, PI salary, funds for travel to the field site and for instrumentation to monitor surface greenness and microclimate.

4. How you would like to see your research program evolve over the next 5-10 years?
I have been working to develop automated approaches to monitor plant responses to environmental change through observing surface greenness and microclimate, and to create a data management system that can make it simple to use these approaches at diverse alpine and arctic sites in the U.S. and around the world. Over the next 5-10 years, I would like to be working with others to further improve the instrument arrays for use in remote mountain environments and to establish long-term monitoring plots across topographic gradients where the instrument arrays would be placed. In combination with expanding the use of these monitoring methods, I would also like to work with others to establish long-term experiments that manipulate the timing of snowmelt and increase summer temperatures using a common methodology across many sites. I have been working with Chris Landry, a snow scientist at the Center for Snow and avalanche Studies, to learn how to implement our method for manipulating the timing of snowmelt at other sites.

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Keywords: Streamflow, climate change, snowmelt, hydrology, mountains

1. What are your central research objectives?
My work characterizes the response of mountain-derived streamflow timing and quality to climate variability and change. I assemble data on streamflow quantity, quality, temperature, precipitation, climatic indices, elevation, land use, soils.

2. What is the geographic scope of your research?
The geographic scope of my research is western North America. I am currently expanding to other global key mountain regions. My conclusions hold over western North America.

3. What agencies and foundations fund your research?
Clare Booth Luce Foundation (7 years)
U.S. Environmental Protection Agency (3 years)

This funding provides for research materials, some travel, 1 postdoc.

4. How you would like to see your research program evolve over the next 5-10 years?
I would like to develop or modify statistical techniques to better analyze short records with high variability. In addition, I would like to incorporate the vulnerabilities of aquatic ecosystems into my work. Currently, I am expanding my work to other key global mountain ranges.

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Keywords: Climate change, Birds, Central Asia

1. What are your central research objectives?
We study the effect of climate change on migratory birds in the central Asian flyway. We gather historical data on the spring arrival of migratory birds in their breeding grounds and compare them with current information and relate any differences with the climate and land use change. We also address the phenological mismatch of migratory birds and their prey species. We are also involved in studying the movement patterns of migratory birds fitted satellite transmitters.

2. What is the geographic scope of your research?
Mountainous regions of India, Mongolia and China.

3. What agencies and foundations fund your research?
USGS. Initially funding is available for a year, but there is possibility of extension.

b. What kinds of resources does your funding provide for you?
Satellite transmitters, data retrieval facilities.

4. How you would like to see your research program evolve over the next 5-10 years?
This research will generate crucial information on the effect of climate change of migratory birds in the Central Asian Flyway. We envision our project facilitating a regional network of researchers across Asia collaborating to mitigate the effect of climate change on migratory birds. We are using some novel methods to study the movement patterns of migratory birds. We are planning to involve a hydrologist and a climatologist to assess the effect of rapid melting of glaciers on the habitats of migratory birds. We plan to expand to the east Asian Flyway.

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Keywords: Himalaya, Koshi River Basin, land cover change , climate change adapatation

1. What are your central research objectives?
Our central research objectives concentrate on past and future land use/cover change and the relationship between land cover change and anthropogenic activities, climate change, and environmental factors. In respect to the past we are working on the analyses of different historical period remote sensing data , envrionment and social data in order to find the solution to sustainable development for local people. For data sharing we are constructing a platform for all scientists interested in the region.

a. On what phenomena do you take data?
As we focus on land use/cover change, we take data around this phenomena. We using remote sensing data for the land use/cover change detection,such as satellite remote sensing images (MSS, TM, and ETM+) and NDVI. We take environment data and social data for the driving force analyze of land use/cover change, such as GDEM, topographic Maps, land use/cover types, temperature, precipitation,household data for livelihood, and social economic data etc.

b. What are you attempting to predict or characterize using those data?
Our aim is to analyze the land use/cover change and its driving forces, trends and modeling land use/cover change in the Koshi River Basin region in different scenarios to give the decision support for the local development.

2. What is the geographic scope of your research?
Up to now we are focusing on Mt. Qomolangma (Everest) National Nature Preserve and Sun Koshi River Basin. In future, we will extend the entire Koshi River Basin, which may be characterized as a transboundary area between China and Nepal (85-99°E and 26-30°N). Its area is about 70 000 km^2 and its complex terrain ranges between 80 and 8844 m a.s.l. including mountain peaks, plateaus, small scale valleys, basins and plains, as well as glacier, glacier lakes, forested areas, grassland, cultivated land, urban areas, and other landscape features.

a. Where do you gather data?
We are collecting data on a formal collaboration of research institutes of CAS, ICIMOD and research universities(institutions) in the China, Nepal, and India.

b. Over what geographic domain do your conclusions hold?
Up to now on the Koshi River Basin (85-99°E and 26-30°N)

3. What agencies and foundations fund your research?
Funds of Bureau of International Co-operation Chinese Academy of Sciences
National Basic Research Program of China and ICIMOD fund.

a. What are the time horizons for your funding?
We have different foundations in this region since 2005, and the present project is from 2009 to 2011.

b. What kinds of resources does your funding provide for you?
finacial support for the field works, hardwares,Lab facilities,PHD students and networking activities.

4. How you would like to see your research program evolve over the next 5-10 years?
A strong collaboration between the researchers in China, Nepal and India in geography fields and other disciplines should be established. Other aspects related with land cover change should be incorporated so as to generate a more holistic picture of the impacts of anthropogenic activities, climate change, and environmental factors on land cover change. We envisage developing a comprehensive geodatabase for future comparison and sharing with other researchers in other mountain regions in the world.

a. New methodologies for data acquisition?
We will involve in primary data acquisition, such as validation of classic types of land cover and hot points investigation. And we would like to establish/adapt a common standard methodologies for the data acquisition in different countries in the Koshi river basin.

b. New methodologies for data analysis?
Better tools to interpret remote sensing images, model the real land cover change, and validate the results in the Koshi River Basin. Improved methods, including statistics, geostatistics, climate models, will be used to illustrate the relationship between land cover change, climate change and environmental factors.

c. Incorporation of new disciplines into your program?
A closer collaboration with other disciplines, especially meteorologists, glaciologists, botanists, ecologists and social scientists would be appreciated.

d. Expansion to new geographic areas?
Considering the importance of the issue (i.e. the increasing of GLOF risk, the overall decreasing of land resources available, and local sustainable development) and the geological–geographical similarities, the research should be extended to the entire Himalaya region.