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FACTORS FOR ATTRACTING RESEARCHERS AND A COMPARISON OF PEER INSTITUTIONS IN ALPINE STUDIES

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Introduction

When choosing a job, highly skilled researchers are influenced by various factors of attraction to institutions, and these factors vary in importance based on the field of interest. The purpose of this study was to determine which factors influencing job selection are most important to researchers in the alpine field. We researched studies by such sources as the Commission of the European Communities and experts on researcher mobility concerning job selection factors, but there is a lack of data specific to the alpine field. By studying what researchers value and by comparing select alpine research institutions, we have explored which elements of an institution affect its attraction and retention of researchers.

For this study, we chose eight snow and avalanche research institutions based on the number of researchers working in this field at each institution. We compared these North American and European research institutions based on measures of reputation, compensation, and setting. In addition, we sent a questionnaire to current graduate students involved in snow and related research, asking them to assess the importance of various job selection factors. We then used the results of this questionnaire to weight the importance of the measures of the peer institution comparison. As a result of the questionnaire analysis and the institution comparison, we generated a list of recommendations for the improvement of the attraction and retention of researchers by snow and avalanche research institutions.

Context

While research has been done on the attraction of people to different fields and institutions, little research has focused on alpine researchers in particular. In order to determine those factors that influence the attraction of alpine researchers to research institutions, it is necessary to understand the elements of researcher mobility. This not only includes those factors that affect job selection, but also includes those barriers that prevent researchers from relocating.

Mobility

In recent years, the global market has become a major outlet for educated, skilled labor in research and development (Mahroum, 1999). Issues such as human mobility, the movement of scholars internally and globally, and the internationalization of research have become points of interest throughout the world due to the desire to attract and retain top-level researchers to institutions throughout the world. Institutions see globalization as a way to increase their competitiveness through attraction because the mobility of researchers allows for a spread of the reputation and increase in the recognition of the institution, thus attracting more researchers. According to an international comparative study performed by the Technopolis Group to aid in the attraction of more top-level researchers to Ireland, "[internationalization of] their education and research systems, and more importantly [use] of temporary and foreign [science and technology] personnel to improve their research base and stock of qualified researchers/scientists" will greatly increase the attractiveness of research institutions (Boekholt, et al., 2001).

Mobility is defined as the movement of scientists and researchers between institutions or between countries. It can be either external (geographic or a result of labor turnover) or internal (occupational changes). Specifically for science and technology researchers, Dr. Mahroum (1999), an expert on scientific mobility, identifies mobility as the "movement from the educational system to the labor market; mobility within the public research sector (e.g. universities, laboratories, public research institutes) and between public research and industry; mobility of [science and technology] personnel within industry, and international mobility" (p. 170). For the context of this study, we define mobility as the movement of researchers either permanently or temporarily to other international alpine and avalanche research institutions (external), and as the movement to private companies and governmental branches (internal).

External Mobility

A large portion of scientists move, either temporarily or permanently, to other countries offering more career opportunities (Mahroum, 1999). "The key difference between the American and European experience resides in scientific capability. It is true that European research institutes may perform better in some fields than the US, but they lack the magnet power that can transform them into pivotal points in their fields. European universities, for example, attract fewer international students than U.S. universities do…" (Mahroum, 1999). The United States is often seen as the destination for researchers who are willing to move for opportunity, and many European researchers move to various regions of the United States to continue their academic research

(Boekholt, et al., 2001). For example, of all the engineers and scientists born in Switzerland, 5.9% immigrated to the United States in 1995. Furthermore, in 1993 a total of 6,986 Swiss students (4.7% of all Swiss students) matriculated to U.S. universities; of that number, 1,575 (22.5%) remained in the United States after earning their degrees (Immigration Statistics, 2000).

Nonetheless, various studies indicate that Switzerland is one of the leading European countries in terms of attracting top research scientists from other countries (Boekholt, et al., 2001). Switzerland is often seen as the European equivalent of the United States: "…a country that hosts major research and academic centers (such as CERN, the IBM Lab near Zurich, and the Federal Institutes of Technology in Lausanne and Zurich) and which enjoys living standards which are among the highest in Europe, and is also successful in attracting Ph.D. candidates from other European countries (26% of that country's candidates)" (Mahroum, 1999).

Mobility – Factors

There are numerous factors that influence researchers' decisions regarding job opportunities and choices. Some of these factors vary in their importance based on the researcher's age and experience level. Based on the literature surrounding scientific mobility, the main factors for any group are: opportunities for advancements in academia and science; international reputation and prestige; the nature of the work to be performed; opportunities for scientific publication; ease of communication (i.e. reduced language barriers); the setting of the institution, including other opportunities available; the amount of supply and demand for labor in that specific area of science; quality of research staff in the organization; working conditions and salary; and the organization's reputation for excellence, quality and originality.

Richard Florida (2002) discusses a survey that was conducted in 2001 by Information Week to rank 38 factors that play important roles in job choices. Among those information and technical workers surveyed, the challenge of the job and responsibility involved were ranked as the number one factor. From there, the factors were ranked as flexibility, job stability, compensation, peer respect, technology and location, company orientation, organizational culture, career orientation, and benefits (Florida, 2001). This study showed that salary is often overrated as a factor of attraction; while money is essential, it is insufficient for passionate workers. Similarly, another 2001 survey of American workers by Zogby International showed that nine out of ten believed the quality of life and setting was a major factor (Florida, 2001).

According to Boekholt, et al.(2001), government and institutional policies influence the moves of students and graduates the most; the quality and training opportunities are the main concerns of post-grads, as well as international recognition of the institution, accessibility problems in that location, and interactions with other cultures (p. 14). A main legislative factor surrounds immigration legislation, including procedures, policies, information availability, time involved, and work permits for partners/spouses; this was reinforced by the benchmark strategy of Ireland, indicating that immigration legislation is the most important legislative factor in human mobility (Boekholt, et al., 2001). Because immigration legislation has shown to be a major concern in past studies, countries including the U.S., U.K., and France have implemented strategies to lower the barriers for making the move to a foreign country easier.

A main concept of researcher mobility is that researchers as individuals tend to make choices based on where there is a demand for jobs where their skills will be most needed and rewarded (Mahroum, 1999). This statement was further supported by a study performed by G. Steven McMillan and David L. Deeds (1998). The study was conducted on approximately 400 PhD students in the U.S. to determine the importance of various factors that influence job choice by people in science and technology fields. The study questionnaire had a response rate of 16.3%. Of those who had responded, 50.8% (33 students) were primarily interested in working for a research institution, 32.3% (21 students) were interested in private companies, and 10.8% (7 students) were interested in government institutions. The results from this study indicated that the main consideration among researchers and those involved in private industry was whether the employer retained a high standard of science. The quality of research staff, working conditions, and salary were the next most important respectively (Deeds & McMillan, 1998). Those students interested in government institutions differed from the rest of the respondents, in that their top three concerns included high ethical standards, high standard of science, and the quality of research staff. Those students expressing interest in working for a research institution were more interested in publications than the other students surveyed. The authors describe how for researchers, publications provide a larger amount of visibility and show an increased opportunity for publishing, therefore aiding in recruiting researchers.

The study by The Technopolis Group and various other studies list reputation of the institution as the number one influencing factor: “The literature on research mobility stresses that reputation of a particular institution, research group, or professor, is the most important motive for research talents to migrate to another country...” (Boekholt, et al., 2001). Mahroum (1999) refers to sociologist Stephen Shapin’s analysis of science and “trust,” in that “scientists put their trust in organizations that are highly reputed for excellence, quality, and originality. Therefore, ‘attraction’ is dependent on the possession of certain qualities that are not available in all organizations, and which are often difficult to assess from the outside” (p. 176). Along these lines, “Star scientists, though few in number, are critical to the movement of staff. They tend to go where the best facilities are, and their reputation attracts the best young talents” (Mobility of Researchers: Brain Drain or Brain Gain?). Most European countries, seeing the U.S. and the U.K. as the largest competitors for attracting researchers, understand that competition involves improving upon the performance level and international reputation of the research center involved (Boekholt, et al., 2001).

Overall, mobility is key to the spread of scientific knowledge and reputation. As indicated by the Max-Planck-Institut for Metallforschung Stuttgart, “A barrier to the efficient use of European scientific talent is the lack of mobility of scientists at all levels.” General observations by the High-Level Expert Group (HLG) on Improving the Mobility of Researchers show that "there is a striking lack of comprehensive statistics about the mobility of researchers in the majority" of European countries (European Commission, 2001). Not only is there a lack of data available for specific countries, there is also a lack of data for specific fields of study. This study aims to identify the major factors behind the mobility of researchers in the specific field of alpine research.

Internal Mobility

Factors must also be considered in terms of internal mobility, in which researchers would choose private companies, such as consulting or insurance companies, or branches of government over positions at a research institute. While research positions are often deemed more satisfying, private work is often seen as a better financial choice (The Scientist, 2000). Malatest, R.A. & Associates Ltd. (2001) conducted a study of 1,200 people on their opinions on employment in the government. People in the study included the general public, newly hired government employees, long-term government workers, and those who had recently left government positions. This study evaluated the issues of recruitment, attraction, retention, job satisfaction, and employment equity issues. The "quality of work" was a major attraction element for those who had taken or were involved in government postitions; those surveyed wanted jobs that create a "balance in terms of doing intellectually challenging and stimulating work as well as the opportunity to spend time away from work through a good benefits and vacation package…job security was rated as being an important attraction factor…" (Malatest, R.A. & Associates Ltd., 2001). These top three factors were ranked as being important by 80.2%, 77.5%, and 73.6% of those surveyed, respectively. (Malatest, R.A. & Associates Ltd., 2001). In addition, those factors that were cited as indications of a more attractive employer included increased pay and benefits; more respect and/or recognition; more efficient management; greater opportunity for advancement; more flexibility; and a decreased workload or stress due to appropriate hiring (Malatest, R.A. & Associates Ltd., 2001).

While working for private institutions and government branches are options that compete with research institutions for skilled researchers, the measures necessary to compare such employers with research institutions are very different than those measures used to compare peer research institutions. There is also a large range of competitive institutions that could be considered, both locally and internationally. Therefore, comparing all employment options is beyond the scope of this project, and we chose to focus on external mobility between international research institutions.

Strategies in place

A study performed by Ireland discussed various strategies that have been developed and implemented for attraction and retention by countries such as the United States, the United Kingdom, the Netherlands, Finland, and Denmark (Boekholt, et al., 2001). These strategies include utilizing universities; appealing to researchers on national and international levels, as well as researchers ranging from graduate students to post-doctorates; and strategies that are more specific to the individual factors influencing attraction and retention of skilled researchers.

Internationalization strategies need to begin at the university level, directed at students of all levels and in all locations; the movement of students is an excellent method for spreading information and reputation. "The international movement of students represents the internationalization of knowledge, and is arguably the most effective vehicle for creating a [mobile group of skilled researchers]" (Salt, 1997). Esteemed universities often have international post-grads and post-docs, as well as international offices that can keep contact with the research institutions (Boekholt, 2001).

Improving international networks will help to establish contacts with PhD graduates and other top-level researchers.

Attraction strategies need to be aimed at both younger researchers as well as more experienced researchers; treating research graduates as regular experienced staff members will also help in promoting future connections. According to Dr. Mahroum (1999), "Countries whose National Innovation Systems (NIS) revolve around universities will primarily attract academics, and these will be the place where cutting edge national science and technology activities take place" (p. 171). As was found in the literature, "An expanding system needs new blood in all its ranks" (Boekholt, et al., 2001). Therefore, research institutes should work to attract students at earlier stages in their career.

Reputation and prestige of an institution are directly related to the prestige of its employees. It is important to recruit quality employees because of the "chain-effect" that is created: high-quality researchers will be attracted to places where other top-notch researchers work. According to Boekholt (2001), "Any strategy to attract young researchers as PhDs and post-docs will have no long term impact if this is not accompanied by actions to also attract internationally established and renowned scientists to lead research groups, faculties, and institutes" (p.78).

In addition to attracting people with different levels of experience, it is necessary to appeal to researchers on both national and international levels. According to the *RTD Info*, a magazine on European research, "Excluding foreign scientists starves Europe of the skills it needs to complement and strengthen its native capacity, and makes it impossible to develop the centres of excellence where the best scientists want to study and work (Mobility of Researchers: Brain Drain or Brain Gain?).

In addition to factors that attract researchers, there are also those which prevent researchers from making the move to another country or type of institution. These barriers are generally social, cultural, linguistic, and economic. Other factors that can act as barriers for foreign researchers include housing issues, immigration and administrative procedures, social security rights and monetary issues, and inadequate information regarding grant, housing, taxation, and scientific possibilities.

According to the HLG, the first obstacle facing the mobility of researchers is the "legal and administrative obstacles to transnational mobility" (European Commission, 2001). In order to address this issue, the employment of a human resources director to take care of initiating the paperwork necessary for work permits and visas will ease the move to a foreign country by researchers. Several countries have developed a "Clearing House" to coordinate and provide administrative and immigration information for foreign researchers in order to make the information more accessible to foreigners. For example, France has the EduFrance for graduates and the Alfred Kastler Foundation for post-docs and other experienced researchers, and the CIMO organization is in Finland (Boekholt, et al., 2001). Europe as a whole has also been trying to increase attraction through information and promotion of mobility. Since June of 2001, The Commission of the European Communities (2001) has also been pushing for the creation of the European Research Area and Mobility Centres by 2005 to make information regarding human resources easily accessible and to make Europe more attractive to researchers and to increase the mobility between academia and industry (p. 6).

According to the HLG, the European Council is working "to take the necessary steps to remove obstacles to the mobility of researchers in Europe by 2002 and to attract and retain high-quality research talent in Europe" (European Commission, 2001). This study is focused on all research talent in general, but there is a lack of initiatives directed at attracting talent in specific fields of study. Many researchers worry that mobility will halt their career development in that they would either have to make a fresh start in a new country or industry, or that they will not be able to get back into a program within their home country should they try to return (Commission of the European Communities, 2001). One method Switzerland has employed to lessen the barrier that might be encountered upon return involves grants know as "ReBrain Grants," sponsored by the Swiss House for Research and Education, specifically the Gebert Rüf Foundation (http://www.grstiftung.ch/). These grants enable skilled researchers elsewhere in Europe to apply for grants that would encourage them to return to Switzerland.

General methods that could be considered in attraction or in promoting global movement can be broken down into various governmental and institutional categories, including taxes, immigration, grants, scholarships, marketing, as well as other areas. Some improvements in taxes that have been seen in Europe and the U.S. involve tax exemptions for students and tax reductions for outstanding researchers. Issues to be considered would deal with increasing visa application processing; the benefits of having a continuous or specialty visa over renewing permits; and help with immigration procedures. In the area of grants, some countries have utilized international databases for research opportunities, increasing the international educational recognition, funding joint research programs, and participation in international organizations. Miscellaneous measures that could be taken also include accommodations, and travel reimbursement. While a specific research institution may not have control over national immigration or governmental policies, these issues remain concerns of international researchers and should be taken into account.

Methods

A large part of determining how research institutions can better attract and retain researchers is understanding the factors influencing the mobility of these people. Based on a researcher's personal interests, various factors influence job choices. The importance of these factors, in turn, influence the mobility of researchers, in addition to any barriers that present difficulties for researchers in moving from one institution to another. This study helps determine the factors influencing the mobility of people in the field of alpine research, and compares a select group of peer alpine institutions based on these factors. The selected peer institutions are outlined further ahead in this report.

Understanding the factors that researchers and scientists consider when looking for an employer and workplace is necessary for an accurate assessment of alpine peer institutions. Based on our research, we have organized the factors that influence the attraction of researchers, specifically to research institutions, into three main categories. These three categories include compensation, reputation, and setting. These factors needed to be evaluated on an international level because there are various obstacles that foreign researchers would have to face in relocating for their career. We reviewed

literature dealing with the mobility and globalization of researchers by Dr. Mahroum, an expert on mobility, and various other researchers on mobility and "brain drain," as well as papers by the European Commission. We also looked at studies completed by other institutions and nations that focus on the attraction and retention of researchers, including ones done by Ireland, the USSR, and Europe as a whole (These studies are described in greater detail in the Context section).

Next we developed tangible measures for the three main factors that influence attraction. Based on our research of previous studies that were conducted to see what influences job choice, we found that tangible measures such as salary, number of publications, quality of research staff based on degrees and research, and the challenge of the work are measures often used to evaluate decision-making for job choices. Sources that helped us to develop these measures include the *U.S. News and World Report*, the *Gourman Report*, and *Der Spiegel*. These sources contain rankings and ratings for colleges located in the United States, Canada, and Germany, respectively (Der Spiegel; Gourman Report, 1998; U.S. News and World Report, 2002).

Briefly, *Der Spiegel* evaluated the quality of German universities using questions involving seminar attendance, training, quality of mentoring, encouragement of independent research, and quality of the facilities. *The Gourman Report* (1998) used similar measures, including extent of degrees; age of the institution; quality, experience, and research interests/productivity of the faculty; content of work and work opportunities; quality of the work and the facilities; and funding available for research. (The methods used in evaluations for *Der Spiegel* and the *Gourman Report* can be found in greater detail in **Appendices A** and **B**.)

The methodology that the *U.S. News & World Report* (2002) used, however, did not prove to be as useful. It involved ranking programs in the sciences based on a questionnaire that was sent to the department heads and deans or directors of graduate studies of each program in every discipline. The questionnaire had a list of graduate programs in that particular discipline that individuals were asked to rank on a 5-point scale or asked to select "don't know" if unfamiliar with the program. The results were then averaged and schools were ranked based on the results. The *U.S. News & World Report* (2002) also ranks programs that have excellent offerings in certain specialty areas. The questionnaire asked for individuals to nominate programs. When a program received at least seven nominations it was published. The programs were then ranked based on the number of nominations. Based on our understanding of the ranking, we did not feel this methodology would be useful in developing our tangible measures for the factors.

The tangible measures we developed for the three factor categories were those that have appeared to be of high importance to job-seekers in other studies, and are similar to those measures used in the rankings to assess attractiveness of various universities. We evaluated the category of compensation using the tangible measures of salary and opportunity for advancement. While salary is usually assumed to be the deciding factor in job opportunities, research has shown that scientists in research and development are often more concerned with the challenge of the work and opportunity for advancement (Florida, 2002).

We measured salary in ranges, and emailed the peer institutions a short questionnaire asking for the pay range of their research employees, among other things. By asking for a salary range for PhD students and post-doctorate researchers, we were

able to estimate the extent of financial advancement the institution offers. In terms of actual advancement in work or research, we searched the websites for each institution to determine how many departments there were. With different departments, researchers will have more opportunities to specialize or alter their work if they wish to change their current position.

The category of reputation, including journal articles, involvement in international alpine conferences, and employee statistics, was a larger category. Research has shown that the number of scientific publications produced by the institution is a major indication of prestige to job-seekers. As seen in the measures used by the *Gourman Report* (1998) and *Der Spiegel*, conference involvement and attendance is also a sign of involvement within the intellectual community. We studied the minutes from various avalanche and alpine organizational meetings and international conferences to see which peer institutions were represented in attendance, involved in organizing the event, or who presented at the event; these numbers were normalized against the total number of snow and avalanche researchers for that institution. Our approach in determining the number of journal publications for each peer institution is outlined in **Appendix C**.

Employee statistics included percentage of doctorates, age of the institution, and age range of employees. As was discussed earlier, it is necessary for a research institution to have a range of employees in terms of age and experience in order to successfully attract skilled researchers. Therefore, the age range of the employees and the percent employees with PhDs provide us with concrete numbers that can be associated with the prestige and success of the institution. The age of the institution, a measure that was also used by the *Gourman Report* (1998), is also a number that potential employees often consider. Finally, we evaluated the number of publications per researcher that we counted from ISI, scientific journals, and institution webpages.

Setting was the third category that we developed tangible measures for in evaluating the peer institutions. We gathered measures from such resources as *Rand McNally's Places Rated* and the *Places Rated Almanac*. Their measures included cost of living, transportation, jobs, education, climate, crime, arts, health care, and entertainment. The measures we used for this category in comparing research institutes included weather, educational opportunities, cultural and recreational opportunities, unemployment rate of the area, average per capita income, and immigration policies for that country. We found most of these statistics on national statistical databases. The classification of the location as rural or urban, as well as the per capita income, gave us some information regarding the economics of the location. The classification of the location also hinted at the cultural and recreational opportunities available in that location. Further measures that we used included the distance to the nearest metropolitan area, distance to the nearest university, distance to the nearest hospital, weather conditions (average annual precipitation, average annual high and low temperatures), and crime statistics.

In order to classify the locations of the institutions as urban or rural, we used the criteria outlined in Rand McNally's Places Rated Almanac. This source defines a metropolitan U.S. city as any city with a minimum of 50,000 people; in Canada, the area is defined as a city with 100,000 people located near urban and rural areas that are closely tied to the urban areas (Savageau, 2000). Therefore, we were able to define five of the seven locations as urban since they had populations close to or over 100,000 people; we

defined the homes of CRREL and SLF as rural since these locations were only approximately 10,000 people.

Defining peer institutions that are involved in the study of avalanches was the focus of our next step. We searched for avalanche and alpine environment research institutions located throughout the world on websites such as <http://www.avalanche.org/> and other national avalanche organizational webpages. We also utilized general search engines for institutes involved in snow, avalanche, alpine, cold, or glaciological research. **Appendix D** shows the list of those avalanche peer institutions that are involved in any aspects of alpine environment. From there we researched the web pages and information available on each individual institution to see what they could offer in terms of employment opportunities and location. We also looked for information pertaining to the factors we identified as important to the attraction of researchers. Because the age, size, and quality of the institution are important in comparing the institutions, we first looked at the number of researchers employed by the institution. Many of the avalanche and alpine institutions employed much fewer researchers than expected, some even having only four to six researchers. Because we did not feel that such small-scale institutions could be equally compared to more competitive research institutions with a greater numbers of researchers, we decided to choose only the institutions with ten or more researchers. This narrowed down our list of peer institutions to seven from twenty, as can be seen in **Appendix E**. This list is the complete list of peer research institutions we researched further for comparison. Several institutions that we found in our original search became part of our list of prospective institutions; these institutions had large numbers of students involved in related cold research, and could therefore be considered as targets for advertising research or job openings.

The next step of our methods involved conducting background research on the seven selected alpine research institutions to learn what they could offer to potential research employees. We researched webpages of the institutions, yearly audits, and media articles to learn more about the institution's history and the public's perception of them. For example, we studied a peer review of SLF that was conducted in 2001. This provided us with information on employees, funding, and research information. Fortunately, we were also able to contact several administrative researchers at SLF and tour the institution to learn more about their field of research and their location.

We then used the tangible measures we developed to analyze how the selected alpine research institutions compare with one another. We found information for these tangible measures on institutional webpages, peer audits, and statistical databases. For those values that we could not find from these sources, we emailed a brief questionnaire to the directors of each institution to find more about these statistics (See **Appendix F**). We created a matrix of those measures we found for each institution, and then analyzed it in order to compare the seven institutions (See Results and Analysis).

After we filled in the matrix with the values we found from our research, we still had various areas where we had not been able to find information. We emailed each peer institution a second time to request information from those who had not yet responded and to thank those who had responded with the values we needed. In that email, we also presented the information we had gathered in order to obtain verification of the values.

This was a method we employed in order to be sure that the values we had researched were accurate for each institution.

The final step involved defining potential sources of highly skilled researchers, such as academic institutions and universities. We prepared a questionnaire for prospective alpine researchers to serve an important dual purpose. The survey not only identified potential snow researchers that the institutions could appeal to, but more importantly, identified those factors that are important to current graduate students in the alpine field. As was stated earlier in context, there have been various studies to determine what factors influence and attract researchers, but there has not been an in-depth look into what factors influence snow and alpine researchers.

We used avalanche information sites, internet searches, and educational references in the curriculum vitas of employees from the selected institutions as sources for identifying prospective locations (See **Appendices G** and **H**). We researched the departments and programs available in each university that involve avalanche or alpine research to determine the number of students involved in higher education programs in these fields. We pre-tested the questionnaire on current undergraduate students and several graduate students of varying backgrounds. We sent the online questionnaire (See **Appendix I**) to those students who had indicated an interest in alpine research in order to analyze what they are looking for in an employer, and how they rate working with a research institute after graduation, compared with private companies or academic institutions. We then analyzed the responses from these surveys to provide data on what current graduate and PhD students are looking for in an employer in their specific discipline. This analysis was then used to create suggestions of what alpine research institutions could do to enhance their abilities to attract researchers to their institutions.

These steps helped us to determine what factors influence the mobility of researchers, specifically those in snow, avalanche, and alpine research. Determining the sources of skilled alpine researches gave us a view of what today's researchers are looking for in an employer. This identification and the development of measures for them helped us to understand what research institutions could do to lower the barriers influencing the mobility of researchers. The measures also enabled us to create profiles of each selected institution in order to compare the opportunities in the field. We were then able to recommend measures that the research institutions could take to attract and retain top researchers.

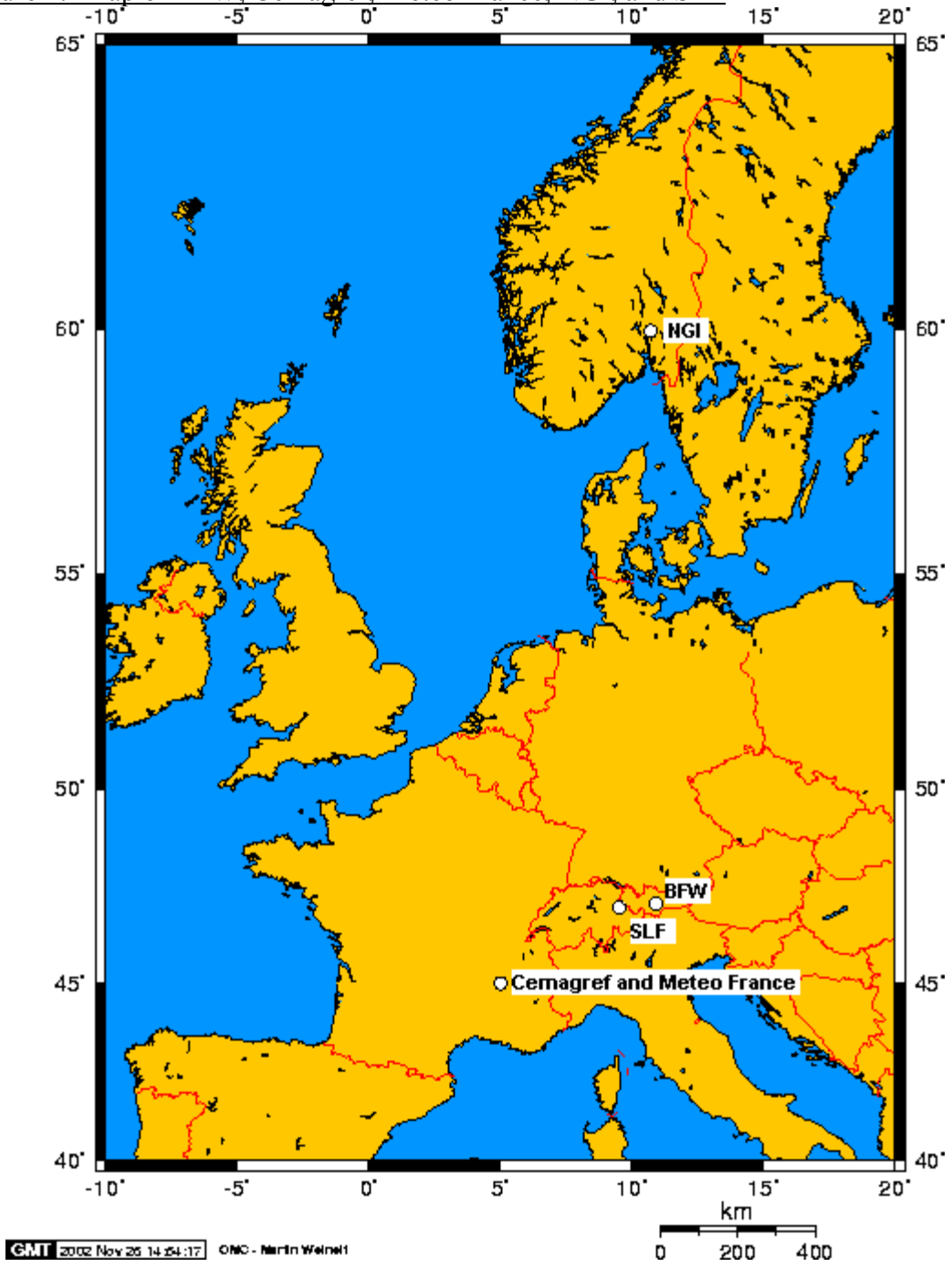
Results and Analysis

The peer institutions that were evaluated along with SLF included the following eight select alpine, snow, and avalanche research centers:

- Austrian Federal Forest Center – Institute for Avalanche and Torrent Research (BFW),
- Cemagref,
- the U.S. Army Cold Regions Research and Engineering Labs (CRREL),
- the Institute of Arctic and Alpine Research at the University of Colorado (INSTAAR),

- Meteo France – Center for the Research of Snow (CEN),
- the National Snow and Ice Data Center (NSIDC),
- the Norwegian Geotechnical Institute (NGI), and
- the Swiss Federal Institute for Snow and Avalanche Research (SLF).

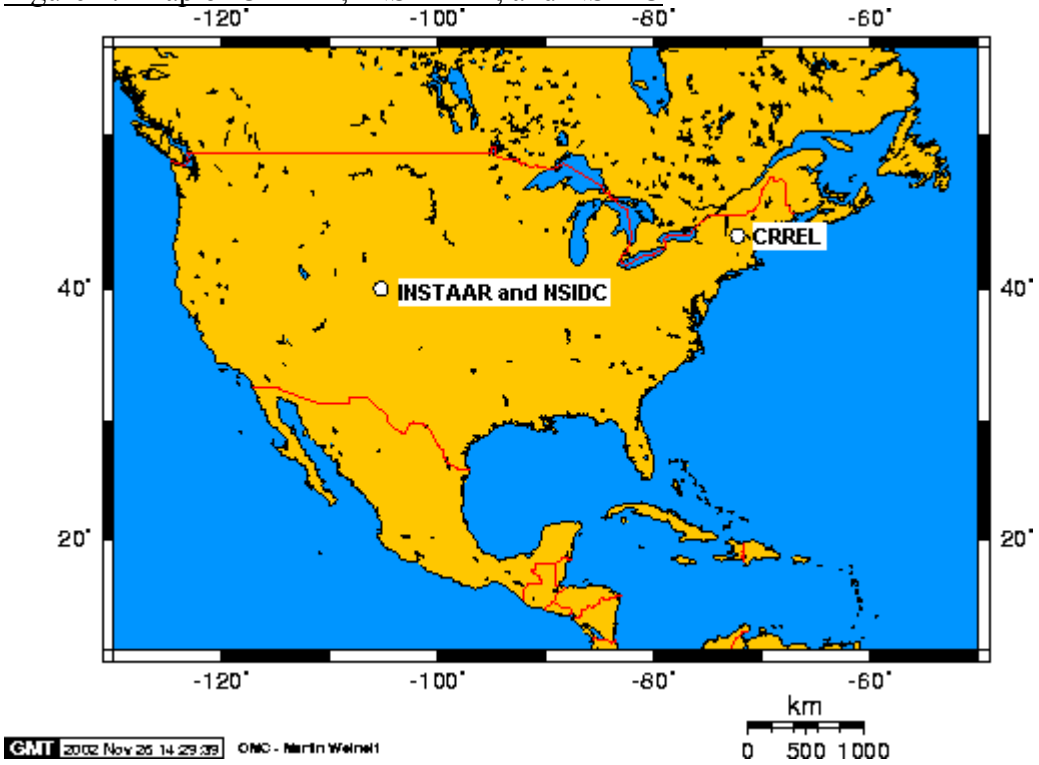
Figure 1: Map of BFW, Cemagref, Meteo France, NGI, and SLF



These institutions were evaluated in terms of reputation, compensation, and setting, using the tangible measures described in the Methods section. The geographical

locations of the peer institutions can be seen in **Figures 1** and **2**. Brief descriptions of the eight alpine research institutions can be found in **Appendix J**.

Figure 2: Map of CRREL, INSTAAR, and NSIDC



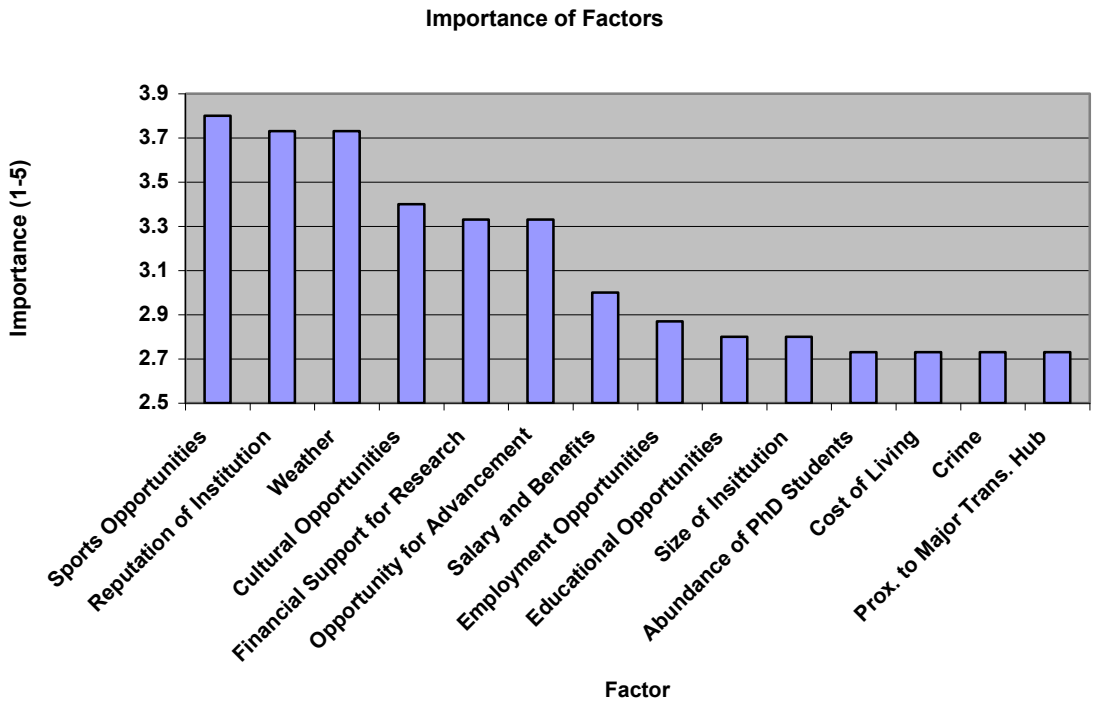
Questionnaires (**Appendix I**) were sent to 74 graduate students involved with Alpine Studies; 76% of these students are studying in the U.S.A and the rest were spread throughout Europe. From this homogeneous group, we received 15 responses, which translates to a 20% response rate. Of these responses 60% were male and 40% female with 60% of the responses currently studying in the U.S.A. and 40% studying in Europe and Canada. The majority of students who responded were above the age of 25 and single as can be seen in **Table 1**.

Table 1: Student Statistics

Age Range			
20 or younger	21-24	25-29	30 or older
0.00 %	6.67 %	53.33 %	40.00 %
Gender			
Male		Female	
60.00 %		40.00 %	
Marital Status			
Single	Partner	Married	Separated
53.33 %	20.00 %	20.00 %	6.67 %
Number of Languages Spoken			
1	2	3	4 or more
46.67 %	33.33 %	13.33 %	6.67 %

Our first question evaluated the factors that influence the attraction of current graduate students in alpine studies. The graduate students ranked the factors on a liker scale of 1 to 5, with 5 being the most important and 1 being the least important. We then averaged the numbers for each factor; **Figure 3** below shows the average rankings for each factor.

Figure 3: Bar Graph of Average Values Assessing Importance of Factors



Opportunities for sports, the reputation of the institution, and weather were the highest ranking factors for the attraction of alpine researchers (3.8, 3.73, and 3.73 respectively). The presence of cultural opportunities was ranked as the fourth most important factor among the students (3.4). Opportunities for advancement and financial support such as research grants were tied as the fifth most important factors, with scores of 3.33. Salary was ranked below all of these, with a score of 3; four factors were tied with the lowest scores of 2.73. The scores for the remaining factors can be seen in **Table 2**.

Table 2: Average Value Assessing the Importance of Job Selection Factors

Factor	**Average**	**Standard Deviation**
Reputation of Institution	3.73	± 0.83
Financial Support for Research	3.33	± 1.07
Opportunity for Advancement	3.33	± 0.89
Salary and Benefits	3.00	± 0.80
Employment Opportunities for Family/Spouse	2.87	± 0.96
Educational Opportunities for Family	2.80	± 0.93
Size of Institution	2.80	± 0.77
Abundance of PhD Students	2.73	± 0.85
Setting of Institution		
Sports Opportunities	3.8	± 1.07
Weather	3.73	± 0.85
Cultural Opportunities	3.4	± 0.75
Cost of Living	2.73	± 0.72
Crime	2.73	± 1.18
Proximity to Major Transportation Hubs	2.73	± 0.95
* 1 = Not Important 5 = Very Important		

The fact that sports, weather, and cultural opportunities, all of which are aspects of setting, were ranked in the top four factors of attraction for this population, shows the importance of personal interests and setting. As Eric Raymond, an economist, has said, "The best people in any field are motivated by passion" (Florida, 2002). The students' interests in alpine research are driven by their love for outdoor activities and a rugged environment; people need to work in a stimulating environment in order to be happy and successful within their job. People, especially those involved in research, want to "…bring themselves to work – their real identities and selves – rather than create a separate, instrumental self to function in the workplace… [Therefore] lifestyle frequently trumps employment when they're choosing where to live." (Florida, 2002). When appropriate setting factors and interests are combined with a flexible work environment, there is a large potential for attraction. A flexible environment enables the employees to integrate their own interests with their research and their workplace.

Previous research has shown that the reputation of the institution is a major factor in influencing the attraction of researchers. When an institution has a strong reputation within its surroundings (location and scientific), there is a larger potential for peer recognition and collaboration. As economists Partha Dasgupta and Paul David (1987) have shown, peer recognition is a strong "force in the 'new economics of science' because it motivates scientists to be lauded as the first to discover something new."

As opportunities for advancement and financial support for research were the next most important factors, ranking above salary, there is more evidence that the quality and flexibility of the institution are important to researchers than a high salary. Previous studies have shown that salary, while still important, is not a major concern of researchers in terms of job attraction. Richard Florida (2002) explains that the conventional view that people work solely for money is overrated; "Motivating creative people has always required more than money. It depends on intrinsic rewards and is tied to the very creative content of their work" (p. 87-88). Financial support for research and other opportunities

("intrinsic rewards") not only shows flexibility, but also allows the researchers to integrate their creative, personal interests into their work. Such flexibility and financial support contribute to the prestige and reputation of an institution as well.

Employment opportunities for partners or spouses was the next factor after salary (2.87). This, alongside the size of the institution, ranked above all of the other factors, which included the proximity of a career to major transportation hubs, the cost of living, crime, and the abundance of PhD students. These are factors that would affect older age groups more, in that they for the most part concern the safety and opportunities for a family.

Table 3: Type of Institutions Students are Interested in Working At

Type of Institution	**Average**	**Standard Deviation**
Academic Institution	3.67	± 1.20
Research Institution	3.60	± 1.15
Non-Governmental Organization	3.40	± 1.09
Private Firm	2.47	± 0.90
Public Administration	2.27	± 0.85

* 1 = Not At All 5 = Very Much

Table 3 shows that graduate students involved with alpine studies would prefer to work for an academic or research institution followed closely by a non-governmental organization. Students were relatively uninterested in working for private firms and public administration. This is likely because academic and research institutes tend to offer more flexibility with research and more challenging work. The relative interest of graduate students in alpine studies to work at various occupational opportunities can be seen in **Figure 4**.

Figure 4: Average Value Assessing the Interest to Work in Different Occupations

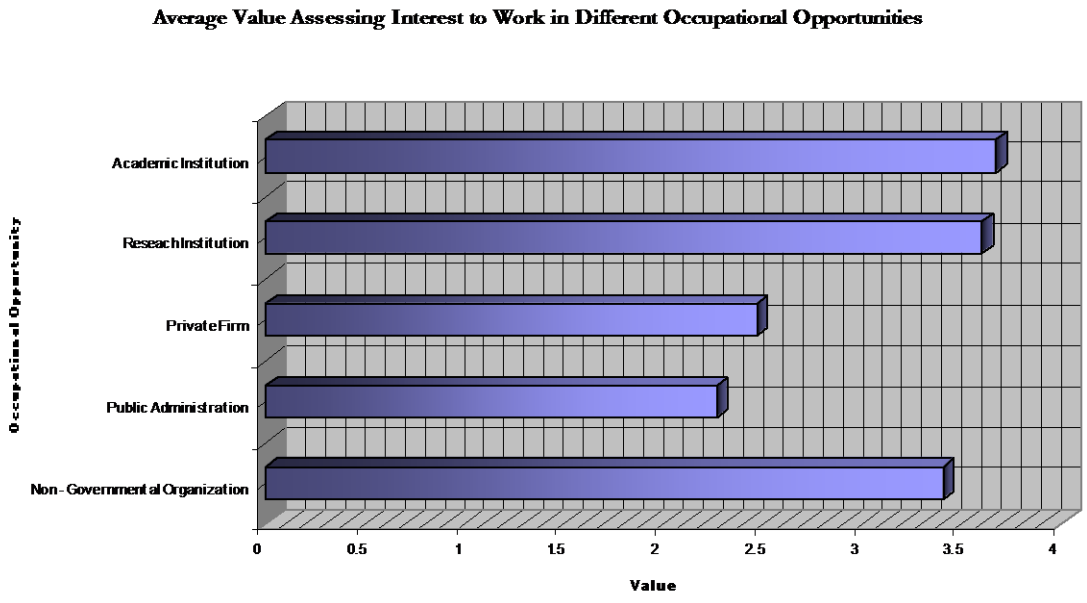


Table 4: Willingness to Relocate Career to Particular Regions

Location	Average	Standard Deviation
New Zealand	3.40	± 1.12
Switzerland (SLF)	3.40	± 1.01
Western Canada	3.40	± 0.83
Northwestern USA (INSTAAR and NSIDC)	3.27	± 1.12
France (Cemagref)	3.13	± 1.23
Southwestern USA	3.13	± 1.11
Scandinavia (NGI)	3.07	± 0.89
Eastern Canada	3.00	± 0.67
Northeastern USA (CRREL)	2.93	± 1.02
Australia	2.87	± 0.84
Austria (BFW)	2.87	± 0.83
Japan	2.33	± 0.80
United Kingdom	2.20	± 0.83

* 1 = Not At All 5 = Very Much

We wanted to examine the students' willingness to relocate their careers to locations where snow and avalanche research institutes are located, as shown in **Table 4**. From these locations, Switzerland was given the highest score of 3.40, which is where SLF is located. Second to Switzerland is Northwestern USA with a score of 3.27, which is where Boulder, Colorado is located, home to INSTAAR and NSIDC. Third is France with a score of 3.13, home to Cemagref and Meteo France. Fourth is Scandinavia with a score of 3.07, which is where NGI is located. Fifth is Northeastern USA with a score of 2.93, home to CRREL. Lastly, Austria had a score of 2.87, which is the home of BFW. The relative willingness of graduate students in alpine studies to move to various regions can be seen in **Figure 5**.

Figure 5: Bar Graph of the Average Value Assessing Willingness to Relocate to Regions

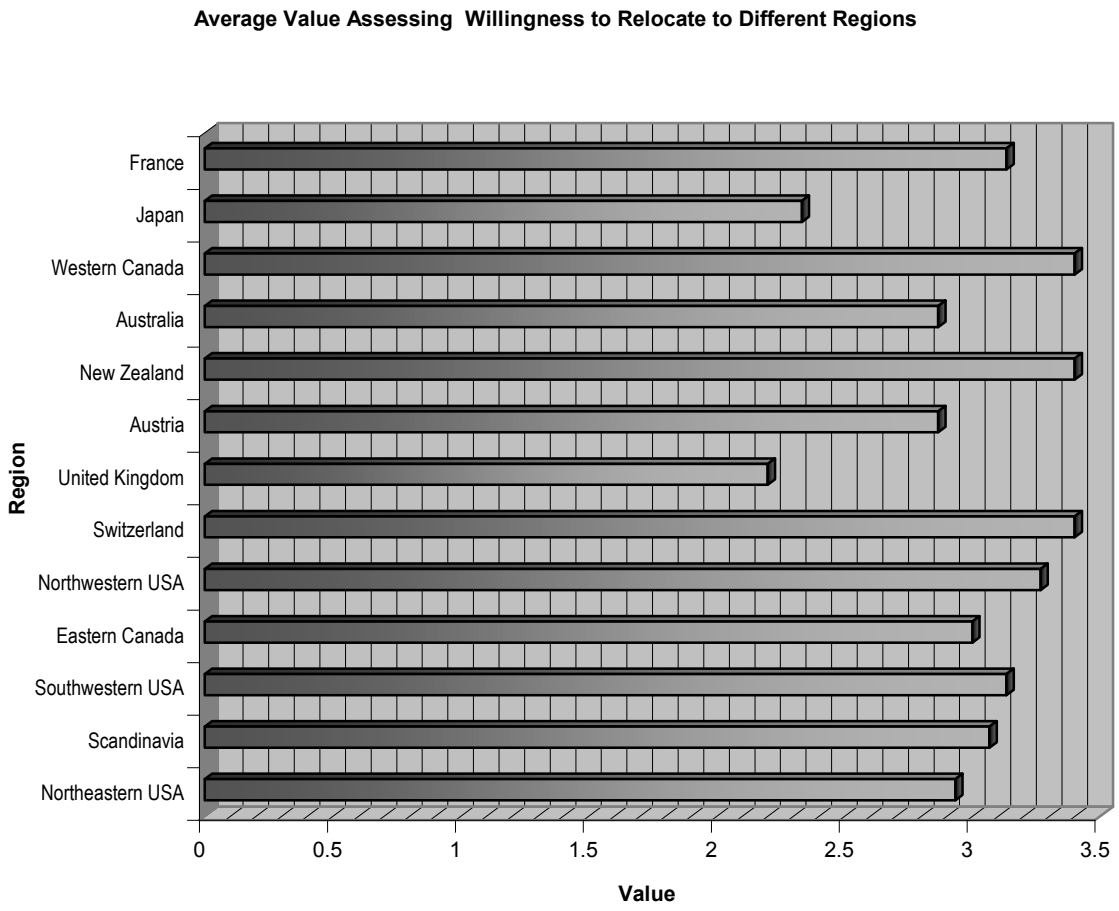


Table 5: Mobility of Students

Area	Percentage			
	Never	**Every Few Years**	**About Once a Year**	**Multiple Times a Year**
Another Region	0.00 %	0.00 %	0.00 %	100.00 %
Outside Student's Country	0.00 %	25.00 %	75.00 %	0.00 %
Outside Student's Continent	26.67 %	26.67 %	46.67 %	0.00 %

Table 5 shows that students involved with alpine studies are mobile when it comes to international travel. Of the students who responded, 75% said they travel outside of their country about once a year and about 47% said they travel outside of their continent about once a year. This means that the students are exposed to other areas of the globe and other cultures and will be more open to relocating their careers to another country or continent.

Table 6: Importance of Job Selection Factors Based on Sex

Factor	**Average Male**	**Average Female**
Reputation of Institution	3.78	3.67
Financial Support for Research	3.67	2.83
Opportunity for Advancement	3.56	3.00
Salary and Benefits	3.11	2.83
Employment Opportunities for Family/Spouse	2.78	3.00
Educational Opportunities for Family	3.00	2.50
Size of Institution	2.89	2.67
Abundance of PhD Students	3.00	2.33
Setting of Institution		
Sports Opportunities	4.67	3.56
Weather	4.00	3.56
Cultural Opportunities	4.00	3.11
Cost of Living	2.00	2.78
Crime	3.33	2.78
Proximity to Major Transportation Hubs	2.33	2.67
* 1 = Not Important 5 = Very Important		

Of the students who responded to the questionnaire there were 9 males and 6 females. Their assessment of the importance of the factors of attraction can be seen in **Table 6** and **Figure 6**. Generally, the responses were pretty similar between males and females. Females did rate the reputation of an institution higher relative to the rest of their responses, and rated things such as the abundance of Ph.D students and salary and benefits lower than the male population. With setting, the primary difference between male and female resondants was that males ranked the cost of living much lower than the female population.

Figure 6: Bar Graph of the Importance of Job Selection Factors Based on Sex

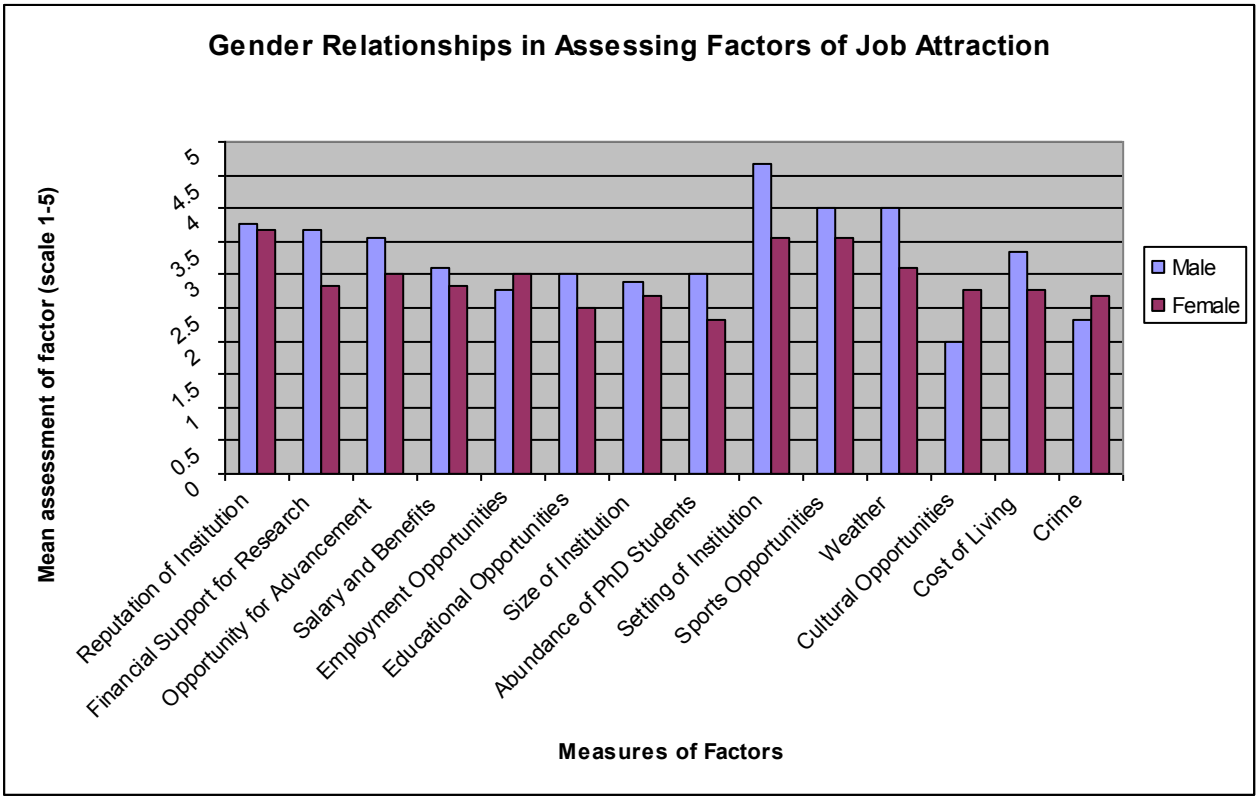


Table 7: Importance of Factors Based on Marital Status

Factor	**Average**		
	Married	**Single**	**Partner**
Reputation of Institution	4.33	4.00	3.33
Financial Support for Research	4.00	3.75	2.33
Opportunity for Advancement	3.33	3.88	2.67
Salary and Benefits	3.67	3.13	2.67
Employment Opportunities for Family/Spouse	3.33	2.88	2.33
Educational Opportunities for Family	3.67	2.63	2.33
Size of Institution	3.33	2.88	2.33
Abundance of PhD Students	3.33	2.88	2.33
Setting of Institution			
Sports Opportunities	3.67	3.88	4.67
Weather	3.67	4.00	4.00
Cultural Opportunities	3.33	3.50	4.00
Cost of Living	3.67	2.75	2.00
Crime	3.00	2.50	3.33
Proximity to Major Transportation Hubs	4.00	2.50	2.33

* 1 = Not Important 5 = Very Important

Of the students who responded to the questionnaire, 8 were single researchers, 3 were married researchers, 3 were with partners, and 1 was a separated researcher.

Because of the small sample size, no conclusions can be drawn, but overall, the factors were rated in the same order regardless of marital status. The differences were in educational opportunities for family, which were rated higher among the married students, and the proximity to major transportation hubs, which were rated higher among the single students. These results can be seen in **Table 7**.

Table 8: Importance of Factors Based on Country of Origin

Factor	**Country of Origin Average**			
	USA	**France**	**Canada**	**Switzerland**
Reputation of Institution	3.33	4.00	5.00	4.33
Financial Support for Research	3.00	4.00	4.00	3.67
Opportunity for Advancement	3.22	3.50	4.00	3.33
Salary and Benefits	2.89	2.00	4.00	3.67
Employment Opportunities for Family/Spouse	3.00	1.50	2.00	3.67
Educational Opportunities for Family	2.89	1.00	4.00	3.33
Size of Institution	3.00	2.00	2.00	3.00
Abundance of PhD Students	2.89	2.50	3.00	2.33
Setting of Institution				
Sports Opportunities	3.67	4.50	5.00	3.33
Weather	4.00	3.00	3.00	3.67
Cultural Opportunities	3.33	3.50	3.00	3.67
Cost of Living	2.67	2.00	3.00	3.33
Crime	2.67	1.00	5.00	3.33
Proximity to Major Transportation Hubs	2.78	2.00	3.00	3.00

* 1 = Not Important 5 = Very Important

Among the students who responded to the questionnaire, 9 were from the U.S.A., 1 was from Canada, and 3 were from Switzerland. Their categorized answers tended to be similar to the general population when compared by region, as shown in **Table 8**. Canada sticks out as having different answers than other regions, however, is based on only one response and therefore is not an accurate representation of Canadian students.

Table 9: Interest to Work in Different Occupations Based on Sex

Type of Institution	**Average**	
	Male	**Female**
Academic Institution	3.56	3.6
Research Institution	3.44	3.6
Non-Governmental Organization	3.33	3.2
Private Firm	2.67	2.4
Public Administration	2.67	1.8

* 1 = Not At All 5 = Very Much

When male and female responses are compared for the type of institution for which they would prefer to work, the answers are ranked in the same order, as seen in **Table 9**. This indicates that both male and female students tend to look for the same types of job after finishing with school.

Table 10: Interest to Work in Different Occupations Based on Marital Status

Type of Institution	Average		
	Married	Single	Partner
Academic Institution	3.00	3.63	4.67
Research Institution	3.33	3.88	4.00
Non-Governmental Organization	4.33	3.13	4.00
Private Firm	2.33	2.75	1.67
Public Administration	2.33	2.38	1.67

* 1 = Not At All 5 = Very Much

When the type of institution students would like to work for is compared by marital status, the answers tend to be the same as the general population with one exception, as seen in **Table 10**. The 3 married students indicated that they would prefer to work for a non-governmental organization.

Table 11: Interest to Work in Different Occupations Based on Country of Origin

Type of Institution	Country of Origin Average			
	USA	France	Canada	Switzerland
Academic Institution	3.44	4.00	5.00	3.67
Research Institution	3.00	4.00	5.00	4.67
Non-Governmental Organization	3.67	3.50	4.00	2.33
Private Firm	2.44	2.00	3.00	2.67
Public Administration	2.44	2.00	3.00	1.67

* 1 = Not At All 5 = Very Much

When the type of institution that students would prefer to work for is compared with the region students are located in, there are two distinct differences. The 9 American students indicated that they would prefer to work for a non-governmental organization, and the 3 Swiss students strongly favored a research institution over an academic institution. These results can be seen in **Table 11**.

From our research and questionnaire to prospective alpine researchers, we were able to define those factors of importance to researchers. From there we developed tangible measures for these factors, which we used to compare the selected alpine research institutions. We collected the data and created several matrices in order to compare the institutions.

One factor, reputation, was measured using various values; the most important factor in reputation was the count of publications. **Table 12** below shows the total number of researchers at each institution, and **Table 13** shows the number of those involved in snow and alpine research. These numbers are also important because the size of an institution sometimes plays a role in how attractive the institution can be. The total number of general researchers was then compared with the total number of publications from 1996-2001, as indicated in the publications list organized by each institution. The number of alpine and avalanche researchers was then compared with the number of alpine publications* from 1995-2002, as indicated on the International Science Index Web of Science.

Table 12: Publication Counts Normalized Against Number of Researchers*

Institution	**Total # Researchers**	**Total # Publications**	**# Publications / # Researchers**
BFW-Austria	283	53	.187
Cemagref	1000	513	.513
CRREL	137	1,134	8.277
INSTAAR	141	694	4.922
Meteo France	137	352	2.569
NGI	148	52	.351
NSIDC	22	94	4.273
SLF	100	172	1.720

Table 13: Alpine Publication Counts Normalized Against # of Alpine Researchers*

Institution	**Alpine Researchers**	**Alpine Publications**	**#Publications / #Researchers**
BFW-Austria	10	5	.5
Cemagref	15	22	1.467
CRREL	137	64	.467
INSTAAR	10	6	.600
Meteo France (CEN)	30	10	.333
NGI	19	5	.263
NSIDC	10	18	1.800
SLF	80	49	.613

*Alpine publications include the following journals: *Arctic, Antarctic, and Alpine Research; Arctic; Cold Regions Science and Technology; Arctic and Alpine Research; Journal of Glaciology; Annals of Glaciology; Natural Hazards; Geophysical Research Letters; Mountain Research and Development.*

As can be seen above, CRREL had the largest number of overall publications per researcher when the total publication count was normalized against the total number of science and technology researchers at the institution (8.277). INSTAAR and NSIDC were also in the top three for total publications (4.922 and 4.273, respectively). However, NSIDC had the largest number of alpine specific publications in comparison with the number of employees involved specifically in alpine research (1.800); Cemagref and SLF had the next largest alpine publication count, with normalized numbers of 1.467 and .613 publications per researcher, respectively.

In our search for internationally recognized journal publications, we came across numerous other forms of public outreach. Such outreach ranged from institutional and local newsletters, national publications, educational programs, and avalanche warnings. For example, INSTAAR focuses on research, education, and outreach, sponsoring public programs, especially for local primary and secondary schools. NSIDC publishes its own quarterly newsletter, *NSIDC Knows*, in addition to reports and educational media. SLF is responsible for releasing avalanche warnings throughout Switzerland, and also publishes numerous articles about avalanches in newspapers and local newsletters. The majority of the institutions in our original list (**Appendix D**) are also primarily focused on public

outreach, educational programs, and avalanche warnings. However they were not included because of their lack of research.

While such local and national public outreach programs do not significantly add to the international reputation of an institution, they do increase the local awareness of an institution. We want to stress that this information is not exhaustive, as it was not a part of our research. However, we feel that this additional bit of information is beneficial in understanding the range of public awareness of institutions.

The other values used to measure reputation included the percentage of PhDs at the institution, the number of different countries researchers originate from, the number of conference proceedings for 2001, the average age of researchers, and the sources of funding. Contacts at the institution responded to the email questionnaire we sent to them, and provided us with the values that are displayed in **Tables 14** and **15**.

Table 14: Other Measures for Reputation of Institutions

Institution	**Percentage of PhD researchers**	**# Countries of origin**	**# Conference proceedings (2001)**	**Average age of researchers**
BFW-Austria	62%	1		36-40
Cemagref	40%	1		41-50
CRREL			43	
INSTAAR	61%	25	400	31-35; 36-40
Meteo France				
NGI	20%	11		41-50
NSIDC	12%	4	17	26-30; 41-50
SLF	65%	10	24	30

Table 15: Funding Sources of Institutions

Institution	**Funding sources**
BFW-Austria	Austrian Federal Ministry of Agriculture, Forestry, Environment, and Water Management
Cemagref	
CRREL	U.S. Army, Navy, and Air Force public works organizations; Corps of Engineers Districts and Divisions; other federal, state, and local government agencies; the private sector (consulting or research)
INSTAAR	NSF (NSF Arctic Program, NSF United States Antarctic Program), Office of Naval Research, donations, State Historic Fund grant, contribution from Douglas County Historic Preservation Board, Environ Protection Industry, NASA, general donations
Meteo France	CNRM (Centre National de Recherches Meteorologiques), EU research programs (Common Development and Research Programmes)
NGI	EU research programs; industry; programs and strategic funding from the Research Council of Norway
NSIDC	National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), and the National Oceanic and Atmospheric Administration (NOAA)
SLF	WSL budget; third party funds such as the National Science Foundation

As can be seen in **Table 14**, not all of the values have been made available to us; several institutions have not replied at all. Nonetheless, SLF has the largest percentage of

PhD holders thus far (65%). INSTAAR, with a high percentage of PhD researchers (61%), also had the largest number of global researchers, with researchers from 25 different countries. From our research, we learned that a large percentage of global researchers can signify a strong reputation. Therefore, a larger number of international representatives contributes to the reputation factor.

INSTAAR has the largest number of conference proceedings from 2001, with almost ten times as many as CRREL. Representation at or hosting of conferences within a field are important indications of experience and prestige within a field and contributes to INSTAAR's international recognition.

The average ages of researchers at SLF and CRREL are similar, at about 30-35 years of age. This is about ten years younger than the average age for NGI, which is about 45. As was referred to earlier in the context of this study in referencing Boekholt (2001), prestigious institutions recognize the importance of having both older, experienced researchers, and skilled, younger researchers affiliated with their institution. This is because older researchers are more knowledgeable and often recognized within the field; however, younger researchers, such as PhD students, are less costly to have on staff. Research institutions often hire younger students because they are paid less, and will hopefully mature into a successful researcher that will advance the prestige of the institute. If the student does go elsewhere they will carry the name of the institution with them, and hopefully represent the institution in a positive way. Therefore, a strong institution would most likely have a higher average age of researchers as to have a balance between older researchers and younger PhD students.

Table 15 shows the funding sources for the eight selected institutions. A large amount of funding is important to researchers so that they will have money available for their research. Therefore, it helps to have well-known, stable funding sources. Based on the information we found regarding funding sources for each institution, INSTAAR appears to be the strongest in funding due to the large number of sources as well as the variety of them.

The compensation factor was evaluated using a starting salary scale for PhD students and post-doctorate researchers at the institutions. Another aspect of this was the opportunity for advancement, which was measured by looking at the number of departments involved with alpine research, and the average length of time researchers remain at the institution. **Table 16** outlines the information received for this factor.

Table 16: Measures of Compensation

Institution	Salary Scale		Opportunity for Advancement	
	Post-doc Researchers	**PhD Students**	**Number of Departments**	**Average Length of Time Researchers Stay**
BFW-Austria	Under € 50,000	N/A	10 main dept. in BFW; 5 dept. w/in Aval. Inst.	11-20 years
Cemagref	Under € 50,000	Under € 30,000	4 scientific dept.; 34 research units	0-1 years
CRREL			8 main divisions	
INSTAAR	€ 38,383 – € 46,464	Under € 30,303	5 research groups	6-10; 11-20 years
Meteo France			6 research groups	
NGI	€ 50,505	€ 40,404 – € 45,454		21 years
NSIDC	Under € 50,505	€ 16,160 – € 20,202	6 main research divisions	6-10; 15-20 years
SLF	€ 44,750 – € 66,024	€ 24,304 – € 27,684	6 dept.; approx. 20 research units per dept.	5 years

For PhD students, the typical starting salary was highest at NGI, where students may expect to earn up to € 45,000. This was much higher than NSIDC's low salary, where students often began their first year earning an equivalent of € 16,160. For researchers holding a PhD degree, the typical starting salary was the highest at SLF, where researchers may begin earning up to € 66,024. This salary range is lowest at INSTAAR, where researchers who had just received their degree earned an equivalent of € 38,383. While salary has been shown not to be the number one factor that attracts researchers, it is remains a factor in that higher salaries could make it easier for an institution to attract researchers.

In terms of opportunities for advancement, the Austrian Federal Forest Research Center had the most research units in its institution with 34. INSTAAR has the least with 5 different research groups. With more research divisions, an institution is not only able to provide more jobs, but also a wider variety of specialized jobs. A researcher would then have the opportunity to move to another department if his or her specialty or interest changed. In terms of the average length of time that researchers stay, NGI retains their researchers for 21 years or more, while SLF retains researchers for a total of 5 years. However, it should be noted that approximately one fifth of the total researchers working at SLF are PhD students, who typically only stay three or four years. It is not valid to draw conclusions from these values.

We evaluated setting on various levels; the first one included categorizing the nature of the location. For this, we looked at the population and the geography of the location as shown in **Table 17**.

Table 17: Nature of Locations of the Institutions

Institution	**Nature of Location**	**Population**
BFW-Austria	Innsbruck, Austria – Urban	113,392
Cemagref	Grenoble, Rhone-Alps, France – Urban	153,317
CRREL	Hanover, NH, USA – Rural college town	10,850
INSTAAR	Boulder, CO, USA – Urban	94,673
Meteo France	Grenoble, Rhone-Alps, France – Urban	153,317
NGI	Oslo, Norway – Urban	512,600
NSIDC	Boulder, CO, USA – Urban	94,673
SLF	Davos, Switzerland – Rural	10,995

When comparing institutions based on the setting, it has to be considered that different people have different preferences on the setting in which they would like to live. As can be seen above, NGI is located in the largest city, Oslo, Norway, with a population of 512,600. With populations of about 100,000, Innsbruck (Austria), Grenoble (France), and Boulder (USA) are still moderate sized cities, but may be preferred to researchers instead of a large city or a rural area. Lastly, SLF and CRREL are located in rural areas of only about 10,000 people. This means that researchers in alpine studies have some decision when deciding what setting they prefer. Other factors such as the cost of living and crime rate (**Table 18**) as well as the distance to the nearest city, nearest hospital, and nearest university (**Table 19**) also affect a researcher's decision.

Table 18: Cost of Living and Crime Measures

Institution	**Employment Statistics**		**Crime**
	Per capita income	**Unemployment rate**	
BFW-Austria	€ 51, 600	1.80%	203.9 crimes/1000 people
Cemagref	€ 58,858	7.90%	N/A
CRREL	€ 30,700	1.60%	N/A
INSTAAR	€ 27,537	2.80%	53.52 crimes/1000 people
Meteo France	€ 58,858	7.90%	N/A
NGI		3.10%	70 crimes/1000 people
NSIDC	€ 27,537	2.80%	53.52 crimes/1000 people
SLF	€ 28,137	1.2% (2001)	43.6 crimes/1000 people

Per capita income is the mean income of an area; when compared with the salary a researcher would make, we can then get a range of the quality of living that researcher would enjoy. By this logic a researcher would benefit from a lower per capita income if

their salary is above that range. Comparing institutes based on per capita income, it can be seen from **Table 18** that Boulder, CO, USA has the lowest per capita income at € 27,537 closely followed by Davos, Switzerland and Hanover, NH, USA. Next Innsbruck, Austria and Grenoble, France have the highest per capita incomes with € 51, 600 and € 58,858 respectively.

When moving to a new setting, the crime rate may also be considered by researchers; obviously a lower crime rate is favorable to a higher crime rate. Crime rate is measured in units of crimes per 1000 people, thereby expressing the average number of crimes committed on a population of one thousand people. Of the data found, SLF located in Davos, Switzerland enjoys the lowest crime rate of 43.6 crimes/1000 people. Boulder, CO, USA and Oslo, Norway have crime rates of 53.52 crimes/1000 people and 70 crimes/1000 people respectively. These rates are not significantly higher than that of Davos, and may not deter researchers when other factors are considered. Lastly, Innsbruck, Austria has a much higher crime rate than the rest at 203.9 crimes/1000 people.

The distances to major services, as seen in **Table 19**, are important for different reasons. The distance to the nearest metropolitan area is important to a researcher because a researcher that is relocating with a partner would be interested in knowing what challenging job opportunities would be available to their partner, what cultural and recreational activities would be close by, and what information sources would be easily accessible. Because healthcare is often a major concern of anyone thinking of relocating, the distance to the nearest hospital also helps in reflecting on the status of the location. Lastly, the distance to the nearest university is important to researchers because working in close proximity to a university enables them to maintain a close relationship with the scientific community. This would especially be true in the alpine field, as snow and avalanche researchers often study in an interdisciplinary range.

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Table 19: Measures of Distance

Institution	**Nearest metropolitan area**	**Nearest hospital**	**Nearest university**
BFW-Austria	Innsbruck: 0 km	University Hospital Innsbruck: 1.41 km	University of Innsbruck: 1.41 km
Cemagref	Grenoble: 0 km	Le University Hospital: 11.10 km	Grenoble University: 11.10 km
CRREL	Manchester, NH: 105.0 km	Mary Hitchcock Memorial Hospital: 6.16 km	Dartmouth College: 3.35 km
INSTAAR	Boulder, CO: 0 km	Boulder Community Hospital: 4.01 km	University of Colorado: 0 km
Meteo France	Grenoble: 0 km	Le University Hospital: 11.10 km	Grenoble University: 11.10 km
NGI	Oslo: 0 km	Aker Hospital	University of Oslo
NSIDC	Boulder, CO: 0 km	Boulder Community Hospital: 4.01 km	University of Colorado: 0 km
SLF	Zurich: 120 km	Spital Davos: 3.46 km	ETHZ: 148.08 km

The simplest way for a researcher to remain close to the scientific community is to work in an area close to a well-known university or in a metropolitan area with easy

access to outside information. Davos, Switzerland, the home of SLF, is located in a small rural town that is at least a two hour drive from the closest city, Zürich, and its universities. In terms of remoteness, CRREL is the second farthest away from a metropolitan area; however, this site is at a larger advantage since it is located so close to Dartmouth College, a prestigious international university. The other institutions are located in urban areas. While urban settings may not be the desired location for all researchers, it has been shown by Urban Economic Prospects in the Knowledge Economy (2000) that urban areas with nearby universities and other institutions will promote the exchange of scientific information. According to this report, "Urban areas can have three kinds of advantages over their suburban counterparts when it comes to growing, attracting, and retaining technology companies and knowledge workers: urban culture and amenities, proximity to research institutions, and industry clusters" (Urban Economic Prospects in the Knowledge Economy, 2000).

Table 20: Weather Conditions

Institution	Average annual precipitation (mm)	Average yearly high temperature	Average yearly low temperature
BFW-Austria	855.8	14.3°C	3.75°C
Cemagref		20.6°C	1.9°C
CRREL	982.6	13.9°C	-4.0°C
INSTAAR	506	18.4°C	-2.67°C
Meteo France		20.6°C	1.9°C
NGI	817	28.9°C	-20.7°C
NSIDC	506	18.4°C	-2.67°C
SLF	1,230	Mean temp.:4.7°C	N/A

Although most people may enjoy warmer temperatures and less precipitation, such generalizations may not apply to alpine researchers. The average annual precipitation, yearly high, and yearly low of the seven locations can be seen in **Table 20**. Avalanche researchers' work would ideally benefit from colder temperatures and more precipitation in the form of snow. SLF in Davos, Switzerland has the most precipitation on a yearly basis, of the institutes with recorded data, as well a fairly low yearly mean temperature. CRREL has the second most precipitation on a yearly basis with 982.6 mm of precipitation followed by BFW and NGI with 855.8 mm and 817. mm of precipitation respectively. Lastly, INSTAAR and NSIDC of Boulder, CO, USA have 506 mm of precipitation each year. Most of the institutes share similar yearly temperatures. NGI has the most significant temperature range, with a average yearly low temperature of -20.7°C, which some people may find to be too low.

Conclusions and Implications

From the results reported in the previous sections, we can draw a variety of suggestions that could help alpine research institutions and univerity departments attract and retain research personnel. These suggestions offer ways to improve the reputation, compensation, and setting of alpine institutions in general. In terms of reputation, an institution could increase relations with a university and other local research institutions,

widen its publication base, and create informational packets. In terms of improving setting, alpine institutions could provide support centers for immigrating researchers, offer a branch office in a metropolitan area, and support local sports opportunities. In terms of compensation, alpine institutions could work to provide more scholarships or grants for research. These suggestions are explained in more detail as follows. Some institutions already practice a few of these strategies, but may still benefit from implementing others.

From our questionnaire, graduate students indicated that they were most interested in working for an academic institution; however, research institutes were ranked as a close second. This suggests that research institutes should work to collaborate with near by universities. Having an established relationship with a university could bring teaching opportunities to the research institute, which could be seen by potential employees as a factor that attracts them to that institute. Fostering relationships with close by universities also allows researchers to stay in close contact with scientists from other areas of study.

The measures we used to assess publications were our strongest indicators for reputation, as our research showed that opportunities for publication are a main concern for researchers. Frequent exposure of an institution in scientific journals is also an indication of excellence to other researchers. Our total count for publications included all those publications for either the institution or its researchers to show the extent of publication opportunities and media exposure. Greater exposure in a larger number of journals adds to the recognition of an institution. Because of this, we suggest that institutions publish in more interdisciplinary journals in order to increase their exposure and their targeted audience, both of which could contribute to the attraction of researchers.

Researchers are interested in working for organizations with a highly productive environment, where results can be shared with the wider scientific community. According to New Schemes for Education, Research Careers and Researcher Mobility, "the publication of scientific results and the organising of conferences and workshops are, thus, indispensable ingredients for scientific productivity" (p. 3). Therefore, for institutions to improve their attraction, they should broaden their base of publications and encourage employees to participate in international conferences and workshops.

Dr. Mahroum (1999), an expert on researcher mobility, has also stressed the importance of conference involvement as a factor in perception of the prestige of the institution. The hosting of international conferences is an excellent way to increase an institution's recognition and appeal to a larger body of researchers. On a similar note, an institution could hold a competition for graduate and PhD students. This could be similar to a contest sponsored by the Eastern Snow Conference, which encouraged students to submit a paper to win a small award and the honor of presenting at a conference at the host institute <http://www.easternsnow.org/student_paper.html>.

By asking graduate students involved with alpine studies what are the most important factors that attract them to an institute, we can draw conclusions based directly on the population of researchers that institutes wish to hire from. The responses of the questionnaire show that researchers in alpine studies, like researchers in other areas, are very concerned with the reputation of the institution. This supports the suggestion that

research institutes should work to publish in a variety of journals and participate in international conferences in order to increase the reputation of the institute.

Another suggestion involves creating stronger ties with the other institutions in the city where the institution is located. One recommendation could be to have yearly meetings with the directors and department heads of the institutions to discuss strategies and developments within their institutions. According to the Organization for Economic Co-Operation and Development (OECD) (2000), networking with other institutions in the same city "helps open new fields of knowledge as workers from different disciplines and technological areas are brought together" (p. 23).

Another development could include promoting the other institutions in correspondence with potential researchers. For instance, if a job-seeker applied for a position at a particular institution, that institution could send a brochure with information on the city when it replies to thank the researcher for the application. This could give the researcher more information on the setting, any other local research institutes, and the opportunities available. According to a study of the migration of Russian researchers, "also important is the availability of information about possible destinations" (Skolnikov, 1994). These measures could make the move to a new city more appealing to a potential immigrant. Another suggestion is to provide an informational packet for all visiting scientists and advisors of PhD students who come to an institution. This packet could provide general information about the institution itself, snow and avalanche research overall, and the setting where the institution is located. Those with these packets could then bring them back to their home universities and share with others interested in alpine studies.

Another means of expanding an institution's reputation is through the involvement in professional societies. Society meetings, minutes, and bulletins could be a potential area for postings of job openings for professional researchers. Professional societies can be very specific as to who may be a member. Depending on what job opening is available, the institution can focus on the societies which would have members who most fit the profile needed to fill a position.

One of the best known ways of spreading the reputation of an institution is through personal contacts. Former and current researchers involved with an institution are a strong source of contacts to spread an institution's reputation. When representatives are unable to go out to international conferences or to travel and manually spread the name of an institution, spreading information through internal contacts is a useful means of increasing an institution's reputation. According to the OECD (2000), "networking and interfirm collaboration at the very least complement external mobility" (p. 23). New job opportunities could reach a wider audience by sending notices to these individuals. This includes past visiting scientists, past and present advisors of PhD students, researchers working elsewhere on sabbatical, and current employees. These individuals could then pass on the information to others who are interested in snow and avalanche research.

One suggestion is to consider employing a department or personnel that will take care of paper work that would otherwise need to be completed by the new employees. In the benchmarking strategy performed in Ireland, there was discussion of how various countries have employed such offices that make information regarding immigration more accessible to new researchers, and help the new researchers to complete the necessary

tasks quickly and easily (Boekholt, et al., 2001). Such information would include providing a listing of available housing, a listing of schools for children, and a listing of other job opportunities for a partner that could be traveling with the researcher.

According to the OECD (2000), "an environment conducive to research and innovation appear important in attracting top foreign talent" (p. 3). Snow and alpine institutions will be able to increase their attraction by improving their facilities for research. The ability to interact with the scientific community increases the opportunities for innovation, therefore more researchers are attracted to metropolitan areas and university campuses to do their work. According to Urban Economic Prospects in the Knowledge Economy (2000), "urban areas can have three kinds of advantages over their suburban counterparts: ... urban culture and amenities, proximity to research institutions, and industry clusters." In order to decrease the distance between the scientific communities between urban and rural areas, a suggestion would be to create a branch of the institution in the nearest metroplitan area where researchers could do desktop work, while still being able to do laboratory work at the main institution. These "small- and medium-scale facilities are also necessary for a vibrant research environment," and when combined with larger scale scientific communities, allows for maximum scientific sharing (New Schemes for Education, Research Careers and Researcher Mobility). If able to conduct most of the desktop research in an urban office, this may ease the burden of performing laboratory research in a remote area.

Another recommendation for alpine research institutions would be to build strong connections and possible cooperative agreements with nearby well-known universities. Many PhD students we spoke with expressed concern with trying to maintain ties with the scientific community at universities while they pursue research positions at research institutions. Strong relationships with surrounding universities will not only increase the institution's exposure, but will also give the institution a larger pool of researchers to target as potential employees.

Setting has been shown to be a major issue in the attraction of researchers. As Richard Florida (2002) has said, "Successful places do not provide just one thing; rather they provide a range of quality of place options for different kinds of people at different stages in the life course" (p. 233). The opportunity for sports and cultural/recreational activities provide this range of activity that appeal to different people throughout the course of one's life. Graduate students indicated sports opportunities as the most important factor of setting. This is important information for research institutions considering that most institutions involved with snow and avalanche research are set in mountainous areas. If this is true of a research institution then it should use this information to its advantage when trying to attract researchers. In addition, institutions wishing to attract alpine researchers should support their employees' hobbies through flexibility in work and sponsorship of sports activities.

Though not the most important factor influencing job selection, salary is still one of the top factors that researchers look at when choosing an employer. According to the Research Innovation group, "competitive salaries and working conditions should be offered to attract the world's best scientists." In addition, institutions should provide "sufficient funding through government support or providing chargeable services to industry... to ensure that the equipment remains state-of-the-art" (Research Innovation). Though this suggestion may not be feasible for some institutions, others may increase

their attraction of the best researchers by offering better incentives such as higher salary and more funding for projects.

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Appendices

Appendix A: Spiegel Methods for University Ranking Questionnaire

In April 1999, Der Spiegel, a popular German magazine, conducted a ranking of 63 universities in Germany. Between February 1st and March 8th, the interviewers asked 12,374 students 16 questions each. The students interviewed were between their fifth and twelth semester, and involved with one of the twelve most popular disciplines. For each of the questions, the students had to rank their answer between 1 and 6. With the data collected, the universities were put into one of three different categories for each discipline: top, average, and low. The 16 questions were divided into four categories: professor conduct, crowding of lecture seminars, content of the studies, and equipment. In each of the disciplines, the universities were awarded points based on the students' answers. A university receiving two points was placed in the top group, one point in the average group, and no points in the low group. The twelve disciplines are as follows: Law, Economics, English, History, German, Philosophy, Mathematics, Mechanical Engineering, Computer Science, Biology, Medicine, and Psychology. The sixteen questions are as follows:

1. Are the seminars rarely or frequently overcrowded?
2. Are seminars often cancelled?
3. Do students always have a seat at required seminars?
4. Does the training correspond to the examination requirements?
5. Does the major area of stude offer sufficient class options?
6. Do professors suffiently offer advise in their area of study?
7. Are results presented in detail with examinations and lectures?
8. Do lecturers orient themselves with professional experience?
9. Are students taught to work on independent research?
10. Are required books readily available?
11. Do students gladly stop by the lounges of the university?
12. Are there sufficient computer stations?
13. Is the equipment of the computer stations in the newest conditions?
14. Are there sufficient places in the laboratory or classrooms?
15. Is the equipment of the laboratory and classrooms in the newest conditions?
16. How satisfied are you with the study conditions altogether?

Appendix B: Gourman Report Methods for Canadian University Rankings

The Gourman Report reviews and ranks departments of Canadian universities based on an 18-point criteria. It is an "objective evaluation of complex information drawn from the public record, private research foundations, and the universities themselves" (Gourman, 1998).

"Statistical data is collected and reduced to a concise 3-digit score for determining overall rank. Information is gathered from public records, the evaluated institutions, and agencies that make accurate projections of the relative success of graduates. The Gourman criteria includes these elements:

- Institutional auspices, control and organization
- Number of education programs and degrees conferred
- Experience level (age) of an institution
- Faculty quality, experience, intellectual pursuits and research productivity
- Quality of students' scholastic works and records of graduates in postgraduate studies and in their field of practice.
- Admission requirements and basis
- Number of students enrolled
- Curriculum content
- Quality of instruction and teaching loads
- Quality of administration
- Quality and access to career placement services and counseling
- Quality of physical plant (buildings, surroundings)
- Finance, budgets, investments, expenditures and funding
- Quality of library (size, material relevance and access)
- Computing facilities and resources
- Funding for research equipment and infrastructure
- Number of teaching and research opportunities
- Atheletic-academic balance" (Gourman, 1998).

Appendix C: Methods for Counting Journal Articles

For the number of scientific publications, we used the International Science Index (ISI). Because ISI catalogs only scientific publications, we felt this provided us with a more accurate count than the websites of the institutions. While some of the institutions did list their publications for a time period on their institutional webpages, there would have been some threat to the validity of using these lists alone because various articles were often included in their count that were either non-journal publications, or publications from journals that are not specific to the field of alpine research. From our research, we compiled a list of avalanche and snow journals that we included in our publication count.

The criteria we used in our search involved setting a time period of 1995 to 2002, and searching solely for articles. These journals included *Arctic, Antarctic, and Alpine Research; Arctic; Cold Regions Science & Technology; Arctic and Alpine Research; Journal of Glaciology; Annals of Glaciology; Natural Hazards; Geophysical Research Letters;* and *Mountain Research and Development*. (Appendix Db lists various sources we used as sources for these measures). We first located the lists of staff researchers for the institutions on their websites. We then searched within our set ISI parameters for each researcher's name. Because the names were often also shared with names of researchers not within the avalanche field, we then looked within those results for the author's name in conjunction with one of the journal titles listed above. This was the method used for BFW in Austria and the Norwegian Geotechnical Institute since we were unable to retrieve any search results when trying to include a locational keyword.

For those institutions where the staff's names were not included on the website, we conducted the first search was conducted using the name of the institution. For example, Cemagref did not list the names of its research staff. Therefore, we searched by location, using "Cemagref" as the keyword. This was then searched for in conjunction with all of the above journal titles. The same search was then repeated using "Grenoble" as a key word for location, since institutions are often found on ISI using the institution name or its location. In this case, we had to be careful not to double-count publications, as some articles were results of both searches.

For those institutions where the researchers' names were available *and* the name of the institution or its location produced search results, we did multiple searches to verify our counts. For example, both INSTAAR and the National Snow and Ice Data Center produced results when searching for the name of the institution as a locational keyword. These institutions also listed all of their employees on their websites. Therefore, we first did counts using any successful locational keywords. We then repeated the search by searching for each researcher's name in conjunction with each journal title. These searches had to be performed carefully to be sure that we were not double-counting publications.

While this publication search accounted for all related snow and avalanche publications, it did not take into account the total number of publications produced by the institution within that time period. We felt the number of total publications was also an important measure of an institution's reputation, as any journal publications are exposure for that institution. We then normalized this number with the total number of general researchers at the institution. For instance, institutions such as Cemagref not only

conduct alpine research, but also conduct research in areas such as agriculture and civil engineering. They therefore produce more publications in a larger number of varied journals, which could increase their recognition from a larger population.

Appendix D: Original List of Peer Institutions

http://www.avalanche.org/;
http://www.avalanche.org/~nac/forecastcenters/forecast_index.html

International Snow and Avalanche Research Groups

Applied Snow and Avalanche Research, University of Calgary
Appears to be made up of one researcher with about 6 collaborators from other research institutes.

Austrian Federal Forest Research Center

Avalanche Research Group, The University of British Columbia
Comprised of one professor mentoring several students.

Beltsville Agricultural Research Center Electron Microscopy Unit
Only a couple of researchers working on snow research.

Bozeman, Montana: Gallatin National Forest Avalanche
Research institute is comprised of only 3 researchers.

Canadian Avalanche Association
An association dedicated to bringing together professionals to develop knowledge and understanding of avalanches, to encourage communication and promote industry standards, and to provide high quality avalanche education rather than a research institute.

Cemagref (France)

CRYSYS Research
CRYSYS is a large interdisciplinary science investigation made up of scientists from other research institutes across Canada rather than a centralized research institute.

Meteo, France; The Centre for Snow Study

Nagaoka Institute of Snow and Ice Studies
Institute is comprised of 7 researchers working on snow and ice related studies.

Niwot Ridge (Colorado) (US)
Niwot Ridge is one division of LTER, which is a large interdisciplinary science investigation made up of scientists from other research institutes across the United States rather than a centralized research institute.

Norwegian Geotechnical Institute

Salt Lake City, Utah: USDA Forest Service Utah Avalanche Center
Avalanche center dealing with education and avalanche advising rather than a research institute.

Shinjo Branch of Snow and Ice Studies, NIED, Japan
Organization is made up of 6 members total, 4 of whom are researchers.

Swiss Federal Institute for Snow and Avalanche Research

Thayer School of Engineering Ice Research Laboratory at Dartmouth College
Only 4 researchers on staff.

The Snow Hydrology Group, University of California, Santa Barbara
Five scientists primarily focusing on a project for NASA's Earth Observing System Interdisciplinary Science Investigation titled "Hydrology Hydrochemical Modeling, and Remote Sensing in Seasoonally Snowcovered Alpine Drainage Basins."

University of Oregon: Geography Dept (Western Snow Avalanche Climatology Project)

Only a project rather than a research institute with only 5 researchers involved.

US Army Corps of Engineers Cold Regions Research and Engineering Lab (CRREL)

Appendix E: Revised List of Peer Institutions

Austrian Federal Forest Research Center (Austria)
Cemagref (France)
Institute of Arctic and Alpine Research, University of Colorado (US)
Meteo France - CEN (France)
National Snow & Ice Data Center (US)
Norwegian Geotechnical Institute
Swiss Federal Institute for Snow and Avalanche Research (Switzerland)
U.S. Army Corps of Engineers Cold Regions Research and Engineering Lab (CRREL)

Appendix F: Questionnaire Sent to Alpine Research Institutions

Dear **********,

We are students from Worcester Polytechnic Institute in Massachusetts, USA, completing our thesis. We are working with the Snow and Avalanche Research Institute (SLF) in Switzerland to determine how the institution can improve its attraction and retention of researchers. As a part of this study, we are comparing SLF to other institutes involved in snow and avalanche research. To help us gather data for the measures we will be using to compare institutions, we would appreciate it if you could provide us with some information.

1. How many researchers involved with snow and avalanche research currently work at your institute? #_____

2. What are the home countries of your researchers? (X all that apply)
   _____ Argentina
   _____ Australia
   _____ Austria
   _____ Canada
   _____ France
   _____ Germany
   _____ India
   _____ Italy
   _____ Japan
   _____ New Zealand
   _____ Russia
   _____ Scandinavia
   _____ Switzerland
   _____ United Kingdom
   _____ USA
   Other _____

3. How long do researchers typically stay at your institution? (Select a range)
   0-1 years 2-3 years 4-5 years 6-10 years 11-20 years 21 years or more

4. What percentage of researchers have PhDs at your institution? %_____

5. What is the average age of researchers at your institution? (Select a range)
   20-25 years 26-30 years 31-35 years 36-40 years 41-50 years 51years +

6. How many journal articles are published yearly by snow and avalanche researchers at your institution? #_____

7. What is the typical starting salary for a PhD-student at your institution? (Select a range)

Under $30,000 $30,001 - $35,000 $35,001 - $40,000 $40,001 - $45,000 $45,001 or more

8. What is the typical starting salary for a post-doctorate researcher at your institution? (Select a range)

Under $50,000 $50,001 - $60,000 $60,001 - $70,000 $71,000 - $80,000 $80,001 or more

Please return the questionnaire even if you cannot answer all of these questions. Our results will be open to the public and posted online. If there are any answers that you do not wish to be made public, then mark them with an *. Thank you for your time. We look forward to your reply.

Jessica McAlear
Julie Banach
Charles Chretien
slfstrategy@wpi.edu

Appendix G: Universities and Targeted Sources of Researchers by Region

North American Graduate Schools for Avalanche Research
(http://www.avalanche.org/~nac/NAC/techPages/gradStud.html)

Austria
- Universität Innsbruck

Belgium
- Université Libre de Bruxelles

Canada
- Memorial University of Newfoundland
- University of British Columbia
- University of Calgary, Alberta

Finland
- University of Helsinki

Italy
- Università degli Studi di Milano

New Zealand
- University of Otago

Poland
- Adam Mickiewicz University

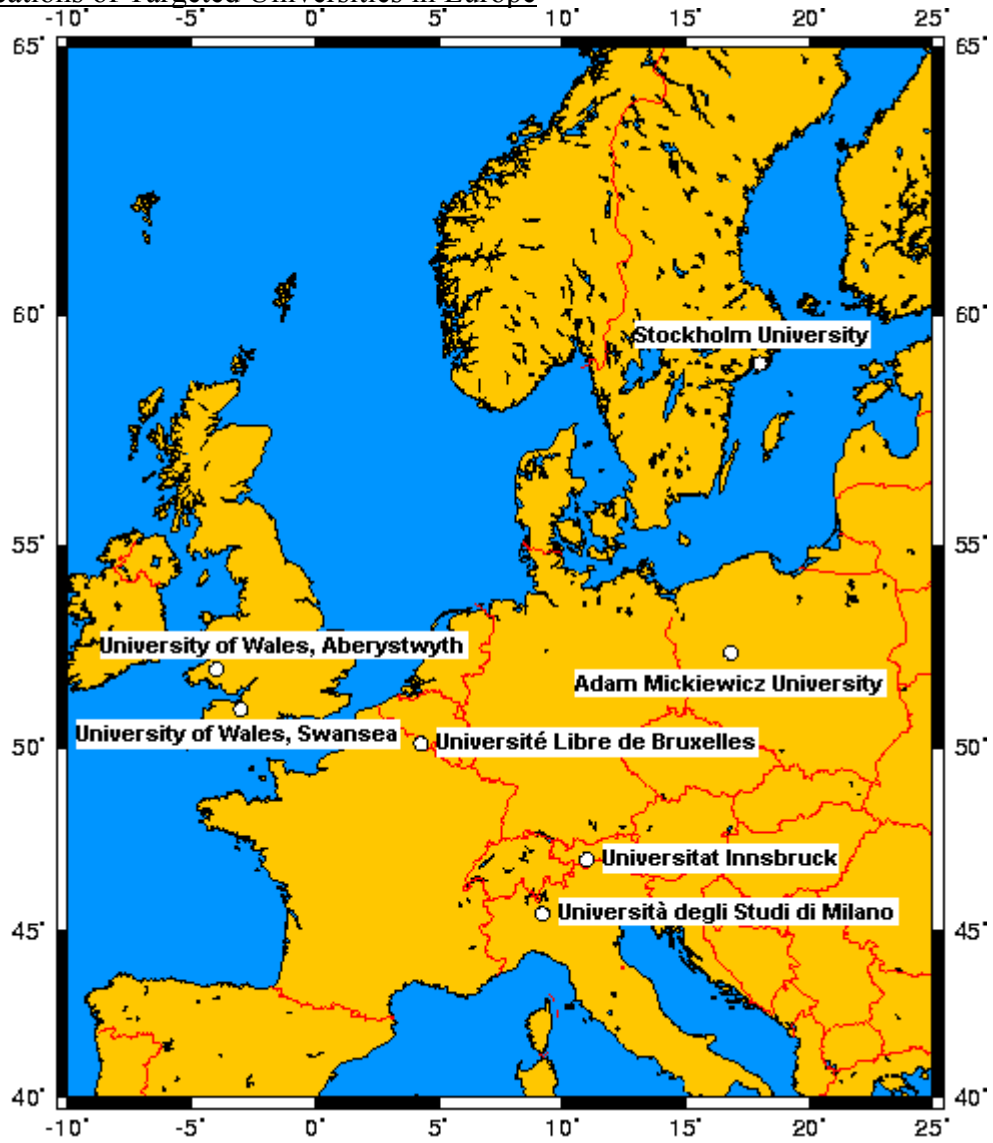
Russia
- Russian Academy of Sciences

Sweden
- Stockholm University

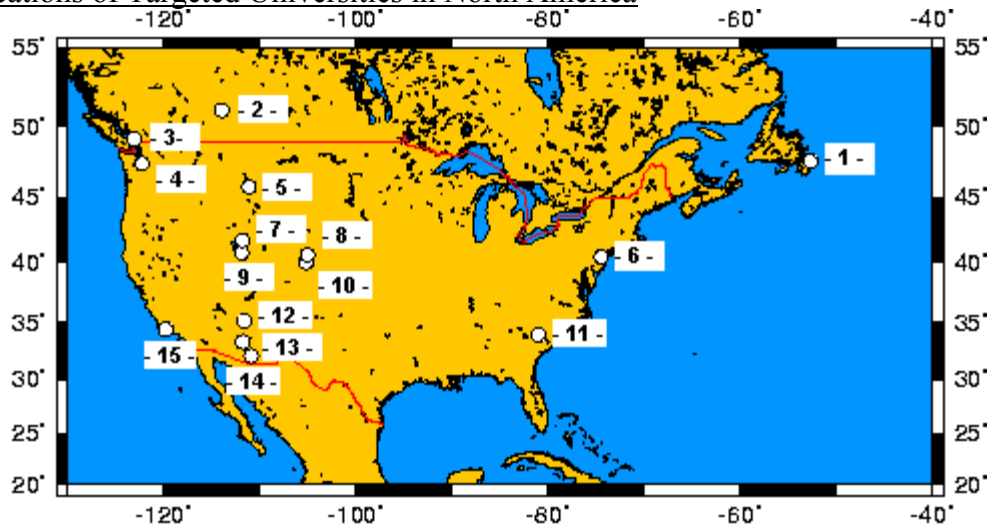
United Kingdom
- University of Wales, Aberystwyth
- University of Whales Swansea

United States
- Arizona State University
- Colorado State University (Fort Collins, Colorado)
- Nothern Arizona University
- Montana State University
- Rutgers University
- University of Arizona
- University of California at Santa Barbara
- University of Colorado
- University of South Carolina
- University of Utah
- University of Washington
- Utah State University

Locations of Targeted Universities in Europe

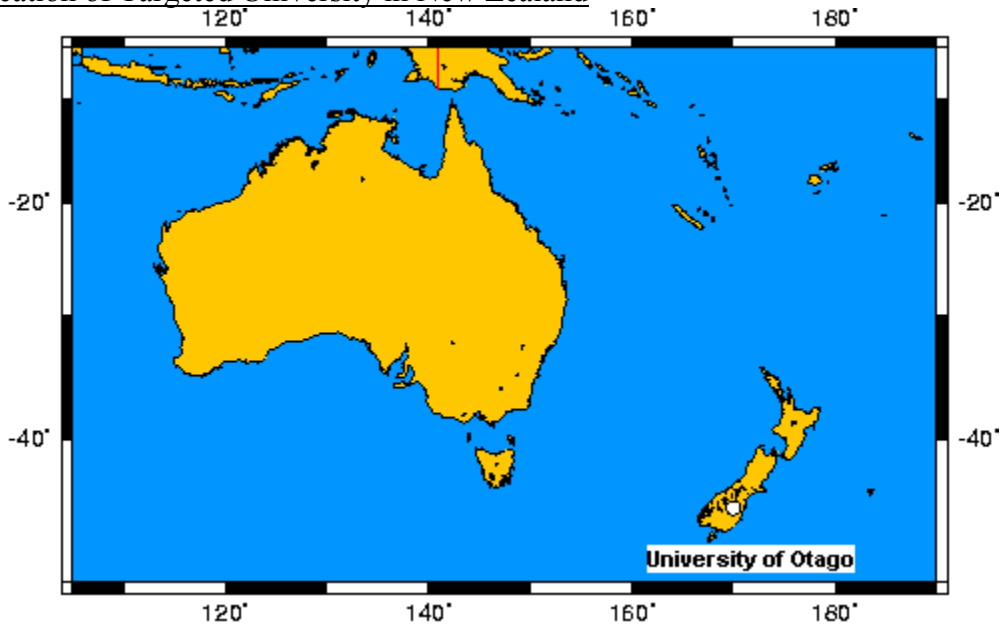


Locations of Targeted Universities in North America



1: Memorial University of Newfoundland
2: University of Calgary, Alberta
3: University of British Columbia
4: University of Washington
5: Montana State University
6: Rutgers University
7: Utah State University
8: Colorado State University
9: University of Utah
10: University of Colorado
11: University of South Carolina
12: Northern Arizona University
13: Arizona State University
14: The University of Arizona
15: University of California at Santa Barbara

Location of Targeted University in New Zealand



Appendix H: Universities and Targeted Sources of Researchers with Information

Name of Institution	Contact Person/ Web Page	Majors	Interests/ Concentrations	Web Page
Adam Mickiewicz University	Jacek Jania – jjania@usctouxl.cto.us.edu.pl	Department of Glacial Geology		Department of Glacial Geology - http://main.amu.edu.pl/~zgg/wel-a.html
Arizona State University	Dr. Andrew Ellis - andrew.w.ellis@asu.edu. Dr. Tony Brazel - abrazel@asu.edu	Geography	meteorology-climatology emphasis; hydroclimatological consequences of snow-atmosphere interactions	http://geography.asu.edu; Office of Climatology - http://saguaro.la.asu/ooc/
Colorado State University (Fort Collins, Colorado)	Dr. Kelly Elder - kelder@cnr.colostate.edu	Earth Resources Department	Avalanches and hydrology	Department of Earth Resources: http://www.cnr.colostate.edu/ER/
Nothern Arizona University	Dr. Lee Dexter - Lee.Dexter@nau.edu (Homepage - http://www.for.nau.edu/~lrd/)	Geography; School of Forestry	snow, ice, and snow hydrology	http://www.for.nau.edu/geography/
Memorial University of Newfoundland (Canada)	Paul B. Barrette - paulb@engr.mun.ca	Department of Engineering and Applied Sciences	Environmental engineering; climate change; sea level change; earth and ocean systems; environmental pollution and mitigation; applied ecology	Environmental Engineering and Applied Sciences: http://www.engr.mun.ca/Engr/Enviro/index.html
Montana State University	Earth Sciences: Dr. Steve Custer - uessc@montana.edu. Dr. Katherine Hansen - ueskh@montana.edu. Dr. Wm Locke - wlocke@montana.edu.	Department of Earth Sciences (Geology and Geography) and the Department of Civil	Spatial variations in snowpack properties, avalanche forecasting, snow metamorphism and weak layer formation, snow stability tests, avalanche climatology, the effects of snow on	Earth Sciences: http://www.montana.edu/wwwes/. Civil Engineering: http://www.coe.montana.edu

	Dr. Karl Birkeland - kbirkeland@fs.fed.us Civil Engineering: Dr. Ed Adams - eda@ce.montana.edu. Dr. Bob Brown - bobb@ce213.coe.montana.edu. Dr. Jim Dent- jimd@ce.montana.edu	Engineering	animal migration patterns, the effect of forests on snow hydrology, and factors which increase wet snow avalanche potential; snow metamorphism and sintering, modelling the evolution of the snowpack, avalanche dynamics (including a project to collect data within flowing avalanches), blowing snow	/ce/ Gallatin National Forest Avalanche Center: http://www.mtavalanche.com U.S. Forest Service National Avalanche Center: http://www.fsavalanche.org
Russian Academy of Sciences	Vladimir N. Mikhalenko – mikhalenko@mikun.msk.su	Institute of Geography		
Rutgers University	Dr. David A. Robinson drobins@rci.rutgers.edu	Department of Geography	hemispheric and regional snow cover dynamics, interactions of snow cover with other climate elements, and the collection and archiving of accurate climatic data, particularly related to snow;	http://climate.rutgers.edu/climatelab. http://geography.rutgers.edu
Stockholm University	Prof. Emeritus Jan Lundvist - Jan.lundqvist@geo.su.se	Department of Physical Geography	Glaciology, ecological geography, geomorphology	Department of Physical geography - http://www.natgeo.su.se/ink/home-e.html
Università degli Studi di Milano		Department of Earth Sciences	Glaciology and glacial geology	Department of Earth Sciences - http://www.gp.terra.unimi.it/
Universität Innsbruck	Snow and Avalanche Research: Dr. Horst Schaffhauser – fbva.aiatr@magnet.at Studies on Avalanche	Institute of Avalanche and Torrent Research; Institute of	Avalanche dynamics, numeric avalanche simulation models, avalanche catastrophe studies; Forest	http://fbva.forvie.ac.at/inst8/avalanche.html

	Dynamics and Snow Mechanics: Dr. Lambert Rammer Management of Torrent and Avalanche Hazard Zones: Dipl.-Ing. Herbert Kronfuß Torrent and Erosion Research: Dipl.-Ing. Dr. Peter Andrecs – peter.andrecs@fbva.bmlf.gv.at Torrent Hydrology Dipl.-Ing. Erich Lang – erich.lang@fbva.bmlf.gv.at	Botany	management and ecological studies in the sub-alpine zone	
Université Libre de Bruxelles (Belgium)	Jean-Louis Tison – jtison@ulb.ac.be	Department of Sciences of the Earth and the Environment (Département des Sciences de la Terre et de l' Environnement)	Ice interfaces in polar and alpine areas; interactions of the cryosphere with the total terrestrial system; chemical and isotopic composition of the Antarctic ices of ice shelves; European project of major drilling in the Antarctic ice; composition of the ices in Greenland; alpine basal ices and implications on the chemistry of subglacial water; physicochemical properties of the Antarctic ices of sea, with interactions with the atmosphere, the ocean, and the biosphere; VOSTOK – major coring in the center of the icecap in the Antarctic	Polar glaciology (Glaciologie polaire): http://www.ulb.ac.be/rech/inventaire/unites/ULB182.html
University	Dr. Roger Bales -	Hydrology	snow hydrology	http://www.h

of Arizona	roger@hwr.arizona.edu (http://www.hwr.arizona.edu/~roger/roger_bales.html			wr.arizona.edu/deptinfo.html
University of British Columbia (Vancouver, Canada)	Dr. Dave McClung - mcclung@geog.ubc.ca	Geography Civil	natural hazards (specifically snow avalanches), avalanche forecasting, interaction of avalanches and forest cover, snow mechanics, avalanche dynamics, and risk analysis	http://www.geog.ubc.ca/avalanche
University of Calgary, Alberta	Dr. Bruce Jamieson - jbjamies@ucalgary.ca	Civil Earth Sciences	Applied snow and avalanche research, avalanche mechanics; metamorphism and strength changes of persistent weak layers; near-crust faceting; avalanche initiation including skier triggering; fracture in snowpack layers; field tests for snow stability; spatial variability of slab stability	http://www.eng.ucalgary.ca/Civil/Avalanche/
University of California at Santa Barbara	Dr. Jeff Dozier - dozier@bren.ucsb.edu, Debbie Donahue - donahue@icess.ucsb.edu	Donald Bren School of Environmental Science and Management; Department of Geography	remote sensing of snow properties and the use of remotely sensed data in the analysis of snow; science, policy, and management	http://www.bren.ucsb.edu/ http://www.geog.ucsb.edu
University of Colorado	Dr. Mark W. Williams - markw@snobear.colorado.edu Homepage: http://snobear.colorad	Department of Geography; Institute of Arctic and Alpine	hydrology and mountain meteorology, including snow hydrology; snow and ice processes in mountain ranges of the	Geography: http://www.colorado.edu/geography/ INSTAAR: http://instaar.c

	o.edu/Markw/mark.html Dr. Richard Armstrong - rlax@kryos.colorado.edu	Research (INSTAAR); National Snow and Ice Data Center (NSIDC)	US, Central Asia, China, Europe and South America, as well as in the Arctic and Antarctic; permeability of snow, meltwater flow through snow, energy balance over snow, sublimation from seasonal snow and from the Greenland Ice Sheet, hydrologic mass balance of snow and ice-covered catchments, and remote sensing of snow and ice properties	olorado.edu/ NSIDC: http://www-nsidc.colorado.edu/NSIDC/ NWT LTER: http://culter.colorado.edu:1030/
University of Helsinki	Matti Leppäranta - matti.lepparanta@helsinki.fi	Department of Physical Sciences	Physical geography; geomorphology, hydrogeography, environmental change	Department of Physical Sciences: http://www.physics.helsinki.fi/fyl_www/english/
University of Otago	Patricia J. Langhorne – pjl@physics.otago.ac.nz	Department of Physics	Ice Research	Department of Physics – http://www.physics.otago.ac.nz
University of South Carolina	Dr. Cary Mock - MockCJ@sc.edu Homepage:http://www.cla.sc.edu/geog/facStaff/mock.html	Department of Geography	snow avalanches, particularly as they relate to climate, GIS, hazards, and glaciology; climatology, meteorology, hazards, geomorphology, GIS, cartography, and hydrology;	University of South Carolina Department of Geography: http://www.cla.sc.edu/geog/index.html
University of Utah	Dr. John Horel - jhorel@met.utah.edu http://www.met.utah.edu/jhorel/homepages/jhorel/jhorel.html Dr. Jim Steenburgh: jimsteen@met.utah.edu	Department of Meteorology; Geography Department	mountain meteorology, snow and avalanches; basic and applied research examining orographic precipitation, lake-effect snowstorms,	Department of Meteorology: http://www.met.utah.edu

	http://www.met.utah.edu/jimsteen/personal/jimsteen.html) Dr. Bill Harrison - w.l.harrison@m.cc.utah.edu (school year); w.harrison@sympatico.co(June - Sept)		thermally driven flows, downslope wind storms, and mountain weather prediction	
University of Wales, Aberystwyth	Bryn P. Hubbard – byh@aber.ac.uk	Institute of Geography & Earth Sciences, Centre for Glaciology	Glaciology	Institute of Geography and Earth Sciences - http://www.aber.ac.uk/iges/ Centre for Glaciology - http://www.aber.ac.uk/~glawww/
University of Whales Swansea	Michael J. Barnsley – m.Barnsley@swansea.ac.uk	Department of Geography	Environmental Modelling and Earth Observation, glacier dynamics	Department of Geography - http://ralph.swan.ac.uk/
University of Washington	Dr. Howard Conway - conway@geophys.washington.edu	Earth and Space Sciences; Glaciology	Glaciology; seasonal snow, sea ice, glaciers, ice sheets and frozen ground;	Earth and Space Sciences: http://www.ess.washington.edu Research Page: http://www.geophys.washington.edu/Surface/Glaciology/
Utah State University	Dr. Michael J. Jenkins – mjenkins@cc.usu.edu	Department of Forest Resources	Forest ecology, inderdisciplinary water shed unit, avalanche ecology, avalanche effects on forest vegetation, recreation resource management, meteorology, engineering watershed science, snow and avalanche dynamics	Department of Forest Resources http://www.usu.edu/~uafclogn/

Appendix I: Questionnaire for Graduate/PhD Students in Alpine and Avalanche Studies

1. Assess the following factors influencing job selection, with 1 being "not important" and 5 being "very important." 1 = Not Important 5 = Very Important

Abundance of PhD students working at Institution	1 2 3 4 5
Size of Institution	1 2 3 4 5
Financial Support for Research	1 2 3 4 5
Reputation of Institution	1 2 3 4 5
Opportunity for Advancement	1 2 3 4 5
Employment Opportunities for Family/Spouse	1 2 3 4 5
Salary and Benefits	1 2 3 4 5
Educational Opportunities for Family	1 2 3 4 5
Setting of Institution	
Crime	1 2 3 4 5
Weather	1 2 3 4 5
Cost of Living	1 2 3 4 5
Sports Opportunities	1 2 3 4 5
Cultural Opportunities	1 2 3 4 5
Proximity to Major Transportation Hubs	1 2 3 4 5
Other_____	1 2 3 4 5

2. How interested would you be to work for an academic institution (university), a research institution, a private firm, in public administration, or for a non-governmental organization? Assess the following, with 1 being "not interested," and 5 being "very interested."

1 = Not Interested 5 = Very Interested

Academic Institution	1	2	3	4	5
Research Institution	1	2	3	4	5
Private Firm	1	2	3	4	5
Public Administration	1	2	3	4	5
Non-Governmental Organization	1	2	3	4	5

3. How willing are you to relocate for your career? Please assess your interest in relocating to the following areas from 1 to 5, with 1 being "not at all" and 5 being "very much." (Circle One)

1 = Not At All 5 = Very Much

Northeastern USA	1	2	3	4	5
Scandinavia	1	2	3	4	5
Southwestern USA	1	2	3	4	5
Eastern Canada	1	2	3	4	5
Northwestern USA	1	2	3	4	5
Switzerland	1	2	3	4	5

United Kingdom	1	2	3	4	5
Austria	1	2	3	4	5
New Zealand	1	2	3	4	5
Australia	1	2	3	4	5
Western Canada	1	2	3	4	5
Japan	1	2	3	4	5
France	1	2	3	4	5

4. How often do you travel to another region of your country? (Circle One)
   Never Once every few years About once a year Multiple times a year

5. How often do you travel outside of your country? (Circle One)
   Never Once every few years About once a year Multiple times a year

6. How often do you travel outside of your continent? (Circle One)
   Never Once every few years About once a year Multiple times a year

7. How many languages can you speak well? (Circle One) 1 2 3 4 or more

8. In what country were you born? _____

9. In what country is your college/university located? _____

10. In what subject are you seeking your master or doctorate degree?
    _____

11. What is your age? (Circle One) 20 or younger 21-24 25-29 30 or older

12. What is your gender? (Circle One) M F

13. What is your marital status? (Circle One) Single Partner Married Separated

Appendix J: Descriptions of the Seven Peer Alpine Research Institutions

The Austrian Federal Forest Research Center is made up of 5 departments: snow and avalanche research, studies on avalanche dynamics and snow mechanics, management of torrent and avalanche hazard zones, torrent and erosion research and torrent hydrology. Since it was founded in 1966 much of their research has been aimed at the development of improved guidelines for active and passive protection from avalanches with the hope of aiding the Austrian national economy. They are also responsible for carrying out the Austrian Federal Law on Forest Reproductive Material; surveys on the status and development of Austrian forests, researching forest, natural hazard, and landscape sciences, specifically in relation to Austrian forests and natural hazard protection; controlling the water budget; testing of equipment, chemicals, and techniques; and acting as an information bureau for the people and for the training of forest guards (http://fbva.forvie.ac.at/050/1851en.html).

Cemagref is a public agricultural and environmental research institute that was setup in 1939 and today has research institutes spread across France. Their work focuses on sustainable development in non-urban areas and contributes to the conservation and acceptable management of land and water systems, the growth of economic activity on a sustainable basis, and the prevention of associated risks. In Grenoble, where the snow avalanche engineering and torrent control group is located, the work is related primarily to mountainous regions.

The Cold Regions Research and Engineering Laboratory (CRREL) was founded in 1961; today they are located in Hanover, New Hampshire, USA with a projects office at Fort Wainwright, Alaska, USA. CRREL is a research and engineering facility that is a part of the Engineer Research and Development Center (ERDC) and a branch of the US Army Corps of Engineers (USACE). CRREL's mission is to gain knowledge of cold regions through scientific and engineering research and put that knowledge to work for the USACE, the Army, the Department of Defense, and the Nation. Within CRREL there are 8 research branches: Applied and Military Engineering, Engineering Resources, Civil and Infrastructure Engineering, Geophysical Sciences, Environmental Sciences, Snow and Ice, Remote Sensing and GIS, and the Ice Engineering Group.

The Institute of Arctic and Alpine Research (INSTAAR) focuses on interdisciplinary research in earth system dynamics with a special focus on high-altitude and high-latitude regions. There are 3 groups conducting research at INSTAAR; ecosystems, geophysics, and past global change. Together they investigate how sensitive or high-energy environments affect, and are affected by, natural and human-induced processes on the local, regional, and global scales. INSTAAR is closely connected to the University of Colorado as an institute within their graduate school and is affiliated with the departments of CEA Engineering, Environmental Studies, EPO Biology, Geography and Geological Sciences.

Meteo France is a research institution located in Grenoble, France. Their focus of research is meteorological studies; specifically the climate, the atmosphere, weather forecasting, physical and atmospheric dynamics, and human interactions. The division of Meteo France that deals with snow and avalanche research is the Centre d'Etudes de la Neige (The Center of Snow Study), which was established in 1965.

The National Snow and Ice Data Center (NSIDC) is part of the University of Colorado Cooperative Institute for Research in Environmental Sciences, and is affiliated with the National Oceanic and Atmospheric Administration National Geophysical Data Center through a cooperative agreement. The NSIDC has a mission to make fundamental contributions to cryospheric science and will excel in managing data and disseminating information in order to advance understanding of the Earth system. The NSIDC collects cryospheric data, manages and distributes collected data internationally and conducts cryospheric research that reveals the impact and response of the cryosphere in the global climate system.

The Norwegian Geotechnical Institute (NGI) was started as a research institute in 1953 and was then privatized in 1985. As a private foundation, NGI still focuses on research as well as consulting in the geo-sciences, including soil, rock and snow. For more than 50 years NGI has worked to produce results that benefit industry and society. NGI specializes in the areas of geotechnics, engineering geology, hydrogeology and environmental geotechnology; with expertise in material properties, modeling and analysis, and instrumentation and monitoring.

The Swiss Federal Institute for Snow and Avalanche Research (SLF) in Davos concerns itself with the study of the characteristics of snow and snow cover. Its research focuses on the study of avalanche formation and avalanche protection. SLF works to develop and improve preventative measures, and also provides an avalanche bulletin service for the surrounding alpine area. Six divisions of SLF work together to conduct the avalanche research. These divisions include Avalanche Warning and Risk Management, Snow and Avalanche Research, the Alpine Environment, Operational Logistics in Davos, the Avalanche Test Station in Sion, and Water, Soil, and Rock Movement Research (See **Appendix K**). Interviews with the various key players at SLF and around Davos provided us with more indepth info, shown in **Appendix L**. More information about SLF from its peer audit can be found in **Appendix M**.

Appendix K: Six Divisions of SLF with Subdivisions

1. Lawinenwarnung und Risikomanagement (Avalanche Warning and Risk Management)

This section is in charge of the Swiss avalanche forecasting service. Furthermore, early warning systems, process and forecasting models as well as risk management technologies are being developed.

1.1 Lawinenwarnung (Avalanche Warning)

This operational avalanche warning service provides daily national and regional avalanche bulletins during the winter. These services are published over newspapers, the radio, television, and the internet.

1.2 Interkantonales Mess- und Informationssystem für die Lawinenwarnung (IMIS) (Intercantonal Measuring and Information System for Avalanche Warning)

This division has worked to create a measuring network of approximately 60 automatic measuring stations. This permits SLF to seize snow and meteorological data directly from the altitudes of typical incipient crack areas around the clock. Measured variables such as wind direction, wind velocity, snow height, air temperature, radiation, and temperatures in the snow cover are measured continuously and allow for expert estimation of avalanche danger. All the stations work automatically and are connected by radio and telephone with SLF.

1.3 Schnee- und Lawinendatenbank (Snow and Avalanche Database)

The measuring data seized by SLF are printed out on paper and fill a whole library. An efficient data storage and archiving system has been created in order to analye and understand this data flood. This allows for all the measuring data to be controlled and kept in one central place. It permits simple and fast access to weather and avalanche data by any interested persons. An application has also been developed to allow easy user friendly access to the database.

1.4 Prozess- und Prognosemodelle (Process and Prognosis Models)

The core activity of the avalanche warning service is to provide danger prognoses. The processing-concepts team develops physical and statistical models to support this prognosis activity. These models are used to answer ecological and hydrolic questions. The group focuses in on the advancement of the snow cover model, SNOWPACK. This model was developed for the regional and national avalanche warning center. This group works to combine expert knowledge with statistics and algorithms derived from the artificial intelligence. The durable and effective models allow for evaluation of possible danger.

1.5 Info-Service und Internet (Information Service and Internet)

Knowing the correct information at the right time can prevent accidents. With the use of the internet, current information about snow and avalanches can be viewed in a user friendly way quickly and at anytime and anywhere. Use of a PC and modem allows for the safeguard of people by accessing the weather and avalanche situation from SLF around the clock.

1.6 Risikomanagement (Risk Management)

The use of mountain areas is endangered by the effects of avalanches, falling rocks, and flood. A combination of organizational, structural, zoning, and biological measures are

aimed at minimizing the risks with as little cost as possible. The group shares the view of prevention, intervention, and reposition. The group measures the components of risk management to examine their cost effectiveness. Only measures that are seen to have optimal cost effectiveness are considered. The group gathers measures for risk management and puts them into practice.

2. Schnee und Lawinen (Snow and Avalanches)

This section conducts research and development in snow mechanics, avalanche dynamics, avalanche and rockfall protection.

2.1 Schneephysik (Snow Physics)

The task of this team is to measure and model the physical and mechanical processes of snow. The research concentrates on improving the measuring techniques for the characterization of snow and the effect and meaning of the connections between individual snow grains. The team focuses in on the measuring methods for the determination of mechanical and structural characteristics, spatial variability, tree-snow interaction, surface properties of ski runways, and incipient crack conditions of avalanches.

2.2 Lawinenschutz (Avalanche Protection)

Avalanche protection is the central task of SLF. The group focuses on permanent avalanche protection by sheeting and zoning measures, as well as temporary avalanche protection by artificial avalanche release. This practice has brought about concrete questions to avalanche research. The specialized knowledge is accessible through training meetings, publications, and cooperative commissions. This team cooperates with other researchers of SLF to examine new avalanche computation models and provide guidelines for practice.

2.3 Lawinendynamik und Numerische Simulationen (Avalanche Dynamics and Numeric Simulations)

This team is concerned with flowing and dust avalanches. They examine incipient crack volume, the admission and deposit of snow, the speeds, flow heights, and thrust forces, and seismic signals of avalanches. They developed a numeric model to estimate the avalanche discharge distance of flowing and dust avalanches. The models are examined and improved based on measurements of artificially released avalanches at the testing ground in Sion. This team also works with the falling rock problem, and the ABS balloon which is an avalanche airbag to allow persons to float to the top of flowing snow.

2.4 Schneesport (Snow Haven)

This team focuses on snow-specific topics of winter sports and tourism. They work on applications of ski runway preperation and sliding and cornering on snow with various sporting devices.

2.5 Schnee- und Lawinenklimatologie (Snow and Avalanche Climatology)

This team works to understand the reciprocal effects between climate, avalanches, and technical measures.

(Appendix A continued)

3. Lebensraum Alpen (Alpine Environment)

This section conducts research on permafrost, snow ecology, disturbance ecology and management of natural resources in alpine areas. This year special emphasis is placed on public relations in the frame of the IYM 2002.

3.1 Schneeökologie (Snow Ecology)

Snow covers the alpine region over half the year. The snow cover and its characteristics are important factors that contribute to the composition and processes of alpine ecological systems. The snow cover is also a habitat for specialized organisms. The team studies the interactions between the snow cover and its ecological systems, and also the characteristics of the ecological system of the snow cover.

3.2 Permafrost und Klimawandel (Permafrost and Climatic Change)

Permanently frozen soils lie in the Alps above 2,500 meters. Climatic changes affect the occurance of permafrost in repeated ways. This team studies the slope stability of permafrost beds with glaciers, and glaciers or falling rocks in connection with permafrost and its changes, in addition to the effect of increased human use of alpine areas. The team examines the reciprocal effects between permafrost, buildings, and the snow cover. They also analyze the growth of plants to investigate the temporal and spatial dynamics of frozen soils and derive information about the climate of past epochs.

3.3 Disturbance Ecology (Disturbance Ecology)

Natural occurances of avalanches and storms shape the life procedures and the composition of alpine ecological systems. In addition, the structure of vegetation influences the frequency and intensity of these natural occurences. This team examines the reciprocal effects between natural occurences and existing ecological systems in the alpine area.

3.4 Nutzung des alpinen Lebensraums (Use of the Alpine Habitat)

This team works to examine the natural dynamics of natural resources, different use strategies, their effects on alpine ecological systems, and their socio-economic meaning. By using models, the team simulates scenarios of future landscapes and looks to find optimized management methods for a lasting development.

3.5 International Year of Mountains – Internationales Jahr der Berge 2002

The UN appointed 2002 as the year of the mountains. This year will be focused on promoting the lasting development of alpine areas, and to sensitize humans to the characteristics and problems of these regions.

3.6 Versuchsflächen (Attempt Surfaces)

Data have been collected about ecology and climate for decades. This data is used by a research council to help answer current alpine questions.

4. Logistik Davos (Logistics Davos)

This section is in charge of public relations activities and the administration, and manages the experimental sites, logistics, electronic and computer services. The six divisions of this team include: 1) Administration, Sekretariat und Empfang (Administration, Secretary and Treasurer), 2) Bibliothek und Publikationen (Library and Publications), 3) Informatik, Elektronik und Netzunterhalt (Computer Science, Electronics, and Net Maintenance), 4) Versuchsanlagen und Logistik / Mechanik (Test Ranges and Logistics / Mechanics), 5) Cafeteria (Cafeteria), and 6) Raumpflege (Space Care).

5. Aussenstelle Sion (Branch Station Sion)

Among other missions, the branch station in Valais is responsible for the avalanche test site in the Sionne valley. This station tests overall dynamic behavior of dense flow and powder snow avalanches, and avalanche impact forces along their path. Application of the data gathered verifies and calibrates the physical models and computer simulation programs.

6. Wasser, Erd- und Felsbewegungen (Water, Soil and Rock Movements)

SLF and the department of water, soil and rock movements of WSL form the research department of natural hazards.

6.1 Erd- und Felsbewegungen (Ground Connection and Rock Movements)

This team works to test civil defence structures against falling rocks in a test range. The core of this research forms the analysis of the forces during the brake applications in wire rope net constructions. The forest effects are examined and documented, as well as the motion, transit, and deposit of falling rocks. Of interest is the connection of erosion and earth slips in torrent catchment areas and in alpine erosion areas.

6.2 Forstliche Hydrologie (Frost Hydrology)

The center of work for this team is locating small torrent catchment areas. The goal of the work is to improve and develop procedures for the estimation of flood events. Investigations form the basis of understanding the influence of different areas characteristics on the discharge. The measurements in the test area form the basis for this work. Snow hydrology forms a substantial component of this work. A further area of interest is the nutrient household of torrents. Series of measurements over many years of the content materials of precipitation and discharge form the basis for process studies and the analysis of long-term changes in the nutrient household of these areas. A data record has been developed which contains more than 11,000 flood and slip events in Switzerland over the past thirty years, and describes the extent, cause, and damage incurred.

Appendix L: Interview Memos

1. Interview with Dr. Amman, 11-8-2002

A concern of the Eidgenossische Institüt für Schnee und Lawinenforschung (SLF) is hiring excellent staff. The institute is open to new ideas and insights to ameliorate the current difficulties of attracting top researchers.

Difficulties in Hiring

There are numerous reasons that may cause scientists to not consider SLF as a job opportunity. It is a two hour drive from the closest metropolitan area, Zürich. For most Swiss citizens, even a 45 minute drive is too long. They may be considered narrow-minded, but this may also be considered a sensible trait, in that they don't waste valuable time in commuting. The Swiss are not used to very long distances, and the situation in Germany is similar. These people are not used to thinking in terms of such large categories, which seems to be the overal European attitude. If a researcher were interested in the opportunity itself, s/he is often bound to a partner who cannot find a job opportunity in Davos.

Another difficulty lies in the fact that SLF can only provide a limited climate of scientific working. It cannot provide the same opportunities as if it were on a university campus. On campus, researchers would easily have discussions and take courses. At SLF, if a PhD student wanted to take a two hour course, a whole day would be lost because of the travel time. A concern of researchers is that they will lose contact to the scientific community if they do not work on a campus.

Most researchers are probably unaware of SLF's capacities as an institute. SLF provides a very interdisciplinary field of activities. There are 15 different academic segments made up of the natural and engineering sciences. In a negative aspect, if SLF needs to hire a high specialist, that person may not be interested in working in an interdisciplinary research. Few are able or ready to work in an interdisciplinary environment.

When researchers work with SLF, they begin to realize their chances for other job opportunities. It is SLF's job to educate people, then lose them. They always lose the best, and this is how they know they are good researchers. On the bright side, every loss is also a chance to provide other good people with a good environment.

Financing

SLF faces the global problem of financing. Limited funds has forced SLF to handle many projects by PhD students, who cost just half that of a Post-doc. This is a good chance to get young people in and let them work on interesting projects. Unfortunately, this hinders the research of experienced researchers. They must spend most of their time supporting the PhD students. There are 25 PhD students, out of 125 total researchers, so PhD students make up one fifth of SLF. Even if SLF applies for funding from the National Science Foundation, the NSF only gives grants at the level of a PhD salary.

MakeUp

SLF wants to hire older scientists. The increase in knowledge at the institute is always flattened when somebody leaves. The average age of researchers at SLF is very low, only 29.5 years. Students coming out of school with a master's diploma are approximately 25 years old, and the PhD students that work at SLF are usually two years older than this. SLF needs more experienced scientists to support its long term strategy.

SLF is organized by the head of the research department, Dr. Ammann. There are four research divisions and one logistics unit. The chief senior scientists, the five heads of the divisions, and Dr. Ammann make up the Directors that are responsible for the entire department. Much of their time goes into mentoring PhD students.

SLF encourages PhD students to work in SLF. The mentoring program at SLF is like a gift to universities. The universities just go through the PhD thesis and give suggestions, whereas the large time committment of mentoring the students is done by SLF. PhD students sign one year contracts which are renewed every year for a total of three years.

There are two different contracts when a researcher enters SLF. The first is a limited two year contract, then a three year contract. After five years, if the conditions are right, the researcher is given an unlimited contract. If someone were unproductive, SLF would be unable to get rid of them.

Currently, the percentage of women working at SLF is still quite low, 25%. Dr. Ammann would like this to increase, but this is quite difficult. This is more of a problem of engineering in Switzerland in general, in that less than 10% of the students are women. Dr. Ammann says that women are more open to interdisciplinary work, which SLF encourages. SLF has installed a KinderZimmer, where mothers and fathers can take care of a child. There is currently a PhD student who is working with a daughter, and the system is working well. This room could be one of SLF's attractions, even if a researcher has no need for it. It shows that SLF is family friendly and woman friendly. In Switzerland, the tendency to care for children is still quite related to the mother.

Dr. Ammann strongly supports sports activities from the institute. He tries to fund sports activities when researchers are forming a team, such as running, skiing, or skating. He works to finance them, get any admissions fees paid, and offers the SLF cars for the use of the participants on their own time. With sports, workers can get to know each other better in another environment than research. They can come together with other departments. In the project side, workers are quite restricted to their division. Sports activities give the opportunity to open the minds of researchers.

Foreign Researchers

The European Unification has lead to less problems than the past. ETHZ has been forced to use the American system of giving a student a bachelors degree and then a masters degree. This is not a definite requirement of Swiss universities, because Switzerland is not a part of the EU. However, this is an opportunity to draw in graduate students from universities in other EU nations and America.

In five years time, SLF hopes for more international recruitment opportunities. Currently, SLF gets applications from mostly Germany, France, and Italy. SLF hopes to become known in other countries. Advertisement is certainly an aspect that SLF can do better. Currently, SLF only advertises job opportunities in journals, Swiss newspapers, and on the SLF webpage. This is very restricted to Switzerland and Germany, and is

certainly not penetrating the international market. SLF is interested in learning how they can advertise internationally, without spending a lot of money.

Because of the European Unification, the European nations have agreed for a free exchange of information. Switzerland is not a part of the EU, but has bilateral contracts with the EU. Researchers can move easily throughout Europe, but for others, movement is quite difficult. It is just as difficult to hire a Russian or Chinese as it is to hire an American. Foreigners have to apply at the Foreign Federal Police and the Foreign Cantonal Police. The whole process can take four months or longer. If foreign researchers are allowed to work in Switzerland, often their spouse and children cannot come with them.

Foreign researchers have to go through the same process as any other workers entering Switzerland. Davos lies in the canton of Graubünden, where 80% of the income comes from the tourism industry. The canton relies on foreign servants to support this industry, so they are on the same level as top researchers. All incoming workers must enter through the same door, no matter their social standing. Even a worker coming for two weeks requires the same amount of paperwork as someone staying for three years.

Competition

Dr. Ammann doesn't feel that SLF has any real competitors in the same field of research. People who could work for SLF are taken by institutes that rely on climate change studies, weather climate, hydrology, and environmental aspects. Zürich, Bern, and Basel are cities where other universities sit in Switzerland that could draw researchers. Most researchers think that their chances for a job are better when they are close to university institutes.

SLF works to keep researchers connected to the academic world. The institute tries to get people into assistant or associate professorships with universities. If researchers do become professors, SLF hopes that they keep their ties with the institute. Researchers are encouraged to keep their work at SLF. However, there is a risk that SLF will lose the researchers completely. It is their duty to give people the chance to develop so that they become aware of their possibilities.

Davos Setting

Davos is an excellent place for sports. As one of its big assets, it also attracts more of the younger people. The educational possibilities for children are not bad in Davos. Students can get an education up to Matura, which allows them to enter a university. Davos also has the same type of school which combines sports activities with the curriculum, known as Gymnasium. In the cultural aspect, there are quite a few activities in terms of concerts. There are some theater events which are not the same high class quality as can be found in Zuerich, but they are still good. Overall, if you like mountains and the environment, Davos is a good place.

On the negative side, Davos is just as expensive as Zuerich. Apartments are very expensive, but it is possible to find cheaper apartments in adjacent villages. It is the resort aspect of Davos that raises prices. Also, when new apartments are built, the builders can always find a foreign buyer to increase the price. If one is working in Davos as an alpine researcher, one can nearly only work at SLF. If one wanted another job, they would have to move. This would especially be difficult if one has a spouse and children

to think about. This also means that a researcher at SLF is less flexible to get other job opportunities.

Davos does not have four distince seasons, which can be hard for those who enjoy the seasons. It has a very long winter, from mid November through May, and nearly no spring. The short spring that Davos does have is very cold and wet, and vegetation starts much later than in the lower altitudes. Even through the summer, there is about once a month when the village receives snow. Evenings are still cold enough that one would need a jacket to sit outside.

2. Interview with Mr. Wiehler, 11-8-2002

Positions at WSL and SLF are primarily filled through contacts. It is based on a need from both sides, the employer and the employee, so it is a win-win situation. For example, WSL is looking for a computer programmer, and in a short time received 45 applications. However, it is not the same kind of market for SLF. The time scale is longer. Recently WSL hired an American woman because of their need for her specialty. They found a great deal of difficulty in attracting researchers from the US. WSL also works together with a Russian university, which is a political decision. It allows for an exchange of knowledge and a different approach to problems.

Positions at WSL and SLF are advertised in newspapers in addition to international publications and journals that a researcher would read. The advertisements are mostly in German, but if there is a high need to fill a position, the position is also advertised in English. The Human Resources department is very low cost, and WSL cannot afford to make every advertisement in all languages. HR is only responsible with starting the job and making sure the salary is taken care of. In terms of learning what a researcher needs to know about the new working environment, WSL works as an 'uncle system.' It is up to the department head or coworkers to teach the new employee.

Logistics

Because of the Tax Treaty, employees only pay the taxes of the country they are working in. Taxes in Switzerland are approximately 15%, which is less expensive than in America. The amount differs in each canton, and depends on whether you are married or have children. The taxes include the Federal Tax, the Cantonal Tax, and the Community Tax, which are automatically taken out of the salary. WSL gets a lot of guest lecturers, and the foreign worker papers make up the biggest responsibility of HR.

A pay scale for salaries covers all five governmental agencies in Switzerland. A master's researcher starts at level 18, which is the same level as a PhD researcher. A post-master starts at level 15. All PhD students receive a fixed salary, no matter what field they work in. An experienced researcher is distinguished from a post-doctorate in that he has about 2 years more of career development.

WSL is controlled by parliament, and there is now a new reporting system in effect. Now the reporting includes the number of PhDs and women working at an institute, which makes WSL look to be a better place.

Motivation to Work

The motivation to work at WSL or SLF must be a social situation as well as a professional one. WSL is close to ETH and other research institutes. The infrastructure

is quite good and attractive, and the funding situation is generally better because it is more stable. For their funding, everything is money from the citizen. WSL gets money from the government, the Swiss Natural Firm, and BUWAL, which equivalent to the US forest service.

Most PhD students in Switzerland do not necessarily look for a job in their field. After receiving their PhD, they often go to work for a bank or an insurance company. However, if a PhD has ideas of their own, then they want to work at WSL or SLF. The value of a PhD is becoming less and less as more people receive them. Now students do a PhD as a form of occupation before getting a job, and as a way to improve their social prestige. In engineering, it is not always necessary to have a PhD. A job description may not require a PhD, and if a PhD wants the job, they usually want too much money. However, working with a PhD student is cheaper for an institute.

Exit Interviews

It is the Davos supervisor of the department in which an employee works that does exit interviews. If a researcher works in Birmensdorf, then HR does the exit interview. Generally, researchers only stay five years. If the conditions are right, then they can stay longer. However, after five years, most researchers get a new perspective on things, and want to move on.

3. Interview with Dr. Werner Schmutz, 11-12-02

On Tuesday, 12 November, we spent the morning at the Physico-Meteorological Observatory Davos and World Radiation Centre (PMOD/WRC) interviewing Dr. Werner Schmutz, director of the institution. Upon entering the building, we noticed a framed picture of about 100 global scientists and researchers. Dr. Schmutz explained to us that approximately every five years, scientists from all over the world come to the center to have their equipment calibrated. The institute itself has two main functions. On one side, it provides an operational service and is contracted by Switzerland in the name of the World Meteorological Organization. They are also responsible in research to measure the total radiation of the sun and with the aid of one of their instruments, can calibrate instruments for measuring radiation. Based on our interview questions, we were able to find out information about the organization that was directly related to the issues of setting and attraction/retention of researchers.

There are about 20 employees at PMOD/WRC, the majority of which are from Switzerland. The Swiss employees were mainly originally from the German-speaking cantons of Switzerland, although a few were from the French-speaking regions. The PhD students working at the institute were mainly Swiss, with a few from Germany, Austria, and Russia. All of the students are working at ETH to obtain their PhDs, and therefore have responsibilities in Zurich. This therefore requires them to travel to Zurich at least one day a week during the school semester. The burden of traveling such distances to balance both areas often becomes too much for PhD students; for instance, the institute lost two Physics lab technicians after five years because both decided that they had been there long enough and needed to move on. On average, PMOD/WRC usually has openings for one PhD, one postdoc, and one Physics Lab technician per year. Other than that, there is a very stable central staff.

When asked about the institute's ties with ETH or other Swiss universities learned that Dr. Schmutz is himself an honorary professor at ETH, often lecturing unpaid. The institute's ties with ETH also enable the institute to access research funds from ETH in order to pay the researchers' salaries. While salary is not an advantage factor within Switzerland, salaries in Switzerland are higher than many of the surrounding countries. Therefore, Dr. Schmutz believes that high salary is an advantage Davos has over Germany, for example; however, this factor does not matter between Davos and Zurich. Thus Davos remains at a disadvantage in comparison to a major city in Switzerland such as Zurich.

We also asked Dr. Schmutz how PMOD/WRC advertises for job openings to attract researchers. Mainly, job openings at PMOD/WRC are advertised online, via *Telejob* (an internet job search maintained by ETH) and some international webpages; especially important job openings will also be advertised in major newspapers. However, newspaper ads have not proved to be worthwhile for the institution. The only time a response came out of a newspaper was for a job opening placed in *Eos*, an international science newspaper.

Dr. Schmutz believes that the "two-body problem" discussed in the interview with Dr. Ammann poses the same threat to PMOD/WRC. Just as it is often a reason for potential employees to decline a job offer, it has also been a reason for the institution to deselect candidates. Dr. Schmutz explained to us that PMOD/WRC recently decided not to offer an Austrian candidate a job because he said that he would come to Davos and leave his partner behind. The institute felt this was too dangerous because either the Austrian would lose his girlfriend or they would lose an employee should the relationship continue further.

When asked if he thinks that the fact that Switzerland does not belong to the European Union has any negative affect on attraction of researchers, Dr. Schmutz said that he does not see this as a problem. While it is more difficult to get funded for an EU project and it is sometimes difficult to get work permits, Dr. Schmutz states that PMOD/WRC has never been declined a permit if the institution was qualified. If anything, he still believes that Swiss institutes are at an advantage compared with other European ones because of the higher salaries.

Dr. Schmutz believes that the institution's problems in recruiting Swiss PhD students stem from the fact that they are not located in a city like Zurich. The location in Davos, he believes, is a serious disadvantage in attracting researchers. Davos is "too remote and far from everything…it's like one hour out of the mountains, and 2 hours out to the world," says Dr. Schmutz. The mountains and snow and sports related with the environment are often what do attract the people who come; as he said, in order for someone to come to work in Davos, they need to be able to live there and love the mountains. Unfortunately, PMOD/WRC can not afford to give better pay to those researchers in staff positions; therefore, Dr. Schmutz says, the staff really has to love the mountains to remain in Davos.

4. Casual interviews with various PhD students from PMOD/WRC, 11-12-02

While at PMOD/WRC, Dr. Schmutz introduced us to several PhD students who are working at the institute. Given this opportunity, we were able to ask the students

several questions about where they were from and why they chose to move to Davos for their career as a researcher.

The first PhD student we interviewed was a male, originally from New Zealand. He was interesting in that he had first worked at SLF, then at ETH for a short time when a professor told him of PMOD/WRC. When asked what attracted him to this job in Davos, he said that he very much enjoys winter sports and the mountains, so Davos was the perfect setting for that. Because he was from New Zealand, he also is used to there being less people around. He explained that he does not like big cities because he finds it more stressful when there are a lot of people. This is a case where the setting of Davos played a large positive role in attraction.

The second PhD student was a male from Germany who had heard of the job opening from an internet ad. While he believes it is often the area that attracts people to Davos, he explained that he had been hesitant to accept the position because he does not enjoy sports, and felt that Davos had "too much sport." Nonetheless, he was still attracted to the position because of the setting of Davos; he found the atmosphere "fascinating" and enjoyed the history of the institute.

The next PhD student was a female from a French-speaking canton in Switzerland. She had later moved to Zurich before living in Davos, where she has been for the last five years. While she enjoys mountain climbing and shares the opinion that you have to like sports to live in Davos, she explained that what attracted her was the research position – not the setting. Her motivation came from wanting to continue work in her research field with the sun. She did not have a partner at the time, so she found the move fairly easy; she explained that she believes it would be even easier for a family to make the move because most children enjoy outdoor sports. As much as she enjoys Davos and her work, she explained that she is often frustrated that Davos is so far from everything. Davos is a small community, so there is little contact; it is also hard for her to keep in contact with family and friends back home. When asked if she would stay in Davos if she had a permanent position, she was very unsure. While she enjoys Davos and her work, she often wishes there were more possibilities.

Our next encounter was with a female PhD student originally from Germany who had learned of her job opening through *Telejob* on the internet. She explained to us that when she chose to come to Davos a year ago, she did not feel she was at a very decisive point in her life. She knew Davos was very small, but still thought it was something she would like to try. Now, however, she finds it very difficult to balance her work with the university and her research in Davos. She explained that it is very difficult to work in Davos when connected with a university not only because it is time-consuming, but also because it is very difficult to organize lectures from Davos. This student made it very clear that her field of research was the main factor in her decision, and that she would definitely want to leave Davos after finishing her PhD.

The final PhD student we talked with was a male originally from Russia who learned of his position through an ad in the scientific newspaper *Eos*. He stated that the factors for him (in order of importance) were the quality/topic of the job, the quality of the research team, and salary. His main concern was finding a position in a research area he was interested in. Because he researches solar climate and was able to find a position in a large project dealing with this matter, he saw coming to Davos as an additional benefit to the position. Because he came from St. Petersburg, he was eager to get away

from big cities. While he does not do any sports, he enjoys the clean air, nice environment, small setting, and the mountain scenery. Another interesting point with this student was his married status. He explained that his wife was a mountain tourist, and therefore it was not difficult for them to make the move. However, it was hard for her to find a job, as she had a PhD in similar areas as him. In this case, his wife decided to go back and earn another PhD in place of finding a job at this time. If offered a permanent position, the man made it very clear that he would prefer to stay in Davos.

5. Interview with Dr. Veronika Stöckli, 11-12-02

We had a brief meeting with Dr. Stöckli to discuss in greater detail the varieties of peer institutions of SLF. Dr. Stöckli believes that there are two major classifications for the peer institutions we need to research. There are research institutions in avalanche and alpine research, as well as natural hazards in general. One such outlet she suggested we look into is CENAT, a network of institutes researching natural hazards. The other area is private companies involved with research and development, insurance companies, and "Kantonale Gebaudeversicherungen," which are Swiss cantonal offices with different environmental specialists. One suggestion Dr. Stöckli had was for us to look into the education (major background) of people working in the different areas of government, private industry, and natural hazards.

Dr. Stöckli also discussed SLF's funding with us: approximately 40% is from the government, and 60% comes from various sources, including the EU, private companies, and areas within Switzerland. She also said that not belonging to the European Union does not affect SLF's collaborations, except that Swiss institutes were not allowed to be leaders of a project. Switzerland now also has bilateral contracts with the EU, however, which allows Switzerland to handle this role.

According to Dr. Stöckli, in the past four to five years, SLF has lost engineers mainly to private companies, presumably because there is more money in private industry. Private companines will earn more, but there is more risk involved. Research jobs, while rewarding and "safe" are not as well paid. This is the balance that is seen between private industry and research postitions, according to Dr. Stöckli.

6. Interview with Birgit Ottmer, 11-13-02

In a brief interview with Birgit, we discussed our progress and the role she plays in public relations for SLF. According to Birgit, the extent of her responsibilities for public relations is dependent on the time of year. In the winter, SLF will receive many more calls from the media, either with specific questions or with requests for project collaboration. There are also guided tours every Friday at 11AM that are open to the public, and others are set up on specific days for other groups; there are usually about 3 tours a week. Her other responsibilities include putting the media in contact with specific researchers, maintaining the SLF webpage, reviewing media articles before they are submitted, and organizing programs for visiting groups.

In terms of the frequency SLF is seen in the news, it is the most in the winter, at about two times per week. Media forms include Swiss TV, radio, avalanche forecasts on radio and in some newspapers, and weather forecasts. When SLF is in the news within Switzerland, it is often mentioned within the avalanche warnings. However, in terms of international media, SLF is more often mentioned for their research. Currently, Birgit

has been arranging interviews with the BBC radio, and a German TV station to discuss some of SLF's research projects.

Birgit also gave us information on SLF's conference involvement and involvement with the other Davos research institutes. Three of the main organizations SLF is involved with include the International Snow and Safety Workshop (ISSW) in Canada, the International Glaciological Society (IGS), and the European Geophysical Society (EGS). SLF serves as one of the hosts for the IGS, and will also be hosting a Permafrost Conference in 2003 and a Snow Engineering Conference in 2004. Despite SLF's conference involvement and hosting, there are still no established ties with the other Davos research institutes. Birgit believes that the directors might meet occasionally to discuss strategies for attracting more researchers, but she believes the only collaboration there has been was when Davos hosted the Swiss Academy of Natural Sciences.

When asked about SLF's involvement at different educational levels, we learned that SLF has no contact with any high schools; the only contact at the collegiate level involves some teaching that is done at ETH, University of Zurich, and Innsbruck. On a graduate level, SLF unfortunately does not have enough money to offer scholarships to grad students. At the level of PhD students, Birgit says that they want their PhD students to work elsewhere in the world after finishing their degree so that they will come back later more experienced and attracted by SLF's reputation; therefore, she believes that the focus should not be on retaining PhD's right away, but on retaining them in the long-term scope.

Appendix M: SLF Peer Audit Summary

Swiss Federal Research Institute WSL

1. Research Department Natural Hazards
    A. Swiss Federal Inst for Snow and Avalanche Research SLF in Davos
        i. Research Divisions
            a. Alpine Environment
            b. Avalanche Warning and Risk Management
            c. Snow and Avalanches
        ii. Logistic Support Division
            a. Administration
            b. VL : Experimental Facilities/Logistics SLF
            c. IENU : Informatics/Electronics/Net Maintenance
    B. Water, Soil and Rock Movements Research Division in Birmensdorf

12.1995 WSL Peer Review: outlined strengths and weaknesses of WSL

Research Review Panel

Prof. Dr. Brown, Civil Engineering Department, Montana State University Bozeman

Prof. Dr. F. Descoeudres, Institute for Rock Mechanics, ETH Lausanne

Prof. Dr. Wilfried Häberli, Institute of Geography, University of Zürich

Prof. Dr. Inyang, Global Inst. for Energy and Environmental Systems (GIEES), UNC

Dr. Oddvar Kjekstad, Norwegian Geotechnical Institute, NGI

Dr. B. Sotirin, US Army CRREL Cold Regions Research and Engineering Laboratory

Prof. Dr. Weck-Hannemann, Institute of Public Economics, University of Innsbruck

Responsibilities of Natural Hazards

Daily avalanche warning service all over the Swiss Alps

Top-level research

Daily consulting services

Reviewed papers

Daily avalanche bulletins

Main Aim

In-depth process understanding and hazard assessment

Procedures for risk assessment

Methods and tools for an integral risk management

Provide solutions to protect people and their material assets

Contribute towards making it possible to live and work in mountainous regions

Davos is the highest city of Europe

Located in the heart of the Alps

Provides an excellent environment for Alpine research

3 other institutes (total 150 employees)
Research Department
125 employees (average age 30 years) (25% female)
scientific staff (avg. Age 39) (45%) (13F, 42M)
PhD students (avg. Age 30) (20%) (8F, 17M)
Technical and administrative staff (avg. Age 43, 31) (20%) (4F, 18M; 2F, 1M)
Diploma students/student interns (3-4 mon.) (avg. 24) (15%) (7F, 4M; 2F, 4M)
Funding Sources
53 PY WSL-budget (total 2001 SFr 6,678,407)
51 PY 3rd party money (total 2001 SFr 3,600,000)
average PY SFr 107,000
Employment Policy
Start with contract for 2 years
May then be prolonged another 3 years
Then normally get a working contract of unlimited duration
External Cooperation of Research Department
Visiting scientists to broaden scientific contacts
Offers sabbaticals to senior scientists
Encourages PhD students to leave for at least one year for Post-Doc studies abroad
Published Articles (94 total, 2001)
39 Papers in Reviewed Journals
31 Papers in Non-Reviewed Journals
24 Conference Proceedings
Public Awareness
Media (TV, radio, print-media)
Exhibitions (Swiss Alpina Martigny)
Public events (Science et Cité in Zürich Hbf)
Freestyle contests (Zürich)
Open House at SLF every Friday 11-12 :30
Public Lectures
Leaflets
Project Activity in 2001
Fundamental Research 180 Person Months
Applied Research 595 PM
Development 110 PM
Consulting 35 PM
Teaching 35 PM
Extension 65 PM
Visiting Scientists Home Universities
FH Ravensburg
Forestry Preservation Division, Shizuoka, Japan
Forestry Research Institute, Hokkaido, Japan
Gifu University (Japan)

Kyushu University, Japan
Landconservation Division, Kobe, Japan
Montana State University
Moscow University
SASE Indian Snow and Avalanche Research Center
Technical Highschool, Rapperswil (Switzerland)
Università degli Studi di Torino (Italy)
Universität Innsbruck (Austria)
Universität Wien (Austria)
University of Basel

Sabbaticals at Foreign Universities

Department of Geography and Environmental Sciences, Carleton U., Ottawa, Canada
Department of Geography, University of Colorado, Boulder
Institute of Arctic and Alpine Research
Kyushu University, Faculty of Agriculture
Montana State University, Bozeman Montana USA
University of British Columbia, Vancouver Canada
USGS / Cascades Volcano Observatory, Washington USA

Conferences and Workshops planned for SLF

2001: 4 2002: 2 2003: 6 2004: 3 2005: 2

Media Reports 2001 (131 total)

Print: 97
- In Switzerland: 93
- In foreign countries: 4

Radio: 6
- In Switzerland: 4
- In foreign countries: 2

TV: 18
- In Switzerland: 13
- In foreign countries: 5

Doctoral Program

Includes Diploma Students and Student Interns

26 Doctoral students
- 21 PhD students at SLF in Davos
- 5 PhD students in Water, Soil, and Rock Movements in Birmensdorf

Disciplines

Biology, Mechanical Engineering, Civil Engineering, Environmental Sciences, Environmental Engineering, Forestry, Forest Engineering, Geography, Geology, Geophysics, Hydrology, Meteorology, Microbiology, and Physics

Advisors

ETHZ, Universities of Zuerich, Berne, and Basel, University of Innsbruck, University of Freiburg, University of Mendoza, and the Tokyo Inst. of Tech.

SLF-curriculum for doctoral students (Doktoranden-Kolleg)

To avoid a potential competitive disadvantage for students at SLF because the nearest university is 3 hours away by train

In-house program gives students the opportunity to receive additional graduate education and credit

Salary

1st year CHF 36,800

2nd year CHF 38,550

3rd year CHF 40,300

Printing Costs for Thesis Publication

SLF pays for 80% of the costs

Universities of current SLF researchers

1. ETHZ
2. Institute for Atmospheric Sciences, ETHZ
3. Institute for Structural Engineering, ETHZ (structural impact dynamics, earthquake engineering)
4. Institute of Arctic and Alpine Research, Colorado
5. Institute of Terrestrial Ecology, ETHZ
6. Laboratory of Hydraulics and Hydrology / Glaciology, ETHZ
7. Massachusetts Institute of Technology (MIT)
8. Swiss Federal Institute of Technology Lausanne (EPFL)
9. University of Basel
10. University of Bayreuth
11. University of Berne
12. University of California
13. University of Colorado, Department of Geography
14. University of Geneva, Switzerland
15. University of Fribourg
16. University of Innsbruck
17. University of Lausanne, Department of Geography
18. University of Maryland
19. University of Munich, Institute of Geography
20. University of Vienna, Austria
21. University of Zürich, Department of Geography

Diplomas of current SLF researchers

Atmospheric Physics

Atmospheric Sciences

Bauing.

Biology

Chemistry

Civil Engineering

Computer Science

Electronic Engineer

Electrotechnics

Environmental Engineering

Environmental Natural Sciences

Environmental Sciences

Forest Engineering
Geography
Geology
Geooekologie
Geophysics
German
Glaciology
History
Law
Material Science
Mathematics
Media Science and Communications
Meteorology
Philosophy
Physical Geography
Physics
Soil Physics
Statistics
Veterinary Medicine

Former Employers of current SLF researchers

1. ABB, Daettwil, Switzerland, research center
2. ABB Sweden
3. Alden Electronics, Vienna and Colorado
4. Asplan Viak A/S, Arendal, Norway, GIS consultant
5. Australian Junior Skiteam, coach
6. BBC AG, Baden, software development of microprocessor based systems
7. BEP Uldry SA, Sion, design engineer
8. Consulting Engineers, J.L. Merz, Lausanne
9. Credit Risk Management UBS, Basel
10. CRREL, USA
11. Delphi Solutions AG, Spreitenbach, presales and postsales of Scopus Products
12. Ecole Complèmentaire Suisse de Montrèal
13. Elektrowatt Engineering S.A., Zürich, design engineer
14. Field Station Pinkham Notch, New Hampshire, excursion guide
15. Geo Data Weibel, Horgen, Switzerland, forestry GIS applications
16. Geotechnical Company, Zürich
17. Geotest AG, Zollikofen, consultant in the field of natural hazards and risks
18. GSS Consulting Engineers, Zürich (nuclear waste disposal, storage concepts)
19. Hilti AG, Schaan, Liechtenstein
20. H.U. Scherrer, Nesslau, SG, engineering office
21. ILU-ALPIN, Samedan, private institute for GIS and ecological studies
22. Markasub, Basel, Measurement Technology
23. MetAir AG, Illnau, Switzerland, calculation and interpretation of pollutant budgets
24. Ministry of Environment, Graubuenden
25. New Zealand Skiteam, national coach

26. Phys. Meteorological Observatory/World Radiation Center PMOD/WRC, Davos
27. Profidata AG, Neuenhof, software development of database systems
28. R&D-Department Construction Technology, Hilti Ltd, Schaan/FL
29. Red Cross
30. Regio Basiliensis, Basel, Department for Co-ordination of Regiona Affairs
31. SKS Consulting Engineers, Zürich (bridge design, hazard and risk management)
32. Softing GmbH, Muenchen, developing software tools
33. Swiss Federal Forest Agency
34. Swiss Institute of Asthma and Allergy Research, Davos
35. Swiss Junior Skiteam, coach
36. Swiss National Museum Zürich
37. Swiss National Park, Zernez
38. Swiss Ornithological Station, Sempach, scientific collaborator
39. Syscom AG, Zürich (earthquake strong motion equipment production company)
40. TOKO AG, Altstätten, Cross Country Racing Team (ski wax testing)
41. United States Geological Survey, Reston, VA
42. Visiomation AG, Schaanwald FL, image processing aided material handling sys.
43. WELS Research Corporation, USA
44. ZAMG, Central Institute of Meteorology and Geodynamics, Vienna
45. Zuehlke Engineering, AG, Schlieren, software development

Professional Societies of Current SLF Employees

1. ACM (Association for Computing Machinery)
2. American Association of Avalanche Professionals
3. American Geophysical Union
4. American Physical Society
5. Association Nationale pour l'Etude de la Neige et des Avalanches
6. Austrian Meteorological Society
7. DPG (Deutsche Physikalische Gesellschaft)
8. EMS (European Meteorological Society)
9. FachFrauen Umwelt
10. FAN Forstliche Arbeitsgruppe Naturgefahren
11. Federal Expert Commission for Avalanche Defense Structures
12. FERN (Swiss Remote Sensing Group)
13. Forest Working Group for Natural Hazards
14. GHO (Swiss Group for Operational Hydrology)
15. Glaciological Commission of the Swiss Academy of Natural Sciences
16. ICAR (International Commission for Alpine Rescue
17. ICAS (Interacademic Commission for Alpine Studies)
18. ICSI (International Commission of Snow and Ice)
19. IGS Council (International Glaciological Society)
20. International Association of Hydrological Sciences
21. International Glaciological Society

22. International Permafrost Association
23. IUFRO Task Force Mountain Forests
24. Mountain Forum
25. Mountain Guides Association
26. MRS Materials Research Society of America
27. PLANAT Swiss Natural Hazards Plattform
28. SAS Swiss Academic Sciences
29. SBS (Swiss Cableways)
30. SBV (Schweiz. Bergfuehrerverbandes)
31. Seismological Society of U.S.A.
32. SGEB Swiss Society for Earthquake Engineering and Structural Dynamics
33. SGmG: Swiss Geomorphology Association
34. SI (Schweizer Informatik Gesellschaft)
35. SIA (Swiss Engineers and Architects Association)
36. SILS Swiss Association Avalanche Warning Systems
37. S-QUAT: Swiss Quaternary Group
38. SSEA Swiss Scandanavian Engineering Association
39. SSS (Swiss Statistical Society)
40. Swiss Academy of Natural Sciences: Meteorological and Hydrological Society
41. Swiss Forest Society, Foresters Society of the Grisons
42. Swiss Geomorphology Society
43. Swiss Permafrost Co-ordinating Group
44. Swiss Physical Society
45. Swiss Snowsport Experts Association
46. Swiss Society for Soil and Rock Mechanics

<u>Research Division Alpine Environment</u>

Alpine Environment, established in April 2001

- Vulnerability of ecosystems and disturbance ecology
  - VC Natural Hazards
  - Mechanical stability of trees
  - Succession on windthrow areas
  - Biodiversity in avalanche tracks
  - Varves, ice cores, and tree rings; archives with annual resolution
- Snow ecology
  - Influence of snow on mobility and behavior of alpine ibex
  - Regeneration of Norway spruce in snow-rich environments
  - Effect of artificial snow and snow additives on vegetation and soil
- Permafrost
  - Interaction between snow cover and permafrost
  - Low-altitude frozen ground and forest dynamics
  - Snow-supporting structures in alpine permafrost terrain
- Natural resources management
  - Effects of grazing on forest dynamics
  - Management of the long term research area ‘Stillberg’ near Davos

Inter-annual climatic cycle in the Dischma Valley near Davos

Mission Statement
- Improve knowledge on the alpine environment
- Offer a base for a sustainable use of its natural resources

Teaching
- University of Torino (Italy), Universities of Zuerich, Bern, and Basel, ETH Zuerich, ETH Lausanne, University of Fribourg

Services
- UN International Year of Mountains (IYM 2002)
- International Conference on Permafrost in Zuerich 2003

Networking
- University of Zuerich, ETH Zuerich and Lausanne, University of St. Gallen, University of Freiburg, University of Torino, CRYCIT Mendoza, University of Colorado, Institute of Arctic and Alpine Research CO, Carleton University, WPI

Infrastructure
- 4 major test sites: Stillberg, Lusiwald, Schafberg, Mont Dollin

Long term goals
- Improve the basic understanding of protection effect by forest and vegetation
- Improve the basic understanding in snow ecology
- Improve knowledge of the complex system of frozen ground
- Improve knowledge in the temporal dynamics of the alpine environments

Funding Sources
- 2 researchers paid by WSL, 9 by 3rd party, 4 PhD students, 2 Diploma students

Projects (see Excel worksheet)

<u>Research Division Avalanche Warning and Risk Management</u>

Avalanche Warning and Risk Management
- Avalanche Warning
  - A dense network of automatic measuring stations
  - Meteorological data and weather forecasts
  - A dense network of human observers with various complementary duties
  - Decision support tools based on statistics and data mining
  - Numerical snow pack and snow drift simulation
- Warning Systems and Decision Support Tools
  - IMIS-measurement stations
  - Data communication between measurement stations, observers, and SLF
  - Development and maintenance of graphical tools
  - Development of a relational snow-and-weather database
  - Development and maintenance of an integrated information system
  - New distribution channels for the avalanche warning products
- Process Models
  - Theoretical understanding of the temporal evolution of the snow pack
  - Estimation of the persistence of weak layers in the snow pack
  - Daily calculation of the amount of new snow at every location
- Risk Management

Vulnerability assessment of damage potential
Hazard assessment for different natural hazards
Risk assessment and counter measures

Mission Statement
Secure and continuously improve the quality of the avalanche warning
Further develop physical process models
Improves decision support tools
Contributes to keep WSL as the leading institution for natural hazards

Researchers 15; PhD students 6; Diploma work 2; Guest scientists 2

Networking
Academic networks via PhD students
Team Process Models in the EU project MARIS (snow drift) with 10 partners
European standardization efforts in avalanche prevision (definitions, verification)
Weekly phone conference with SLF, Austria (Innsbrueck), and Italy (Bolzano)
Phone conferences and annual meetings with the forecast experts of MeteoCH

Goals for the next three years
Continuous improvement of the quality and presentation of products and support
Apply information technology for the improvement of measures against hazards
Further development and validation of snow pack models
Non-avalanche related applications of snow cover modeling
Continuous effort on decision support tools
Securing Integral Risk Management as a central WSL-competence

11 Researchers paid by WSL, 9 paid by 3rd party, 5 PhD students, 2 Diploma students

<u>Research Division Snow and Avalanche</u>

Snow and Avalanche
Snow Physics and Mechanics
Experimental research group that develops and applies devices
Recent and Significant Contributions
High resolution micro-penetrometer
Study the structure and variability of the snowpack
3-Dimensional reconstruction of snow samples
Computer controlled microtome
microCT-scanner for 3D-measurement of snow samples
Avalanche Dynamics and Numerical Simulation
Develop new experimental methods to capture avalanche flow velocities
Cornerstones
1-to-1 avalanche field test site Vallee de la Sionne
Numerical simulation programs AVAL-1D/2D
Avalanche Defense Measures
Formulate cost-efficient defense concepts
Know-how transfer
Expertise, publications, seminars, and workshops
Work with South America, Iceland, Austria, and Italy
Snow Sports
Created to technically support the Swiss ski industry

Ski company Stoeckli
Wax company TOKO
Ski surface coating company IMS

Mission Statement

Carry out research in snow physics and mechanics, avalanche dynamics, and avalanche defense measures
Laboratory experimentation, field tests, natural observations
Numerical modeling, statistical analysis, geographic information systems, basic applied physics

Professions

Geotechnical Engineer, Structural Engineer, Environmental Engineer, Physicist, Geophysicist, Geographer, Earth Scientist, Forest Engineer, Mountain Guide, Technician

Networked with every major snow and research center worldwide

Austria, Canada, Chili, France, Germany, Iceland, India, Italy, Norway, Russia, Spain, and the United States
Contacts with research groups in Kyrgyzstan and Kazakhstan
Defense Measures team consults with Chili and Turkey
Close ties with every major Swiss university

ETH Zuerich, ETH Lausanne, Universities of Zuerich, Berne, and Basel

7 Researchers paid by WSL, 7 paid by 3rd party, 3 unpaid, 11 PhD stud., 4 diploma stud.