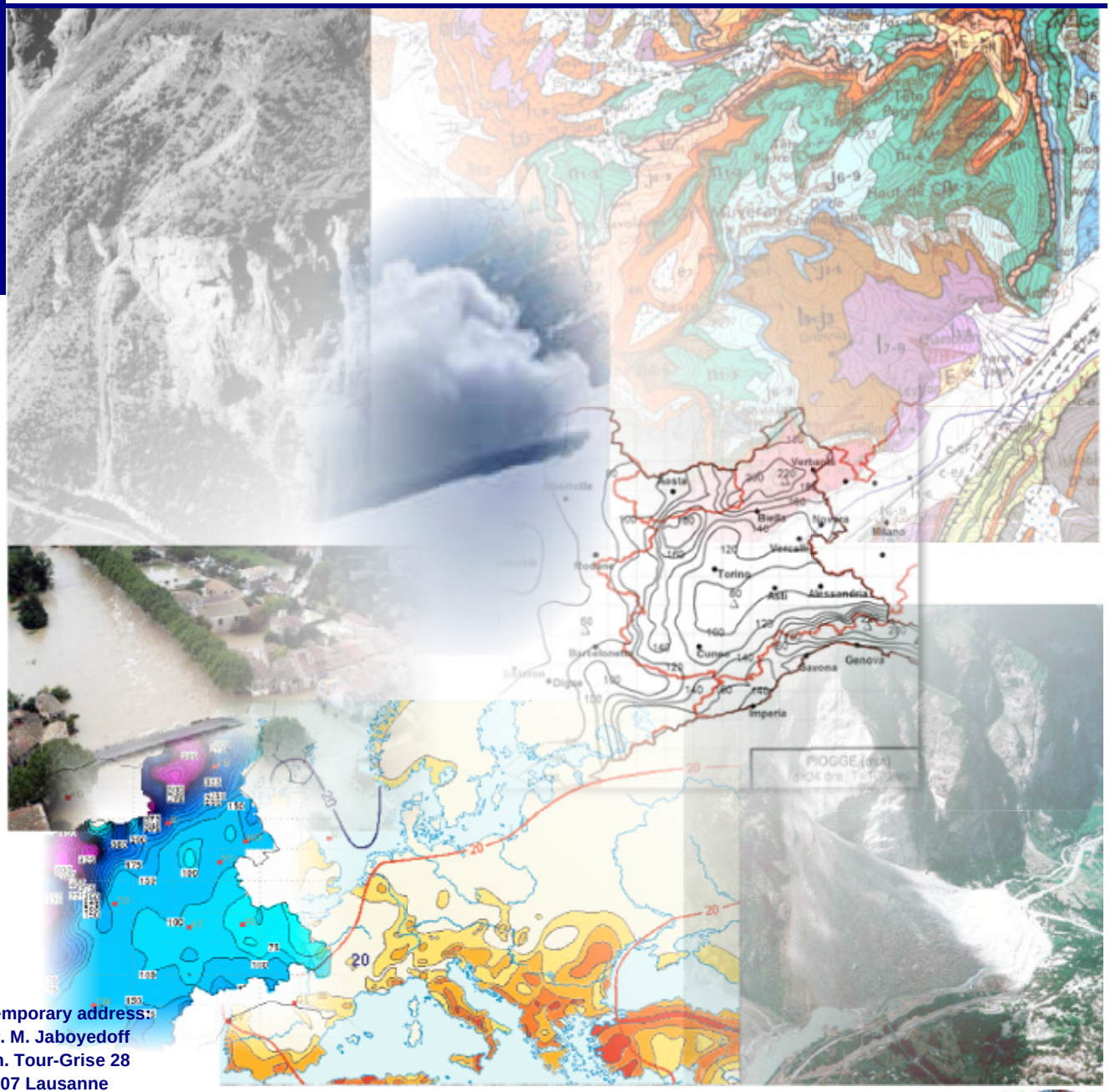
Quanterra

INTERNATIONAL INDEPENDENT CENTER OF CLIMATE CHANGE IMPACT ON NATURAL RISK ANALYSIS IN MOUNTAINOUS AREAS

Project



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INTERNATIONAL INDEPENDENT CENTER OF CLIMATE CHANGE IMPACT ON NATURAL RISK ANALYSIS IN MOUNTAINOUS AREAS

Management summary

Le centre **QUANTERRA** projette de devenir dans les quatre ans un centre d'excellence international de modélisation de l'effet des changements climatiques sur les processus d'érosion globaux en milieu montagneux. Les directions de recherches nouvelles qui seront prises assureront cet objectif. L'un des points clés des objectifs de **QUANTERRA** est l'estimation des risques naturels; les modèles développés auront des applications pour l'aménagement du territoire.

QUANTERRA se base sur une approche interdisciplinaire volontaire, soutenue par une interaction forte entre le monde académique pur et l'aménagement du territoire. Des applications seront développées en collaboration avec le monde privé.

Nous attendons des échanges avec les chercheurs invités d'autres pays une interaction stimulante et des contributions aux recherches, 450'000.- CHF par an sont prévus au budget à cet effet. Cette démarche comprend une coopération avec les pays en voie de développement.

Le budget de **QUANTERRA** s'élèvera à environ 4'000'000.- CHF par an qui devraient se partager entre différents services de la Confédération Suisse et d'autres pays, des universités et hautes écoles et l'économie privée.

Le démarrage de **QUANTERRA** est planifié pour la fin 2003, une équipe complète sera formée le plus rapidement possible, de façon à préserver une authentique interdisciplinarité.

Within four years QUANTERRA Center will be an international excellence center of modeling effects of climate change on global erosion processes in mountainous regions, mostly because really innovative topics of research are taken into account. Putting into practice natural risk assessment is also a key point of **QUANTERRA** ; the developed model will be implemented for landplanning.

QUANTERRA is based on a determined interdisciplinary approach supported by an active interaction between the purely academic world and the various trades linked to landplanning management. Implementation will be designed in collaboration with the economic world.

Exchanges with invited researchers from other countries are planned and stimulating interactions with them are expected as well as significant contributions to the present project, taking into account that 450'000.- CHF/year are dedicated for that purpose in the budget. This approach also implies cooperation with developing countries.

A budget of around 4'000'000.- CHF/year is expected to be shared between Swiss federal services and other countries, universities or high technical schools and private companies.

QUANTERRA is planned to start at the end of 2003, a complete team will be constituted as soon as possible, in order to preserve a true interdisciplinary approach, and to avoid developing a dominant subject.

Cover pictures modified from: Thonons-les-Bains, BRGM, Eclogae Geologicae Helvetiae, CEMAGREF, www.crealp.ch, Interreg II France-Italie, Sudouest., Natural disasters, Springer.

Abstract

Switzerland is a wealthy and densely populated country with large mountainous areas. Within a perspective of international cooperation, Switzerland should be a leader in evaluating natural hazards and risk assessment. Recent events have demonstrated how important it is to properly manage risks in mountainous areas, because their costs increase in direct proportion to urbanization.

Because of its many mountainous areas, the Swiss landscape is ideally suited for developing knowledge in natural hazards and risks assessment. Hazards and risk assessment mapping is a necessity. Yet no approach has been taken that integrates the multitude of slope processes. The uncertainty about climate change is the basis of this project and that is why an integrated approach of natural hazards is proposed.

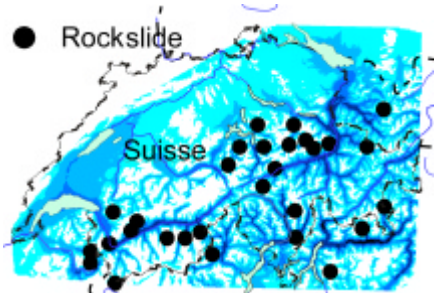
The present document describes the creation of a competence center based on new principles of hazard and risk management. The organization of this center is innovative in its new management, which will consider natural hazards and associated risks linked to erosional processes (landslides, rock-falls, debris flows, bank erosion, floods, etc.). The center will publish peer-reviewed scientific papers in international journals of high impact, and also supply support for the economic world through the introduction of new methods in order to stimulate private companies.

The main goals of the center are to:

1. Create a global geomorphologic model of slope changes and watersheds (erosion s.l.), which permits the evaluation of various scenarios depending on various hypotheses of climate change.
2. Develop exchanges with other countries, for instance by creating invited researchers positions within the center.
3. Gather an interdisciplinary team, in order to study efficiently the numerous aspects of global erosion.
4. Take into account time in order to estimate risks, which are deduced from hazards, based on the above model.
5. Obtain support from both international and private sources. The latter will also provide leadership in areas that are not in the direct field of expertise of the center.

In addition, the center will make projections about long term topographic relief based upon current measurements. Starting from the present state of a relief and to anticipate its changes in the future. The impact of phenomena affecting topographic relief will be assessed and hazards will be estimated.

1. Introduction



Glacier-ice thickness at Würm period. Present sediment not subtracted. (after Eisbacher et Clague, 1984; Jäckli, 1962)

Natural disasters in recent years have underscored that assessment, prediction and, prevention of natural hazards have to be taken into account in landplaning. With its growing population and infrastructures at risk and because of its mountainous landscape, Switzerland is facing increasingly complex land planning issues. It is Switzerland's obligation to be a leader in natural risk analysis in mountainous areas. Switzerland has the potential and the knowledge to lead such researches, even though they are spread out in different organizations.

The federalist structure of Switzerland with its bits and pieces does not promote the creation of a Swiss University level College in natural risk analysis in mountainous areas. Competence does exist, but because of the competition and the lack of communication between universities, departments, Cantons and sectors, skills develop without any precise goal or coordination.

Debris flow of Fully (Vs., Switzerland, 2000)

The W.S.L (Federal Research Institute on Forest, Snow and Landscape) is not concerned by the above remarks. This organization basically works on snow avalanches and has attempted to establish itself in other hazards, though through an operational approach rather than fundamental research (see WSL web site www.wsl.ch to be convinced of the above affirmation).

Planat (Natural Hazard Competence Center) and Cenat (National Platform Natural Hazards) are support organizations which coordinate existing competences but which do not pro-

mote the emergence of innovative research because scientists are mostly experts in fields not directly concerned with natural hazards. Synergies surely do exist, but the merging of several existing competences rarely generates new research topics.

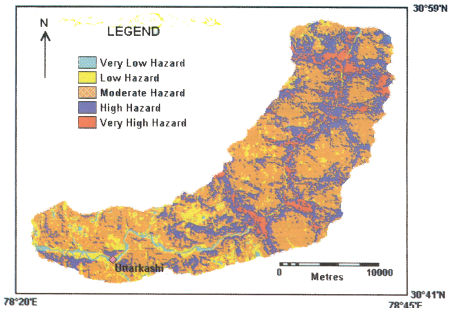
NRP 31 (a Swiss national research project: climate change and natural disasters) did give results in every field of research concerned, but it did not achieve a global approach to natural hazard and risk assessment in mountainous areas. This lack of a global approach is emphasized by the fact that there are not enough professors in Swiss universities whose major research topics are either natural hazards or risk assessments.

Val de Bagnes (Valais, Switzerland, 2000)

The above picture is not restricted to Switzerland, however in many other countries natural hazards and risk assessment are research topics in themselves.

It is important to create a center in Switzerland promoting interdisciplinary and innovative research where geographers, engineers, geologists, forestry engineers, etc. can find a common ground, in order to explore new areas of research. Global climatic changes oblige us to expand relations with other mountainous countries, especially with neighboring countries, because natural phenomena, such as floods, know no borders. Switzerland is well positioned to offer its expertise concerning natural hazards which are within its range of experience. On the other hand, Switzerland can benefit from the experience and inventiveness of other countries[1] like Algeria, countries in Africa located in mountainous areas, Austria, Bhutan, Canada, Spain, USA, France, Germany, India, Italy, Japan, Morocco, Nepal, Russia, Scandinavian countries, republics from the ex-USSR (from Caucasus to Mongolia), Czech, etc...

[1] The case of south-America is more problematic because the hazards linked to volcanism are frequent, and this is not the main topic of the center.



Landslide Hazard Index (From Gupta et al., 1999)

Among all those countries the center will develop close relationships with neighboring countries (Austria, France, Germany, Italy) and with Canada, which especially favors research and education.

For its part Switzerland can contribute tremendously to research in the field of risk assessment, thanks to its high quality documents covering its territory, to its researchers, professionalism and to its propensity for consensus required for efficient risk management. It is Switzerland's duty to create such an excellence center and to take a role as a leader, because Switzerland is wealthy and is traditionally an aid oriented country. An international scientific council will assess the options of research chosen by the center.

Research

The purposes of such an international center are multidisciplinary, emphasizing research, scientific exchanges and education related to natural hazards and risks in mountainous areas in relation with relief changes. Scientific exchanges and interdisciplinarity are its original features. Its approach will be based on a new understanding of how to manage natural hazards and risks.

Comparison of ancient rockslides with precipitations - seismic hazard (after Eisbacher et Clague, 1984)

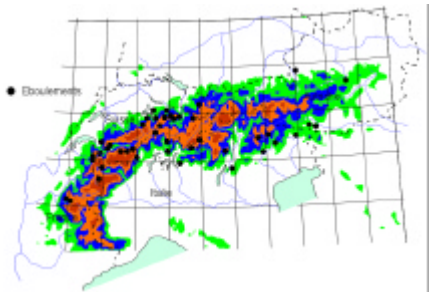
So far hazard surveys have been made by each discipline separately. They are based on the state of the system as it is perceived at the time of the survey, and on local modeling. Global models are missing and thus surveys are usually performed where disasters have already occurred. Surveys are seldom predictive. Mountainous areas should be studied as systems which are changing

Rockslides isopleths (after Eisbacher et Clague, 1984; topo. NOAA)

with the passing of time under the effect of climate (precipitations, temperature, sun, etc.) and under the effects of all erosion phenomena. Our goal is to develop a comprehensive model of all erosion phenomena and water flows which affect slopes and watersheds (such as landslides, river erosion, floods, permafrost, rock falls, earthquakes, mudslides, snow avalanches, etc.).

Susceptibility to various erosive factors and to floods will be estimated. What are the benefits of such an approach and in what way is it different from a more conventional one? Modeling makes it possible to rapidly update models, taking into account uncertainty linked to climate changes and water as a major factor governing relief changes. Furthermore several scenarios can be developed, and starting from present topographic relief the models can predict its future changes.

Modeling provides an estimation of catastrophic phenomena frequency, which leads top risk assessment through scenarios. Estimating frequency of events still remains a partially unsolved issue. Both economic and sociologic impacts will be examined.



Topographic level - Rockslides (after Eisbacher et Clague, 1984; topo. NOAA)

Seismic hazards are also an important factor in relief changes: they are taken into account as well.

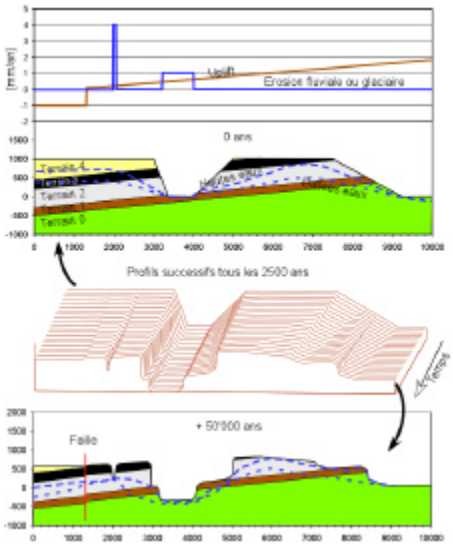
The study of snow avalanches (WSL) is not directly related to the present project, but it is indirectly, because the way the slope changes affect the vegetation cover and thus affects their protection against avalanches.

Modeling is based both on the analysis of the intrinsic features of hazards (permeability, rock types, morphologies, riverbank

profiles, etc.) and on the impact of external factors such as precipitation, earthquakes, aquifer systems, etc.

Differences with other approaches

Methods of studying natural hazards require the studies to be completely redone when conditions change. The simultaneous consideration of all phenomena affecting slopes and watersheds makes it possible to obtain multi-hazard and multi-risk analysis, which is not so obvious using other approaches. The proposed scientific approach uses a global modeling of phenomena. In order to create models, it will be necessary to work in an interdisciplinary way. Such an approach as proposed here has only been possible since accurate digital documents were available and could be managed with geographic information systems (GIS).



Simple 2D slope erosion model.

The purpose of the center can be worded as follows: *studying natural hazards taking into account external factors such as climate, by means of creating models involving erosion and surface and underground water circulation in all types of mountain slopes. Such an analysis is based on external factors such as climate.*

This approach follows the principle of climate change adaptation. For that purpose the numerous groups of climate change studies will furnish the climatic models used as input for erosion models.

Our center is partially based upon the same principle as the "Institut des hautes études scientifiques de Bures-sur-Yvette (France) and the Institute for Advanced Study in Princeton,

such that both private and public funds will be required for fundamental research.

Scientific Strategy

A global approach will be emphasized in the creation of the center and it is at the junction between several disciplines the engineering and academic emphasizes, which typically have little communication:.

A look at the bibliographies of articles from both engineering and academics is enough to illustrate that: the titles in the bibliographies have practically no overlap.

Applied publications on civil engineering, and rural engineering and in applied geology have virtually no impact. Probably for the following reasons:

- Too many publications are technical reports.
- These are no reviews of these articles
- There are many articles about the same type of subjects that have no real innovations.

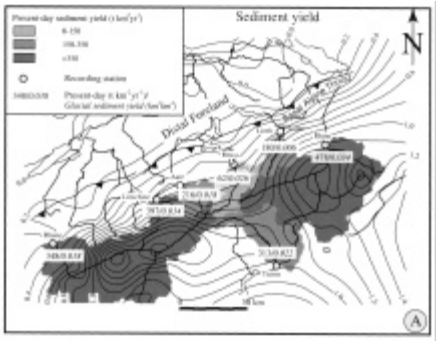
All the above reasons lower the publication impacts. This is also true regarding high standard journals, because their references contain mostly non-reviewed papers.

On the contrary, thanks to a theoretical approach preceding its implementation, it is possible to publish articles in leading international journals in the Earth Sciences.

Basic knowledge in Earth Sciences must first be developed and only then be used for basic goals and be put into practice in natural hazard management.

The center policy belongs to high-level scientific logic aiming at a strong impact on implementations: articles on erosive models must be published in the best research journals.

Lectures and communication



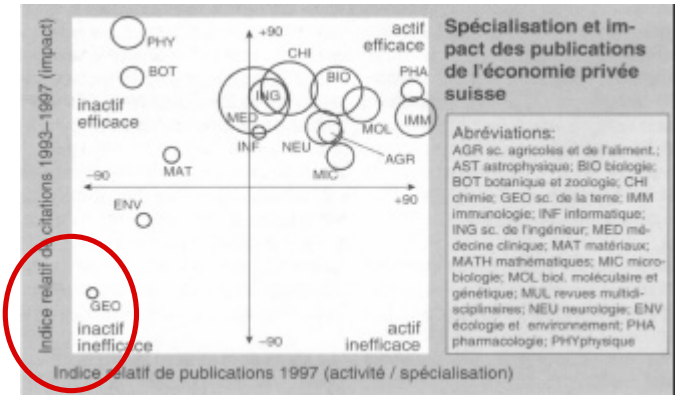
Relationship between sediment transport — watershed and uplifts velocities (from Schlunegger et Hinderer, 2001)

Few people are specialists in natural hazard management in regard to increasing risks inherent to urbanization and climate change, consequently lectures will account for a major part of the center activity. It will be provided by home as well as invited guest researchers. Lectures will either be held in partnership with universities and/or as an independent organization, and also considering for the needs of cooperation with developing countries. A council of researchers and professors could help give a general orientation to the lectures provided.

Lecture handouts and a newsletter will be edited. Free access to international level information is the basic principle. Specialized books will be produced, shareware software will be designed and will be distributed. Information will basically circulate through the Internet. The Internet will have a major role to play in international exchanges, this medium is often over looked in continental Europe.

There is no hazard management without communication. A small communication team will be responsible for the mailing and the distribution of pamphlets for the general public; it will also keep the media informed. Eventually information about

Illustration of the bad impact of impact the private company working in geology and environment in Switzerland (Vision, 1999, n° 3).



natural hazards and risks will be spread through short TV films as well.

Information will be diffused to private companies, where courses will be provided as well. Private geology offices and environment offices in Switzerland have a reputation of low-level publications (see fig.). Information and courses may help heighten the scientific quality of their publications.

Relations with the economic world

The center will coordinate and provide support to private companies and make a contribution to the implementation of new methods. It also should provide specialized software such as 3DEC, ARCinfo, PCI, Erdas, ENVI, Oracle, finite elements software etc. The center will stimulate the private sector as far as new methods are concerned and will expert that, and on the other hand it will call on the private sector to undertake the leadership role for tasks that are not a primary focus competence the center. Supporting developing countries is also a goal.

Organizing workshops or congresses

One or two meetings a year will be organized by the center focusing on primary concerns of the center. They will be related to the center goals. Such meetings will inject enthusiasm in the research of the center.

2. Setup

The center will be called:

QUANTERRA

INTERNATIONAL INDEPENDENT CENTER OF CLIMATE CHANGE IMPACT ON NATURAL RISK ANALYSIS IN MOUNTAINOUS AREAS

Personnel

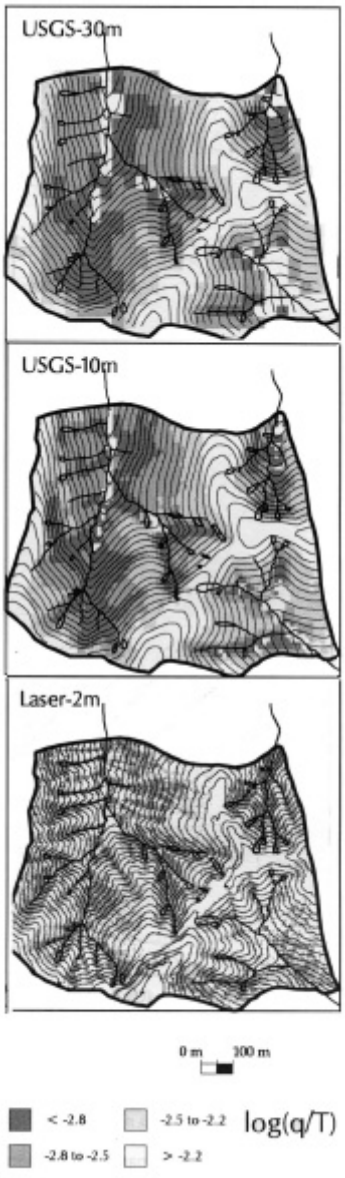
Personnel will consist of:

- A permanent high-level research team with emphasis ranging from physical processes, physical geography, hydrology, applied statistics, climatology to study of vegetation. All of which are necessary for a global understanding of phenomena.

- Guest researcher positions are planned for periods of up to 6 months. Guest researchers will give lectures as well.

- A small administration, management, and a communication team.

- PhD students will be connected to the center, primarily through research projects founded by the Swiss National Science Foundation (SNSF). An SNSF three year project of CHF 2'000'000.- will be requested for as soon as the center is established.



Simulation of parameters controlling slope stability and sensitivity of the model for different DTM meshes. (From Dietrich et al., 2001).

- The research team will include two numerical computer scientists so that scientific programs can be developed and efficiently implemented.

- A multimedia team will be created. Because publications will be rapidly formatted and published and because the Internet site will have to be maintained, a webmaster position and a multimedia specialist will be part of the staff.

- A technical engineer will be needed to implement analog modeling. S/He will be assisted by a laboratory assistant.

- Urban town planning, land planning, sociology, history, economics, ethics, etc. will not be permanently represented, because they have a lower significance regarding the main goals of the center. They will be studied through guest researchers.

Our ambition is eventually to favor exchanges and create a new way of modeling natural dangers and of planning their economic and sociologic impacts.

Term of the center

The center will be initially established for a period of 10 to 15 years. Once the research goals are reached, it will cease its activity unless it is proven useful.

This time limitation will stimulate the research team to be really efficient in order to continue the activities of the center.

It is essential for the center to start as a whole as soon as possible, more precisely after one ground work year. Because inter-

disciplinarity will not resist to a long period of implementation. A limited team will be formed at the end of 2003 and it will be completed during 2004 to 2005.

Management

The center will certainly be a foundation. A foundation council, formed by organizations and companies financing the center, will then supervise it. A management and administration board will include tenured researchers, an administrator, and representatives from organizations and participating countries. Scientific and education meetings will be held periodically in an advisory capacity. A director will be chosen among the professor level researchers and will be assisted by an administrator. The latter duo will be supervised by a management board. The administrator will coordinate research groups in the center and deal with outside relations. S/He will distribute the publications, and play an active role in public relations and in the multimedia team. S/He will be partly responsible for collecting funds. The purpose of having an administrator-director pair as the executive team is to let the director pursue her/his research.

Frank slide (Alberta, Canada)

Field trip fees, travels, equipments and subsidiary budgets.

Most expenses are related to computer science and office equipment. Numerous software licenses will be required especially the ones related to GIS and to satellite image analysis (such expenses can be part of a subsidiary budget).

A travel budget is planned for guest researchers and for tenured researchers for field trips and international meetings.

A budget must be dedicated to a small library.

Budget for field investigations to gather information and validate models is planned.

A budget is dedicated to tasks performed by private companies or other academic partners.

Finances

Items	N	Unit Price	Total
Staff			
Administrator	1	200'000 CHF	200'000 CHF
Researchers - professors	4	180'000 CHF	720'000 CHF
Researchers (post graduates)	6	110'000 CHF	660'000 CHF
Personnel (secretary, etc..)	4	100'000 CHF	400'000 CHF
Guest researcher (level prof., 6 months)	3	90'000 CHF	270'000 CHF
Guest researcher (post graduated, 6 months)	3	55'000 CHF	165'000 CHF
Technical engineers	1	120'000 CHF	120'000 CHF
Laboratory assistant	1	100'000 CHF	100'000 CHF
		Sub-Total	2'635'000 CHF
Subsidiary Budget			
Discretionary	1	180'000 CHF	180'000 CHF
Miscellaneous equipment	1	40'000 CHF	40'000 CHF
Computer equipments and software	1	190'000 CHF	190'000 CHF
Library	1	75'000 CHF	75'000 CHF
Publications	1	180'000 CHF	180'000 CHF
External resources financing	1	500'000 CHF	500'000 CHF
Congress organization	2	35'000 CHF	70'000 CHF
Travel fees (field trips, congresses, travels)	1	240'000 CHF	240'000 CHF
		Sub-Total	1'475'000 CHF
		Total	**4'110'000 CHF**

Estimation of the annual budget of the center.

Financial resources will be provided by public and private organizations, which will sit on the management board. The partners will sign an independence charter. Complementary funds can be requested by specific research projects and expert orders. However the latter will be restricted in order not to compete with private companies.

Financial contributions from Switzerland and other countries as well as private companies and will be requested.

Digital documents will be acquired from the Swiss Topography Center. Depending on agreement those document can be free or purchased requiring CHF 300'000 to CHF 600'000.-

Place

The center can find an adequate location in a university-level school (University of Lausanne), providing that the center can work in an independent way. The PSE at EPFL in Lausanne

(Parc scientifique) is a favorable location which is easily accessible. It is close to established scientific competences.

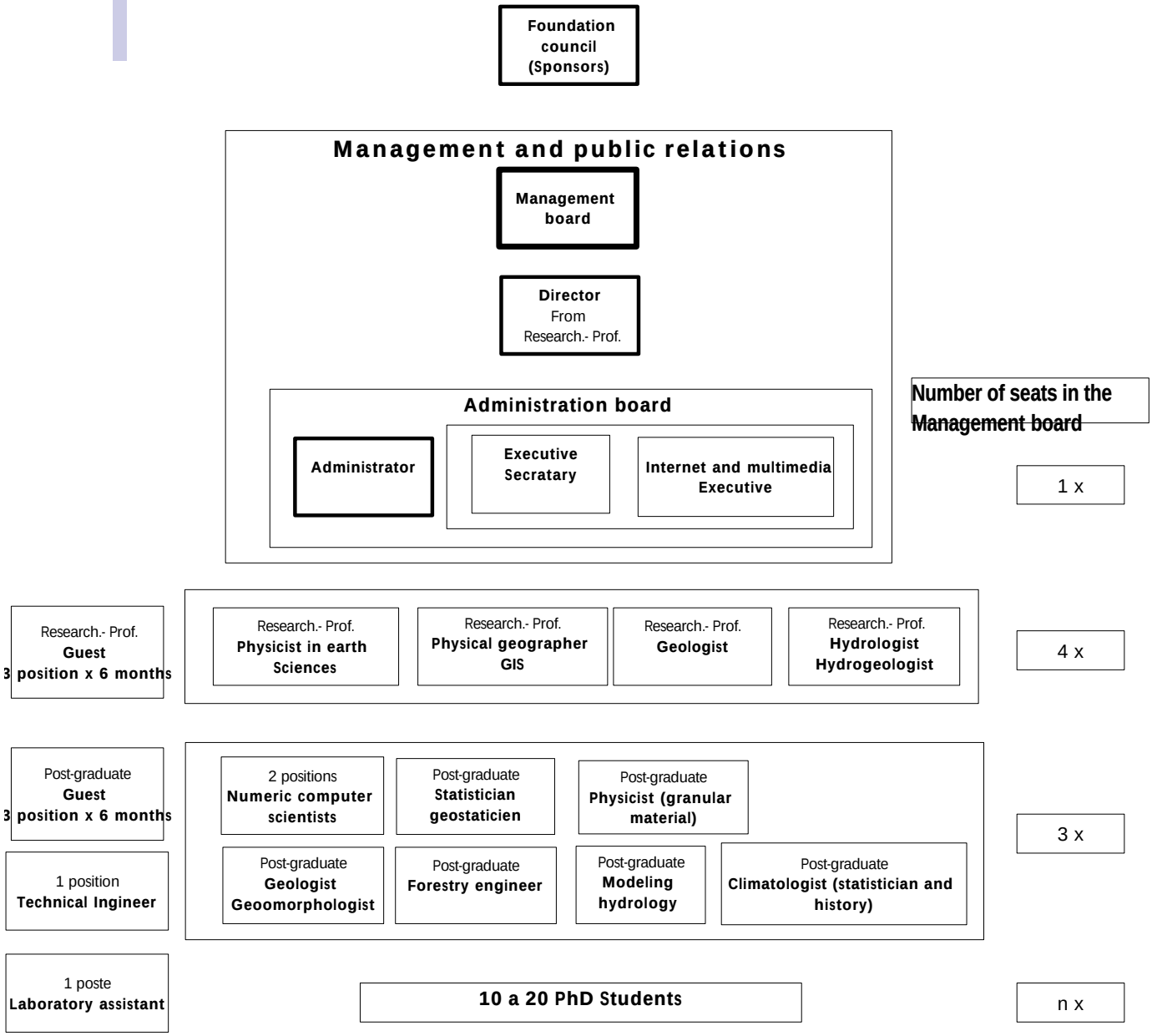
3. Creating the center and achieving its goals

There is no doubt that creating such a center is a matter of great urgency. It will explore new research topics, analyzing the lack of previous researches which have their origin in the climate change and in a non-integrated approach. Furthermore, the conjunction of new digital documents and powerful computers favors the creation of new types of modeling.

Within the next fifteen years, an interdisciplinary team will achieve new slope change models which will take into account global phenomena thanks to all the concerned disciplines. The team must be created rapidly (1 to 3 years). Interaction with the public is intrinsically part of the structure and working of the center itself.

Expansion prospects

Once the center is setup and after a first positive evaluation, a strategy of expansion will be worked out. We plan on opening up other centers in other countries based on the same principle and participating to a networking with the other ones. This could be done in countries like India which have relations with SDC (Swiss Agency for Development and Cooperation), with local universities such as Roorkee, and also with countries like Canada which gives 50 % of the funds if 50 % of the start-up capital are brought.



Structure of the center.