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Swiss National Research Programme 31 (NRP 31): "Climate Changes and Natural Disasters"

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Mots clés: Changements climatiques, catastrophes naturelles, cycle de l'eau, cryosphère, société, aménagement du territoire, Alpes suisses

ABSTRACT

The objective of the NRP 31 is the detailed study of the mechanisms and consequences of future climate changes in the Swiss environment, and the resulting interactions between climate, the water cycle, natural hazards, ecosystems and society.

This programme should help improve our understanding of the response of the environment to abrupt short-term climatic events and to long-term climate changes, and provide answers to economic and political decision making. The emphasis of research will be on processes acting on the regional scale, especially in the Swiss Alps. Consequences of climate changes on the cryosphere and the hydrosphere are exposed, according to the announced evolution of the parameters temperature and precipitation.

NRP 31 is an attempt to bring together specific projects in especially sensitive geographical test-zones, as representative as possible of Swiss conditions.

RESUME

L'objectif du PNR 31 correspond à une analyse détaillée des mécanismes et des conséquences des futurs changements climatiques sur l'environnement en Suisse, ainsi que des interactions consécutives entre le climat, le cycle de l'eau, les dangers naturels, les écosystèmes et la société.

Ce programme doit contribuer à améliorer notre connaissance de la réponse de notre environnement à des événements climatiques brusques à court terme, de même qu'à des changements climatiques à plus long terme, ainsi que de fournir des réponses aux décideurs économiques et politiques. Les recherches sont principalement dirigées vers les processus intervenant à une échelle régionale, en particulier dans les Alpes suisses. Les conséquences des changements climatiques sur la cryosphère et l'hydrosphère sont présentées en accord avec l'évolution annoncée des paramètres température and précipitations.

Le PNR 31 représente une tentative de faire collaborer différents projets spécifiques, dans des zones-tests géographiques particulièrement sensibles aussi représentatives que possibles des conditions suisses.

1. Introduction

Our environment is a dynamic system which operates both in the short term (for example extreme weather events) or in the long term (climate processes). While natural catastrophes are often caused by unpredictable extreme perturbations, causing destructive effects on local or regional scales, climate changes operate on far larger spatial scales and impact upon the natural environment and also, in the long term, on socio-economic systems.

The general public, the media, as well the national and international policy-makers are becoming increasingly concerned by such problems, as exemplified by the United Nations Conference on Environment and Development in Rio de Janeiro in June 1992, as well as the Climate Conferences in Berlin in March 1995 and in Geneva in July 1996. The potential impacts of abrupt climate changes are sufficiently important to justify immediate negotiations, even if many uncertainties remain as to the nature and amplitude of climate changes in decades to come.

In this context, the Swiss Federal Council approved in June 1990, the NRP 31 Programme on *"Climate Change and Natural Disasters"*, which is financed by the Swiss National Science Foundation. This programme represents a Swiss contribution to international research efforts on this theme, and is coordinated for example with the UN International Decade on Natural Disasters Reduction (IDNDR). NRP 31 brings together fundamental research, interdisciplinary studies, and policy response strategies in order to provide a scientific framework for economic and political decision making on the national level (NRP 31 1992).

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2. Swiss National Research Programme 31: Context and Objectives

The principal objective of the NRP 31 is the basic study of climate processes in the alpine region – both in present-day climate and in a changed global climate – and the detailed examination of the consequences of possible future climate changes. This programme should help improve our understanding of the response of the environment to sudden short-term climatic events as well as to long-term climate changes, and then to test how society and politicians react to these events in Switzerland (NFP 31, 1992, 1993; NFP 31, 1992–1997; Müller et al. 1997).

Climate changes represent one of the major environmental preoccupations of this decade. Conclusions of the IPCC – Intergovernmental Panel on Climate Change – predict an alarming increase of the atmospheric temperature on the earth. The ground-level atmospheric temperature has increased globally by 0.3 to 0.6 °C since the middle of the last century, corresponding to the end of the Little Ice Age. If this trend is confirmed, predictions for the future are pessimistic: a rise of 1.8 °C by the years 2030–2050 and between 2 to 5 °C by 2100 with the IPCC scenario A: "*Business as usual*" (IPCC 1990, 1992, 1996). This is a rate of change 10–100 times greater then natural climate variability.

Specific model calculations for future climates in 2030 for the Southern Europe, based on a doubling atmospheric CO_2-concentration scenario (IPCC-A), reveal trends of increasing mean temperatures, especially in summer (+ 2 to + 3 °C), and increasing precipitation sums in winter (+ 5%) but a marked precipitation decrease in summer (– 5 to – 15%). These trends are consistent with present-day hypotheses concerning greenhouse-gas forcing of the climate system (Beniston et al. 1994; Ohmura et al. 1996).

3. Consequences for the Swiss Alps

Conclusions of the IPCC on the global scale will have also effects on the regional alpine scale. If the expected global warming is confirmed for the next century, we can forecast major consequences on the cryosphere and the hydrosphere (Beniston 1994, Kunz 1996):

- A change in the precipitation regime (more rain and less snow); with an upward migration of the lower snowfall level or "ligne de névé" (150 to 300 m until 2050) according to the temperature gradient with the altitude: 0.6°/100 m.
- An acceleration of the water cycle, with reduction of the storage of snow and ice at high altitude, increasing run-off and slope erosion in the mountain areas.
- A probable increase in frequency and size of storms (windstorms, hailstorms), although the great variability of the extreme events occurrence prevents a reliable prediction for the future.
- A spectacular retreat of the glaciers in the Alps. Since 1850, almost 27% of the surface and 31% of the volume of the Swiss glaciers have already disappeared. By the middle of the next century, only one quarter of the present surface area will remain, releasing large zones of screes.
- An upward migration of the lower permafrost boundary (200 to 400 m) affecting especially the periglacial zones above 2400 m, for example the rock glaciers.

4. Climate changes: effects on the Natural Disasters

Under climate changes, the risks of natural disasters may grow in frequency and intensity for the next decades. The mountain areas like the Swiss Alps are very sensitive to environmental changes, due to the presence of glaciers, snow and permafrost (Beniston 1994). As "trigger" parameter, water is one of the major factors responsible for meteorological and hydrological disasters.

Among effects of climate changes one can mention:

- Acceleration of the water cycle with transition from snowy to rainy regime: heavy rainfalls, storms, high water discharges, floods, mudflows, debris flows.
- Reactivation or increasing activity of slope instabilities: erosion of soils and river beds, landslides, rockfalls, glacial damages, releasing of periglacial zones (permafrost).

Critical meteorological periods in the year are fall and winter according to the precipitation distribution (0 °C limit above 3000 m), and also summer depending on the frequency of extreme weather events (storms, heavy concentrated rainfalls).

Areas prone to natural disasters are in fact already well delimited: periglacial zones are and will remain very sensitive areas to climate changes in a close future. In most cases, these endangered zones show historical and geomorphological evidences for past events, that's why they should be monitored in priority, taking into account frequent as well as episodic phenomenon.

5. Impacts on the Society

Natural disasters are also caused by a combination of different unfavorable factors linked to human development (settlements or change in land-use). These disasters will have more serious effects and increasingly affect areas that have so far remained untouched by such phenomena, according to the increasing loss potential and vulnerability of our society (Egli & Petrascheck 1996).

From an economic point of view, costs due to more frequent natural disasters may be enormous, for example one can mention investments for protection infrastructures or impacts on mountain economies with changes in: ecosystems, landscape, water ressources, energy supply, agriculture, forestry, land-use and tourism-especially winter skiing (Abegg 1996).

The problem of climate change on the regional scale and its resulting interactions between climate, ecosystems, natural hazards and society is the main thrust of NRP 31 activities. Nu-

Tab. 1. Summary of the main themes examined in the research groups of the NRP 31.

NRP 31 Groups	*Themes*
CLIMATE	Historical climate data, post-ice age climate history reconstruction (in lacustrine sediments and ice cores), simulation of present and future alpine climate, regional scale climate data (downscaling methods).
WATER CYCLE	Flow discharges, water regime in ground and snow cover, karst and ground-water reservoirs behaviour, dimensioning of hydraulic works, heavy rainfalls, hail, monitoring with radar technology, dynamic of storms.
NATURAL HAZARDS	Processes of ice and snow melting, glacier fluctuations, icefalls, avalanches, permafrost evolution, drainage processes in torrents, floods, mudflows, climate influence on landslides, rockfalls and rockslides.
ECOSYSTEMS	Impacts on soils and roots, modification of vegetation types, reactions to a rise of atmospheric CO_2-concentration, simulation of changes in ecosystems, impacts of storms, forest fires.
SOCIETY	Social, economical, political, and administrative aspects, land-use planning, risk and disaster management, impacts on tourism and agriculture, damage statistics, risk perception of population and decision-makers.

merous applications of the research supported by NRP 31 are envisaged. The emphasis of research will be on processes acting on the regional scale, in which the Swiss Alps and their interaction with their surroundings will be a major focal point (NFP 31 1992, 1993).

The completion of the programme is scheduled for the end of 1997. To date, 55 research groups are taking part in the NRP 31, coming from Swiss higher educational institutes (Universities and Federal Institutes of Technology), administration, private research firms. A particular emphasis will be given to interdisciplinary studies. In order to encourage cooperation between researches and facilitate the collation of results and their applications, five project groups have been formed.

Consequently, it will be attempted to bring together specific projects in especially sensitive geographical test-zones, as representative as possible of Swiss conditions. Three regions in the Swiss Alps have been designated for this purpose, characterized by a concentration of research projects (areas situated in both French and German parts of Switzerland). These are the Surselva region (canton of Graubünden), the Ormonts Valley (canton of Vaud) and the Vispertäler region (canton of Valais).

By the beginning of 1998, research results will be continuously subject to detailed and realistic assessment of the risk potential under changed climatic conditions, and a sound assessment of the policy response strategies.

6. Conclusions

On the basis of the final report of the NRP 31, which will be published in 1998, recommendations for practical applications, strategies and action plans, will be made for both state institutions and private individuals. Follow-on projects will also be formulated. Although we cannot act to control climate phenomena directly, we do have the possibility of reducing the consequences of natural disasters through appropriate preventive measures. In future, we shall increasingly be faced with problems of catastrophic impacts on natural and socio-economic systems, especially if an increase in frequency and intensity of meteorological "trigger" events are to be expected as a result of global warming.

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