Interdisciplinary Postgraduate College Natural Disasters

M. Jaya[1], C. Hauck[1], H. Noppel[2]
[1]Graduiertenkolleg Naturkatastrophen, Universität Karlsruhe
[2]Institut für Meteorologie und Klimaforschung, Universität Karlsruhe

Abstract

Postgraduate colleges (german: Graduiertenkolleg) are implemented by the Deutsche Forschungsgemeinschaft (DFG). The aim is the interdisciplinary training of young scientists and the integration of research and training. In such systematically organised programmes, doctoral students are provided with the opportunity to work and prepare their theses in a comprehensive research context.
An interdisciplinary cooperation is therefore required: natural sciences like physics, hydrology and meteorology as well as the geosciences contribute to the understanding of the basic mechanisms causing natural disasters. Mathematics and computer science are employed in the description of fuzzy information, complex models and their prediction. Economics' task is to quantify and monetarise risk. The research projects of the programme are designed according to the aspects "Modelling of Vulnerability and Risk," "Design of Disaster Scenarios," "Measures for Damage Reduction" and "Economic Implications of Natural Disasters." The interdisciplinarity achieved in the programme is to bring about great benefit: a better understanding of the causes, processes and effects of natural disasters helps to single-out and evaluate already in advance vulnerable and risk-prone regions.

Zusammenfassung

Das Ziel des Graduiertenkollegs „Naturkatastrophen“ ist es, die Ausbildung für Graduierte unterschiedlicher Fachrichtung durch ein über die übliche Promotionsbetreuung hinausgehendes Programm auf eine breite Basis zu stellen. Außer der Vermittlung von fachübergreifendem Wissen soll dabei sowohl das Verständnis für die Zusammenhänge gefördert werden, als auch die Fähigkeit, Wissen aus dem eigenen Fachgebiet an Fachleute anderer Disziplinen und an Entscheidungsträger zu vermitteln.
Das Forschungsprogramm ist so gestaltet, dass in den Projekten möglichst viele für Naturkatastrophen relevante Fragestellungen behandelt werden. Dabei wird die gesamte Wirkungskette vom Verständnis und der Vorhersage von Naturgefahren über die Abschätzung des Risikos bis zum Katastrophenmanagement betrachtet, wobei auch ökonomische und soziale Aspekte berücksichtigt werden. Die Entwicklung, Anwendung und Validierung moderner Methoden der Mathematik und Informatik ist aufgrund der Komplexität der meisten Naturkatastrophen ein Schwerpunkt der Projektbearbeitung. Darüber hinaus soll die interfakultative Zusammenarbeit mehrerer Fachinstitute gefördert werden.

Introduction

According to United Nations data, damages by natural disasters have risen in the last 35 years from 50 to 360 billion US$. It is not only the most disaster-prone countries like the USA, Japan and many developing countries who are affected. Also in Central Europe and Germany do storms, floods and hail cause increasing harm to man, environment and economy. Already before the beginning of the UN International Decade for Disaster Reduction (IDNDR) in 1990 it has been a great challenge for scientific research to make feasible forecasts of vulnerability and risk and to allow for conducting more efficient risk reduction and rescue measures.
All natural disasters have in common that they are complex phenomena which may not be described by simple, deterministic and causal models. Additionally, extreme events usually occur haphazardly resulting in an incomplete and imprecise database for research. These phenomena render risk

assessment, risk and damage prediction as well as the development of risk reduction measures even more difficult.
Thus, an interdisciplinary cooperation is required: natural sciences like physics, hydrology and meteorology as well as the geosciences contribute to the understanding of the basic mechanisms causing natural disasters. Mathematics and computer science are employed in the description of fuzzy information, complex models and their prediction. Economics' task is to quantify and monetarise risk. Engineering develops measures and tools for damage reduction.
The University of Karlsruhe presents unique conditions for such an interdisciplinary programme, as all thematically relevant institutes are present on the campus. The postgraduate college "Natural Disasters" was established on October 1st, 1998 with the aim of developing adequate modelling techniques to meet the rising demand for problem-oriented know-how and solutions in the field of natural disaster research (Gehbauer,F. und J. Mehlhorn). This interdisciplinary programme focuses on the entire chain of effects of natural disasters from risk assessment to risk prediction and finally damage reduction measures.
Involved in the programme are 15 institutes at the University of Karlsruhe (TH) of the faculties civil engineering, computer science, bio- and geosciences, physics, mathematics and economics. The research projects of the programme are designed according to the aspects "Modelling of Vulnerability and Risk," "Design of Disaster Scenarios," "Measures for Damage Reduction" and "Economic Implications of Natural Disasters."

Objectives and structure of the college

The interdisciplinary cooperation achieved in the programme is likely to bring about great benefit: a better understanding of the causes, processes and effects of natural disasters helps to single-out and evaluate already in advance vulnerable and risk-prone regions. This knowledge can be used in city and regional planning for reducing or mitigating risk on a long-term basis. With the help of improved prediction models and early warning systems, measures for local protection can be quickly implemented in affected areas and the population may be warned in time. The following objectives are pursued by the research programme:

1. **Development, application and validation of modern methods of mathematics and computer science** serving for the description of fuzzy and imprecise information and complex models as well as for the prediction of complex systems behaviour, of which intrinsic mechanisms are known only vaguely.
2. **Analysis and characterisation of different types of natural disasters**, which differ with respect to physical model complexity, data base precision and the possibility of damage reduction.
3. **Investigation of the whole chain of effects**, which in the case of natural disasters reaches from vulnerability assessment and risk prediction to measures of damage reduction. Such a stepwise approach is mandatory, as risk evaluation is strongly contingent on risk and damage prediction.

Additionally, rapid information processing by new information technology is crucial for effective disaster management during disasters. Decisive for the quality of initiated disaster response measures is also the improvement of rescue and recovery machinery, which is a further aim of the programme. In the frame of this interdisciplinarity, a joint research work of four PhD students at the college was conducted (Fig. 1). The complete list of all working groups and their research programmes currently conducted by the PhD students and postdoctoral research associates is given in the Appendix A.

Figure 1: One of the joint research work of the college PhD students.

For an adequate training of graduates from various disciplines a broad, comprehensive study programme with a common basis is necessary. Therefore, in the mandatory curriculum for all graduates, a survey lecture covering various aspects of natural disasters and an introductory stochastics course are offered. Invited speakers contribute to the survey lecture as well as offer extra sessions. Each semester, the graduates report about their work in a graduate seminar. It is planned that the individual doctoral theses are finished in total three years time. Lectures in the optional part of the curriculum are best selected by the graduates themselves. At least four courses from the following thematic fields should be selected:

- Methods of mathematics and computer science; Lectures concerned on extreme value statistics, risk theory, neural nets, fuzzy logic and knowledge representation are offered.
- Natural disasters; Here, lectures deal with different types of natural disasters. Especially landslides, earthquakes, extreme weather and flood events as well as geochemical aspects are included.
- Economic effects and disaster relief; Lectures on economic evaluation methods, aspects of insurance, risk management, geographical information systems, remote sensing and topics specific to the development of machinery are also offered.

The complete list of the lecturers engaged in the college is given in Appendix B. The focus of the programme is to endow the participants with the ability to understand and evaluate the relevant relationships of natural disasters. Additionally, the graduates should be able to propose and implement adequate solutions needed for an optimal disaster management. Scientists trained in this manner are increasingly demanded not only by research but also by government institutions, the insurance industry and firms offering commercial disaster management advice.

Concluding remarks and acknowledgment

Postgraduate colleges (german: Graduiertenkolleg) are implemented by the Deutsche Forschungsgemeinschaft (DFG). The aim is the training of young scientists and the integration of research and training. In such systematically organised programmes, doctoral students are provided with the opportunity to work and prepare their theses in a comprehensive research context. The colleges are organised in an interdisciplinary fashion; they are established for a duration from three to maximum nine years and are funded by the DFG and the respective federal state whom we gratefully would like to thank for their financial support.

Preferences

Gehbauer, F. and J. Mehlhorn, 1998: Graduiertenkolleg an der Universität Karlsruhe, Festschrift anläßlich des neu gegründeten Graduiertenkolleg Naturkatastrophen.

Appendix A: Working groups and research programmes

Understanding and modelling of hazards

- Model based monitoring and statistical analysis of hazards-related hydrogeological and geochemical signals (Jens Hartmann)
- Objectivation of landslide hazard analysis with artificial neural networks (ANN) (Tomás Fernández-Steeger)
- GIS modeling of rockfall events in the Eastern Alps (Veronica Berceanu)
- Development of a flood warning method for small and middle sized catchments founded on distributed online soil moisture measurements (Wolfram Schädel)
- Water balance and failure risk of water dikes (Alexander Scheuermann)
- Strong precipitation due to orographical influence (Michael Kunz)
- Inversion of geophysical and meteorological data to assess the stability of mountain permafrost slopes (Christian Hauck)
- A modular implementation of forward and inversion methods in modelling physical evolution problems (Makky Jaya)
- Regional distribution of windspeed in mountainous terrain in case of strong wind (Heike Noppel)

Hazards management and measures for damage reduction

- Decision-supporting systems for the strategical operation control (Uwe Wagner)
- Building extraction and damage recognition using video sequences (Michael Kauffmann)
- Rescue methods for slopped objects (Sascha Gentes)
- Efficiency and realization of intensification arrangements on earthquake-prone buildings (Maria Bostenaru-Dan)
- Disasters mitigation in Quito, Ecuador (Agustin Castro-Rodríguez)

Economic and social aspects of natural hazards

- Risk management for predictable natural disasters (Claudia Flores-González)
- A stochastic model for disaster damage (Peter Ender)
- Macroeconomical risk management of natural disasters (Reinhard Mechler)
- Perception and evaluation of risks of natural disasters (Susanne Tina Plapp)

Appendix B: Lecturers

Chairman:
Prof. Gehbauer, Inst. for Construction Management and Machinery

Faculty of Civil Engineering and Geodesy:
Prof. Bähr, Inst. for Photogrammetry und Remote Sensing
Prof. Brauns, Inst. for Soil and Rock Mechanics
Prof. Gehbauer, Inst. for Construction Management and Machinery
Prof. Jirka, Inst. for Hydromechanics
Prof. Nestmann, Inst. for Water Resources Management, Hydraulic and Rural Engineering

Prof. Plate, Inst. for Water Resources Management, Hydraulic and Rural Engineering
Prof. Ruck, Inst. for Hydromechanics

Faculty of Biology and Geosciences:
Prof. Czurda, Inst. for Applied Geophysics
Prof. Stüben, Inst. for Mineralogy and Geochemistry

Faculty of Informatics:
Prof. Calmet, Inst. for Algorithms and Cognitive Systems
Prof. Dillmann, Inst. for Process Control und Robotics
Prof. Goos, Inst. for Programming Structures and Data Organisation
Prof. Menzel, Inst. for Logic, Complexity and Deduction Systems

Faculty of Mathematics:
Prof. Henze, Inst. for Mathematical Stochastics

Faculty of Physics:
Prof. Fiedler, Inst. for Meteorology und Climate Research
Prof. Kottmeier, Inst. for Meteorology und Climate Research
Prof. Wenzel, Geophysical Institute

Faculty of Economics:
Prof. Hipp, Inst. for Insurance Sciences
Prof. Werner, Inst. for Insurance Sciences

Appendix C: Contact Address

Postgraduate College Natural Disasters, University of Karlsruhe
Am Fasanengarten, Bldg. 50.31, R. 016
D-76128 Karlsruhe, Germany
Tel. +49 (0)721 608 8080 (Dr. M. Jaya/Dr. C. Hauck, Coordinators)
Tel. +49 (0)721 608 8079 (W. Kühfusz, Secretary)
Fax +49 (0)721 695245
E-mail: gknk@imb.uni-karlsruhe.de
http://www.gknk.uni-karlsruhe.de