

Table of Contents

Preface	
Our Focus	
The Increasing Demands of Tunnel Construction	
Flood Research: An Aid to Mitigation of Hazards and Damages	
Implementation of Comprehensive Regional and Local Planning	
in Fast Developing City-Regions of the Second and Third World	1
Highlights	1-
Structures	1-
Infrastructure Systems	10
Resources	1
Geo-, Structural and Environmental Data	2
High-Tech Measuring Systems	2
Studying at the Department of Civil, Environmental and Geomatics Engineering	2
Facts and Figures	2
Adresses	2

Preface

The Department of Civil, Environmental and Geomatics Engineering has successfully completed its second year since merging the former Department of Civil and Environmental Engineering with the Department of Geodesy in October 1999. During the past two years, the department has been busy in detailing and implementing its strategy formulated in May 2000 (see Annual Report 2000), which focuses on research, teaching and organisation. A further, very important element of change, was the introduction of financial autonomy for our department within the budget constraints given by the board of ETH Zurich.

As a result we have gained complete transparency with regard to research activities and the allocation of resources to each professorship and institute within our department. Furthermore, we have agreed on a mechanism for allocating our resources in the future and we have initiated basic discussions about future research focuses and their impact on longterm planning. In this respect, emphasis has been laid on the profiles of new professors to be elected during the present (up to 2003) and future (up to 2007) planning periods.

A determined attempt has been undertaken to increase the number of students in the three curricula of our department, e.g. civil, environmental and geomatics engineering. For this purpose we have strengthened our public relations activities in the high schools and within the organisations for professional career advice. In addition, we organized an "open day" in May 2001 (see Our Focus). These various measures have resulted in an increased intake of students of about 20% since 1999.

Overall, the developments and changes brought about since our new department was founded in 1999 are substantial and successful. The many critical discussions and important decisions that have taken place have made our department more open and dynamic, and increased cohesion among professors and staff. As a result our performance in research and teaching has considerably improved. Our department has become a very attractive institution internationally for undergraduate and graduate students as well as for scientists.

Hans-Rudolf Schalcher Prof. Dr. sc. techn. Head of Department







Our Focus

Our Strategy

In order to maintain national and international leadership in research and teaching, we focus our activities and resources on the following five strategic areas:

- Design, dimensioning, construction and rehabilitation of complex and outstanding structures, such as buildings, bridges, tunnels, dams and protective structures.
- Planning, realisation, operation, maintenance and rehabilitation of infrastructure systems (traffic, water supply, water and solid waste disposal, protection against natural hazards, energy production and distribution, communication, precision navigation).
- Management of natural and man-made resources (space, soil, water, air, building materials, built infrastructure), land use and land development as well as material life-cycle considerations (exploitation, use, recycling and disposal).
- Collection, processing, administration, interpretation, analysis and visualisation of data related to geodynamics, environment and built infrastructure as basic information for planning, simulation and control of environmental, industrial and infrastructural processes, of socio-economic processes as well as of land use and land development.
- Development of innovative high-tech measurement systems and evaluation algorithms (aeroplane and satellite based sensors for surveying and geodynamics, industrial measuring techniques, control of technical systems, monitoring of man-made and natural objects and processes).

Our Curricula

In our Department the teaching focuses on three curricula:

- Civil engineering
- Environmental engineering
- Geomatics engineering

Making the Allocation of Resources more Dynamic

When D-BAUG was founded in 1999 a moratorium of the mode of distribution of financial resources to the institutes and personal chairs of the former departments D-BAUM and D-GEOD was agreed upon. Before this deadline was reached, in the period covered by this report, a new method was worked out, which will permit a more flexible distribution of the funds D-BAUG. The allocation of the credit for personnel (in number of positions), for operational costs and for computer resources is according to the following categories:

- Basic allocation for each institute, depending on the number of professorships and staff
- Allocation for fixed commitments of the institute (running of labs, teaching courses, services on a national level)
- Allocation based on performance and projects in teaching and research
- Allocation from a small reserve to finance unforeseen expenditures

Resources granted when filling professorships are considered as a fixed commitment for a maximum of 6 years and will then come under the new philosophy concerning the allocation of resources.

Open Day:

"Our changing environment"

Our planet Earth is in a continuous process of change. We notice this in the change from day to night, the changing seasons and when natural catastrophes occur. Other processes proceed more slowly, for example climate changes, continental plate movements, soil erosion or the ageing of our structures. All these changes influence our life and work, sometimes dramatically, sometimes imperceptibly.

The Department of Civil, Environmental and Geomatics Engineering, ETH Zurich, is researching the effects of such changes to both our natural and built-up environments. On Saturday 12th May 2001, on a glorious sunny day, the department opened its doors to about 3000 visitors, giving them an insight into its teaching and research activities. By means of demonstrations, experiments and competitions, questions were answered on the following topics:

- Safety and risk
- High tech construction; computer-aided civil engineering
- Virtual and real worlds
- Water and soil
- Mobility and transport

The Open Day commenced with Federal Councillor Ruth Metzler-Arnold, Minister of Justice and Police, opening the youth forum "Die Schweiz bauen" ("Building Switzerland"). Under the chairmanship of Prof. I. Rickenbacher, high school pupils and students of our department engaged in a lively discussion with Mrs. Metzler and representatives of ETH and of industry about visions of the Switzerland of tomorrow.

High school pupils were invited to participate in a bridge competition. The bridge models were not allowed to exceed o.9 N (90 g) in weight and had to exhibit a span of 960 mm. The winning group of the high school Rychenberg, Winterthur, whose bridge carried a load of 463 N, were able to visit the NEAT tunnel site in Sedrun by helicopter.

We would like to express our sincere thanks to the sponsors whose generous gifts covered our all expenditures.

New at the ETH Zurich

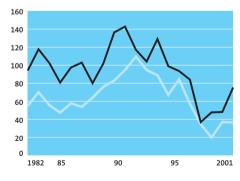
Future of the Institute of National, Regional and Local Planning (ORL)

In the discussions on the future of ORL new ways of a co-operation with D-ARCH have been developed, which define the obligations of the departments to their institutes more clearly and with the network "city and landscape" creates the basis for a productive co-operation in teaching and research. Thus a first step was taken which anticipates the interdepartmental co-operation being worked towards by the Board of the ETH.

Bachelor's – Master's Course of Studies

The preparation for the Bachelor's/Master's course of study is part of the ongoing discussions in our department on the harmonisation of the three curricula, civil, environmental and geomatics engineering. The new framework of a three-year Bachelor's course followed by a 3–4 semester Master's course opens up new possibilities of co-operation with D-ARCH and the departments involved in the project "environmental systems".

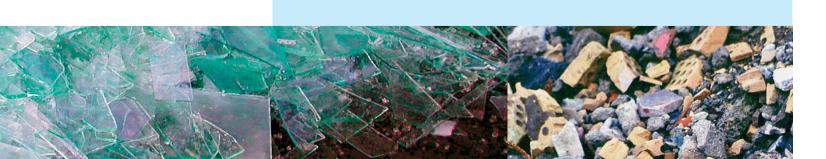
First Year Students 1982 – 2001



Total Civil Engineering

Total Environmental and Geomatics





The Increasing Demands of Tunnel Construction

Heinrich Brändli, Gerhard Girmscheid, Kalman Kovari

Tunnels have never been built for their own sakes, but in the case of traffic tunnels, to provide transportation routes for humans and materials by water, rail or road. Originally the objective was very clearly to overcome topographic obstacles. Interestingly, the first transportation tunnels served canals with their intrinsically very strict vertical alignment requirements, a good example being the Sapperton tunnel in England built in 1789 with a length of approximately 3.5 km! Later came the railways with their strict geometric requirements demanded by the steel wheel on steel rail system and concentration of driving power. Large compromises were initially necessary between tunnel construction, technical feasibility, operating requirements and costs, as the first alpine transit route, Semmering of 1854, attests

New Requirements

Since the early days the range and cost of mobility have increased enormously and continue to rise with economic growth. In addition to the growing demand for new transportation tunnels, the qualitative requirements for tunnels have become more varied as well. Tunnel designers today must consider such factors as construction practice, industrial safety, ventilation, lighting, management and planning, active and passive safety, rescue operations, and maintenance during operation as well as the geometrical requirements such as cross section and profile.



Intensively folded sedimentary rock at the depth of 1200 m at Ferden (Lötschberg base tunnel)

At the same time that the demand and the qualitative requirements for tunnels have increased, the reasons for tunnel construction have become more varied. Moving traffic remains the priority, but tunnel construction today is increasingly pursued for other reasons including lack of space on the surface, noise protection, to be city-friendly and due to public opposition to building new transportation facilities.

Project Engineering is Demanding

The actual building material for underground construction is the ground itself, i.e. soil and rock. The state of the ground and the presence of any bedding planes are therefore given with the choice of the alignment (horizontal and vertical). Together with the choice of profile, the tunnel driving method is considered one of the most crucial factors in tunnel design. The shape of the tunnel profile depends on the criteria of use (clearance), the statics (rock pressure) and the selected tunnel driving method (driving by blasting, tunnel boring machine, etc.). During tunnel driving engineers must secure the opening against cave-in, rock spalling, complete collapse or damaging surface deformations. Materials including rock anchors, shotcrete, steel arches or prefabricated concrete elements and segments are used for this purpose. Following driving, the tunnels are normally sealed against groundwater and provided with reinforced or rigid concrete linings. Modern underground construction is normally designed and built for a one hundred year operating life.



Study of the alignments for NEAT in the area of Bellinzona (black: existing lines).



System NEAT Gotthard Base Tunnel



Hard Rock Gripper Tunnel Boring Machine (TBM): NEAT, Loetschberg axis, Steg face



Suspended infrastructure platform for the blasting work: NEAT, Loetschberg axis, Mitholz face.

Inaccurate Geological Information and Ecological Requirements

Rock characteristics vary widely, tunnel lengths and depths are increasing (Gotthard Base Tunnel), and technological development is also progressing rapidly, so the task of the planning and design is becoming more multi-disciplinary and demanding. To be successful, it is necessary to always ensure, despite the often inaccurate geological information, that the tunnel is built with a high degree of safety as well as to determine construction costs and the construction period as precisely and reliably as possible. Finally, strict ecological requirements including groundwater protection and construction emissions are becoming an increasingly significant part of the tunnel construction process.

Requirements of the Construction Phase

The main factors governing economic and sound tunnel construction are cost control and schedule.

This calls for industrializing the tunnel construction process. For many large new tunnel projects

the use of tunnel boring machines (TBMs) is technically and economically promising due to the geological, hydrological and geometrical conditions in the construction area.

Tunnel Boring Machines (TBMs)

There are two main types of TBMs for use in rock. The first is the Open Gripper TBM, which propels itself forward from supporting brackets in the rock, and by jacking provides the appropriate contact pressure of the drilling head. The second is the Shielded TBM with segment construction, in which the contact pressure of the drilling head develops by support from the segment lining already in place by means of jacking.

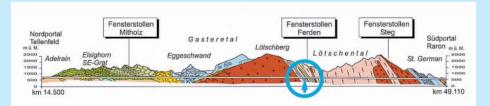
In the back-up system, which today is called a logistics system, adjoining the TBM, further construction takes place including final tunnel lining. Back-up systems enable tunnel construction to take place in an efficient, parallel development process by separating construction from the flow of materials as well as providing support services to the TBM. These back-up systems are designed to bridge over the areas of permanent lining construction especially at the bottom of the tunnel and thus make it possible to provide a flow of construction material to the working area and to

supply the TBM with fresh air, energy, cooling water etc. Thus construction of the future traffic route behind the back-up system can take place efficiently and quickly, guaranteeing an optimal logistics system. Such a system can proceed at a rate of between 18 and 36 meters per day.

Innovations in Blasting

The efficiency and speed of the second major type of tunnel construction, blasting and/or conventional tunnel driving, was in the past governed by the cyclic operations of a mostly manual labor construction process. Currently, and particularly due to development of the TBM, there is significant competition for innovations between the two tunnel driving methods. The cyclic operation is supported today by highly-mechanized, partly automated specialized machines.

The separation of the construction processes from the flow of materials using back-up systems, and the employment of highly-mechanized, partly robotic systems, are the main innovations which have developed tunnel construction into an extremely modern construction engineering process .



Geology of the Loetschberg Base Tunnel.

Flood Research: an Aid to the Mitigation of Hazards and Damage

Paolo Burlando, Gian Reto Bezzola, Hans-Erwin Minor

Damage and casualties due to floods are a major concern of modern society. All over the world flood-prone areas have experienced more severe floods in the last decade than were predicted on the basis of historical information, even including long-term historical records. In alpine valleys debris flows during floods cause considerable damage. During the last 25 years about 20 people died as a result of debris flow events in Switzerland. The total annual costs related to torrent hazards amount to almost 100 mio SFr

Human lives, infrastructures and goods can be protected if flood hazards are adequately predicted. The scientific community has made substantial progress in the last twenty years. Advances have been achieved in the understanding of physical processes and in their modelling. The increased availability of data on a large scale from remote sensing and improved computing technologies have led to better models. Prediction and prevention of flood hazards are therefore possible, and both structural and non-structural measures are available. However, the increasingly intense exploitation of river basins and the associated anthropogenic changes require a continuous improvement of the methodologies used

in flood analysis and prediction. New approaches in flood protection and in evaluating the risk associated with flood hazards are necessary. The department is active on both fronts through the activities carried out by its various institutes. The activities are coordinated within the Natural Hazards Competence Center (CENAT).

Challenges for Research in Hydrology

The erratic behaviour and the complexity of associated processes challenge the capability of hydrological models at simulating the occurrence of extreme events (peak flow, and flood volume and duration). The lack of extended hydrological data with fine resolution in space and time makes the analysis and prediction of the occurrence of floods in alpine streams of small and mesoscale basins difficult. The focus of the latest research of the Chair of Hydrology and Water Resources Management has been on techniques that are capable of overcoming such uncertainties and provide a robust way to analyse the frequency and magnitude of flood hazards. A wide range of methods have been developed, investigated and compared, the use of which depends on the level of required accuracy, data availability and prediction target. Moreover, they represent a method to improve the design of flood protection systems, which rely on the estimation of a design flood that defines the hazard intensity and provides the basis for an efficient mitigation of hazard impact.

Advanced Flood Estimation Methods

Statistical flood regionalisation techniques have been implemented, which depend not only on flood records, but also on the physical, climatic and geomorphological characteristics of river basins. This allows us to interpret the statistical pattern of the time and space distribution of floods as the signature of a complex natural process, thus making possible the recognition of basin heterogeneities even in a simple statistically-based flood estimation method. The estimation of flood frequencies and associated intensities when flow data is lacking are based on a derived distribution approach, which allows one to carry out flood frequency analysis by deriving analytically the frequency curve of flood events from rainfall data (or model) and catchment characte-

The need to increasingly account for detailed analysis at different locations in the basin and for man-induced non-stationarities, such as land-use changes, has required also the development of models to simulate the continuous response of river basins to both actual observed storm events and future scenarios. Thus rainfall-runoff distribu-

Granular debris flow surge in the Dorfbach Torrent near Randa (Canton Valais). Photo by M. Zimmermann, May 1995.





tion models have been developed, which rely on a

digital raster representation of the catchments

characteristics, such as topography, soil proper-

ties, land cover or land use and geology. Therefore

the dynamics of flood events can be accurately

described in terms of both hill-slope and channel

response throughout the entire basin and its

drainage network. Moreover, these models can be

coupled with long-term series of climatic varia-

bles, either observed or stochastically generated.

This allows one to fully simulate flood events

(flood peak, duration and volume) characterised

by large return periods, which are the starting

point in designing protection works and elaborate

flood risk mitigation policies.

Modelling Mud and Debris Flows

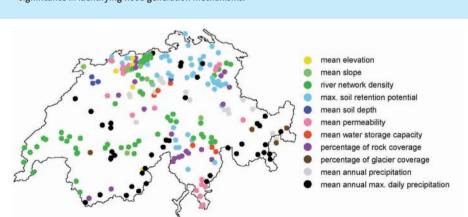
Debris flows are instationary two-phase flows of water-sediment mixtures in steep channels. Their appearance and flow characteristics depend on the material composition and water content. Debris flows can roughly be divided into two types: granular debris flows (in which the portion of fines is small and cohesive materials do not play an important role) and viscous debris flows. Compared to fluvial processes our knowledge on debris flows is still limited. The main problems are the estimation of debris flow magnitude and of the run-out distance. Both processes are crucial for hazard assessment, the accuracy of risk area delineation or the planning of countermeasures. Debris flow processes, which are a major research focus of the Laboratory of Hydraulics, Hydrology and Glaciology (VAW), can be investigated with the help of scale model experiments, field observations, theoretical analysis and numerical models

The research primarily focuses on the debris flow initiation due to progressive channel erosion, and deposition mechanisms. Systematic small-scale experiments lead to the formulation of a threshold criterion for the initiation and of relationships for the main flow characteristics (flow

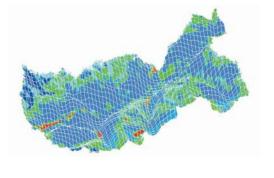
depth, velocity). In combination with flood estimates deduced by rainfall-runoff models it is therefore possible to improve the prediction of granular debris flows in terms of frequency and

Due to the larger areas affected, the deposition processes are often investigated with the help of numerical models. Such models require appropriate constitutive equations for the description of the two-phase flow. However, the parameters contained in these rheological models are not well defined and conventional rheometric methods do not allow the analysis of debris flow material containing large particles. At VAW a new experimental system is developed to determine the rheology of debris flows. Bodies of different geometry (e.g. spheres) are dragged through debris flow material and the drag forces are measured. From these measurements the relationship between shear rate and shear stress, i.e. the relevant rheological parameters, can be deduced.

Clustering of basin characteristics with respect to their significance in identifying flood generation mechanisms.



Soil saturation in the upper Reuss river basin reproduced by a distributed rainfall-runoff model during the flood event of August 1985.







Example for nature-orientated riverbed stabilisation: The Dala Torrent at Leukerbad (Canton Valais). Left: low flow conditions; right: during the flood of

New Flood Protection Strategies

October 2000

The increased value of infrastructures and settlements at risk, as well as the effort to minimise the threat to human lives have suggested a more comprehensive way of tackling the problem of mitigating flood risks. Together with the increased environmental awareness and the high costs associated with structural flood defences, this has led to a new strategy on how to cope with flood risks. This new approach is based on allocating appropriate areas for natural flooding of rivers by integrating structural defences, flood forecasting systems and floodplain management in the general context of water resources management. Thus the design of structural defences has become more specific, especially in those basins where the complexity and the diversity of flood related hazards requires accounting not only for water levels, but also for significant debris transport and its associated effects on the river network. A special aspect in this respect is represented by flood risk in the alpine environment.

> Driftwood retention with a large trash rack placed in the sediment retention basin at the Dorfbach Torrent near Sachseln (Canton Obwalden)

Flood Risk Mitigation in Alpine Valleys

The main processes causing damage during floods are (1) the flooding due to lack of channel capacity or (2) channel obstruction, (3) vertical or lateral erosion along the channel combined with (4) the mobilisation of large amounts of bedload. Countermeasures consist in enlarging the channel cross-section, preventing erosion by increasing the erosion resistance of the river bed and banks or in the diversion of water to reduce discharge. During floods, the obstruction of bridge crossings or culverts by driftwood can lead to inundation and thus cause considerable damage. Based on several case studies and on systematic model tests, different measures either for driftwood retention upstream of or for improved driftwood routing through critical sections have been deve-

Focuses of current research are the flow resistance and the bed-stability of mountain streams and torrents. A better understanding of these processes leads to an increased reliability of hazard assessment as well as to the development of design guidelines for stable high gradient channels. Following the natural morphologies manmade step-pool systems represent ecologically valuable alternatives to other common structural



Another important research topic concerns the morphodynamics of wide rivers. Physical and numerical modelling are used to describe and quantify the interaction of riverbed with discharge morphology and sediment transport at steeper gradients and for riverbed material having a wide grain-size distribution (alpine rivers). The enlargement of rivers has, besides mitigating flooding,

also a strong ecological impact. In a widened river,

the natural braided pattern can redevelop. Hence,

the morphological variety and the habitat condi-

tions in the river are improved.

solutions such as check dams or block ramps.

Finally, a large number of case studies at VAW deal with diversion structures on rivers. As examples the diversions of the Reuss River near Andermatt and near Flüelen (Canton Uri) are mentioned here. Both examples represent bypass solutions to limit discharge within a river reach with limited capacity. Near Flüelen, the motorway running parallel to the Reuss River is used during severe floods to guide the diverted water towards the Lake of Lucerne.

Current situation

Third World

Jacques Feiner, Willy A. Schmid

In recent years, many cities in the second and third world have experienced a strong urbanization. Due to the improvement of transportation infrastructures, rural migration as well as high natural birth rates, expanding economies and the effects of globalization in general these cities increase quickly in size and become more regionalized. Meanwhile, planning remains mostly local and focused on the main urban area of a region, while urbanization spreads outside of it. Development is often so rapid that traditional maps are no longer accurate enough to serve as a planning basis.

Constraints

Implementation of Comprehensive Regional and Local

Planning in Fast Developing City-Regions of the Second and

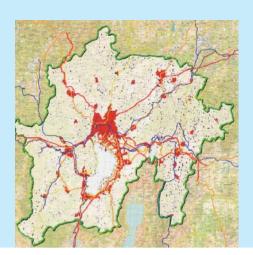
The result is that local authorities gradually lose control and the overview over the development of their region. The lack of region- and sustainability-oriented planning strategies and a comprehensive planning approach leads to an uncontrolled and uncoordinated urban development. Indeed, there is a huge risk that many development possibilities will be lost, synergies will remain untapped, and that environmental pollution as well as traffic problems will get out of control.

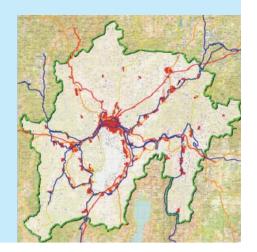
Goals

The new task for planning in these emerging metropolitan areas of the second and third world is to manage the space over a greater extent, to coordinate local and regional functions, and to create sustainability-oriented urban transportation and settlement patterns. To keep an overview over development dynamics, the suggested planning system should also include monitoring and controlling approaches. Meanwhile, the planning basis - the basic map and its geo-oriented information - should be comparatively cheap, easy and fast to provide and ultimately up to date. Finally, the planning approach as such should be simple to apply, adapted to planning level and scale, and strongly coordination- and sustainabilityoriented



Greater Kunming Area: 3-D Modelling of the base of IRS Satelitte images





Greater Kunming Area: GIS-based modeling of alternative settlement and transportation patterns for the year 2002: Unguided monocentric urban expansion basing solely on motorized transportation (trend development, left); coordinated regional development basing on a strong public transport system (vision scenario, right)

Suggested solutions

To match these requirements in the case of Kunming, capital of Yunnan Province, PR China, the adoption of sustainability-oriented planning policies¹ and the implementation of a GIS-based comprehensive surface-covering planning system has been suggested to the city and its agglomeration, the Greater Kunming Area (GKA). The approach is now in its pilot project phase. In principle it includes the following steps:

(a) Providing the legal and administrative framework

- Definition of the planning goals and contents
- Definition of the administrative levels concerned with spatial planning
- Definition of the territorial division
- \bullet Definition of the interested parties
- \bullet Definition of the organizational setup
- Definition of a the planning process and time frame

(b) Individual definition of guiding ideas and planning principles for the planning units on the regional, sub-regional and local levels (c) A stepwise implementation of regional, sub-regional and local surface-covering planning, by using cross-sectorial and multi-disciplinary approaches.

The more technical aspects of the implementation of comprehensive planning on the different levels are:

- Establishing the planning base. Recent orthorectified IRS satellite images (5m resolution) and a digital terrain model with an average precision of about +- 2om constitute the basic map for the regional (prefecture-) and sub-regional (county-) levels. For the local level, satellite or aerial images with a higher resolution (1m or better) are required. Basic documents on main development issues and the collection of georelated information (current land use and infrastructures) complete the planning base of the GIS-based planning system.
- Defining and implementing plan and data structures. The above mentioned planning base, a conceptual planning framework and guidelines for the implementation of planning are the main sources of information for the design of the comprehensive (guiding) plans. They concern the main issues of regional coordination, regulation and protection and have been split up into the following thematic fields: (a) Settlement and Landscape, (b) Transportation, (c) Supply and Disposal, (d) Public Infrastructure and (e) Lake Protection. On the local level, a comprehensive plan resumes all the thematic maps.

Considering implementation, in a first stage, drafts of the plan are submitted to involved government institutions and interested parties which will discuss and consolidate it. After being adjusted the plans will be approved by the different institutions and will get a legal status.

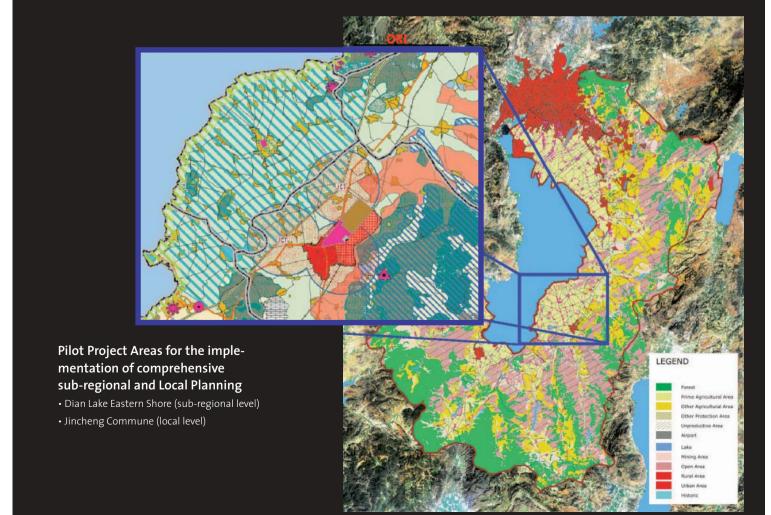
• Analysis and visualization. The GIS-based planning model is designed in such a way that spatially relevant processes (e.g. urbanization) and development issues (e.g. consumption of fertile land, or the state of pollution in lakes) can be controlled and monitored. The system as such is flexible and can easily be adapted to changing circumstances, as altering land use for example. In principle it can be continuously updated. Furthermore, the current state, future projects and expected results can be very well visualized (also in 3-D)

Conclusions and remarks

This kind of approach is very adaptable to rapidly developing urban regions, where the government institutions have the capacity to carry out comprehensive planning, as it is the case in PR China. Indeed, in many parts of China development pressure is so strong, and the consumption of fertile land and the increase of the pollution level so fast, that the implementation of comprehensive and surface planning is urgently needed. Though still in the pilot project phase, we consider the selected method to be quite feasible and promising.

The technical approach we took is adaptable to all locations where "normal" maps were not available or where development is so fast that existing information is no longer up to date. Ideally it should be combined with the above mentioned implementation of GIS-based planning. Last but not least, the visualization capacities of the GIS-model are very helpful for communication between administrators, planners and interested parties in the planning process.

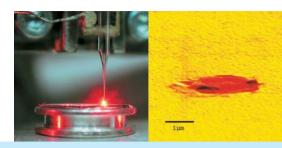
Pilot Projects advocating the implementation of comprehensive regional and surface-covering local planning



- ¹Outline of sustainability-oriented planning policies:
- Promoting Kunming as the main future center of population and economic activity in Yunnan Province (and relieving rural areas of surplus population)
- Actively preparing the Greater Kunming Area for its future role as an agglomeration of regional size:
- Planning and coordinating settlement and transportation patterns
- Promoting a decentralized concentration of urban settlements inside the urban region, leaving space for nature and recreation
- Promoting mass transportation and non-motorized transportation
- Promoting mixed uses around city centers
- Promote clustering of industries of the same type and services at the most suitable locations, and prevent the further spreading of polluting low-tech industries in remote rural areas
- Protect historic sites and city centers and its original functions, by keeping the original population

Structures

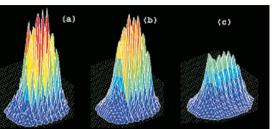
High resolution sensors: Glass capillaries with nanoscopic tips (left) Copper structures in the submicrometer range (right)



Exhibition of Swiss Railway Bridges in the Central **Building of ETH Zurich**



Experimental Set-up: the cross section of the gallery (right) Pressure distribution of an impact event measured by flexible tactile pressure sensors (left)





CALICE: Computer-Aided **Learning in Civil Engineering**

Internet-based courses have been developed at the IGT (Prof. Sarah Springman) and IBK (Prof. Thomas Vogel) for computer-aided teaching and learning for undergraduate courses in soil mechanics and structural analysis. The pilot project is funded by ETH WORLD – the developing Virtual Campus at ETHZ. The main pedagogical aims of these courses are to improve the student's understanding of the subject through discovery and reflection, and to support a wide range of individual learning styles. A multi-threaded approach has been adopted in mixing traditional methods (e.g. lectures, exercises, laboratory work and textbooks) with interactive Internet-based learning resources, including:

- Hypertext-based on-line reference material with significant multimedia content
- Java-based simulations that promote discovery
- Challenges that include essay-type open-ended questions relating theory to practice
- Multiple-choice and numerical questions that consolidate learning and help the tutors to monitor the student's progress
- the whole course
- Tests from previous examination sessions as training material

http://www.calice.igt.ethz.ch/, http://www.ibk.baug.ethz.ch/Vo/calice/

Fire Tests on Wooden Modular Hotels

A series of fire tests on wooden modular hotels was performed by the IBK (Group of Prof. Mario Cantonal Fire Insurers (VKF). The tests showed the high level of fire safety of modular hotels in timber using sprinkler and detection systems. The influence of combustible and non-combustible • Messages addressed to individual students or to surfaces on fire growth and fire spread was analysed as well as sprinkler and detection systems. The tests enlarged the experimental data for validation of natural fire simulations and for verifying the methods for the fire resistance calculation of wood constructions. Further, the tests provided important data for the revision of the Swiss fire regulations.

Fontana). The research project was supported by industrial partners and the Association of

Interactive Teaching Assignments in CALICE



High Resolution Sensors for Monitoring the Durability of Concrete Structures

Glass capillaries with nanoscopic tips (image on the left hand side) were used to produce small copper structures in the sub-micrometer range (image on the right hand side). The approach of the nano tips is controlled by a focused laser beam to prevent the tip from breaking.

The possibility to produce very small copper structures helps developing high resolution sensors that can be used to monitor the durability of steel in concrete structures.

Exhibition Swiss Railway Bridges

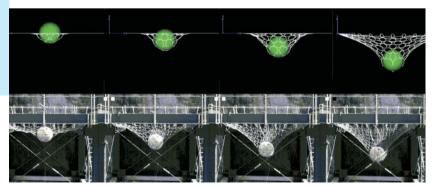
An exhibition on Swiss railway bridges was presented in the entrance hall of the main building of the ETH in November 2001. Conceived in 1999/ 2000 at the Institute of Structural Engineering (IBK, Group of Prof. Peter Marti) the exhibition includes 60 panels illustrating (i) railway development until 1900; (ii) the Swiss railway development; and (iii) 27 selected Swiss railway bridges. The exhibition is one of a series of exhibitions owned by the Society for the Art of Civil Engineering, a private organisation founded in 1995. Based at the ETH the society has over 200 members from Switzerland and neighbouring countries. To date, the society's eight exhibitions have been presented 67 times in 37 different cities in Austria, Germany, Italy and Switzerland, typically for periods of about one month. The exhibition material is available in a catalogue comprising 175 pages.

Impact of Falling Rock

Rockfalls occur most frequently in steep mountainous terrain resulting in large movements of soil or rock masses down a slope. They can damage the local infrastructure such as roads, railways or electrical power lines. Protection galleries must be designed to resist the high impact energy of the falling rock boulders, and so the magnitude and distribution of the impulse loading on the gallery roof must be determined. Often cushion materials are used for effective dissipation of energy. Physical modelling is being carried out in the ETHZ geotechnical drum centrifuge (IGT, Group of Prof. Sarah Springman, Thesis Ravikiran Chikatamarla) so that scaling advantages may be used to represent input energies of the typical design 3000kJ event or greater. (A 50 gram artificial rock will be equivalent to 50 tonnes under an acceleration equivalent to 100 times gravity, and the prototype rockfall heights can be modelled by a 300 mm fall to be equivalent to 30 m, which would translate to a 15000 kJ event.) Innovative use of flexible tactile pressure sensors is proving to be a significant advantage in that the distribution may be measured over 2000 sensels during the impact loading

Numerical modeling of rockfall protection systems

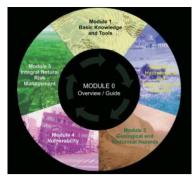
Flexible wire ring-net protective systems are one means of protection from large, fast-moving falling rocks. The systems are designed to stop rocks gently over long breaking distances in order to reduce the peak load on the system components. The IBK (Group Prof. E. Anderheggen, Thesis Axel Volkwein) is developing a special-purpose simulation software in a joint research project with the Federal Swiss Institute for Snow and Avalanche Research (SLF) and the Swiss developer of the nets, Fatzer AG Geobrugg. The program will be used to optimise the ring-net systems and reduce timeconsuming and expensive prototyping tests. The program, based on the finite element method, is being validated at SLF's full-scale rockfall test site in Walenstadt. Important research topics in this project are the numerical analysis of impact and contact, large strain material behaviour and sliding friction. The program employs an explicit time integration scheme and models entire systems consisting of steel nets, cables with breaking elements and hinged support posts. The joint research project is financed by the KTI.



Rockfall event at the full-scale test site with corresponding simulation

Fire Tests on Wooden Modular Hotels for EXPO-02

Infrastructure Systems



Structure of the Swiss Virtual Campus "Dealing with natural hazards"

From static to dynamic traffic assignment models

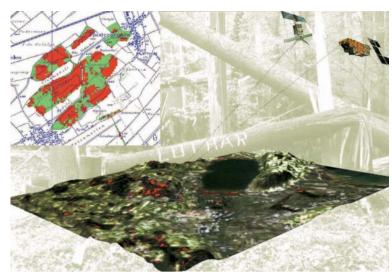
Based on networks of the Federal Office for Spatial Development the IVT has recently developed a static assignment model of Switzerland's main road system (about 3,000 zones (municipalities and districts within the major cities), 8,000 nodes and 21,000 links). The results of such static models have limited validity, if the demand varies strongly within the period modelled and if there are multiple bottlenecks in the network. Dynamic assignment models promise better, more correct results under these now fairly common conditions. As part of an ongoing project for the Federal Office and the Swiss Federal Railways the existing symmetric daily demand matrix was split into 24 hourly asymmetric matrices (IVT, Milenko Vrtic, group of Prof. Kay Axhausen). The results obtained with a commercial software package (VISUM online), which approximates a theoretically fully consistent equilibrium, already show the variability in time and space of traffic congestion in Switzerland (see figure below). The future work at the IVT will be directed towards the development of fully consistent dynamic approaches using micro-simulations of route and travel choices. This work will also derive recommendations for the use of static assignments, as these will remain the main tool of practical applications for a long time to come.

Swiss Virtual Campus "Dealing with natural hazards"

The project named Swiss Virtual Campus (SVC) "Dealing with natural hazards" aims at establishing a comprehensive and common educational virtual platform in the field of natural hazards. The impact of floods, landslides, earthquakes, or avalanches has increased with the expansion of human settlements in the undisturbed landscape, therefore requiring a broader knowledge and understanding of the hazardous processes, and skills to mitigate the consequent risk. The networking way of transferring knowledge increases the accessibility and exchange of information among students, professionals, and researchers who are often separated by geographical obstacles. The course is divided into five modules highlighting the interdisciplinary kernel of the subject. It is being developed in English to account both for the multi-lingual structure of Switzerland and for a subsequent access at an international level. The IHW (group of Prof. Paolo Burlando), is involved in the project in conjunction with many other universities and ETH-domain institutions in Switzerland, including the IKA (group of Prof.

Project "Combined Remote Sensing natural disaster monitoring"

The KTI project CIRSTEN (Combined remote sensing natural disaster monitoring) of IGP (Group of Prof. Armin Grün) addresses the localisation and mapping of natural hazards using Synthetic Aperture Radar (SAR) and optical images from earth observation satellites, in order to improve the efficiency of existing management practices. SAR sensors offer the unique opportunity to retrieve data at any time of day and for any weather conditions, being essential for rapid response to an actual disaster. The use of remote sensing data for damage assessment has been successfully demonstrated by a study of the forest damage caused by storm Lothar in 1999. A damage map of Western Switzerland, based on ERS SAR imagery, was generated automatically only two weeks after the incident, being at that time the first comprehensive damage information. Independent testing of the French satellite provider SPOT Image proved that almost 90% of the extensive damage was detected correctly. Further studies included among others the mapping of flooding incidences along the Aare River in Switzerland and the Mekong River in Vietnam (www.photogrammetry.ethz.ch/research/projects.html).



Combined remote sensing natural disaster monitoring

Validation of a numerical model to simulate the Rhine river delta at the lake of Constance

The largest river delta at a lake in Europe is formed by the river Rhine at the Lake of Constance. The solids which are transported into the lake consist mainly of fine material. To prevent the silting up of the harbours near to the mouth of the river, lateral dams are being built to convey the suspended material to deeper parts of the lake. To achieve a more "natural look" of the delta, it is planned to partly lower the height of the levees. The aims are to get local depositions in the overbank region and to improve the ecological situation without affecting the flood protection safety upstream of the mouth of the river.

The impact of different levee configurations on the development of the sediment transport and the delta formation was investigated with the help of numerical simulations (VAW, Prof. Hans-Erwin Minor, project of Dr. Roland Faeh and David Vetsch). The model was validated by comparing it

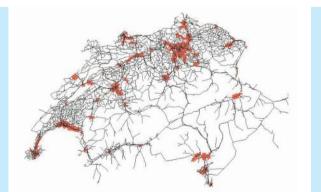
with field measurements of the morphological changes which took place over a period of about six months. The results show that the general progradation direction and pattern of depositions are satisfactorily reproduced, lending support to the use of the model as a tool for geomorphological investigations.

Information management: Relevance and organizational development in urban water management

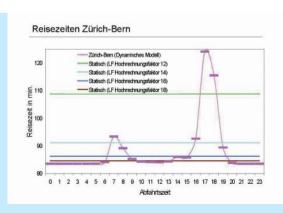
Providing high level water services for urban residents with economic efficiency is one of the goals of urban water management. A critical resource for achieving this goal is an appropriate information infrastructure throughout the public (municipalities, cantons, federation) and the private sectors (engineers). A research project at IHW (group of Prof. Willi Gujer, Thesis Stefano Gianella) supports the transfer of experience with information management into the private sector by consider-

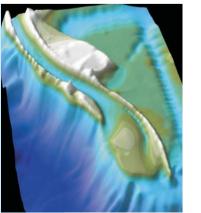
ing the specific requirements of the primarily public water industries.

Because of the number of private and public agencies involved, the distribution of competence and the structure of the business processes, the information infrastructure has to fulfill many requirements. Extended quality for the information infrastructure can be obtained by providing policies and standards (e.g. for assuring the portability of data) as well as appropriate management tools for planning and implementation by the public and private sectors. Information management provides such tools. It supports the organization of planning, operation and controlling tasks. It creates the conditions for acquiring, storing, using and sharing the required information. Further, it helps decision makers to choose the right information technologies.



Links with a more than 70% load factor (17:00-18:00; average working day 1998)







View of the Rhine Delta at the Lake of Constance (right)

Numerical modelling of sediment transport and delta formation (left)

Pilot plant for anaerobic ammonium oxidation

July January

Spatial representation of the flood seasonality for Swiss gauging stations

Expedition to the Okavango Delta

Resources

The Okavango flows from its source in Angola into the interior of the continent, fans out into an inland delta in the Kalahari basin of Botswana, and evaporates completely. The wetland of the delta, which is partly permanent swamp and partly seasonally flooded, is a highly complex and valuable ecosystem, which offers the spectacular African megafauna one of their last retreat areas. Due to the increasing water demands of the population on the fringe of the delta (population growth, increasing standard of living) there is a conflict of interest between water withdrawal and the requirements of habitat protection. In order to be able to assess the impact of water withdrawal

with reference to size, place and temporal distribution, a hydrological model of the Okavango delta is being developed at the IHW with the help of IGP. This model couples surface and groundwater and describes the transport of dissolved salts. For the calibration of the model, measurement data from the delta are being acquired. Last year a four-month expedition obtained the microclimatic data necessary for the interpretation of satellite images, as well as data on the microtopography and salinity distribution.

Anaerobic ammonium oxidation (Anammox): Treating ammonium-rich wastewater at low costs

In wastewater treatment plants (WWTP) with anaerobic sludge digestion, 15–20% of the inlet nitrogen load is recycled with the return liquors from sludge dewatering. Separate treatment of the ammonium-rich digester supernatant would significantly reduce the nitrogen load of the main stream and improve nitrogen elimination. A new combination of partial nitritation and anaerobic ammonium oxidation promises to be a powerful tool to improve nitrogen elimination. Partial oxidation of ammonium to nitrite in a first reactor (nitritation) followed by autotrophic denitrification of the produced nitrite with the remaining ammonium in a second step (anammox) was evaluated for three years (IHW, group of Prof. Willi

Gujer, Thesis Christian Fux). Promising experiments in a pilot plant (3.5 m3) at the WWTP Werdhölzli resulted in guidelines for commercial up-scaling. Compared to traditional nitrification/ denitrification the investment costs are similar but about half of the annual operation costs can be saved. The first full-scale plant in Switzerland with this new process is planned to be built in 2002/2003 at the WWTP Kloten/Opfikon.

Stochastic Catchment Areas of Drinking Water Wells

For an effective protection of drinking water wells from pollution their catchment areas must be determined. The catchment is the area of the land surface over which the groundwater abstracted by a well is replaced. In principle the catchment area can be determined from the recharge rate, the distribution of hydraulic conductivities and the abstraction rate of the well. Due to the poor accuracy with which the aquifer parameters are known and also due to seasonal variation of the

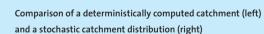
catchment depending on varying hydrological conditions or pumping rates, catchment areas can only be determined approximately. Here a method is proposed to tackle this problem. Instead of determining a unique catchment area a map is constructed which shows for each point on the land surface the probability with which it belongs to the catchment area. The figure shows the comparison of a deterministically computed catchment (left) and a stochastic catchment distribution (right) for a simple artificial example. The stochastic modelling also allows quantification of the value of additional measurements. Data is the more valuable the stronger it constrains the stochastic distribution.

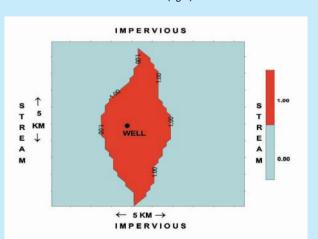
Regional flood frequency analysis in highly heterogeneous environments

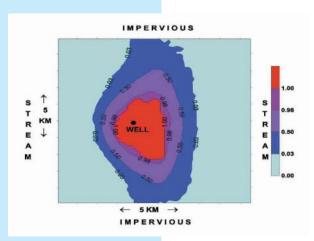
The demand for modelling techniques that are able to provide reliable predictions of flood hazards is still increasing because of the large social and economic impacts produced by flood events. Flood regionalisation is an approach to obtaining flood design values at any site within a study area, even for ungauged locations (EU project "FRAMEWORK", group of Prof. Paolo Burlando,

Thesis of Martin Pfaundler). This requires an information transfer from gauged catchments to ungauged sites of interest. To this purpose, homogeneous regions must be identified on the basis of physically or statistically based criteria, prior to transfer of information. The homogeneity assumption becomes critical especially in heterogeneous geographical environments such as Switzerland. The method, which is essentially based on a similarity measure that considers a range of hydro-meteorological and physiographic basin characteristics, has been extensively investigated to test its sensitivity, on the one hand, and its performance, on the other. The encouraging results indicate this technique may be a robust alternative to established but somewhat less performing approaches. The practical application is facilitated by a software that has been developed to provide several statistical, as well as more physically oriented homogeneity tests, which can support the user in evaluating the suitability of identified regions for effective information transfer.

Satellite view the Okavango Delta (Landsat ETM, ca. 300 km x 300 km)

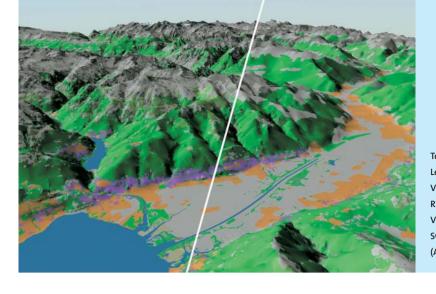








Geo-, Structural and Environmental Data



Topographic 3D-map of Locarno and environs, view from south.

Left part: Integration and visualisation of the digital landscape model

VECTOR25, based on the Swiss National Map Series 1:25'000.

Right part: Combination of the two landscape models

VECTOR25 (foreground) and VECTOR200 (background, based on the

Swiss National Map Series 1:200'000.) using level-of-detail techniques.

(All data: © Federal Office of Topography, Wabern.)

Reconstruction and interpretation of the geoglyphs of Nasca.

In cooperation with the Rietberg Museum, Zurich and the German Archeological Institute the photogrammetric 3-D reconstruction of the famous geoglyphs of the areas Sacramento and San Ignacio in Peru has been completed by using the most advanced analytical and digital techniques available today. The datasets have been implemented on a powerful laptop-based real-time visualization system and a conceptual datamodel for a GIS has been designed. This generates the basis for a comprehensive GIS-based analysis of the various hypotheses that exist concerning the purpose of the geoglyphs. The combination of extensive geodetic, photogrammetric and archaeological data on a GIS platform is a milestone in modern archaeology. Several TV documentaries, reports in the scientific literature and newspapers, and exhibitions are in preparation (www.photogrammetry. ethz.ch/research/projects.html).

Towards a Swiss National Spatial Data Infrastructure (NSDI)

On an international level a "Global Spatial Data Infrastructure" (GSDI) has been promoted for several years. The intention is to support a global access to geographic information. This is achieved through the implementation of NSDIs (National Spatial Data Infrastructure), which co-ordinate common standards and effective mechanisms for the development and availability of interoperable digital geographic data and technologies. Research and expertise at the Institute for Geodesy and Photogrammetry (Group of Prof. Ch. Giger) enables both Federal and local as well as private institutions to build up metadata servers as their contribution to an NSDI. Especially the interdepartmental GIS Co-ordination Group (KOGIS) of the Swiss Federal Government was supported by our group in defining a Swiss model for geographic metadata, which will serve as the main part of a Swiss NSDI to support a GSDI on the basis of an international standard (ISO DIS 19115).

Geomonitoring of tropospheric water vapor

One of the still existing problems in GPS precise positioning is the refraction effect of tropospheric water vapor. Last year the Geodesy and Geodynamics Laboratory (IGP, Group of Prof. Dr. Hans-Gerd Kahle) succeeded in modeling this influence with direct measurements of water vapor using ground sensors and balloon sondes. In addition a software package has been developed which utilizes measurements of the Automated Meteorologic Network of Switzerland (ANETZ). It is based on an advanced interpolation technique using collocation algorithms: COMEDIE (Collocation of Meteorological Data for Interpretation and Estimation of Tropospheric Path Delays). It enables to calculate GPS path delays within a 4-D refractivity field. Last year we reached a break-through in modeling the wet path delays in terms of an analytical continuous time series. The validation resulted in a good agreement between the COMEDIE approach and other independent methods of better than 1%. The zenith path delay for lowland regions is significantly higher than for mountainous areas. This is mainly due to the longer ray paths travelling through the atmosphere as well as to the increasing content of water vapor at lower elevations. http://www.ggl.baug.ethz.ch/research/wg37/

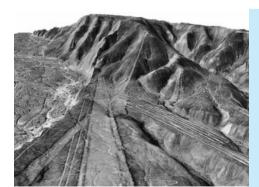
Automatic generation of interactive vector-based topographic 3D-maps

The project's objectives consisted in investigating and developing methods to generate high quality topographic three-dimensional maps as well as in implementing a software system for desktop computers to automatically generate such maps and to allow their interactive visualisation (IKA, Group of Prof. Lorenz Hurni, Thesis of Andrea Terribilini). In stark contrast to traditional maps, interactive topographic three-dimensional maps are not subject to any thematic, spatial or temporal restrictions. By allowing the reader to choose the point of observation, topographic threedimensional maps offer the possibility to view the landscape from an ideal angle and in a way that comes very close to human spatial perception, making understanding easier and more intuitive than traditional topographic maps. A disadvantage is the restricted visibility, resulting from occlusions and distortions which make it hard to interpret sizes and proportions. The developed software system allows an object-based modeling of the terrain surface, the creation of high quality topographic three-dimensional maps and the possibility to interactively navigate through the map model.

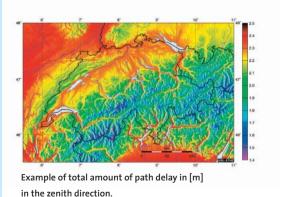
Geodata time series analysis for Geodynamics

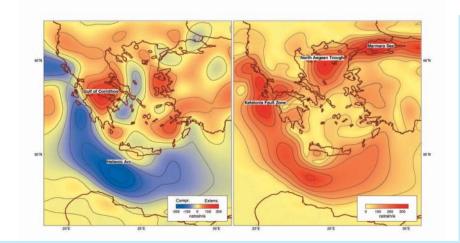
The Hellenic arc is one of the most active seismotectonic regions in the collision zone between the African and Eurasian plates. Results of GPS measurements are used to investigate the ongoing tectonic deformation. The Geodesy and Geodynamics Group (IGP, Group of Prof. Dr. Hans-Gerd Kahle) has installed a continuously operating GPS network covering an area extending from northern Epirus and the Ionian islands all along

the entire Hellenic arc to the islands of Crete Rhodes and Kastelorizo. From 5 years of GPS observations time series of daily coordinates have been calculated. These time series allow to estimate the velocities of the sites and to analyse the trajectories of crustal motion in great detail. This includes transient deformation as well as co-seismic slip. The largest strain rates have been found along the North Aegean Trough/Kephalonia Fault Zone and in Central Greece centered around the Gulf of Corinthos. A significant co-seismic slip of 12 cm has been identified during the Strofades earthquake in the Ionian Sea. The ultimate goal is the determination of a geodynamic model of strain accumulation and seismic stress release (http://www.ggl.baug.ethz.ch/research/wg57/).



View onto the 3-D model of the Nasca geoglyphs in Peru





Geodetic strain rates calculated from the GPS-determined velocity field in the Eastern Mediterranean. Units are in 10-9 strain/a = nanostrain/a; 1 nstrain/a corresponding to a velocity gradient of 0.1mm/ 100km per year.

a) The 2-D dilatation rates calculated from the trace of the 2-D strain rate tensor. Remarkable features include the Hellenic arc exhibiting compressional strain rates and the Gulf of Corinthos associated with large extensional strain rates of more than 200 nstrain/a.

b) The 2-D maximum shear strain rate field calculated from the difference of the eigenvalues from the 2-D strain rate tensor. The largest shear strain rates are found along the Kephalonia Fault Zone and along the Zone Marmara Sea - North Aegean Trough. This region is also the site of numerous large earthquakes, such as those at Izmit and Duzce. NW Anatolia.

Automatic camera installed on the Crête du Plan (2830 m), for albedo measurements of the Haut Glacier d'Arolla



The two-color light source of the ETH dispersometer

No safety without monitoring – A monitoring concept for on-line sensors

Measuring Systems

High-Tech

On-line measurements at wastewater treatment plants are used to enhance the capacity of the treatment, to reduce energy and chemical consumption and to improve treatment efficiency. The new sensor technology has the inherent danger of unidentified bias, which can cause non optimal control decisions or serious safety problems. A new concept has been developed, which helps the operator to quantify the accuracy of the sensors, detect "out-of-control" situations and decide whether maintenance of the measurement system is necessary. A warning phase will issue first indications of probable errors and a request to increase the monitoring frequency. During the alarm phase the error hypothesis has to be validated and should allow immediate and specific action by the operator.

The implementation of the concept in a software environment with a database is under development. This will enhance the efficiency of data analysis and guarantee that relevant information such as comparative measurements, raw signals of the sensor, service actions or calibration characteristics will be immediately available for the operator (IHW, Group of Prof. Willi Gujer, Thesis Leiv Rieger).

Towards an understanding of glacial processes: high-tech instrumentation on glaciers

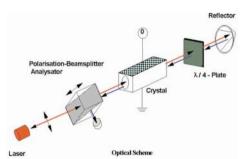
Glacial processes and their interrelation with changing environmental conditions have been the subject of scientific investigations by two groups of the D-BAUG. The Glaciology section (Head Dr. Martin Funk) of VAW (Director: Prof. Hans-Erwin Minor) has carried out, among others, high temporal resolution measurements of glacier flow on the Lauteraar Glacier, Bernese Alps, Switzerland. GPS surveys, borehole depth, longitudinal surface strain and sub-glacial water pressure measurements were carried out from June to October 2001. These allowed us to detect a good

correlation between changes in surface elevation and borehole depth for one event recorded in the advanced melting season. This is in contrast to other observed surface uplift events in June, which can be explained by cavity formation at the bed due to large water inflow.

The effects of climatic fluctuations on hydrological processes are being studied on the Haut Glacier d'Arolla (IHW, group of Prof. Paolo Burlando). Automatic weather stations have been in operation on the glacier during a summer field campaign. For daily survey of the dynamics of surface processes an automatic camera was installed. The geo-referenced images of this camera can be used to estimate surface albedo. The initiatives of 2001 in Arolla are a first step towards establishing a continuously monitored test site for extensive investigations aiming at integrated modeling of water resources in highly glaciated alpine basins (www.arolla.ethz.ch).

Development of the world's most accurate absolute electronic distance meter (EDM)

In a collaboration of TU Munich, Leica Geosystems, and IGP/ETH - basing on the actual Mekometer principle with polarization modulation – a new EDM for the precision tracking of fast moving targets has been developed and tested. The key technology to achieve the ambitious specifications of micrometer accuracy was the change from analogue to digital synthesizing procedures and sophisticated real-time data processing. In the meantime, the sub-micrometer accuracy EDM has been successfully implemented into Leica Lasertrackers for industrial metrology and is used in a NASA application (www.geometh.ethz.ch).



Set-up of the Electronic Distance Meter (EDM)

refraction-free high-precision direction measurement The actual limitations in direction and

Nanometer detection enables

The actual limitations in direction and distance measurements are the propagation and distortion of wave fronts in the air. One approach to overcome these limitations is the so-called dispersometer technology based on two laser beams with extremely separated wavelengths. In collaboration with the ETH Laboratory for Solid State Physics we succeeded in generating an adequate laser source by doubling an infrared laser source with a Caliumniobate crystal. For the functionality it was necessary to detect the blue and infrared laser spots in the focal plane of a geodetic telescope with a resolution of a few nanometers. This has been achieved by the new so-called GAP-technology which is based on a special semiconductive effect in differential optical position-sensitive detectors. The effectiveness of this method is demonstrated by the fact that the noise of the refraction-free direction is white. With this method it will be possible to control the trajectory of construction machines with the required accuracy and reliability (www.geometh.ethz.ch).

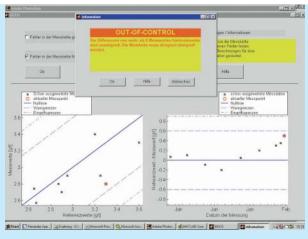
Modelling Human Faces with Multi-Image Photogrammetry

Measurement and modelling of human faces has

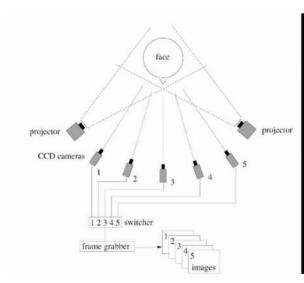
found many diverse applications in medicine, computer animation, video surveillance, teleconferencing and virtual reality. We are aiming at an automatic system to measure the human face quickly and with high accuracy. A photogrammetric system with five synchronized CCD cameras acquires simultaneously multi-images of a human face. Artificial random texture is projected onto the face to increase the robustness of the measurement. The process consists of five steps: acquisition of images, determination of the camera positions and internal parameters, establishment of a dense set of corresponding points in the images, computation of their 3-D coordinates and generation of a surface model. Moreover, a colour texture image can be draped over the model to achieve a photo-realistic visualisation. The main advantages of our method are its flexibility, the low costs of the hardware and the possibility to perform surface measurement of dynamic events like the speech of a person. The system is operational and we are evaluating applications in different fields. (www.photogrammetry.ethz. ch/research/projects.html).

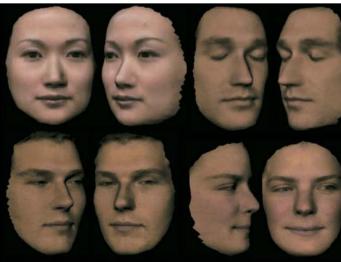
Arrangement for measurement

Automatically reconstructed photo-textured 3D faces



Monitoring of on-line sensors in a sewage treatment plant





Studying at the Department of Civil, Environmental and Geomatics Engineering



Surveying in Kavimba, Botswana

I completed my studies as an Environmental Engineer at the Department of Civil, Environmental and Geomatics Engineering in Spring 2001. This course of studies consists of two different parts: In the first two years, the focus is on engineering skills. Whilst the range of teaching areas is rather wide at this stage, students have but a limited choice of subjects. Having passed the second exam for the diploma course, students are allowed to pursue their further studies according to preference, with various project studies being offered. The common topic of all the project studies is learning how to apply the acquired scientific tools to practical work, identify the relevant problems and find out which methods and data can best be used to solve them. The small number of students is a good basis for individual support from both the teaching assistants and professors and allows a close contact between the students.

During my Master Thesis, part of which was carried out in Botswana, my colleague and I realized

in several situations how useful this education had been to us. Growing water demand in the local villages of northern Botswana led to the development of different water supply scenarios. To assess the alternative of supplying groundwater from an aquifer, a regional groundwater flow model was established as a Master Thesis Project. We started our work gathering all the needed equipment for fieldwork, taking advantage of the well-stocked ETH laboratories. In the course of time we came to realize that a lot of things we learnt during our studies suddenly became useful, even if the practical relevance had sometimes been hard to see during the preparation period for the exams. The partnership between the Institute of Hydromechanics and Water Resources Management and the University of Botswana enabled us to get all the available data for the project from the government departments with a minimum of bureaucracy, as well as full technical support out in the field.

The practical relevance of the project studies and the Master Thesis as well as the opportunity to work abroad were probably the most satisfying aspects of my studies. The interest that the government of Botswana showed in our work made clear to me that after studying at ETH we had a good background to work in the field of environmental and civil engineering, both in Switzerland and abroad. It is now obvious to me that we have not been trained in the engineering subjects only, but have also learnt how to deal with entirely new subjects where the basic knowledge has to be acquired quickly. The good relations between the ETH and universities abroad as well as engineering firms in Switzerland will no doubt continue to generate interesting topics for master thesis and project studies for the students of D-BAUG.

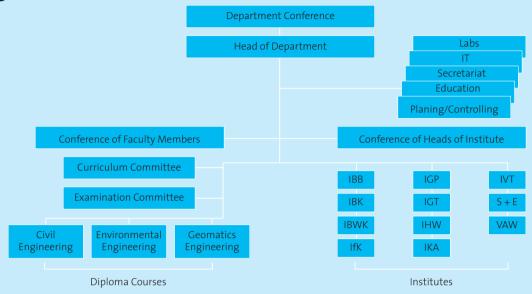
hilip Brunner

Philip Brunner got his Diploma Degree in Environmental Engineering in 2001





Facts and Figures



Students

25

Institutes

Institute for Construction Engineering and Management (IBB): Proff. G. Girmscheid, H.R. Schalcher Institute of Structural Engineering (IBK): Proff. E. Anderheggen, M. Fontana, P. Marti, T. Vogel, M. H. Faber Institute of Building Materials (IBWK): Proff. H. Böhni, J. G. M. van Mier

Institute of Geodesy and Photogrammetry (IGP): Proff. A. Grün, A. Carosio, H. Ingensand, H. G. Kahle, Ch. Giger Institute of Geotechnical Engineering (IGT): Proff. S. Springman, P. Amann, K. Kovari, R. Hermanns Stengele Institute of Hydromechanics and Water Resources Management (IHW): Proff. W. Kinzelbach, P. Burlando, W. Gujer Institute of Cartography (IKA): Prof. L. Hurni

Institute of Land Improvement and Water Management (IfK): Prof. W. A. Schmid
Institute of Transportation, Highway- and Railway-Engineering (IVT): Proff. K. W. Axhausen, H. Brändli
Laboratory of Hydraulics, Hydrology and Glaciology (VAW): Prof. H.-E. Minor
Resource and Waste Management (S+E): Proff. P. Baccini, S. Kytzia

Faculty

Students (Academic Year 2000/2001)

Retirements: Prof. Dr. F. H. Wittmann Material Science September 30, 2001

Appointments: Prof. Dr. J. G. M. van Mier Material Science March 1, 2002

students (reducine real 2000/2001)		Students					
	1st year	2nd year	3rd year	4th year	Total	Diplomas	
Civil Engineering	60	39	59	65	223	79	
Environmental Engineering	20	22	10	24	76	13	
Geomatic Engineering*	17	13	27	30	87	41	
TOTAL	97	74	96	119	386	133	
(* incl. Rural Engineering in the 4th year)							
	Doctoral Students						
	D-BAUG	oth	er Departme	ents	Total	Diplomas	
Civil Engineering	73		6		79	10	
Environmental Engineering	24	11			35	9	
Geomatic Engineering*	39				39	5	
TOTAL	136		17		153	24	
/* in all Decoral For aire a min al							

(* incl. Rural Engineering)

Staff (including part-time employees)

Institute	Professors	Senior Staff	Assistents, PhD-Students		Administr. Staff	Total
D-BAUG		6		4	4	14
IBB	2	3	9	1	3	18
IBK	5	5	36	4	5	55
IBWK	2	2	24	5	3	36
IGT	4	11	22	12	4	53
IHW	3	6	24	3	3	39
IfK	1	4	13	1	1	20
IVT	2	12	24	4	4	46
VAW	1	12	28	16	3	60
IGP	5	12	33	2	6	58
IKA	1	3	16	2	2	24
S+E	2	2	10			14
Total	28	78	239	54	38	437

Postgraduate Studies (NDS), Postgraduate Courses (NDK), Short Courses

NDS/NDK	ORL	Regional Planning
NDS/NDK	VAW	Hydraulic Structures (together with LCH of EPFL)
NDS/NDK	IHW	Hydrology and Hydrogeology (together with IATE/HYDRAM of EPFL)
NDK	ORL	Space as a Factor of Decision Making
NDK	IGP/IKA	Spatial Information Systems
NDK	D-MAVT, IBK	Risk and Safety
Short Course	ORL	GIS in Regional Planning
	IVT/SBB	Integrated Public Transport
	IBK	Fire Safety in Steel Structures
	IGT	Constitutive and Centrifuge Geotechnical Modelling: Two Extremes
	IVT	Possibilities and Limits of Travel Demand Management
	IVT	Regional Public Transport between Market and Politics
	IVT	Forum Braunwald: Planung und Erstellung Regionaler ÖV-Angebote
	IBK	Multi-storey Timber Structure (together with the Swiss Association of Wood Research)
	IBK	Risk and Reliability in Civil Engineering (together with IABSE)
	IBK	Risk Based Inspection Planning for Offshore Facilities (together with Bureau Veriats, Paris)

Workshops, Symposia, Congresses

Event	Institute	Date
Robust Statistics and Fuzzy Theory in Geodesy and GIS	IGP	12 to 16 March
Swiss Railway-Bridges, Exhibition of the Society for the Art of Civil Engineering	IBK	6 to 16 November
Course on Groundwater Recharge Estimation in Arid Environments (in collaboration with DEZA)	IHW, IGP	
Meeting of Doctoral Students of CENAT (Natural Hazards Competence Centre)	IHW	
Swiss Transport Research Conference	IVT	1 to 3 March
International Workshop "Automated Extraction of Man-Made Objects from Aerial and Satellite Images (III)", Monte Verita	IGP	10 to 15 June
Nasca-Symposium "Neueste Forschungen zu den Scharrbildern von Nasca, Peru-Dokumentation, 3-D Visualisierung und archäologische Deutung"	IGP	8 December

Honours	
Prof. Dr. Hugo Bachmann	Honorary Doctorate of Universität Gesamthochschule Kassel
Prof. Dr. Willi H. Hager	Honorary Member of the Assoziazione Idrotecnica Italiana
Dr. Robert Boes	ETH-TIT (Tokyo Institute of Technology) Postdoctoral Award for excellent young scientists (stay at TIT form October 4–18, 2001)
Dr. Katja Emmerich-Trommer	Medal of ETH Zurich for her Dissertation
Tobias Brühlmeier	1. Price of the Swiss Society of Applied Geography for his Diploma Thesis "Interaktive Karten – adaptives Zoomen mit Scalable Vector Graphics"
Dr. Jacco Huisman	Otto Jaag-Prize 2001
Mattias Pfund	Young author best paper award (3rd ISPRS Workshop on Dynamic and Multi- Dimensional GIS, Bangkok May 2001)
Dr. Sascha Oswald	Dresdener Grundwasserpreis
Atlas der Schweiz – interaktiv	Design Preis Schweiz 2001 (Interaction Design)
Katrin Beyer, Philip Brunner, Michael Frei, Martin Eugster, Christoph Schmid	Medal for the best Students of ETHZ
Katrin Beyer, Mathias Boesch, Philip Brunner	Willi Studer-Prize
Konrad Ernst Bähler	Baubetriebs-Förderungspreis
Pirmin Bitzi	SVVK-Prize
Philip Brunner, Martin Eugster	Award for Risk Management and Sustainability (PriceWaterhouseCoopers)
Dr. Anja Simma	Award for the best Doctoral-Thesis by the Austrian Research Ass. Road and Traffic

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