D-BAUG

Department of Civil, Environmental and Geomatic Engineering

Annual Report 2009

10 Years D-BAUG

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Table of Contents

In the middle of difficulty lies opportunity.

Albert Einstein

Preface

Dear readers


Lorenz Hurni

For ETH Zurich and for the Department of Civil, Environmental and Geomatic Engineering (D-BAUG), the year 2009 was marked both by continuity and by important changes.

The Executive board could further develop and consolidate various initiatives to helping to promote a qualitative growth of ETH Zurich. In particular, there is a plan to establish about 80 new professorships; however, the funding provided by the government will still remain unchanged. In order to meet this goal, new funding models must be developed. Therefore, the importance of professorship and project sponsoring is growing; besides department-specific networks, the ETH Foundation is thereby playing a central role. For the outside viewer, this growth is represented by numerous new buildings, which are under construction or planned at "ETH Zentrum" and "Science City Hoenggerberg". D-BAUG currently prepares to move the Laboratory of Hydraulics, Hydrology and Glaciology (VAW) into a new building at Hönggerberg.

Unfortunately, the Vice President for Research and Corporate Relations of ETH, Prof. Peter Chen, had to resign only after two years due to a case of fraud in his research group. The increasing pressure to publicise may be a reason why such cases tend to increase on international level. Presumably, fundamental research is more affected than goal-oriented domains with an application-induced risk awareness. The Executive board of ETH was able to limit the damage by a clear decision and by a timely and comprehensive information policy. D-BAUG puts all its efforts into the compliance with the guidelines for research integrity and good scientific practice.

Also unpleasant were some undifferentiated, politically motivated scurrilities in a newspaper advertisement, targeted at German professors in Zurich. In fact, a comment on this should be obsolete. Naturally, our department is convinced that only a college of professors consisting both of Swiss and foreign members can guarantee the highest level of quality in research and teaching. Many colleagues of D-BAUG, of ETH and of the University of Zurich distanced themselves publicly from these polemics.

In autumn 2009, the Department of Civil, Environmental and Geomatic Engineering could already look back on its 10th anniversary. D-BAUG evolved in October 1999 from a merger of the former Departments of Civil and Environmental Engineering (D-BAUM) and Geodetic Sciences (D-GEOD), as well as from the former Divisions of Civil Engineering (II) and Rural Engineering and Surveying (VIII). On August 1, 2009, I had the honour and pleasure to take charge of the Department, being the successor of Professors Hans-Rudolf Schalcher and Peter Marti, and being very actively supported by my Deputy Prof. Ulrich Weidmann. I would like to thank my predecessors for having launched and navigated the department successfully, despite some intermittent storms and calms. I would like to extend my sincere thanks to all colleagues, staff and institutes members; by their devotion and enthusiasm, they allow for excellent results in research and for a high level education of our students. I am looking forward to continue to work together with all of them in the coming years.

The reorganisation of the faculty is still under way. In the reporting year, the following colleagues have retired: Prof. Hans-Gerd Kahle (Geodesy), Prof. Hans-Rudolf Schalcher (Construction planning and management), and Prof. Armin Grün (Photogrammetry). Besides, two colleagues have left ETH Zurich: Prof. Jan van Mier (Fracture mechanics of concrete, per December 31, 2009), and Prof. Alessandro Dazio (Earthquake Engineering and Structural Dynamics). We would like to thank them for their excellent work during all their years at ETH and wish them all the best for the future.

Preface

In 2009 we could welcome the following new colleagues at D-BAUG: Dr. Irena Hajnsek as Professor for Earth Observation (Microwave Remote Sensing) per November 1, Dr. Robert Boes as Professor for Hydraulic Structures per February 1, and Dr. Eberhard Morgenroth as Professor for Process Engineering in Urban Water Management per August 1. On January 1, 2010, Dr. Bryan Adey was appointed Professor for Infrastructure Management.

Currently, a number of appointment procedures are pending; they will presumably be terminated in 2010: Spatial Information Engineering, Photogrammetry, Construction Materials, Structural Mechanics (externally funded Assistant Professorship), Industrial Ecology/Air Quality Control (Assistant professorship together with EMPA), and Structural Dynamics and Earthquake Engineering.

The number of incoming new students has increased again and amounts to a total of 289. In the curriculum of Civil Engineering, 178 new entries were registered. The increase of 21 students compared to 2008 can be attributed solely to new female students, fortunately! The curriculum of Environmental Engineering has 91 new students; the entries in the curriculum of Geomatics and Planning remain slightly below 20. There is a large discrepancy between the number of Geomatic engineers leaving ETH and the demand in the professional world. As an appeal on the website of the University of New South Wales in Sidney/Australia shows, this represents a world-wide emergency: „There is a desperate need globally for both Surveying and Spatial Information System professionals." We hope to find a remedy by increasing the public presence of the domain through involvement of the new professorships and by improving the information of high school students and career counsels (see also pages 12–13).

The Bologna System with Bachelor and Master curricula was established in 2003, and the first graduates started their professional career in 2008. Currently, the Bachelor curricula are being revised, based on the experience gained in the first years and the feedback of the alumni. The curricula will come into effect in autumn 2010.

The Excellence Scholarship programme for outstanding Masters students which was initiated with support of the ETH Foundation, is still pleasantly evolving. Currently, 7 students are being supported (see page 5). They had the opportunity to present themselves to the private, institutional and company sponsors in the large experimental hall of D-BAUG. A report about this useful networking event and on the Excellence Scholarship programme can be found on pages 6–11. We would like to thank the sponsors for their very much appreciated support, which directly fosters the new members of our professional domain. We hope that this enjoyable development will continue.

Also this year we would like to thank all our partners in the ETH domain, in the national and international environment and in institutions and companies. Through your collaboration and support, you place your trust in us and in our graduates. We are looking forward to further mutual projects and stimulating contacts and we hope you will enjoy reading our Annual Report 2009!

Zurich, March 2010

Lorenz Hurni
Head of Department

MSc Excellence Scholarships

Maren Peter

Was born March 22, 1987 in Leipzig (Germany), is proud to be a Saxon, she likes to show different personalities on stage and has sometimes a too high focus on details. Whenever there is time she tries to cook and to save money for her next journey. Not only through her camera but also in sciences she likes to watch out for different perspectives.

Notable achievement

Maren did her bachelors degree at the Freie Universität Berlin in Geographical Sciences about the water problem in Istanbul. Due to her good academic achievement she was considered for the Mcs scholarship, so she can keep researching on that topic.

Corinna Elaine Salzer

Was born August 14, 1984 in Stuttgart (Germany). She enjoys spending time in nature, prefers being aware of where her food comes from and sets high value on cultivating friendships. Lack of moral courage annoys her. Corinna is enthusiastic about sustainable ideas and innovations, which align the world with future requirements. Thanks to her scholarship she can focus on her studies.

Notable achievement

Corinna feels strongly about applying her knowledge in regional contexts. She has worked in South Africa, Turkey and Nepal so far and graduated as BSc in Civil Engineering with very good results at the Bauhaus University Weimar.

Stella Viktoria Schieffer

Was born August 24, 1987 in Neuss (Germany). She enjoys travelling and is very much interested in foreign countries and cultures. Besides her studies, Stella likes listening to music and to explore the art and culture scene of Zurich. As a creative free thinker she gets annoyed with humorless bureaucrats and petite bourgeoisie and plans to change the world when she gets the chance.

Notable achievement

Stella is thankful for the MSc Excellence Scholarship after her Bachelor studies in civil engineering at the Massachusetts Institute of Technology (MIT) and the University of Cambridge.

Benjamin Wissmann

Was born August 30, 1985, from Berne, Switzerland. He's looking for the challenges in work and studies, relaxes on his racing bicycle, likes to eyeball our society and is inspired by contemporary art and design.

Notable achievement

Benjamin received the MSc excellence scholarship for his excellent academic achievement during his Bachelor studies in civil engineering at the Swiss Federal Institute of Technology in Zurich.

"Switzerland is still in the making"

The Excellence Scholarship Programme seeks to support talented ETH Master's students. Civil engineering scholarship holders recently met with their sponsors. Konrad Basler, a donator of the ETH Zurich Foundation, explains in an interview with ETH Life why he supports young people and how he sees the future of Civil Engineering.

by Thomas Langholz, ETH Life

What has influenced you, Mr. Basler, to actively support students?
I am very attached to ETH Zurich, since essentially it is thanks to the ETH that I myself have gotten this far. Although programmes like the Excellence Scholarship did not exist in my student days, I received support and encouragement from my teachers. I consider it to be a snowball effect: we support the young students and they in turn will support the next generations.

Konrad Basler is committed to promoting outstanding young scientists and actively supports the ETH Zurich Excellence Scholarship and Opportunity Programme.

What can you tell us about your own education?
I was a farmer's son and I initially learned the carpenter trade before changing to what was then known as the Technical College in Winterthur. Taking up civil engineering studies at ETH was then only a stone's throw away. In those days, Civil Engineers were regarded as something special. They were the people who built big dams and tunnels, and impressive railway bridges like the Rhaetian Railway Bridge, which has now been incorporated into the UNESCO list of world heritage sites. In the fifties, Civil Engineering was the biggest department at the ETH.

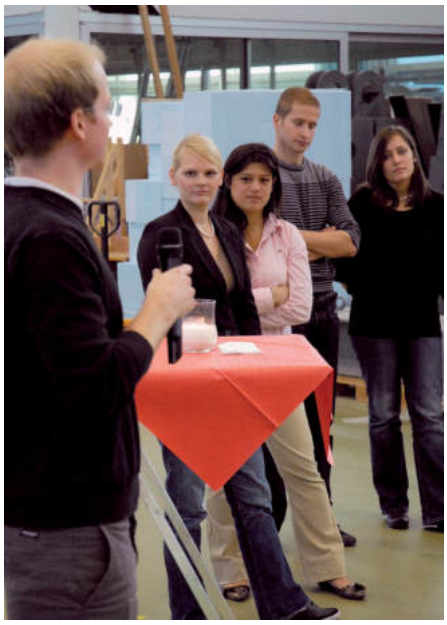
What distinguishes ETH for you?
My studies at ETH were the key to my future career. I like the idea that the ETH wants to be a leader amongst European universities. This philosophy also partly reflects the success of our own company, Basler & Hofmann. We want to be a cut above the rest and not simply compete with them. We must offer excellence.

What is your impression of the scholarship holders whom you have met?
They come across as motivated, friendly people. Their visions are still vague, but they want to be above the average and I am convinced they will succeed. I would say they know the name of the game at ETH and that is why I want to support them.

How would you compare your studies at ETH with the current Bologna programmes?
My grandchildren are studying and fill me in on the current situation. Regardless of the Bologna process, I think it's important that students still have time for philosophy, the theatre, art and life. Nowadays cultural interests are sacrificed to the examination sessions. I don't know how this problem can be solved.

What is your advice to students?
I wish we could improve our use of the Bologna system to effectively promote student exchange. In Switzerland, the EPF in Lausanne provides the opportunity of learning another language and getting to know another culture. We must build bridges across language barriers, which is also of political importance.

The Excellence Scholarship Programme should also aim at supporting young engineers. Has it reached its goal or should it promote more engineers?
It could definitely support more engineers. The fact that there are too few engineers is a never-ending discussion.



Even in this current economic crisis, there are too few engineers.

Certain circles maintain that Switzerland is increasingly being supplanted with industrial and residential areas. Is engineering a career for the future?
Absolutely! Take the terminal train station in Zurich, for instance. We are currently constructing a cross-over line under the main station. The denser the population, the greater the challenges. In the pioneering days, workers would have done it in no time with shovels and picks. Today it's a two-billion franc project engaging the best engineers. Switzerland will always need a high level of engineering. This country is still in the making!

Konrad Basler

Konrad Basler was born in 1929 in Thalheim on the river Thur. When he finished his apprenticeship as a carpenter, he studied at the Technical College in Winterthur and completed his engineering studies at ETH Zurich in 1954. His concluded his doctoral studies at Lehigh University in Bethlehem (USA) in 1959. From 1960, he worked as a self-employed advisory engineer in Egg and since 1969 has been a shareholder in Basler & Hofmann Engineering and Planning Ltd. From 1977 to 1991, he represented the SVP in the National Assembly where his main political focus was on energy, the environment and finance. In the eighties Mr. Basler was a member of the Swiss Federal School Board (now called the ETH Board; www.ethrat.ch). Today the Basler & Hofmann group has about 500 employees working on construction, energy, environment, mobility and security. The company has numerous offices throughout Switzerland and branches in Germany, Singapore, India and Slovakia.

The Excellence Scholarship Fund of the ETH Zurich Foundation

In 2007, the ETH Executive Board initiated the scholarship programme. Its aim is to recruit excellent students from at home and abroad for Master's studies and to educate talented young scientists for the industry. Financial contributions are made by private donors. The ETH Zurich Foundation wants to establish partnerships with enterprises and foundations and to identify private sponsors. Scholarship applicants must hold an excellent record in their Bachelor's studies and submit a sound project outline for a research project. Currently, 30 scholarships are awarded, but it is intended to raise this number to 50 scholarships a year.

"A future of provenance"

Innovation and promoting young scientists at the Department of Civil, Environmental and Geomatic Engineering

Organised jointly by the ETH Zurich Foundation and Professors Peter Marti and Lorenz Hurni, the partners of the Excellence Scholarship Programmes (excellence scholarships for Master's students) were, on 20 October 2009, invited to meet the young talents they support at an event held in the D-BAUG experimental hall. Needless to say, this was an ideal opportunity to thank the funders for generously supporting our young talents and to present some current research work to our guests.

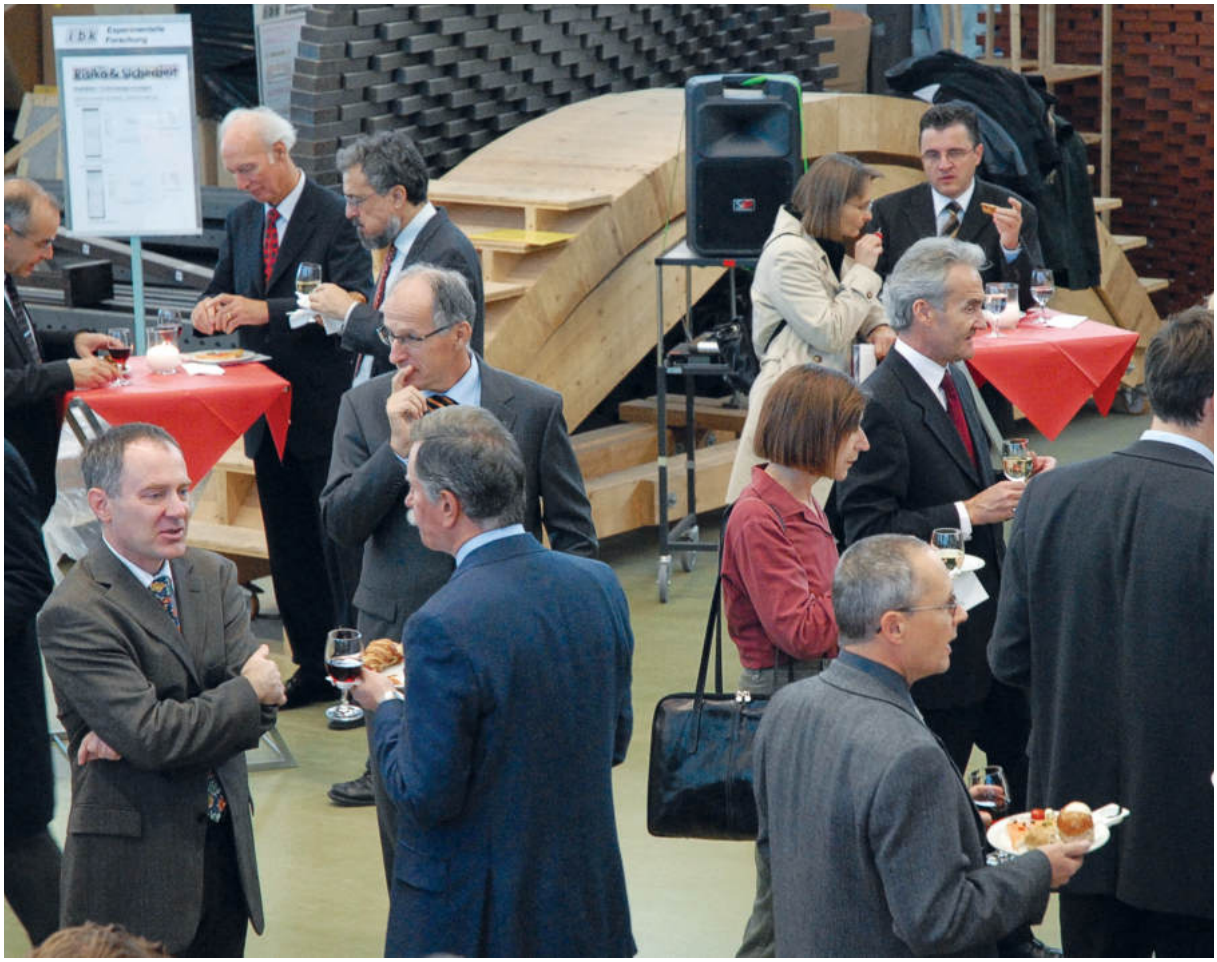
This event also marked a change in office when Professor Marti, the former head of department, officially handed over duties to his colleague, Professor Lorenz Hurni. In office since August 2009, Prof. Hurni maximized the occasion by bringing our guests up to date on recent events within the department.

Young talents at D-BAUG: our five scholarship holders

Since the launching of the "Excellence Scholarship & Opportunity Programme" at ETH Zurich, six talented Master's students at D-BAUG have each been awarded a scholarship. Five scholarship holders attended the 'talents meet funders' event and introduced themselves to the event participants. These young scientists spoke individually about what this scholarship has helped them to achieve and how they foresee their future. Naturally, they also thanked the partners for their kind support. The students' light-hearted, informal presentation went down well and gave this event its rather special tone.

Whether our young, innovative scientists take up employment in research, seeking to resolve tomorrow's problems, or in a company, both have a common denominator: they strive towards progress and effectiveness by engaging in joint collaborative efforts.

Nathalie Fontana
ETH Zurich Foundation



If we meet someone who owes us thanks, we right away remember that. But how often do we meet someone to whom we owe thanks without remembering that.

Johann Wolfgang von Goethe

Donators D-BAUG

We'd like to thank the following companies, foundations und individuals who supported us in the year 2009, and likewise those who do not want to be mentioned by name:

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Prof. Dr. Willy Wilk
Hansjakob Windler
Maximilian Winkler
Walter Zumstein

Development of Student Figures

Teaching, a key aspect of our mission at D-BAUG, focuses on three Bachelor's and four Master's curricula courses to support doctoral studies and continuing professional education: Civil Engineering (CE), Environmental Engineering (EE), Geomatics and Planning (GP), and Spatial Development & Infrastructure Systems (SDIS, only MSc).

by Patrick Dilger, Planning & Controlling D-BAUG

From the year 2000 onwards, figures for new incoming students have shown a positive trend: they have actually more than tripled since D-BAUG was established in 1999 (Fig. 1), clearly surpassing the figures of the early 1990's.

In 2009, the number of incoming female students rose significantly to 81, which accounts for a good 28% of all incoming students. This represents a vast increase of 50% since 2008 and points towards a general trend at ETH Zurich: the number of first-year female students has never been so high. It can safely be said that the efforts made (e.g. 'ETH on the road' to meet grammar school pupils or the annual Researchers' Night) to attract more female students are beginning to pay off.

By the end of the 1960's, less than 5% of incoming students were female. This number increased to 25% by the end of the 1990's. Engineering, a field in which females were far and few between, has seen considerable growth in female registrants. In fact, Civil Engineering is attracting an increasing number of women who want to take up professions that serve society and produce results. Overall, however, Switzerland must further endeavour to draw more women towards the engineering professions. Most female students at ETH Zurich still pursue studies in architecture, pharmacy, sport, food science or biology.

The recently initiated Master's degree courses have developed nicely. Since the MSc programmes were introduced in 2006, the number of incoming MSc students has risen from 70 to 140 (Fig. 2). In the wake of the Bologna Reform, 2009 has been the second year to award Master's degree certificates (Fig. 3) to successful graduates. Compared to 2008, the number of graduates completing the course has doubled.

The number of doctoral graduates has increased steadily over the years, although the increase flattened and stabilised at 39 graduates last year. At the end of 2008, there were 204 registered doctoral students at D-BAUG. (Fig. 4).[1]

While in 2009, the University of Zurich had, for the first time ever, over 25,000 matriculated students, ETH Zurich has exceeded the impressive number of 15,000 students. Since the number of grammar school pupils completing their matriculation examinations ("Matura") is rising, it is expected that the overall number of students in Switzerland will increase during the next 3–4 years. Thereafter statistics show that this growth curve is expected to flatten.

[1] For additional figures, see Section *Facts & Figures*.

New incoming students at D-BAUG (BSc-level)

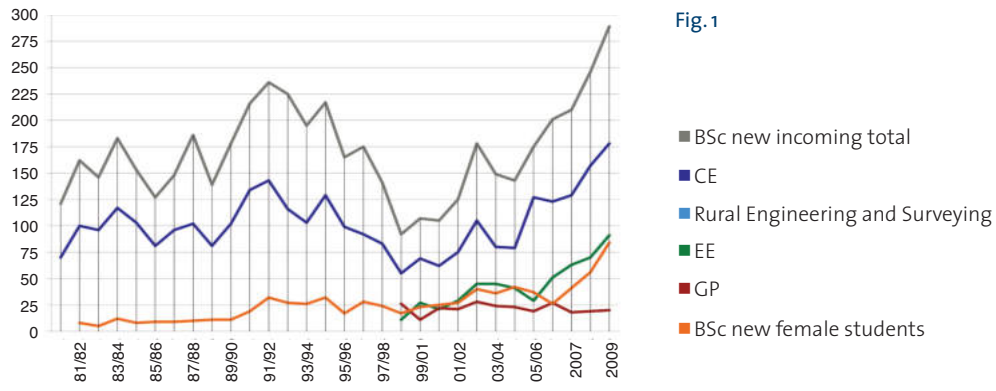

Fig. 1

New incoming students at D-BAUG (MSc-level)

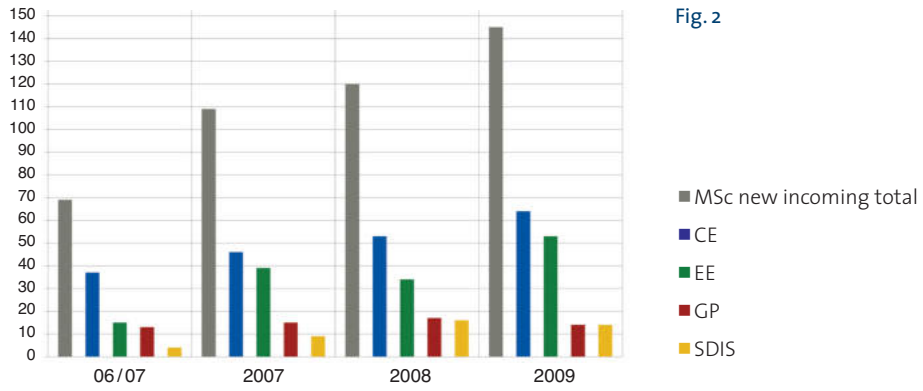

Fig. 2

MSc degrees (MSc ETH)

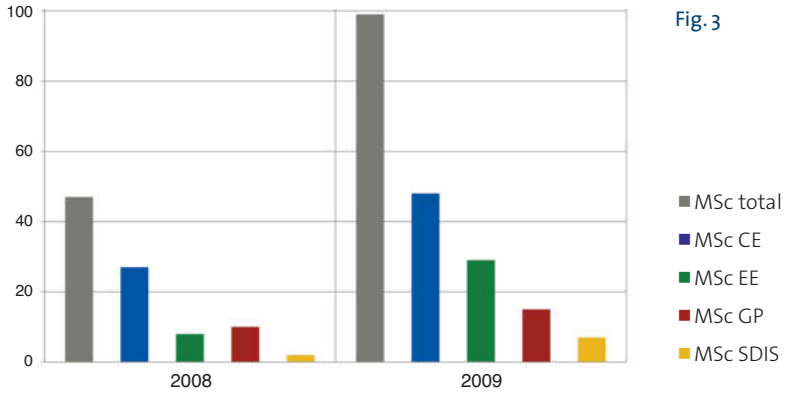

Fig. 3

Doctoral students and dissertations

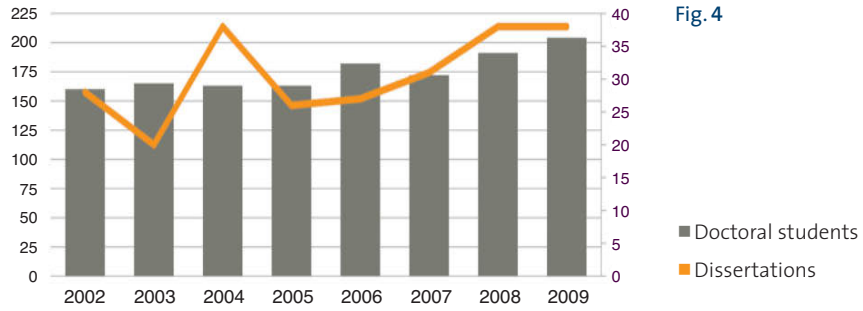

Fig. 4

Field Trip to Vienna's Water Supply and Waste Disposal Plant

Organised for the second consecutive year, the study excursion to Vienna's Water Supply and Waste Disposal Plant, which is an official course in the Master programme, was scheduled from 30 April – 3 May 2009.

by Michael Margreth (MSc Geography) / IfU
and Christian Maslo (Ing. Mag. [MSc in Engineering]), AQUA-PR and senior lecturer at the University of Vienna

Excursion overview

About 30 students studying environmental sciences and engineering at ETH Zurich, or geography at the University of Zurich, had the opportunity to visit Vienna's Water Supply site, its sewerage treatment plant, units and technical facilities, as well as its headwaters.

Stop in Vienna, the federal capital (30 April 2009)

During our one-day visit of our eastern neighbours' capital city, the students had a tour of the sewerage treatment plant, which was upgraded in 2005. Located to the south-east of Vienna in Simmering, the 11th Viennese district, the plant treats the entire effluent of the city's 1.8 million inhabitants. With a cleaning capacity of around 96%, this plant is the most modern of its type In Europe.

In the afternoon, we visited the water tower on Wienerberg in the 10th Viennese district, "Favoriten". Built between 1898 and 1899, the tower, which from 1910 was only used occasionally once the second Viennese mountain spring water line (German acronym: HQL) came into operation, was finally closed down in 1956. It is considered as a building of industrial historicism and is under monumental protection. The pressure for supplying the surrounding houses was enabled by the principle of "communicating vessels". Most impressive of all, visitors may look around the originally built technical facilities. In the evening of the first day of our visit, our entire delegation from Zurich was invited by the City of Vienna to a reception hosted by the mayor followed by dinner in the basement of the Viennese City Hall. Not only was this an ideal opportunity to interact socially and professionally with our colleagues from the Viennese water supply works, but our students could also relish the many delights of Viennese cuisine.

Stop at Vienna's Headwaters located in the provinces of Lower Austria and Steiermark (1–3 May 2009)

Vienna's drinking water supply is largely based on spring water which, considering its type and quality, is unique for a city with a population of one million people. Depending on whether the year was dry or wet, the percentage of spring water is between 92 to 98%. The remaining 2 to 8 % is groundwater in porous media and comes from ground water works (Lobau and the third Viennese water supply line in Moosbrunn). Spring water is extracted in the east Karst region of the northern Kalk Alps in the provinces of Lower Austria and Steiermark and is piped to Vienna via the first and second Viennese mountain spring water line. With the exception that the Pfannbauern spring water has to be pumped, drinking water from all the other springs flows to the Austrian metropolis only with the help of gravity along the ducts of the first and second Viennese mountain spring water line. About one sixth of the Austrian federal territory is covered by landscape shaping processes which are generally referred to as karst formation.

During our three-day visit of the City of Vienna's headwaters, the students were shown different types of springs: dolomite springs with a relatively constant delivery and lime springs with high fluctuating delivery. The connection between spring delivery and karst formation system in lime or dolomite inside the mountain is crucial. Since, before seepage in the karst rock, the water is filtered mostly only through a relatively thinly covered soil layer, the danger of contamination in the spring water catchment area is high. For this reason, the protection of the spring water catchment area – from the plateau to the spring water immersion points in the valleys – is of major importance.

Fig. 1: Participants of the Vienna water field trip May 2009.

Fig. 2

In particular, measures taken and developed, especially the implementation of protective measures, were brought home to our students. This included setting up sanctuaries in spring water catchment areas and constructing an elaborate monitoring system which, by means of specially developed sensors, measures the water quality parameters constantly online in very short intervals (e.g. of a minute). Needless to say, this guarantees a closing monitoring of the quality of the water. Such measures ensure an optimal management of the spring water and an excellent water quality for its consumers.

Our visit concluded with a tour of the water reservoir, Neusiedl am Steinfeld, which is considered to be one of the largest closed water reservoirs in Europe. It is mostly used to balance out the partly high fluctuating spring water delivery and to optimise water supply to the city of Vienna via the first mountain spring water line. A total of 600 million litres of water can be stored in four vaults which suffice to meet the water supply demand for 1.5 days. By means of a pipeline network stretching over 3300 kilometres, drinking water is delivered to over 100,000 house connections in the urban area.

This excursion provided our students with an excellent overview of the technical and financial complexities that have been involved in building both the mountain spring water lines and the adjacent facilities since 1873 when the first HQL went into operation. All the students thoroughly enjoyed the excursion and express their thanks to D-BAUG for financing the study trip.

Fig. 3: Route of drinking water from the karstic springs to the Austrian capital via the I. and II. Viennese pipeline network.

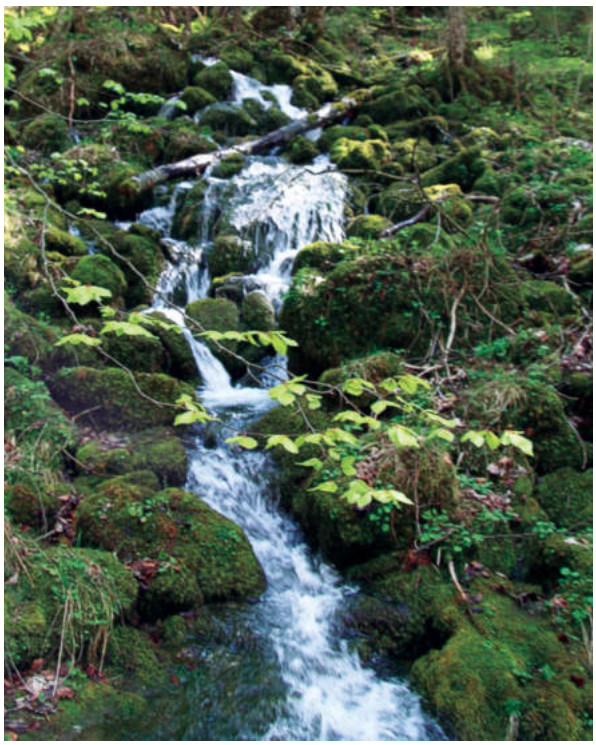

Fig. 4: Spring: Side branch of the Kläfferquelle covered with moss. With the capacity of a maximum 40'000 l s^{-1} is this spring the biggest chanelled karstic spring of Central Europe.

Fig. 6: Flowstone cave: Lime sediments of different shapes in the cave system of the Lurgrotte.

Fig. 5: Drinking water reservoir: Arches of the water container Neusiedl located in the suburbs.

Fig. 7

Fig. 8: Bird's eye view ot the sewerage treatment plant of Vienna .

Doctoral studies at the Department of Civil, Environmental and Geomatic Engineering

"Never again study – work, here I come!" In 2003, I was resolved to adhere to this motto following my geomatic engineering studies.

by Hans-Martin Zogg, Dr. sc. ETH

Now I am sure you are wondering for how long I kept that up ...? Motto here or there, after one year in the working world, I dared to return to university life for my PhD studies.

One thing at a time however! When I finished my degree course at ETH Zurich, I was tired of the constant exposure to an academic, theoretical and scientific environment, and simply wanted to get on with using this knowledge in the practical world. My geomatic engineering studies at ETH Zurich, referred to as a Master's degree in Geomatics and Planning since the Bologna Reform, were varied and thought-provoking. I had been well prepared for the working world. No sooner had I completed my diploma thesis on terrestrial laser scanners at the Institute of Geodesy and Photogrammetry than I had the chance to go directly and work at Leica Geosystems in the USA. What a unique opportunity to be able to work abroad in the industry! I gained considerable experience and began to realise that learning and instruction are also an integral part of the professional world. After spending one year in San Francisco, I decided to return to Switzerland and soon had the opportunity to take up PhD studies at the Institute of Geodesy and Photogrammetry (IGP), ETH Zurich, while maintaining contact with Leica Geosystems by attending to some smaller projects. That was certainly an offer I could not refuse and my "Never again study – work, here I come!" motto quickly faded into oblivion. The practical experience I gained during that year certainly encouraged me to take up PhD studies. It also emphasised the importance of a good education and participation at continuing education courses to enhance professional development. In addition, being able to study an interesting topic in-depth was very motivating.

So, in autumn 2004, I returned to the ETH, one year after my degree, to work as an assistant and doctoral student for Professor Ingensand, Chair of Geodetic Metrology and Engineering Geodesy. I spent half of my working time on teaching and the other half on researching terrestrial laser scanners and other smaller research projects. This combination of activities gave me great diversity at work. Initially, I was challenged by the direct contact with the students. It was no longer a matter of asking the assistant questions as in my student days – I myself now had to answer them! Since I always strove to give clear explanations which the students could follow, I could not formulate my answers in a sparse few words. I tried to get down to their level and to recall my own experiences and expectations as a student. As a result, my teaching memories are still very positive. I tutored students taking surveying courses and those preparing their Master's thesis. Needless to say, working as an assistant did have its drawbacks: the lectures and exercises, as well as the students' questions, became repetitive. Still, two major highlights during my time as an assistant at ETH Zurich soon obliterated the negative aspects: organising and conducting the 3-week geodetic project course for Master's students in Sedrun and, in autumn 2006, accompanying Master's students on their final year trip to Lisbon.

I had not just returned to the ETH to teach, but rather to continue my research studies and prepare my dissertation. Concluding my research project required a great deal of energy, particularly when my research work was making no progress. This is, needless to say, part of a researcher's life and I had to learn how to cope with setbacks or the unexpected when experiments did not go just quite the way they should have. But, sure enough,

Fig. 1: ISPRS Congress 2008 in Peking. The congress centre was right beside the "bird's nest" (Olympia Stadion).

Fig. 2: Presentation of research results at the third Swiss-Baltic Week 2008 in Tallinn.

Fig. 3: Basic surveying at the Gotthard intermediary construction phase in Sedrun with visiting scientists from Lituania (2005).

every cloud has a silver lining and, slowly but surely, my research progressed. After about two years of research work, a small light finally appeared at the end of the tunnel encircling my PhD studies: the motivation to complete my studies and prepare my dissertation. During the entire period, the Institute of Geodesy and Photogrammetry provided me with an excellent environment to conduct my research work, not only in terms of its infrastructure, but also thanks to the scientific competence of the professors and staff working at the Institute.

In those four years spent at the Institute, I learned to experience and appreciate scientific exchange between research groups in an international environment. The various seminars, conferences and congresses were welcome highlights in the everyday life of a scientist. Besides being exposed to new thinking and perception processes, I also got to know new cultures by participating at conferences in Graz, Vilnius, Fulda and Tallinn. I especially remember the ISPRS Congress (ISPRS – International Society for Photogrammetry and Remote Sensing) in Peking which took place in summer 2008 shortly before the Olympic Games. Naturally, the Olympic spirit penetrated the scientific lectures and reflected itself in both the content and the diverse levels of the contributions.

In autumn 2008, I concluded my PhD studies by handing in my dissertation, the defence of which was my last official exam at ETH Zurich. I had to, or rather could, present my results obtained over a research period of four years to a large audience. Primarily, I had to defend my results by answering the assessors' critical questions and presenting convincing counter-arguments.

In retrospect, and considering the experience I gained at work immediately after my doctorate, I would definitely register again for PhD studies. The scientific and cultural diversity, the collegiality and the optimal research environment are, in my opinion, unique at ETH Zurich. My motto, "Never again study – work, here I come!", is certainly part of history, and I am more convinced than ever that taking up PhD studies at ETH Zurich provides optimal qualifications for life and work.

Fig. 4: Research project surveying in an extraordinary setting on the Jungfraujoch (2007).

Fig. 5: Swiss and Baltic State researchers' scientific meeting at the second Swiss-Baltic Week 2007 in Lituania.

Fig. 6: Poster session at the MCG Conference (International Conference on Machine, Control and Guidance) in Zurich (2008).

Fig. 7: Evaluating surveying data during the geodetic project course at the course centre in Sedrun (2007).

The Juneau Icefield Research Program – A long-term study on the implications of climate change

Glaciers are significant indicators for climate change and research teams around the globe try to analyze and understand the process of glacial changes. The Juneau Icefield in Alaska has been subject to such research since 1946 and measurements for the interpretation of climate change implications are available for more than 60 years. The geodetic surveys and processed data serve as basic data for this purpose.

by Werner Stempfhuber / IGP; Melanie Kunz / IKA

Approximately 5% of Alaska is permanently covered by ice and snow. The Juneau Icefield is referred to as 5th largest contiguous glacial area in the western hemisphere and covers an area of over 4000 km^2. Situated in the north of the Alaskan capitol Juneau, the Icefield consists of about 140 glaciers, some as long as 30 km and the main glacier with the name of Taku is over 1400 m thick. The area was mapped by the Preliminary Boundary Survey from 1983 to 1894 and again from 1906 to 1910 with more sophisticated methods. After World War II the Juneau Icefield Research Program (JIRP) was founded under the leadership of Dr. Maynard M. Miller (University of Idaho). Since 1946 JIRP expeditions are run every year which makes the Juneau Icefield one of the most explored glacial areas worldwide.

The Juneau Icefield Research Program (JIRP)

Every summer scientists cross the Juneau Icefield with a group of students from the southern end towards Atlin (Canada) in the north. Equipped with the latest survey hardware they gather and analyze data to answer glaciological questions in the domain of glacier dynamics and mass balance. The scope of the research and training program is to offer practical projects based on the following fields: glaciology, hydrology, geology, geomorphology, geophysics, geodesy, photogrammetry, remote sensing, meteorology, botany, as well as environmental and resource protection. This long-term study produces answers to current questions about climate change through countless publications and dissertations (crevassezone.org/reports-JIRP.htm). The extensive JIRP infrastructure encompasses around 20 base camps and allows for a convenient stay on the icefield. However, research teams and students have to cover the 150 km long way across the glaciers only with their skis, carrying all their gear with them. And exactly these experiences fascinate every JIRP participant and make an unforgettable memory (Fig. 1). In the year 2009 an ETH staff member was able to actively join this research program and spend an amazing summer in Alaska.

JIRP is run by the Glaciological & Arctic Sciences Institute of the University of Idaho and by the Foundation for Glacier and Environmental Research. The collected information about the program and an extensive literature list are available at crevassezone.org and www.juneauicefield.com.

Surveying the Juneau Icefield

From 1946 to 2009 countless surveys have been conducted, the data analyzed and visualized. Because the early surveys were based on theodolite and distance measurements, a holistic processing of all available survey data is not fully possible. Since 1992 all longitudinal and cross sections on the icefield are surveyed with the help of 2-frequency GPS receivers and for the last few years also with GLONASS receivers. With this global surveying method processing and visualization of the geodetic data are possible in a continuous system. In Figure 3 (upper left) all surveyed longitudinal and cross profiles are presented graphically in a georeferenced LandSat-satellite picture. With the available stakeout and reference points the profiles can easily be staked out and measured in real-time. The two plots of results (Fig. 3, upper right and middle) show the changes over the years exemplary for a profile on Taku glacier. Together with the information on annual layers gathered in the snow pits, mass balances can be modeled. Some cross profiles are measured twice during the season, which provides information on the flow rate of the glacier surface. On Taku glacier this velocity is over 60 cm per day (Fig. 3, bottom). Long-term surveys on Lemon Creek glacier (Fig. 4, left), which have been analyzed and evaluated in connection with the International Geophysical Year of the American Geographical Society between 1957 to 1999, resulted in a decrease of the total mass from 901 x 10^6 km^3 to 695 x 10^6 km^3. This

Fig. 1: above – Gilkey Trench; below – small Building at Camp 18.

Fig. 2: Left – GPS-reference point near Camp 10; right – GPS-rover survey on Taku glacier.

trend can also be observed in the GPS surveys from 2001 to 2009 (Fig. 4, right), which provide point and line data for the determination of ablation, flow rate and analysis of glacier deformation. In order to conduct a holistic evaluation of mass balance, information on precipitation, topography, meteorology, as well as runoff and inflow over the whole glacial area have to be considered.

Nowadays also terrestrial and remote sensing methodology can be used for the survey of glacier surfaces. CryoSat-2 is a satellite which has been built for the precise determination of elevation-changes in areas covered by snow and ice. This satellite mission is expected to start soon (www.cryosat.de). To help this mission, a preparation of the available survey data is necessary. At the moment a database for the consistent handling of the survey data and additional information is being built and filled. This homogeneous system forms the basis for further research projects. Apart from the future satellite surveys for the exact determination of the thickness and surface position of the ice research projects in the field of strain and stress analysis as well as the derivation of uplift rates (momentarily approx. 11 mm/year) are planned. For this purpose a monitoring system which delivers data to the office 365 days a year would be helpful. Preliminary assessments for such a project have already been conducted.

Outlook

So far the geodetic JIRP projects have been limited to surveying profiles with RTKDGNSS. However, the existing data represent a unique series of measurements for an analysis of the icefield. The survey data accurately document the annual changes of the surface and form the basis for all further research. With the future satellite data even more high quality data will be available, allowing for new research perspectives. Since these data have first to be verified via ground control points, the expedition team is still facing new challenges.

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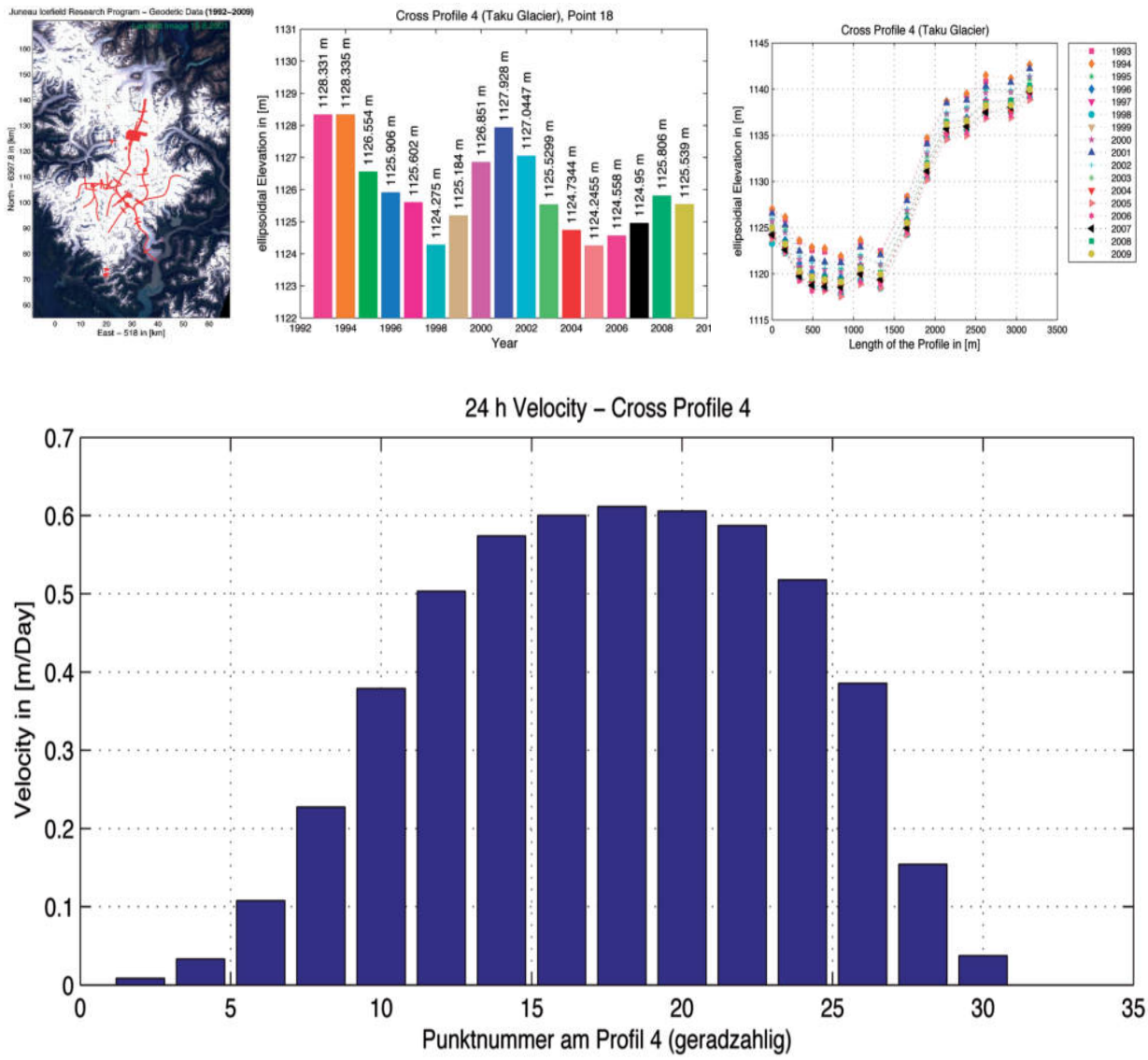

Fig 3: Upper left – Longitudinal and cross profiles on the Juneau Icefield; upper right and middle – Example of cross section surveys on Taku glacier, plot of the elevation of a point in the middle of the glacier; bottom – velocity vector on Taku glacier.

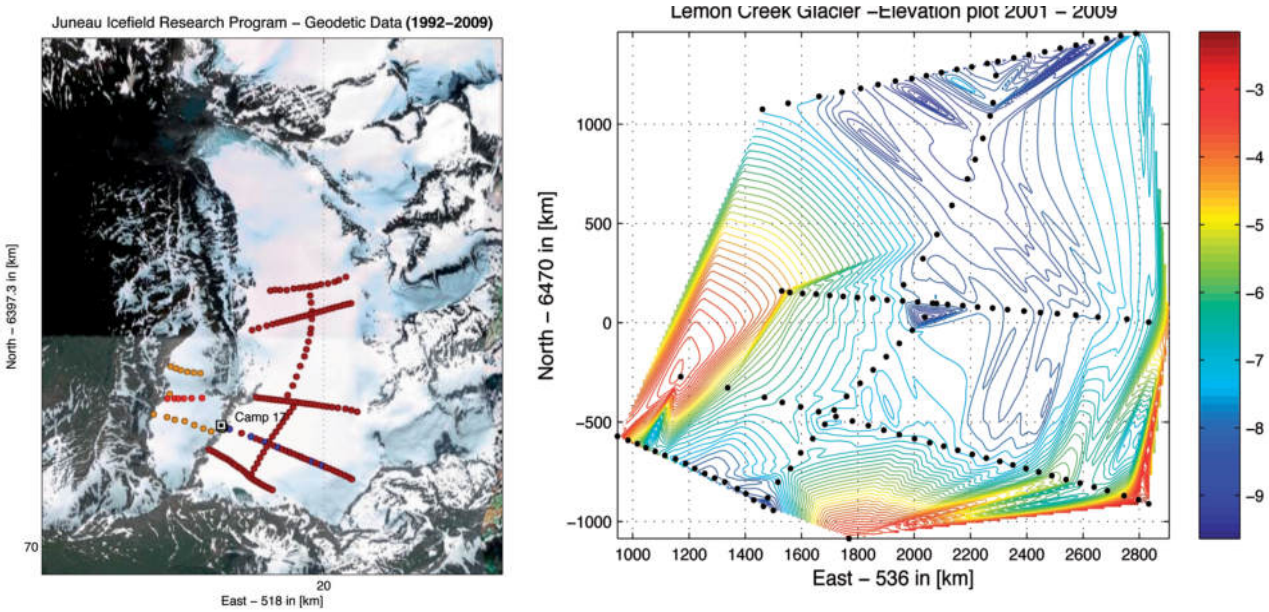

Fig. 4: left – areal changes on Lemon Creek and Ptarmigan glacier; right – Elevation changes on Lemon Creek glacier.

The Rüdlingen Monitoring and Landslide Experiment

A large scale field experiment was conducted on a steep forested slope in north Switzerland to trigger a landslide by means of artificial rainfall. The experiment was successful and has delivered valuable knowledge about the behaviour of landslides.

by Sarah Springman, Amin Askarinejad, Peter Kienzler, Francesca Casini, Marco Sperl, Ernst Bleiker / IGT;
Devrim Akca, Armin Grün, Professur für Photogrammetrie / IGP

One of the many strengths of working in Switzerland and at the ETH Zurich is the many and varied possibilities to engage in 'big picture' research that offers an opportunity to contribute within a multidisciplinary environment to solve a problem of societal concern. In this case, civil and geomatic engineers were at the centre of a fascinating project that sought to expose the ways in which landslides would be triggered, leading to understanding about initiation of failure and the subsequent movement of the displaced soil. Earlier field experiments in Gruben (Teysseire, 2006) and Tössegg (Thielen, 2007) were forerunner doctoral projects that were largely focused on geotechnical aspects alone. Nonetheless, they contributed much useful knowledge for the planning and execution of this project as well as a clear understanding that we needed to incorporate input from colleagues in the fields of geology, hydrology, soil physics, geophysics, photogrammetry, bio-engineering and instrumentation and sensor technology.

The Competence Centre for Environmental Sustainability has provided the stimulus for an overarching project entitled TRAMM[1], Triggering of Rapid Mass Movements, in which groups from WSL, ETHZ and EPFL, coordinated by Dr Manfred Stähli, have focused their research on enhancing understanding of triggering and initiation mechanisms, including the transition from slow to fast mass movement processes, and flow characteristics of such catastrophic mass movements. The roles of heterogeneity of hydro-mechanical slope processes on the onset of snow avalanches, landslides, and debris flows are also being studied by other research groups.

The Rüdlingen Experiment was a sub-project within TRAMM, led by the first author. The express purpose was to trigger a rainfall induced landslide, having characterised the slope, instrumented it with a range of state of the art sensors to observe its response to the environmental loading and exposed it to 24 hour observation using high resolution cameras to witness the slide. Rüdlingen village (Fig. 1) was chosen following an extreme event in May 2002 in which 100 mm of rain had fallen in 40 minutes, leading to 42 landslides around the local area. Student projects were carried out in three of these locations in 2003 during the remediation period, in support of the local council. The Council President, Katy Leutenegger was open to the idea of a controlled experiment being conducted on a slope within their territory, when she was approached in 2007. Permission was obtained to fell a few trees, which were mainly at the boundaries of the slope. The Schaffhausen cantonal authorities, represented by their delegate for natural hazards, Jürg Schulthess, and the neighbouring Buchberg village were both supportive and interested in the outcomes of the research, which has already been reported back to the community in 2010. Local assistance was essential at a practical level during the period of the experiment and in the clean up afterwards!

Having identified a possible steep forested slope that would be susceptible to slope instability on the basis of geology, topography, accessibility, vegetation and expected ground profile (Fig. 2), it was necessary to characterise the layers of soil and determine depth to rock to decide whether the experiment would be feasible or not. A series of test pits were dug around the edges of the projected test field to determine soil layering, investigate the root systems, locate rock depth and extract soil samples to enable the relevant properties to be measured. Infiltration tests

[1] http://www.cces.ethz.ch/projects/hazri/tramm

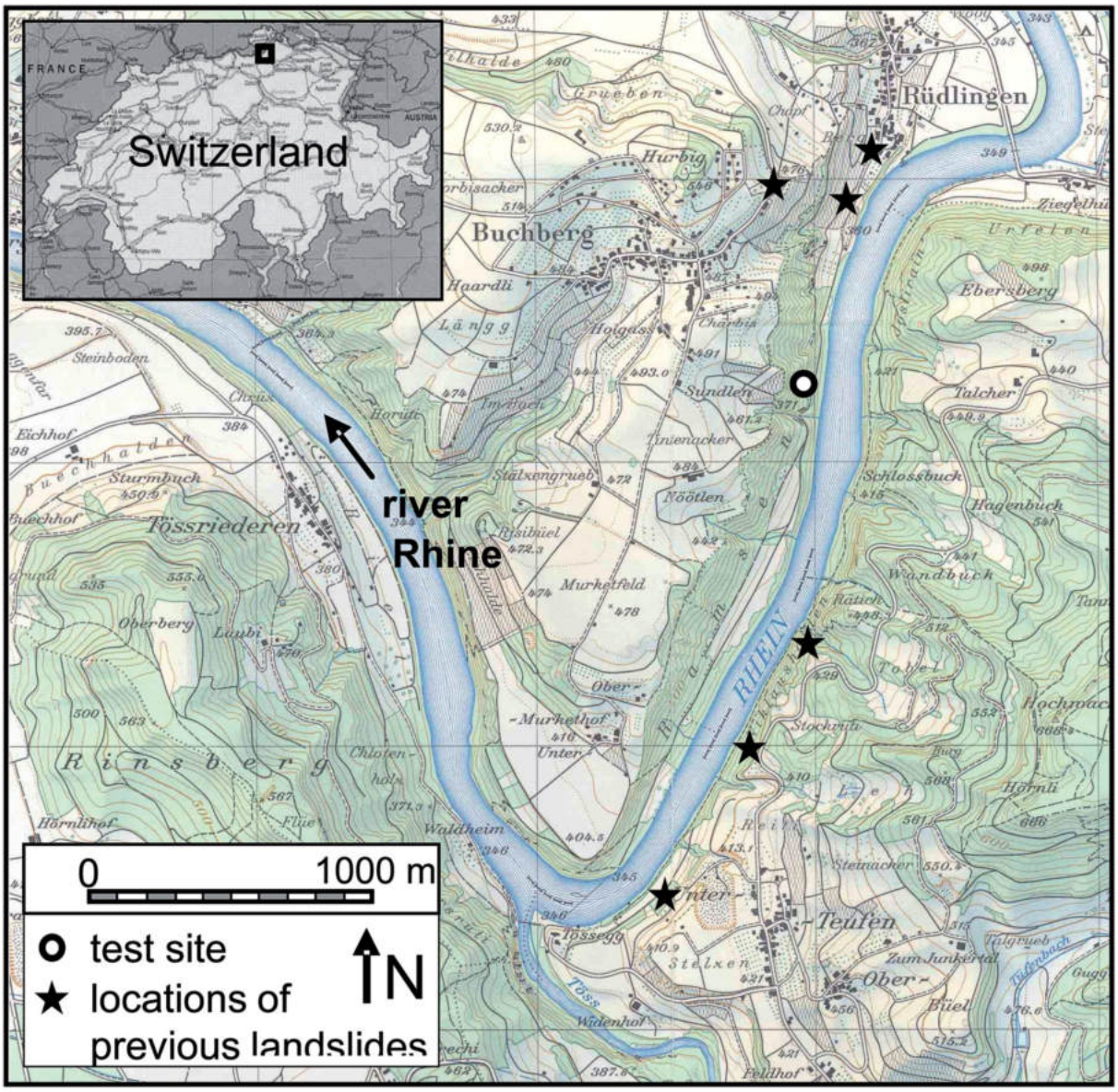

Fig. 1: Location of the test site, detailed map and map of Switzerland (after Sieber, 2003).

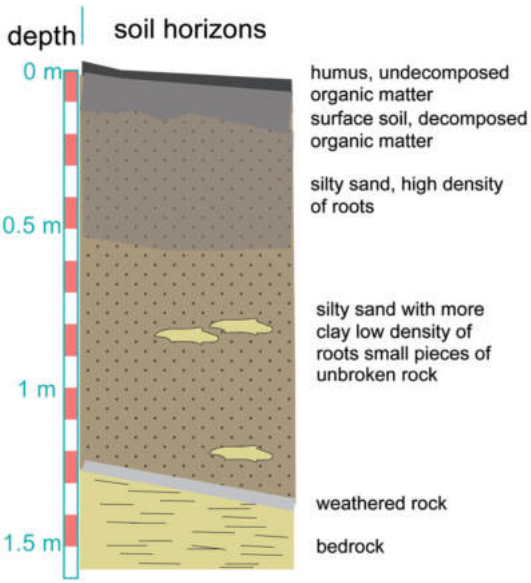

Fig. 2: Soil profile from upper part of the slope.

Fig. 3: Dye pattern in the middle section of a test pit (scale: from ground surface to 1.3 m depth).

were also carried out, using water coloured with brilliant blue dye, to investigate the mode and speed of infiltration of water into the ground (Fig. 3). These exhibited homogeneous saturation and staining of the soil profile (Fig. 3) with only little preferential flow and possible local build up of a perched water table at the transition to bedrock (here at 1 m depth), which confirmed the high vulnerability of the slope to a deep-seated failure above the transition to bedrock rather than a near-surface failure. Furthermore, since a small percentage of active clay minerals, increasing with depth, were found in the soil, and these would tend to reduce the soil strength and the permeability, it was quickly established that a likely failure surface would lie above the bedrock at between 1 and 2 m depth. State of the art seismic dilatometer testing was also conducted by Andreas Schmid and René Rohr (IGT: Chair Geomechanics) to deliver shear wave velocity near the surface. Combined with the planned area of the experimental test field of 35 m longitudinally and 7 m transversely on the slope, around 500 m^3 of debris could be mobilised in the worst case: a not insignificant amount! Since much of this could have been expected to flow over the road and into the Rhine, protection measures were sought with the help of GEOBRUGG, who generously donated two panels of their Swiss made ring net, instrumented to measure force at impact.

The reasons why a slope fails suddenly due to rainfall can be compared to the collapse of a sandcastle due rainfall or flooding. The capillary action of at the water-air-soil particle interface in partially saturated ground adds strength to the soil due to the suctions that increase contact stresses between the particles. As the ground saturates due to infiltration, the suctions reduce as does the shear resistance in the ground, with the reverse condition emerging as soil saturates and a groundwater table rises. In this case, increasing hydrostatic porewater pressures reduce contact stresses and hence the strength. The relationship between the degree of saturation and the suction becomes a critical means of evaluating the contribution to strength (see Fig. 6).

A 4-camera arrangement was adopted for the image acquisition. IDS cameras were placed in housing shields to protect them against environmental effects and two each were equipped with 8.0 mm and 12.0 mm C-mount lenses. They were fixed on two tall trees at the foot of the slope (Fig. 4) at approximately 25 metres height by a professional climber. Approximately 250 white ping-pong balls (with diameter 40 mm) were glued onto wooden pegs and embedded in the ground in a 1 m by 1 m grid (Fig. 4). 21 well distributed ground control points were established on the surrounding stable trees. The a priori point positioning accuracy of the ping-pong balls, using an in-house developed network simulation tool, was estimated as ± 10.3 mm along the horizontal direction and ± 3.5 mm along the vertical direction. In the second sprinkling experiment, the area of interest was moved ca. 5 metres up the slope. In order to make the targets more discernable on the image space, the ping-pong balls were replaced with approximately 80 white tennis balls. A posteriori point positioning accuracy obtained from bundle adjustment in the first sprinkling experiment was ± 16.5 mm along the horizontal direction and ± 3.4 mm along the vertical direction. For the second experiment, these values were ± 11.0 mm and ± 4.3 mm for the horizontal and vertical directions, respectively. Just prior to the monitoring experiment in October 2008, Cornelia Brönnimann (EPFL), conducted a pumping test close to the lowest instrument cluster above bedrock. No groundwater table could be sustained. This rejected one of the possible triggering mechanisms due to watertable rise. Furthermore, geophysical monitoring conducted by Klaus Holliger's group from Uni Lausanne, led by Barbara Suski with Francesca Gambazzi, indicated the likelihood of a strata change in the underlying Molasse rocks, which would confirm the presence of cracking in the more competent coarse grained Susswasser Molasse compared to the weaker, fine grained Meereswasser Molasse.

A safety concept was also set up to make sure that noone was buried during the landslide, since it was predicted that failure would occur within a matter of seconds, and it would not be possible to escape the muddy onslaught. The observational method was used as a decision-making framework depending on the degree of saturation and suction with depth, linked to stability calculations of a predicted failure mechanism (Fig. 6). A traffic light system backed up with appropriate observations, measurements and permitted actions at each level, set up clear command, control and communications between the team members and the local community. A 'red' state meant that the slope could fail at any time and so noone was permitted to pass below the net or within 20 m of the slope.

Connecting up the water supply (Figs. 7a, b, c) was successfully achieved. The first experiment ran in October 2008. After a preliminary testing phase, a total of 1.7 m of rainfall, calculated as an average over the slope area, was supplied over 3.5 days. The mode of saturation of the ground was observed and some deformations were measured in the top right quarter of the field, but failure did not occur. Furthermore, some extremely promising technology using acoustic sensors developed (Fig. 4) by D-BAUG Associate Dani Or's group, were installed by Gernot Michelmayr and hinted at some significant shear movement during one of the most extreme rainfall periods (at 40 mm/hour), that was supported by data from both the surface deformations and the inclinometers.

The research team concluded that failure had not occurred on two accounts, because of the leaky base rock in the lower half of the slope, where the greatest part of the water had been supplied so that a groundwater table could not rise and root reinforcement, characterised by WSL/STEP doctoral researcher Massimiliano Schwarz, from a tree stump in the lower left quadrant of the slope.

Measures taken included confirming that there was less permeable base rock underlying the top of slope to permit a groundwater table to rise during the rainfall event, and re-orienting the sprinklers at closer spacings, further up the

Fig. 4: Location of the instrumentation clusters (Cl. 1 – 3), the sprinklers and the photogrammetry cameras.

Fig. 5: Deformation probe.

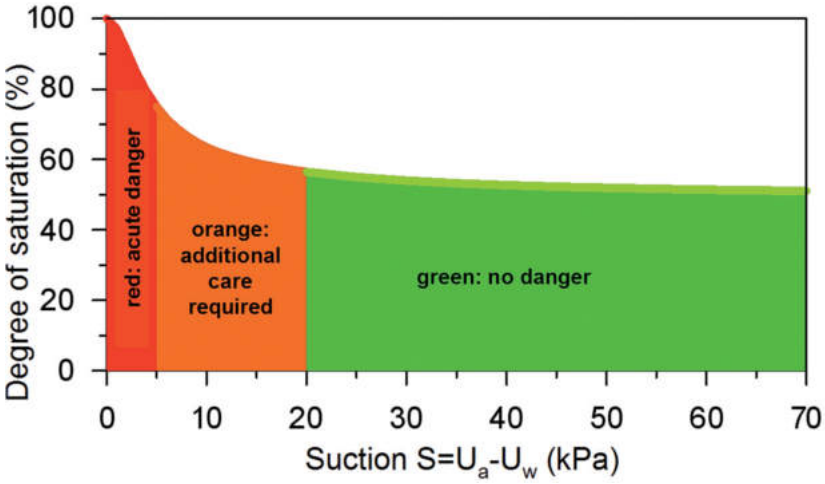

Fig. 6: Decision – making graph for the observational method.

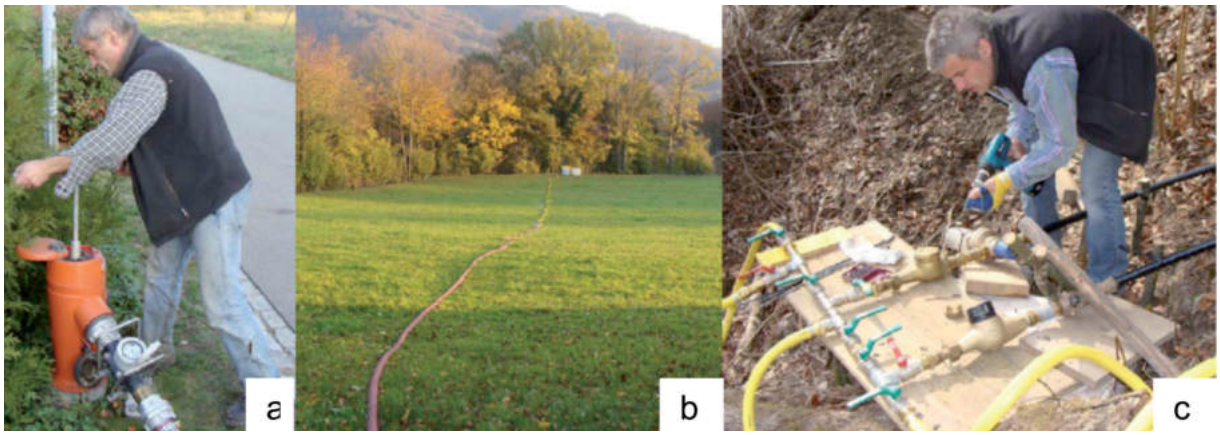

Fig. 7: a) Supply of water from a hydrant, b) long water pipe to the test field c) water-meters and main connections to the sprinklers.

slope (Fig. 8), where less influence was expected from the vegetation and a rising groundwater table would be possible. Roots were severed to a depth of 40 cm along the sides of the field and more extensive tracer / run-off experiments were planned for a follow-up experiment in March 2009 over 2 weeks, so that saturation could be achieved prior to initiating failure.

Pre-test predictions of a failure event were as follows: a landslide would be triggered towards the end of the first week, it would be initiated in the top right quadrant, and travel towards the bottom right of the field, with a failure surface at a depth of about 1.5 m, mobilising between 100–300m³ of debris.

With newly aligned sprinklers, the rainfall was adjusted to an average distribution of 15 mm/h. There was an instant response in the upper part of the field as the saturation degree increased, suctions dropped and then the water table rose over 5 h to about 1.5 m below ground level, where it stayed for the next 10 h. 15 h after the rainfall had begun, at 3:00 am, the upper right quadrant started to creep downslope, with the rate increasing until 3:23 am (Fig. 9). A crack opened up parallel to the top of the test field, and as the failure surface spread through the ground, the right hand side of the landslide followed the scar made through the vegetation and the left ripped away from and through the surficial vegetation (Fig. 10). It took 36 seconds to mobilise about 130 m^3 (3 super script) of soil and roots, which travelled left towards the tree stump in the lower part of the field, which re-directed the flow to accelerate towards the bottom right, whereupon it took only 12 seconds more to impact on the protection net. Not one grain of debris reached the forest road below (Fig. 11). Water oozed out of the back scarp for several minutes after the event and the research team celebrated 'a bonnie slide', which was quite well predicted in size and shape. The difficulty of estimating the time to failure was emphasised however.

Lessons for the locals include that a cracked base rock is very effective at draining the overlying ground, rather like trying to fill up a bath when the plug is not in! The challenges of slope instabilities lie when shallow soil layers overly semi-impermeable rock so that a water table can build up locally or even flow out of the ground. Useful hints to such episodic springs can be obtained from vegetation and during winter from the build up of ice (Fig. 12). In general, vegetation has a very positive effect on slope stability, with tree roots acting as effective deep reinforcement, which could be quantified by the experiment.

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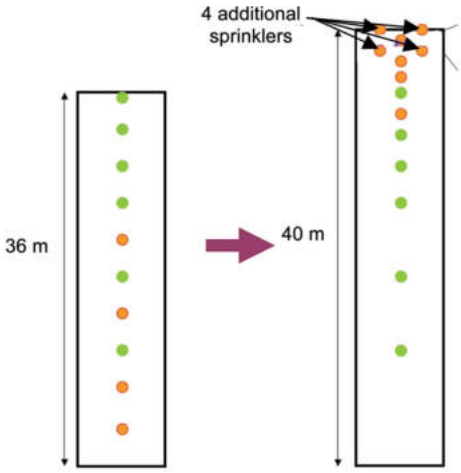


▲ Fig. 8: Sprinkler locations: October 2008 (left); March 2009 (right).

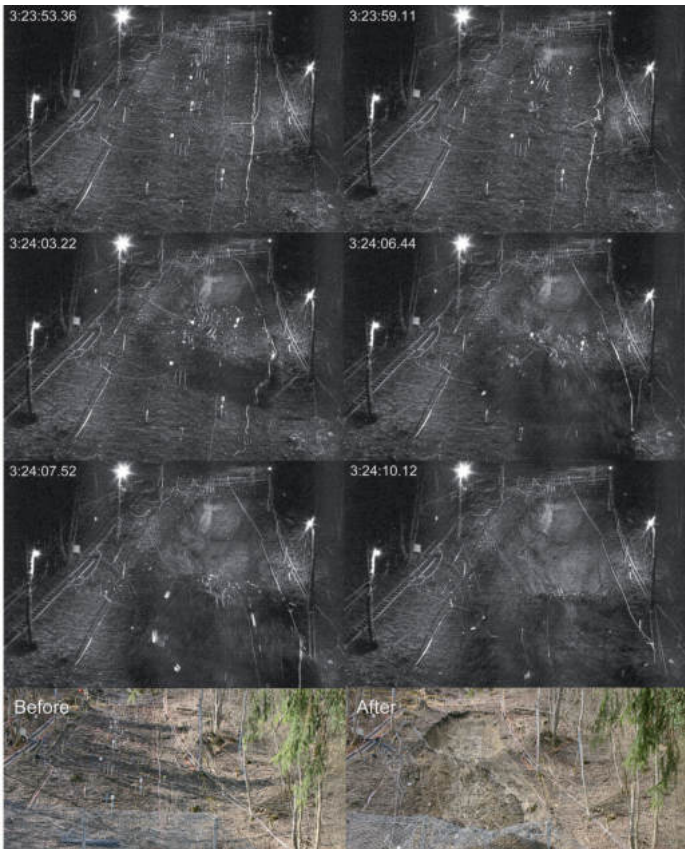


Fig. 9: Sequence of movements in the upper part of the slope[1]. ▶
[1] Vgl. Video auf:
http://www.cces.ethz.ch/projects/hazri/tramm/film_landslide_ruedlingen.wmv

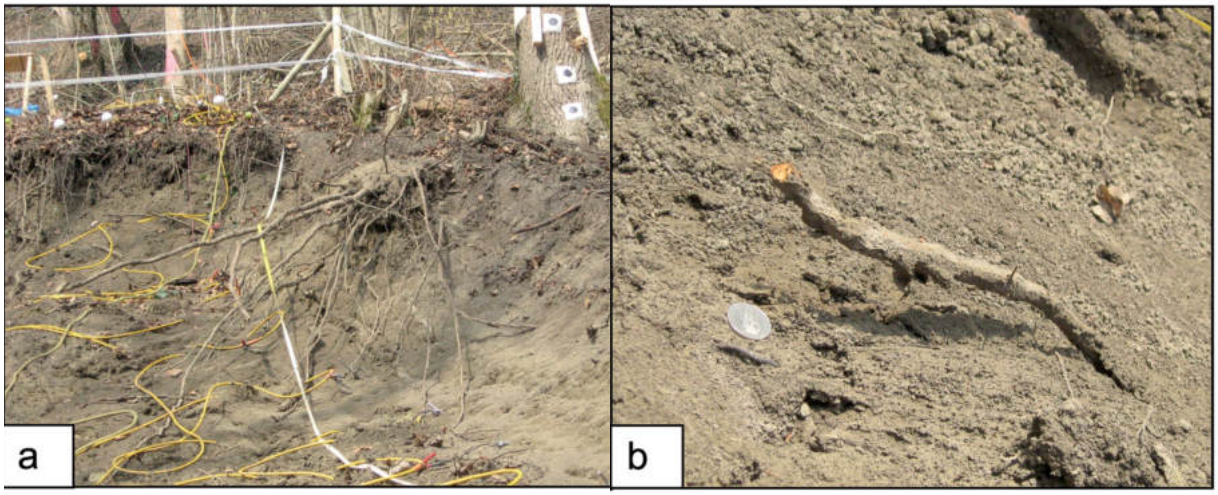


Fig. 10: a) Pulled out or b) broken roots at the side of the failure wedge.

Fig. 11: GEOBRUGG net containing debris.

Fig. 12: Frozen springs.

Raum+: A project to assess land reserves for settlements – a contribution to sustainable spatial development1

One of the most strategic tasks for spatial development in the near future is the reduction of the consumption of land in our cities and regions.

by Bernd Scholl und Hany Elgendy / IRL

Innenentwicklung vor Aussenentwicklung

In the 1990s, the amount of land in Switzerland already in use for development purposes was ca. 400 m² of land per person. (Arealstatistik des Bundesamtes für Statistik, BFS 1992/1997). Since then, land consumption has been disconnected from population growth, as in other European countries, and continues to grow steadily. Every second about one square meter of land in Switzerland is sealed for settlement purposes – about eight hectares per day (Arealstatistik, BFS 1992/1997).

The main driving forces behind this development are the continuously changing demographic structure, increased individual mobility, increasing prosperity as well as changing demands on living space by the Swiss population. In recent times, a new upsurge in population numbers has added to the problem. The results are expressed in the increasing amount of living space per person. In Switzerland, living space per resident climbed from 34 m² in 1980 to 44 m² in 2000 (BFS: Eidgenössische Volkszählung, 1980 & 2000]. At present, this important statistic lies at ca. 50 m². Looking at this figure in relation to the number of residents, it shows that Switzerland has a relatively high ratio compared to land use in other European countries.

Many of the investigations of recent years have delivered numerous supporting evidences that show the reduction of land use can help avoid some undesirable developments, for example, in conflicts between areas designated for settlement, landscape and transport. Against the background of the demographic developments, an economical use of energy and available (but always more limited) financial resources gives limiting settlement areas additional topicality and expanded dimensions. In the meantime, the strategic significance of a reduction in the amount of land used for settlement purposes has also been politically recognised. The economical use of land is anchored in the Federal Constitution and was established in Article 1 of the 2006 Federal Law on Spatial Planning (Bundesgesetz über die Raumplanung 2006). As a consequence, "inner development before new development" is now finding a place in land-use planning strategies in Switzerland (Bundesamt für Raumentwicklung – ARE 1996).

As a minimum effort towards sustainable spatial development, the strategy of inner development before new development is not only an effort to halt the use of valuable cultural land and to steer settlement development towards inner development , it is also to promote a transformation of the current inventory. Thus, its intention is not to bring spatial development to a standstill, but rather to manage the use of settlement land. In truth, the transformation that more than doubled the settlement inventory in the last 50 years is the actual central challenge and a task for future spatial development. This will also trigger large investments for the renovation and expansion of the building inventory and the infrastructure, as has happened in the past.

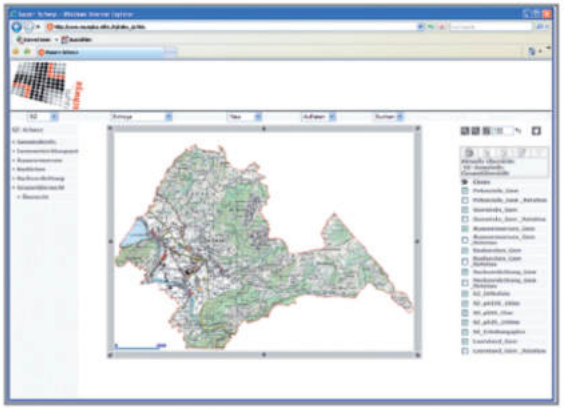
Following the inner development before new development principle, however, requires an overview of potential settlement areas, i.e., quantities, qualities and availability. The usual information in a spatial inventory only includes quantitative information on the settlement reserves outside the currently settled areas or infill areas within the settlement. It does not give specific information at the level of land parcels. Other important potential sites, e.g., disposable or fallow areas, have not been available in the records for a considerable amount of time.

To fill this information gap, a site-by-site overview of the potential areas is required to finally make the distribution pattern of potential areas visible. The overviews also bring

Cooperation and dialogue-oriented

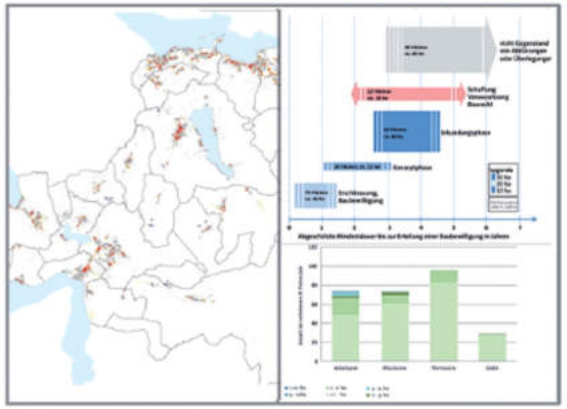
- Actors on site often have very good and usually very detailed knowledge on land use
- Introduction to the subject for community representatives
- Opportunity for exchange between canton and communities away from formal events and situations

Decentralized and adjustable



- Access to data is independent of time and place
- Added value for communities
- Follow-up and updating are possible

Overview and situation assessment



- Uniform consideration in community comparisons
- Strategic development differentiated and field-appropriate possible
- Mobilisation obstacles
- Spatial distribution

Fig. 1: The methodological approach of Raum+.

in information on temporal availability and potential obstacles through the activation of available potential areas. This is the purpose of the Raum+ initiative from the ETH Zurich Chair for Spatial Development.

Raum+: The methodological approach

The first Raum+ initiative was launched in 2006 as a cooperative project by six regions of Baden-Württemberg (with over 400 communities), the Canton of Basel-Landschaft (with all its cities and communities), the Environment and Economic Ministries of Baden-Württemberg, the University of Karlsruhe and ETH Zurich. By its conclusion in 2008, the project had provided a wealth of experience in the methodology of surveys and their evaluation. These experiences were incorporated into the pilot project in the Canton of Schwyz, which will be reported later in this report.

Raum+ is a problem-oriented project that tests the possibilities and limits of inter-municipal cooperation. The basis of the project is made up of problem-oriented and cross-border overviews of potential settlement areas in inner cities and suburbs in a form that can be adjusted and brought up to date. Along with the overview, a resilient and flexible basis for the discussion and adjustment of the existing approaches, planning instruments and promotion mechanisms for sustainable land management should be created.

The core of the methodological approach of Raum+ is to make an instrument available to the cities and communities of the various cantons that will provide an overview of any potential settlement areas necessary for their cantonal spatial development, without involving any major effort[1]. In addition, expert consultants are provided to help in the creation and regular updating of the overviews. This survey of the community and its follow-up become the foundation for the generation of overviews of potential settlement areas for the canton and perhaps in future for all of Switzerland. An essential element of this activity is an Internet-based platform that allows information to be gathered independent of time and place. The access eligibility for the platform can be decided by the participants and correspondingly regulated by them. The basis for the Raum+ approach is built upon the following three fundamental elements:

- Cooperation and dialogue-oriented: a cooperative approach based on trust is critical for regional land management.
- Decentralised and updateable: The basis of the Raum+ approach is an Internet-based planning information system that is decentralised, accessible and updateable.
- Overview and situation evaluation: The Raum+ approach enables, for the first time, the evaluation of potential settlement areas by quantity, spatial distribution and quality, as well as across administrative boundaries.

Raum+ in Canton Schwyz

In 2007, the Canton of Schwyz and the Federal Office for Spatial Development (ARE) took the initiative to create an overview of settlement area reserves throughout the canton. A further goal of the initiative was to update the Canton's Planning Guide 2006 within the framework of the approval process and, based on the information gathered, to make a discussion about the existing building zone reserves possible. The resulting project, Potential settlement areas for a spatial development policy of 'inner development first' – Raum+ Schwyz, was conducted by ETH Zurich in cooperation with ARE as part of the pilot project on sustainable settlement development. A total of 30 communities in the Canton of Schwyz participated in the project.

The existing settlement area reserves within the legally binding building zones of these communities were surveyed and divided into the following three categories:

- Inner development potential: areas larger than 2,000 m2 within the current settlement area, both built up and not built up areas.
- Building gaps: ready to build land parcels and classic building sites with an area between 200 and 2,000 m2, inside or outside of the current settlement area.
- External reserves: areas larger than 2,000 m2, outside of the current settlement area that are not built up.

A total of 1,724 potential settlement areas were surveyed in the Canton of Schwyz with a total surface area of 541 ha. Of these, more than half are within a current settlement area and corresponds to an area of 15 m2 per capita (residents and workers in a spatial unit). Transferred into the survey's three categories, about 307 ha have inner development potential and infill areas that can be placed at the canton's disposal. The remainder, about ca. 234 ha, are reserves outside the current settlement area, but within the legally defined building zones.

If, for example, the inner development potential and infill areas were completely consumed in residential areas, a mid-sized utilisation of 0.4, about a million square meters of floor space, could be created. This would allow, using a simplified estimation of 50 m² of floor space per resident, the addition of about 20,000 residents, i.e., about a 15% growth of the population. And, this would still conform to the prerequisites of mobility for the area and maintaining the living space need per capita at its present level. From another viewpoint, the areas with inner development potential and infill areas would also be sufficient to provide the same number of residents in the Canton of Schwyz with a growth in living space per resident to 10 m².
Availability of settlement reserves.

Availability of settlement reserves

A central question for inner development is the question of availability. According to the survey and evaluation, about 30% of the inner development potential can be mobilised without any obstacles. For the other 70%, there is a minimum of at least one obstacle to mobilisation, of which, according to the community representatives, the most common by far is a lack of owner readiness.

Likewise, about 30% of the infill areas and 46% of the external reserves do not present obstacles, which means

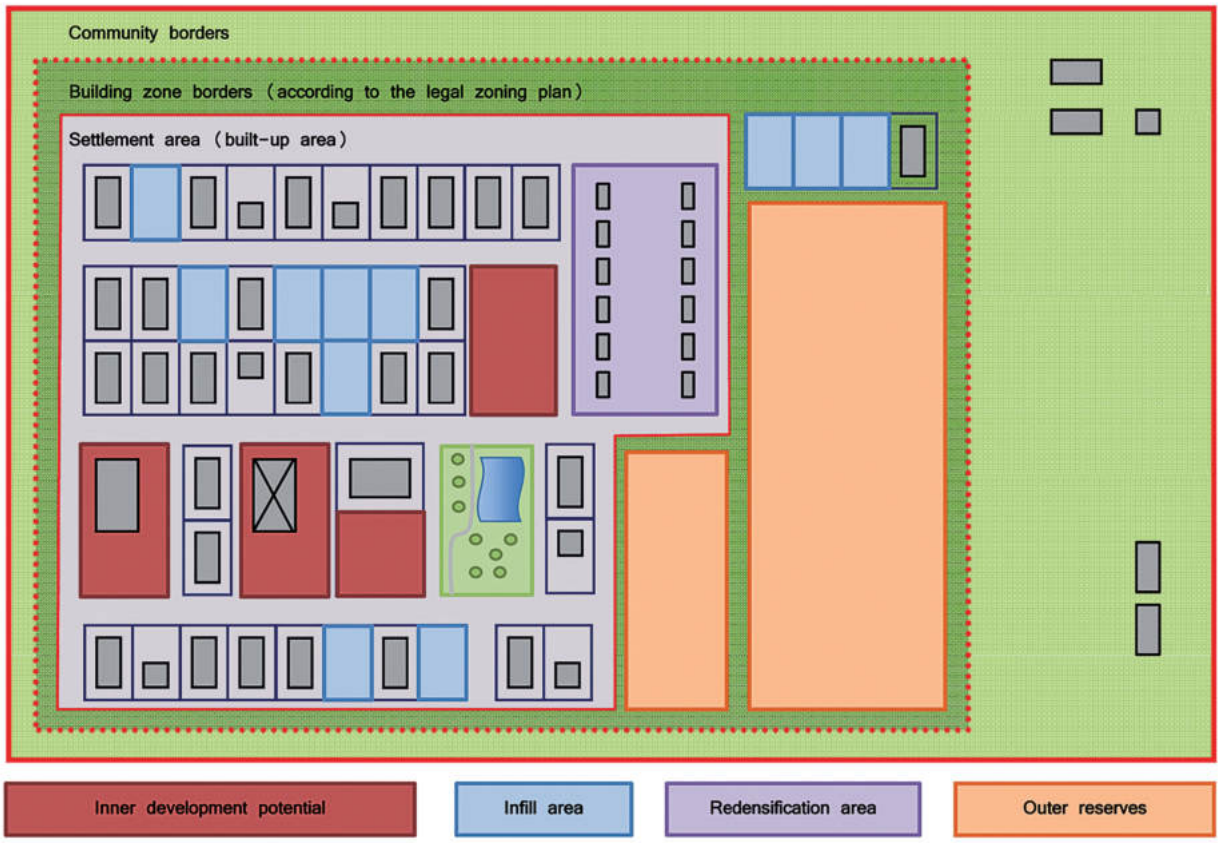


Fig. 2: Categories used in the survey of potential settlement areas.

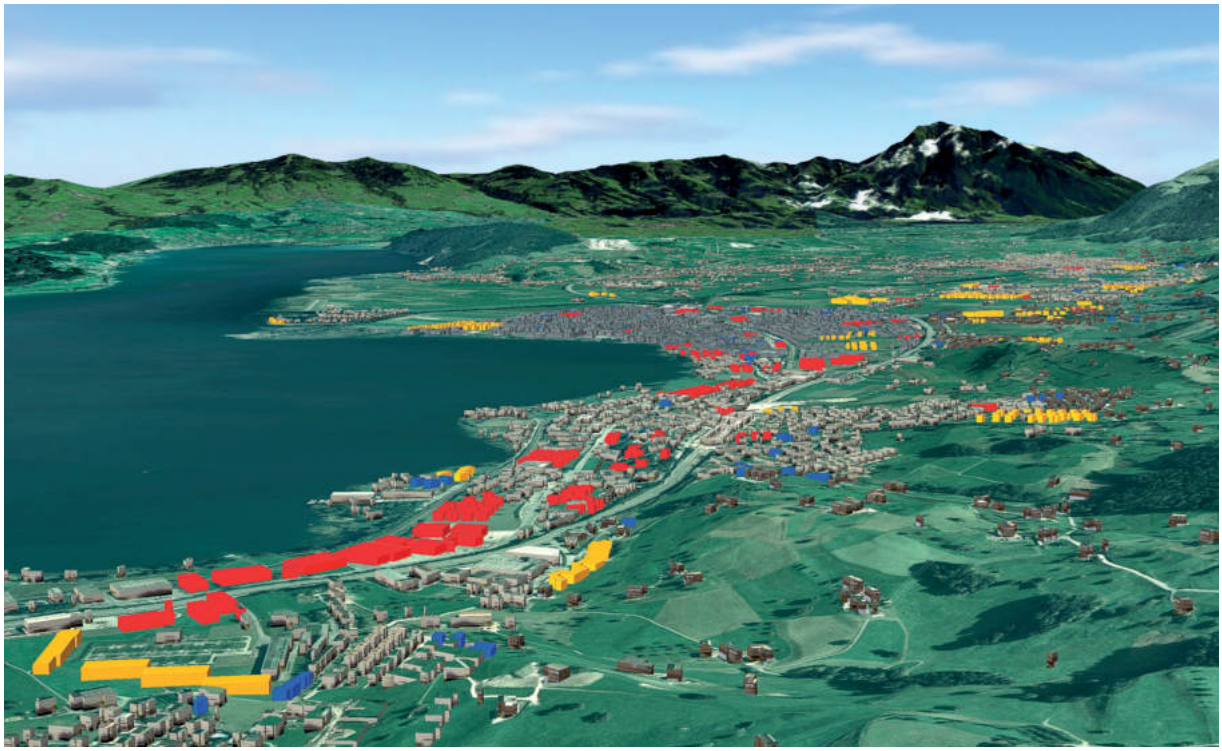


Fig. 3: View from the southwest of the communities of Altendorf, Galgenen and Lachen. Represented are the cubatures of a possible build-up with heights normal for the site. The colours represent the various potential categories: Red: redevelopment; blue: building gaps, yellow: reserves outside the current settlement area.
Basis data from SWISSIMAGE © swisstopo (DV 012725); DTM-AV © 2009 LN089 Umweltdep. Kt. SZ, AVG, Cubatures: Survey results.

that at least a third of the inner-city reserves can be mobilised in the short term. Here as well, it is good to differentiate spatially and consider if mobilisation can be accelerated through the concerted action of individual communities, through the communities working with each other and communities working together with the canton. However, the readiness of owners to evaluate the potential is the most common obstacle here as well. Now, more than in the past, it will depend on being able to, first, awaken interest in an exchange through an active strategy of inner development , and second, to activate interest in the diverse potential through offers, consultations and mutual planning. This means that, more than in the past, is will be important to invest in planning support for the mobilisation of inner development reserves.

A differentiated examination of the temporal availability and additional tasks needed to mobilise the potential areas shows that, under these conditions, the readiness of the landowners to grant building permission would have to take place in a time frame of ten years at the latest.

Perspectives and recommendations for further steps

The experience with the pilot project supports the concept that a survey of potential settlement areas can be managed within a level of appropriate expenditure for the communities. The technical conditions for the use of an Internet-based overview and for the evaluation of the data are now available to all the communities in the canton. During the pilot project, the canton had already begun to make arrangements to ensure that communities will have access to the overviews over the long term. Based on the experiences with the pilot project, the following recommendations have been formulated:

a. From the overview of land management in the Canton of Schwyz

- To agree on performing a regular follow-up of the overviews in the Canton of Schwyz.
- To prepare regular status reports on the land-use balance in the canton and to submit the reports to the government.
- To check which special processes of an especially important nature for a inner development -oriented settlement policy in the defined spaces in the Canton of Schwyz can be supported and therefore what special means can be placed at their disposal.
- To entrust the Federal Office for Spatial Development with the coordination of the work required.

b. Nationwide support for the implementation of the minimum strategy: inner development before new development

- To request community and inter-community concepts and strategies for inner development and to promote and support them.
- To provide argumentation and implementation help for a inner development -oriented settlement policy in the form of instruments and to test and compile examples of their implementation and make these available to the communities and cantons.
- To test inter-community cooperation and processes to establish their positive effects.

c. Gradual expansion of the overviews

- To use the knowledge gained from the pilot project for a gradual nationwide expansion of the use of the overview instrument and to make provisions that, starting in 2010, the overviews can be compiled in two to four additional cantons. The experiences of the Canton of Schwyz in the follow-up processes should be added to this information as an update.
- To ensure comparability and a minimum content requirement for the overviews and to coordinate this between the cantons.
- To investigate and approve the general legal conditions and technical prerequisites in the federal and cantonal governments needed for a nationwide expansion of the use of this instrument.

Sources

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- Professur für Raumentwicklung der ETH Zürich (Herausgeber): Schlussbericht des Modellvorhabens „Raum+ Schwyz: Siedlungsflächenpotenziale für eine Siedlungsentwicklung nach innen“, Zürich 2010.

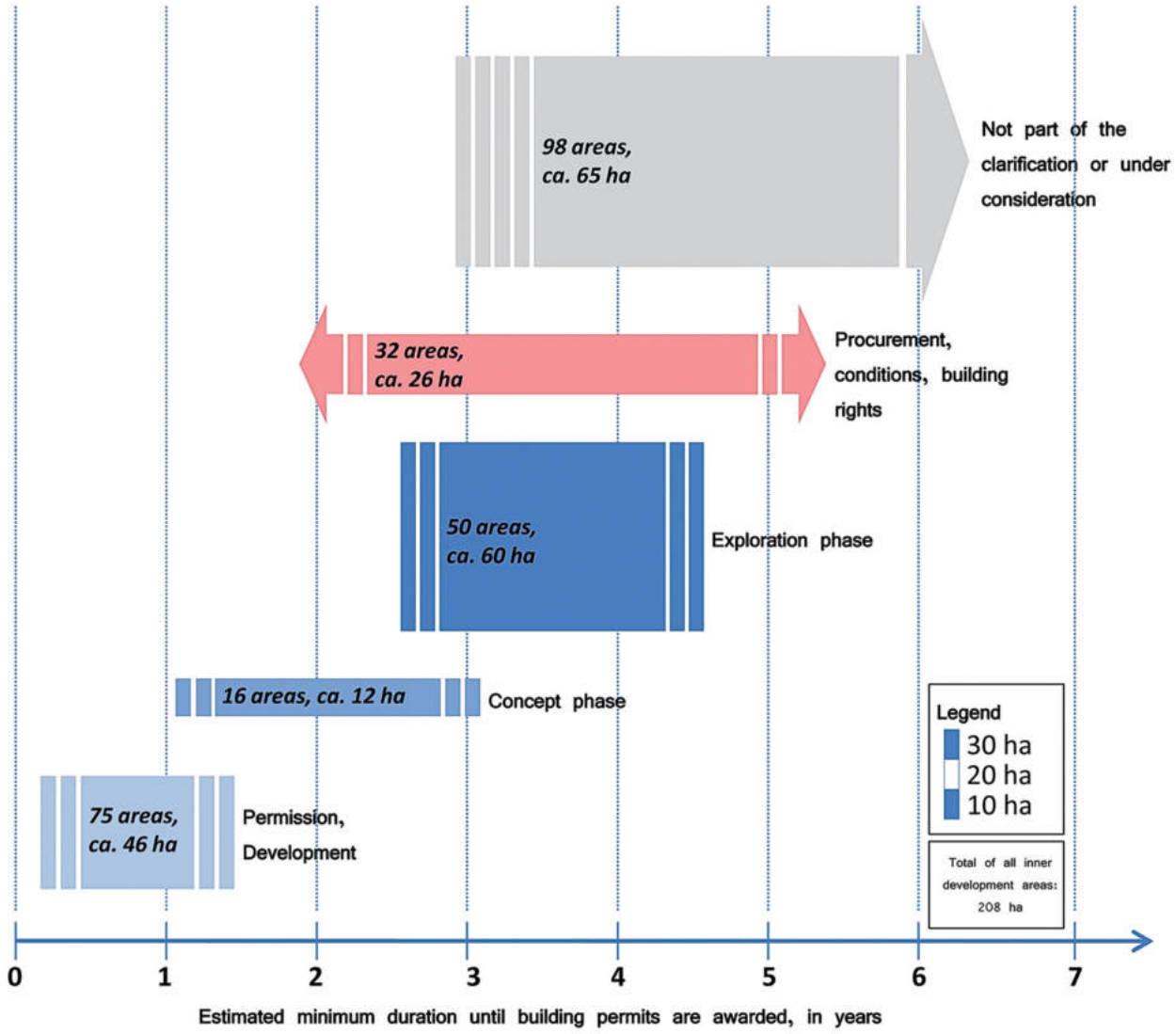


Fig. 4: Total surface area of potential inner development areas in the Canton of Schwyz by planning status.

The mountain hut of the future – the New Monte Rosa Hut SAC

High above Zermatt, exposed at an altitude of 2883 m above sea level in the centre of the spectacular Monte Rosa massive, ETH Zurich and the Swiss Alpine Club (SAC) have successfully concluded a ground-breaking project in high alpine construction.

by Patrick Dilger, Planning & Controlling D-BAUG

The project on the New Monte Rosa Hut SAC was launched in 2005, the 150th jubilee year of ETH Zurich. In collaboration with SAC, ETH Zurich strove to construct a transforming, innovative and ecologically sustainable hut, exemplary in design and technology, and mirroring the research conducted at the Swiss Federal Institute of Technology. ETH Zurich considers this visionary mountain hut, nicknamed "Mountain Crystal", to be the most complex timber construction in Switzerland. In addition to elaborating the project's architectonic and technical concepts, ETH Zurich actively searched for sponsors, but did not contribute to the construction costs amounting to CHF 6.5 million.

Due to the extreme climatic conditions, construction had to be completed during the five spring/summer months. Each cubic metre of cement, each wooden element and every single screw were flown to the site by helicopter. Bearing in mind that a maximum load was limited to 600 kg, the high level of prefabricated elements had to be ready to assemble. Since Mountain Crystal's wooden construction is enveloped in a layer of lamellar aluminium fascia, its polygonal shape glistens and glows in the heart of this majestic rocky landscape. Not only pioneering in terms of its facade, the alpine hut is also eco-friendly. The high alpine building is 90% energy self-sufficient. Starting in March 2010, "Mountain Crystal" is scheduled to welcome approximately 120 guests. For further information, see:

www.neuemonterosahuette.ch
www.sac-cas.ch

D-BAUG was also involved in the construction of the New Monte Rosa Hut SAC, providing input on ecological sustainability and fire prevention. The following two articles focus on these topics.

Map section: Monterosa area

Publication (available in German only)
«Neue Monte-Rosa-Hütte SAC
Ein autarkes Bauwerk im hochalpinen Raum»

Vorworte von Ralph Eichler, Meinrad K. Eberle, Reto Jenatsch, Franz Steinegger.
Beiträge von Paul Knüsel, Marie-Anne Lerjen, Ákos Moravánszky, Adolph Stiller.
Gespräch mit Ákos Moravánszky, Andrea Deplazes, David Gugerli.
Fotografien von Tonatiuh Ambrosetti.
Ausführliche Projektdokumentation mit Beiträgen der beteiligten Experten. 23x27 cm, Hardcover, 224 Seiten, ca. 180 Abb., gta Verlag, Zürich 2010, ISBN 978-3-85676-273-5 CHF 65.– (inkl. MwSt., exkl. Versandkosten).

Environmental Sustainability of the Monte-Rosa Hut

The overall concept of a construction process that preserves resources and is free of pullutants minimizes the impact on our environment and sets new standards in ecological building planning and realisation.

by Stefanie Hellweg, Melanie Goymann, Mathias Wittenwiler / IfU

Goal and scope of the study

Life cycle assessment (LCA) and prospective material and energy flow balances were used during the planning of the new Monte Rosa hut. The use of these tools in the early stages of the planning phase allowed them to have a high leverage effect on design choices, allowing for sustainable construction and operation. For example, increased insulation can reduce heat consumption, and the environmental impact of energy consumption can be reduced through the use of renewable energy sources. Construction materials and processes, including manufacture, transport, and disposal, were also analyzed. Figure 1 shows the system boundaries of this analysis. Operation of the hut, including transport of provisions, was included, although the production of food and beverages was neglected. It was assumed that there is no increased demand for nourishment as a result of visiting the hut.

Methods

An LCA was performed to evaluate the environmental impacts of the building materials and processes "from cradle to grave". Various material choices were assessed, and the best materials were indicated. For hut operation, electricity and heat generation, including the production, transport, and disposal of photovoltaic and lead battery system, and all other technical devices were considered. Electricity use of the hut was estimated by extrapolating measured electricity use data from the old hut. Meteonorm software was used to calculate solar insolation, and subsequently solar electricity and heat production. The energy supply system of the hut will be supplemented with a combined heat and power plant, which will serve as a back-up system during bad weather periods. The fuel use of this device was calculated based on historical weather data, using the difference between solar energy supply and anticipated demand. Helicopter flights to transport food and fuel were included in the study. The life cycle assessment data for the production of materials and energy were taken from the database ecoinvent (www.ecoinvent.ch) and additional project-specific data. Life cycle impact assessment was performed using two different methods: cumulated energy demand and global warming potential, calculated over a 100 year timeframe and expressed in CO_2 equivalents.

Results

Although the new hut offers more space and a higher level of comfort, the energy demand and greenhouse gas emissions per overnight stay are significantly reduced compared to the old hut (Fig. 2). This decrease in CO_2 emissions comes primarily from the use of renewable energy sources and building materials, as well as from a well insulated building, energy-efficient equipment, and by the avoidance of snow melting through recycling and seasonal storage of water. Melting and heating water in the old hut led to the use of 6000 kilograms of coal annually (Fig. 2). The new wastewater purification plant uses electricity but reduces the impact of wastewater emissions to the environment.

The use of nontoxic and recyclable materials helps to preserve resources and to reduce the emission of substances harmful to the environment and human health. Figure 4 shows the high fraction of renewable energetic resources used in the production and disposal of the new hut materials. This is particularly due to the large amounts of wood used as building material. Almost one third of the total cumulative energy demand of the construction comes from the outer wall. The façade is the part of the outer wall with the highest impact, and the selection of an ecological façade was therefore very important. Vacuum isolation panels (VIP), glass with integrated sodium carbonate hydrate heat storage, and conventional isolation combined with an aluminium skin were analyzed, and are shown in

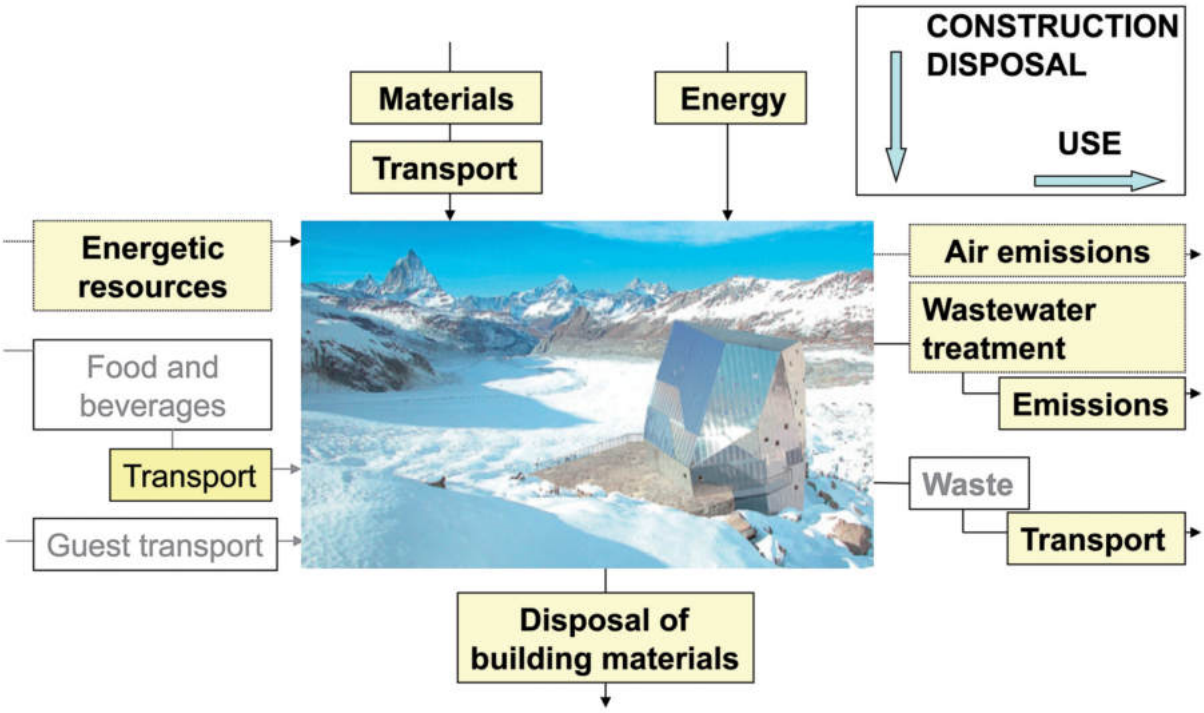


Fig. 1: System boundaries of the life cycle assessment. All processes marked in yellow were assessed.

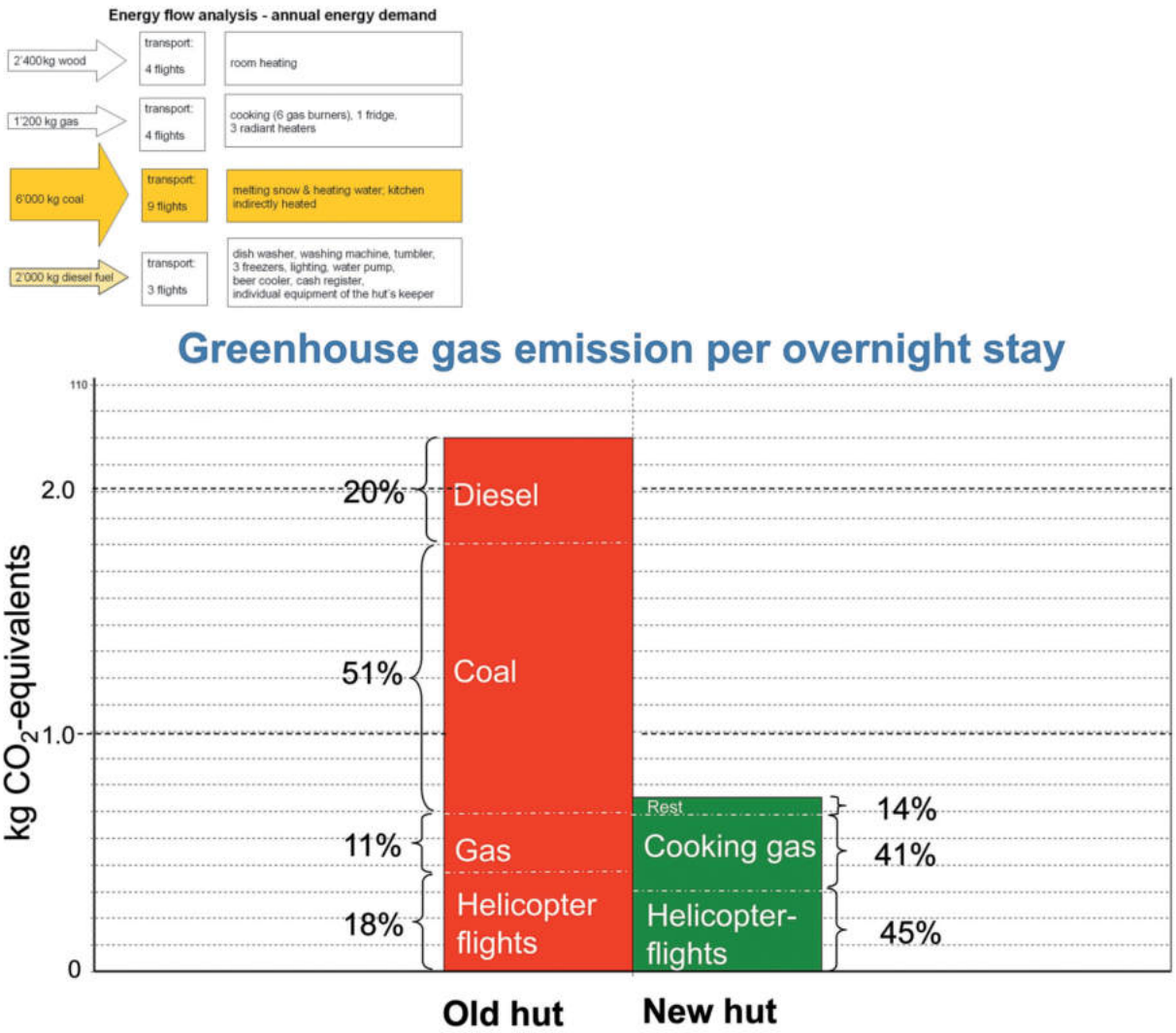


Fig. 2: Energy flow analysis of the old Monte-Rosa hut (above) and comparison of greenhouse gas emissions per overnight stay in the old and new Monte-Rosa hug (below).

figure 3. All three options had similar insulation properties, but the conventional isolation/aluminium skin package was shown to be the most favourable alternative. The new Monte Rosa hut was therefore built with a conventional isolation package.

The key to achieving truly low-impact construction and operation was the integrative use of life cycle assessment during the entire planning phase. The new Monte Rosa hut shows that a sustainable mountain hut can also provide a high level of comfort. Even though the electricity demand of the hut will increase, because of increased guest numbers and an the addition of a wastewater treatment plant, the sustainable energy supply and the use of ecological construction materials will bring down the quantity of non-renewable energy and cumulated CO_2 emissions. Life cycle assessment of buildings normally show higher environmental impacts during the building use than during the construction and disposal phases. Looking at the new Monte Rosa hut, figure 4 shows that this gap is much smaller, as sustainable energy is used whenever possible for running the hut.

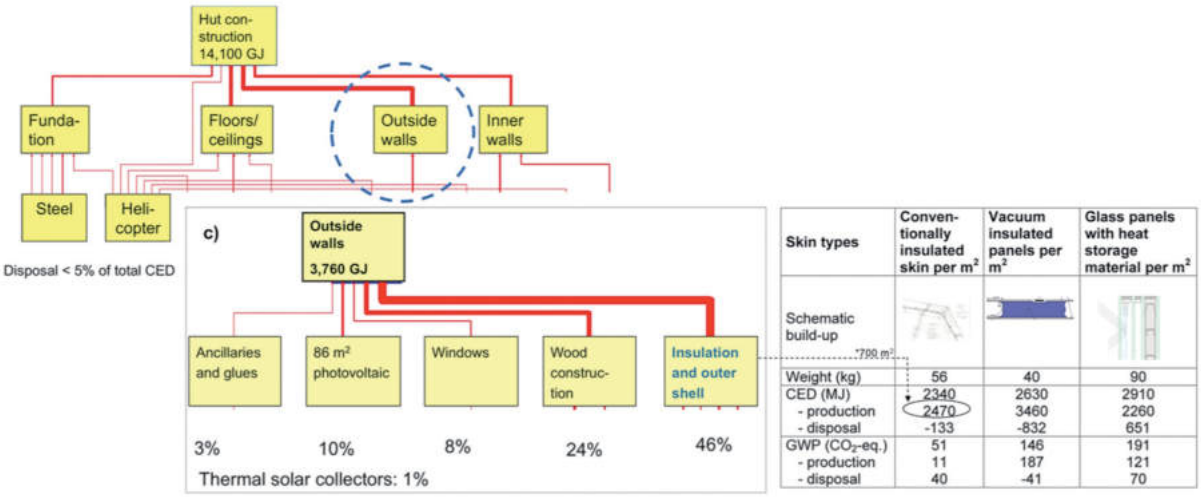


Fig. 3: Energy flow analysis of the construction and disposal of the building (left) and comparison of environmental key parameters of three building skin types (right).

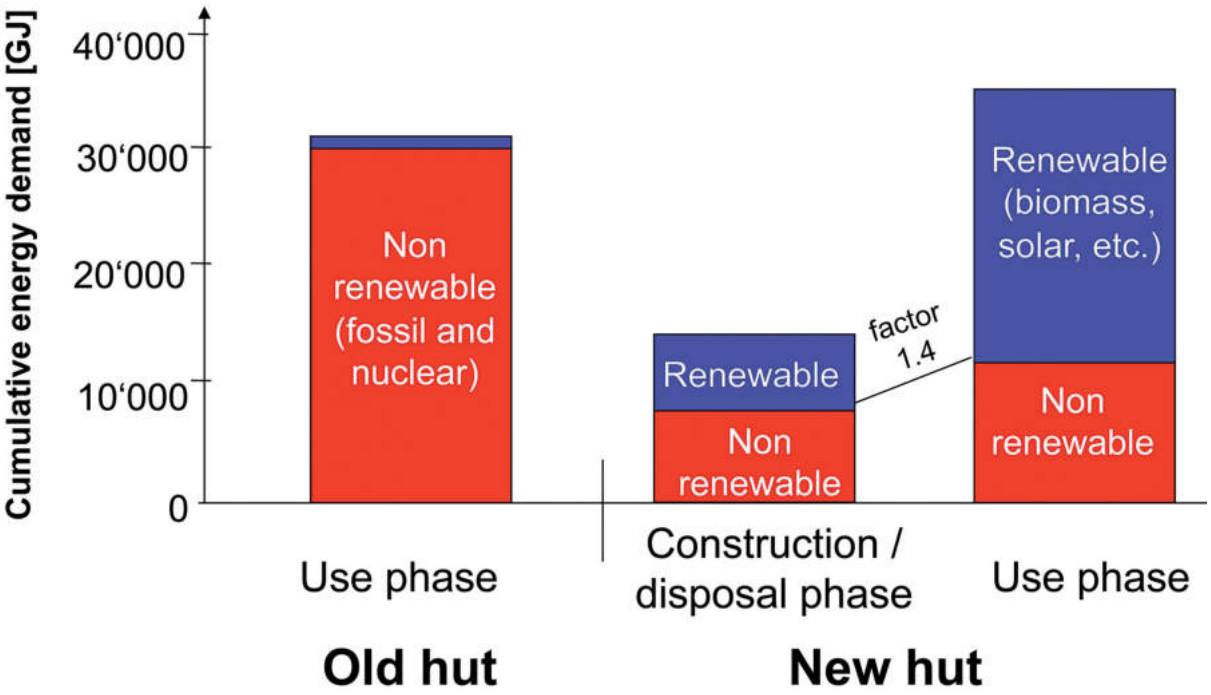


Fig. 4: Cumulative Energy demand of the old and new Monte-Rosa hut over a time period of 50 years.

Fire Safety of Guests and Hut's Crew of First Priority

The choice of structural timber for the new Monte Rosa Hut necessitated an object-specific fire safety concept. In it the safety objectives and all measures were specified that were required to achieve it. The safety of guests and the hut's crew are of prime importance. Quality control ensures the implementation of the concept.

by Hansbeat Reusser, Holzbaubüro Reusser GmbH, Winterthur; Mario Fontana / IBK

The standard concept for Swiss Alpine Club (SAC) huts normally applies the fire protection guideline «Abgelegene Beherbergungsbetriebe» der Vereinigung Kantonaler Feuerversicherungen (VKF) – «Operating Remote Hostels» of the Association of Cantonal Fire Insurers. If a project involves more than two storeys, for the whole structure and the fire compartments a non-combustible construction is required. The selected method of timber construction using prefabricated elements for the new Monte Rosa Hut necessitated a specific fire safety concept for the building.

Fire protection objectives and special features

The safety of guests and the hut's crew was of paramount importance in the formulation of the fire protection objectives. Thus the occurrence of fires and explosions should be prevented using technical and organisational measures. The spread of flames, heat and smoke is limited by constructional measures and the creation of fire compartments while also ensuring the structural stability of the building for a specific period of time. The protection of neighbouring buildings is not a factor here due to the remoteness of the location. The intervention of the fire service is made impossible by the lack of access and the insufficient supply of fire-fighting water. On the other hand, it may be assumed that because of the location of the hut high in the mountains, the hut's visitors are agile, physically fit and quite used to the mountains. However after a fire they must be protected against icy weather conditions.

Concept

Besides the short and convenient escape routes from all the rooms to a safe place, the concept provides each guest room with a secondary escape route using a fixed outside emergency stairs. According to the VKF regulations the new Monte Rosa Hut is defined as having four storeys. Therefore, the detailed design of the timber structure accorded with the building rules for four-storey timber structures with living accommodation, working areas or rooms for educational purposes.

Quality Control

Quality control was considered to be of prime importance in relation to fire safety. The assigned quality control level, agreed upon with the fire safety authority, was Q3 in accordance with the Swiss Timber Industry Lignum documentation «Brandschutz» – «Fire Safety». In general, the work of the fire safety specialists involved the preparation of a fire safety concept in agreement with the fire safety authorities, advising the planners, supervision of the call for tenders, production (prefabrication) as well as periodic checks during erection and the final checks with the authorities. Thus, throughout all phases of the project it was required to act as consultants for the components relevant to fire safety from planning and execution right up to the putting into operation as well as supervising and accompanying the work. This also required close cooperation with the architects and site management personnel.

Technical Fire Safety

The hut is fitted with an automatic fire detection and alarm system with continuous monitoring in all rooms. The system controls the ventilation dampers, the fire doors and the smoke and heat venting system. Emergency lighting facilitates safe escape. The energy is supplied by solar and battery power. For fire fighting, because of the insufficient supply of water, hand-held fire extinguishers and fire buckets with spraying devices are available.

Organisational Fire Safety

A special feature is the provision of 120 bivouac bags outside the hut. These are necessary so that after a fire with a quick successful escape people are not left without protection in the case of icy weather conditions.

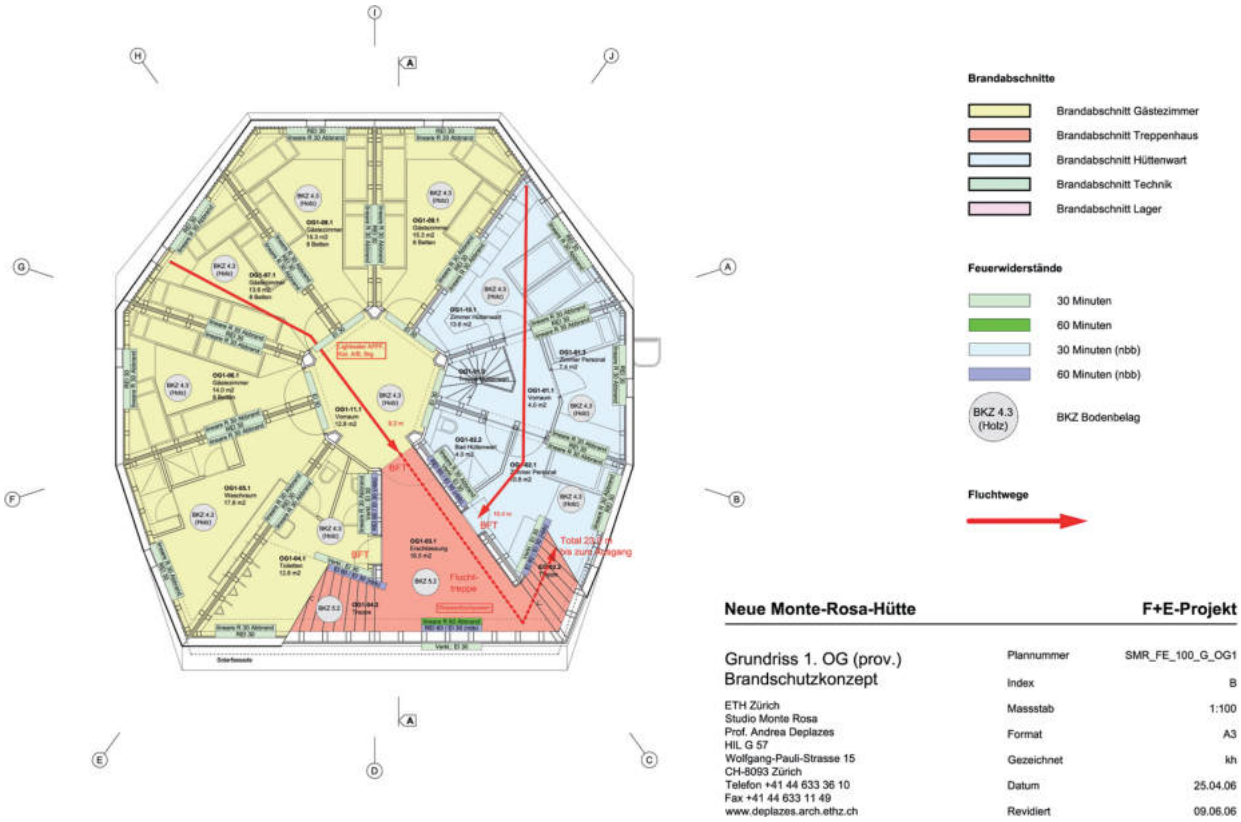


Fig. 1: Plan view of 1st storey with fire compartments and escape routes.

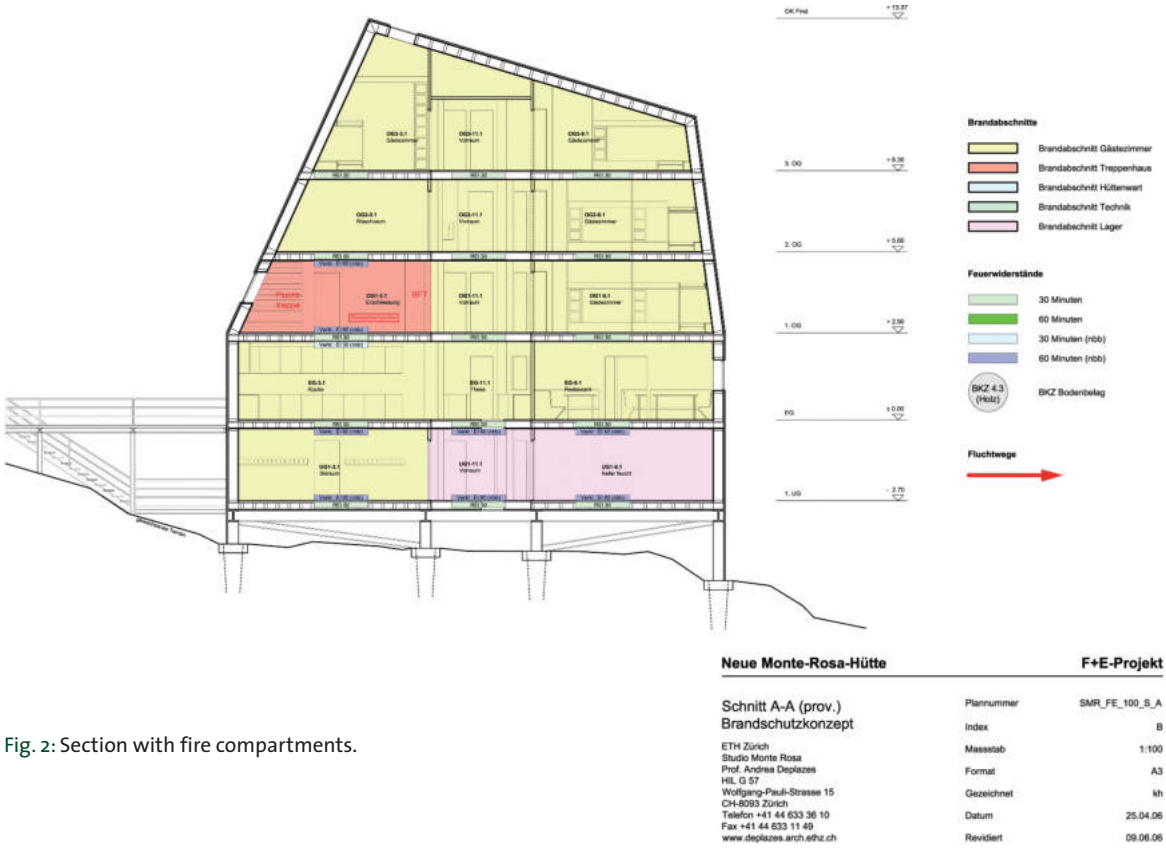


Fig. 2: Section with fire compartments.

Structural Elements

It is certainly unusual for the lower storeys to be built in timber. In this case all structural elements are constructed to have a fire resistance of 60 minutes. All surfaces are coated with non-cumbustible lining. The same applies to the staircase. The ground floor is also provided with a fire resistance 60 minutes. In the dining room however the surfaces are flammable. The fire compartments of the storeys with guest rooms have a fire resistance of 30 minutes with flammable surfaces. All insulation in the building is made with non combustible materials having a melting point of over 1000 degrees Celsius.

Fire Test on Glazing system

In order to keep the staircase free of fire and smoke in the event of a fire, the glazing in this area is furnished with E30 windows. The stud-and-tie system using aluminium in combination with a triple fire protection glazing was not available with the corresponding certificates of approval . Thus a fire test, which was successful, was carried out at the EMPA in Dübendorf under the supervision of Thomas Nussbaumer to obtain a object-specific approval by the fire authorities.

Fig. 3: Fire resistance test on a window at the EMPA Dübendorf (Photo: Hansbeat Reusser, Holzbaubüro).

Fig. 4: Installation duct for the ventilation system with fire protection damper and firewall (Photo: Hansbeat Reusser, Holzbaubüro).

Fig. 5: Installation of fire-protective insulation material for floor element (Photo: Hans Zurniwen).

Elastic modului of spruce wood

Comparison between experimentally and theoretically determined elastic moduli of spruce wood depending on the growth ring angle.

by Daniel Keunecke, Joszef Garab, Peter Niemz / IfB

When wood is mechanically loaded perpendicular to the grain, its elastic modulus depends on the so called growth ring angle. This angle is defined by the load direction and the anatomical structure of wood in the radial-tangential plane (Fig. 1a). Elastic moduli depending on the growth ring angle were, so far, ascertained either theoretically according to the tensor theory for anisotropic materials on basis of elastic engineering parameters for the principle growth directions (L, R, T). Or a dynamic approach was employed (measurement of direction-depending ultrasound velocities).

The goal of a project in the Wood Physics Group (Institute for Building Materials) was to determine these values experimentally using a static approach suitable also for angles between the principle planes. For this purpose, miniature specimens from spruce wood were produced (surface area in the RT plane: 10mm x 10mm; thickness in the longitudinal direction: 4mm) and tested with a micro compression stage. The small specimen size (compared to standard specimens) allowed to assume an orthotropic wood structure, curved growth ring boundaries were avoided. The growth ring angles of the specimens were varied in 15° steps (Fig. 1a: 0° = radial load direction, 90° = tangential load direction) and for each angle 13 specimens were tested. The results (Fig. 1b) show a high correlation between experimentally and theoretically determined values, and confirm the sufficient accuracy of the theoretical approach.

Heat and moisture transport of building envelopes based on wood

How is the behaviour of heat and moisture transport in building elements made of timbered wood compared to conventional wood frame constructions?

by M. Joscak and P. Niemz / IfB

To answer this question, comparative measurements were carried out at the IfB in the group of Wood Physics. Because of the novelty of this type of solid wood constructions, the practical experiences concerning the behaviour under non-steady-state conditions are scarce. Additionally, further investigation and calculation of the heat and moisture transport is needed because of the extremely high material consumption for the manufacturing of such building elements.

For the experiments under natural weathering conditions at the campus of the ETH Zurich, small test buildings without openings were constructed. For further experiments, wood-based building components were created and are currently tested in cooperation with the Fraunhofer Institute for Building Physics in Holzkirchen (Germany).

The conventional wood frame constructions with different types of insulation (low density fibreboard, cellulose flakes and glass or rock wool) improved with thin layers of wooden panels or solid wood are compared to those made of timbered wood, like layered board construction joined with wooden dowels, a construction with slotted wooden boards and a log construction.

For the calculation of the relevant physical parameters such as heat and moisture transport under non-steady-state conditions based on measured data, the simulation software Delphin is employed. (Fig. 2) shows the calculation of the heat transport inside the wall of a small test building made of a layered timber construction joined with wooden dowels. The aim of the investigations is to discover new building physics parameters and their advantages and disadvantages, respectively, for building envelopes made of solid wood. Additionally, the simulation should answer the question, if contemporary calculation models of heat and moisture transport are suitable to calculate building elements based on wood.

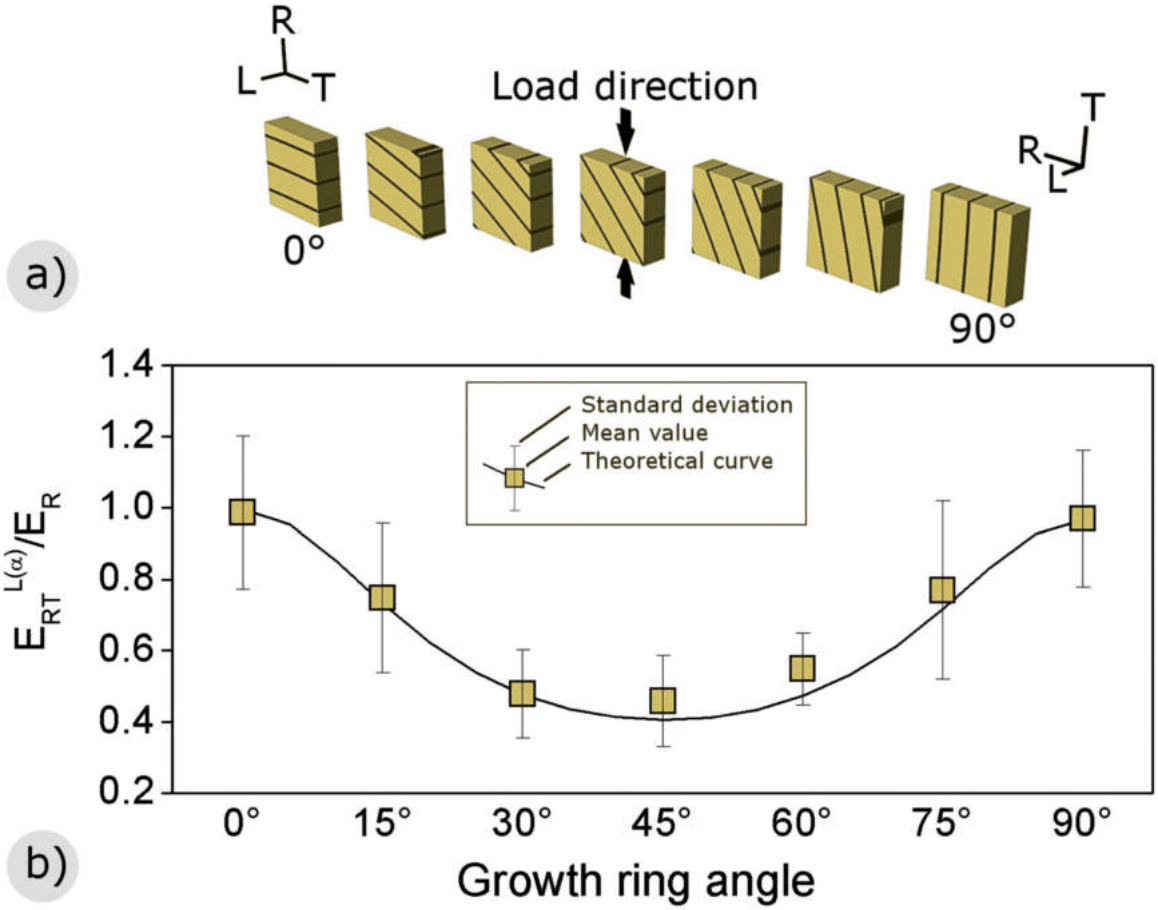


Fig. 1 a) Specimen alignment and definition of the growth ring angle. b) comparison between the calculated and experimentally determined elastic moduli.

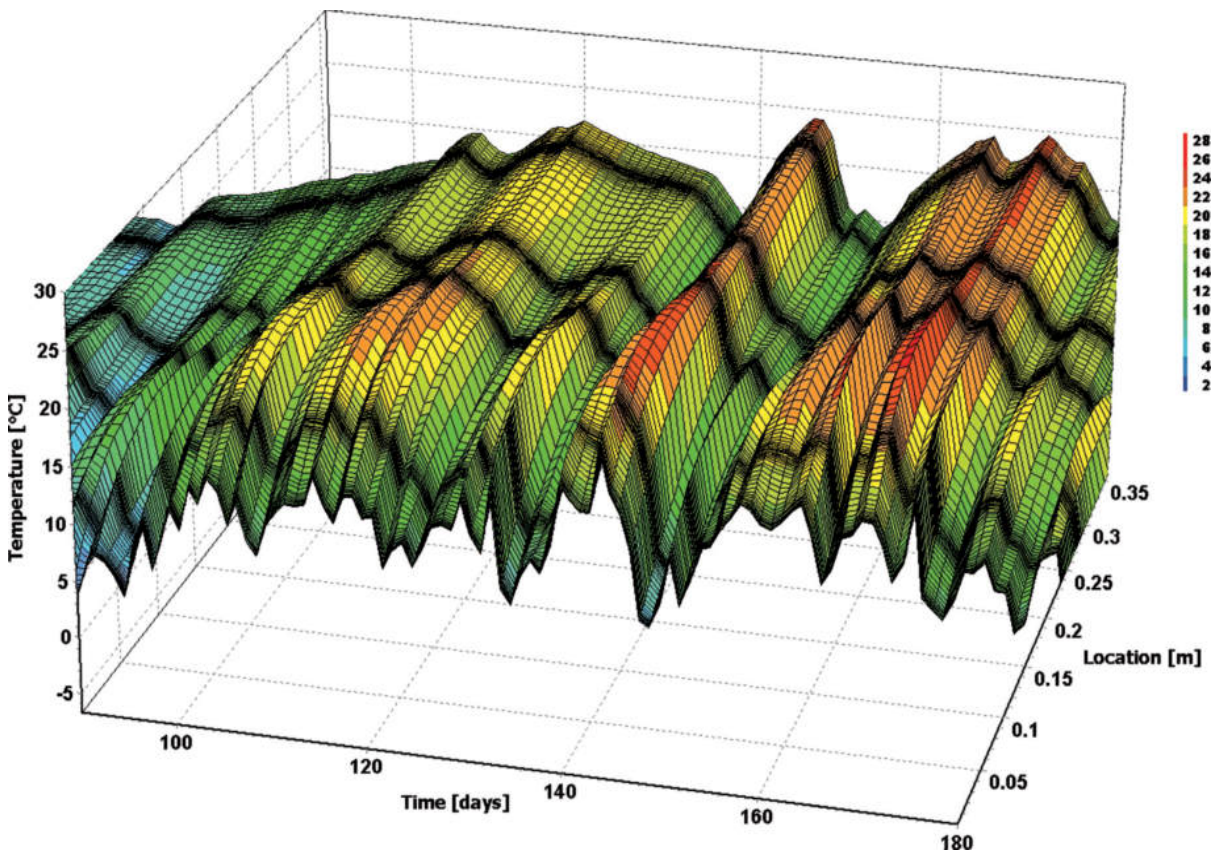


Fig. 2: Calculation of the heat transport inside the wall of a small test building made of a layered timber construction joined with wooden dowels.

Air-Coupled Ultrasound Inspection of Glued Timber Components

Non destructive bonding quality assessment of glued timber products is necessary in order to prevent security hazards.

by S. J. Sanabria, J. Neuenschwander, U. Sennhauser / EMPA Dübendorf; P. Niemz / IfB

Air coupled ultrasound investigations allowed successful imaging of glued and non-glued regions with high reproducibility and spatial accuracy. Glued laminated timber, solid wood panels and prefabricated wood components currently experience a strong increase of use in timber constructions; bonding quality assessment is necessary in order to prevent security hazards. Air-coupled ultrasound (ACU) is a novel non-destructive method with important improvements in reproducibility and fine scanning capability with respect to other traditional ultrasonic technologies used for wood.

As part of an ongoing PhD project, ACU measurements in normal transmission mode with 120 kHz transducers were performed on samples consisting of two 5 mm Norway spruce solid wood lamellas glued together with a polyurethane adhesive, with artificially introduced delaminated areas. Ultrasonic scanning with high resolution was performed to image the presence or absence of glue. The samples were broken up after measurement and the glued and non-glued regions were photographed and compared with the ultrasonic amplitude images.

(Fig. 1) demonstrates successful ACU imaging of glued and non-glued timber down to a spatial resolution of 20 mm. Ultrasound amplitude variations up to 55 dB are observed between glued and non-glued material, which ensures a reliable glue line assessment, despite amplitude variations below 8 dB in bonded regions due to the heterogeneity of wood structure. The reproducibility of the measurement is below 1.5% after one year. Future research work is planned to inspect thicker multiple laminated glued timber structures. The main challenge is to resolve ultrasonic signal changes between bonded and disbonded areas from those introduced by wood heterogeneity.

Modeling the Growth and Impact of Wood Decay Fungi

The wood decay fungus P. Vitreus increases the permeability of wood and thereby the uptake of wood preservatives.

by M. Fuhr, H.J. Herrmann / IfB

The selective degradation of pit membranes in refractory wood species e.g. Norway spruce (Picea abies [L.] Kast.) by the basidiomycete Physisporinus vitreus increases the permeability of the wood. This process which has been termed bioincising can be used to improve the uptake of wood preservatives and environmentally-benign wood modification substances. The bioincised wood can be used for a range different industrial purposes.

The objective of this project is to develop a mathematical model of hyphal growth and expansion of P. vitreus by means of stochastic processes both in space and time (Fig. 2). Irreversible growth has been investigated for a long time in the context of cancer growth, dendritic growth and gelation and penetration in porous media. In addition, the project allows to examine degradation patterns of the fungus and its enzyme activity. By focusing on these fundamental processes, we hope to improve our knowledge on how the complex system (fungus - wood) interacts under defined conditions. This information is crucial for the scaling up of the bioincising process. This work is a joint project of the two research groups Wood Protection and Biotechnology, EMPA St. Gallen (Prof. Dr. F.W.M.R. Schwarze) and Computational Physics for Engineering Materials (Prof. Dr. H.J. Herrmann).

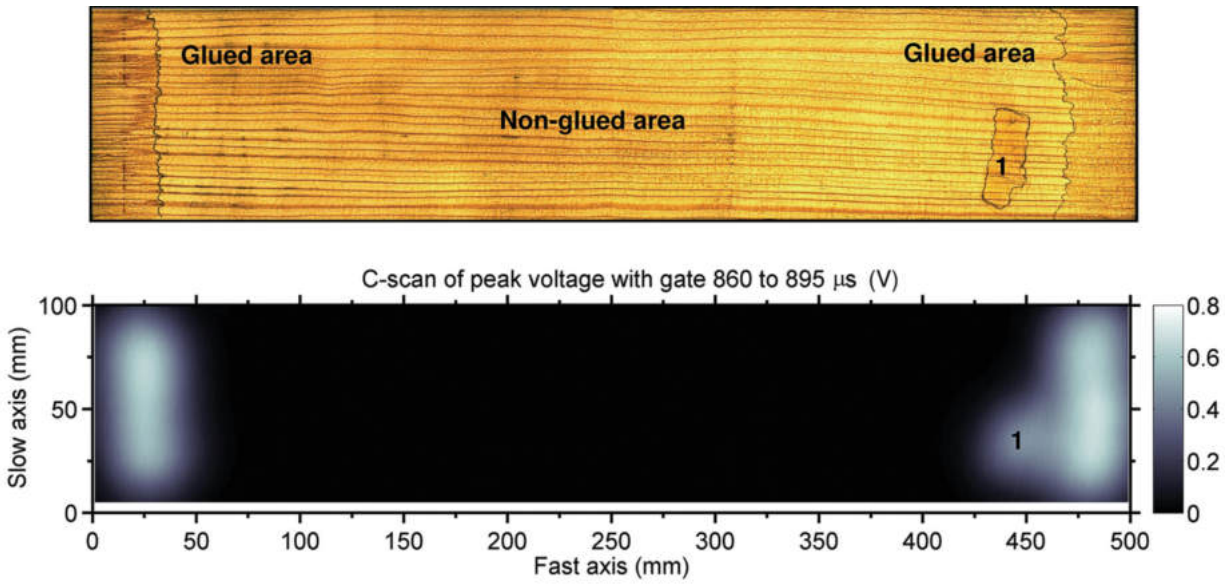


Fig. 1: ACU imaging of glue presence and absence. Top: Photograph of open board; glued and non-glued areas are separately indicated. Bottom: ACU amplitude image. The well glued areas correspond to high amplitude levels; the presence of a droplet of glue (1) can be successfully imaged.

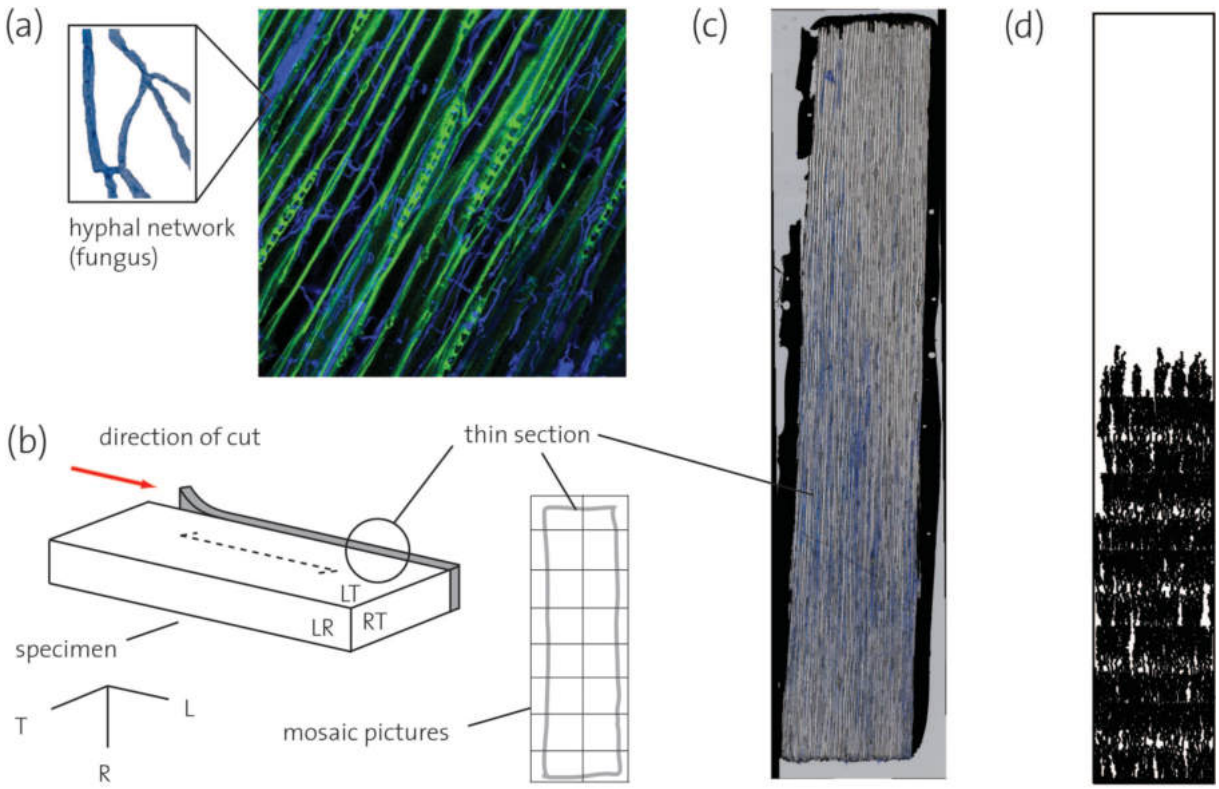


Fig. 2: (a) Wood decay fungi exploit a substrate by forming a network (mycelium) of filaments (hyphae), which are (b) visible under a laser scanning microscopy. (c) Mosaic pictures of thin sections allow the analysis of mycelium's morphology and enable to calibrate (d) mathematical models.

Properties of microfibre reinforced cement

Uniaxial tensile tests on microfibre reinforced cement with aligned fibres were performed.

by C. Rieger, J. G.M. van Mier / IfB

At the Institute for Building Materials steel microfibers were produced by cutting a stainless steel fine wire (d=50µm) in 3mm fibres. These fibres were embedded in cement paste. The micro fibres were mixed with cement pastes with different water/cement ratios. With these mixtures dog bone shaped samples were produced for uniaxial tensile tests. With a special filling method the fibres were aligned in the loading direction in order to enhance the performance of the material. Uniaxial tensile tests were performed with freely rotating supports in closed-loop displacement control. During testing the surface of the specimen was scanned with two high resolution cameras. With digital image correlation displacements and strains can be calculated and with this strain concentrations and cracks can be identified (Fig. 1).

After testing the specimens were cut close to the crack. The cross section can be used to verify the fibre alignment. It could be shown that the filling method worked well for fibre alignment. As a consequence of the fibre alignment the results of the direct tensile tests showed a low scatter in the results.

References:

Proceedings „Advances in cement-based materials“, van Zijl & Boshoff eds. CRC press p. 67–73. Scaling of Fracture Properties of Fibre Reinforced Cement in FraMCoS-7, in press.
Annual Report D-BAUG, 2008, p. 42.

New universality class of fragmentation phenomena

The impact fragmentation of plastic materials of high industrial relevance is investigated.

by G. Timar, F. Kun, H.J. Herrmann / IfB

Fragmentation phenomena are ubiquitous in nature and play a crucial role in a wide variety of industrial processes related to mining and ore processing. Experiments have revealed a striking universality of fragmentation phenomena, i.e. the mass distribution of pieces of heterogeneous brittle materials has a power law form with an exponent depending solely on the dimensionality of the system. It is an important question of high industrial relevance whether such universality prevails for polymeric materials which exhibit ductile breaking.

In cooperation with the Frauenhofer Institute and Thyssen, we carried out an experimental and theoretical study of the fragmentation of polymeric materials by impacting polyoxymethylen particles of spherical shape against a hard wall. Experiments revealed a power law mass distribution of fragments with an exponent of approx. 1.25, which is significantly different from the known exponents of three-dimensional bulk materials. Based on computer simulations of a three-dimensional discrete element model, we show that the dominance of shear in the crack formation and the healing of compressed crack surfaces are the key features which give rise to the emergence of the novel universality class of fragmentation phenomena (Fig. 2, 3).

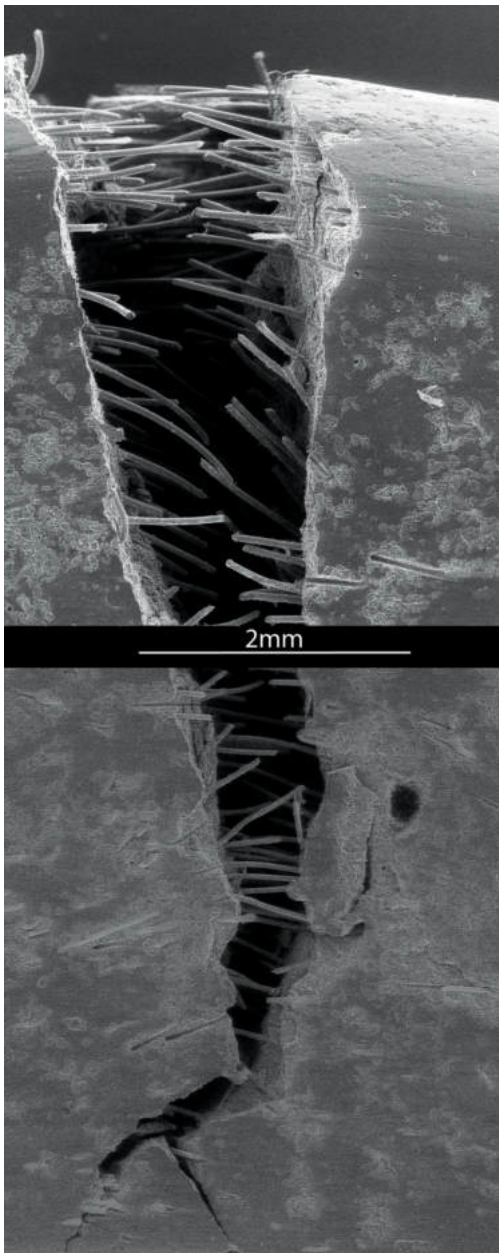


Fig. 1: Crack mouth of micro fibre-reinforced cement.

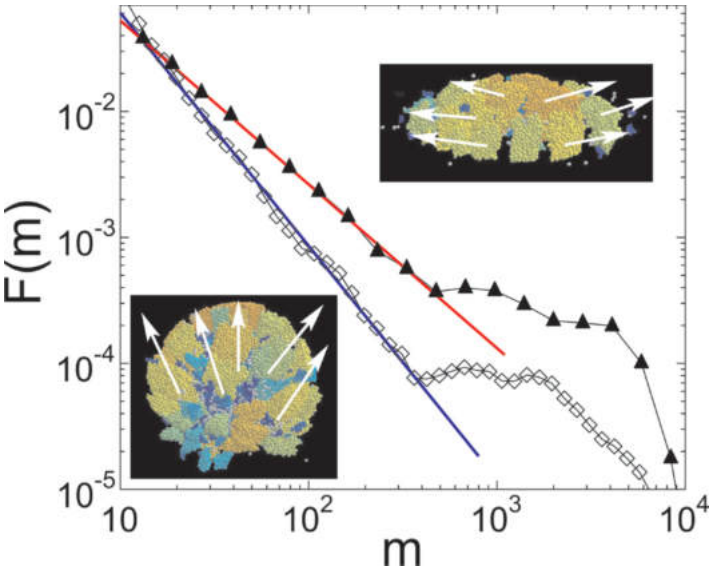


Fig.: Mass distribution of fragments of heterogeneous brittle materials (open diamonds) and for plastic materials (filled triangles). The slope of the fitted straight lines is 1.9 (blue) and 1.25 (red). The insets present corresponding final states of the breakup process where the white arrows indicate the velocity vector of a few pieces.

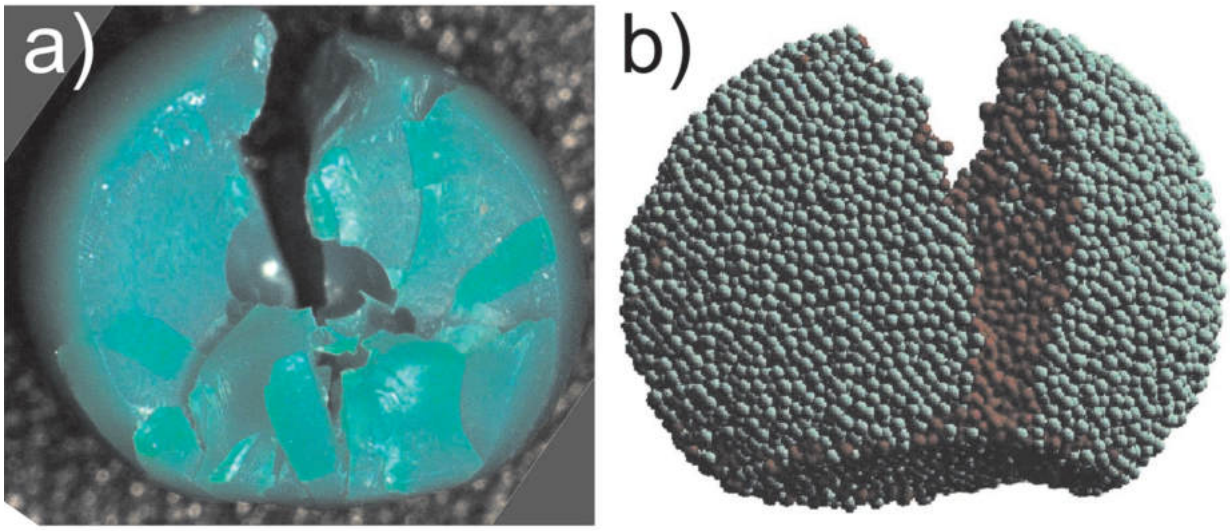


Fig. 2: Final states of impact at low impact velocities in the experiment (a) and in the simulation (b). In the contact area with the hard wall large permanent deformation occurs due to compression, while above it vertical cracks are formed due to tensile stresses. The simulations are in a very good agreement with the measurements.

Numerical simulation of rock fall impact on reinforced concrete slabs

In order to improve the design of rock fall protection galleries, impact load capacity of reinforced concrete slabs is studied using finite element simulations.

by S. Ghadimi-Khasraghy, T. Vogel / IBK

Applicability of numerical analysis is validated calibrating the results with falling-weight impact tests carried out in 2007. By using finite element results obtained simulating the impact loads which initiated the failure during the experiment, a criterion is proposed to investigate failure in the slabs. This provided a reasonable base for extrapolation of the numerical results beyond the range of performed experiments (Fig. 1, Fig. 2).

In addition, a numerical approach is proposed for modelling reinforced concrete slabs subjected to consecutive impact loading, to improve understanding the behaviour of rock fall protection galleries subjected to impact of more than one rock in their history. The gained knowledge is used to model an existing rock fall protection gallery and to study a possible failure.

Finite element methods will also be used to investigate the influence of parameters and assumptions made for a proposed analytical model. The model, which is based on a system of multiple degrees of freedom, enables an efficient way to carry out a performance based design and to predict shear and bending failure.

The combination of analytical and finite element models facilitates a better understanding of the behaviour of slabs subjected to impact loads and allows the knowledge to be applied in improving design of rock fall protection galleries and calculating the capacity of the existing ones.

3D Structure of Concrete Specimens

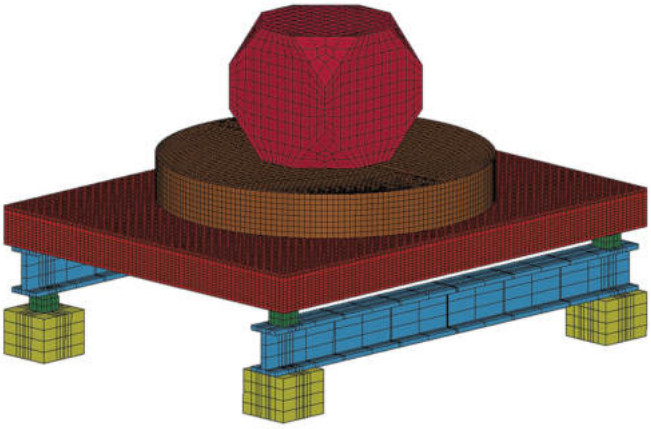
Elastic wave propagation in a segmented X-ray computed tomography concrete model.

by G. K. Kocur, T. Vogel / IBK

Cuboid-shaped, undestroyed concrete specimens (12x12x16 cm) were scanned with X-ray computed tomography (CT) at the Institute of Diagnostic Radiology of the University Hospital Zurich. Based on the recorded two-dimensional X-ray slice data, the 3D structure was reconstructed in the post processing. By means of segmenting, the concrete constituents such as aggregate grains (Fig. 3, left) and air inclusions (Fig. 3, right) could be identified as different phases and separated digitally. In segmentation, related areas of contiguous pixels (2D) or voxels (3D) are allocated to a certain material (phase), i.e. based on threshold values. The digital format of the segmented phases (Fig. 4, left) can be used for further numerical procedures such as the simulation of wave propagation in concrete. The numerical simulations are performed with the finite difference method.

The application of the segmented CT models allows for a differentiated study on the influence of single phases on the wave propagation behavior. The emphasis is on the scattering effect of air inclusions on the propagating wave fronts (Fig. 4, right) and the associated decreasing wave velocities. The study aims at quantifying these influences and at comparing with experimental results.

The segmented CT model which represents the inner structure of the concrete specimen can as well be used to verify purely numerically generated concrete models.



▲ Fig 1: Finite element model of a large-scale falling weight test on a slab.

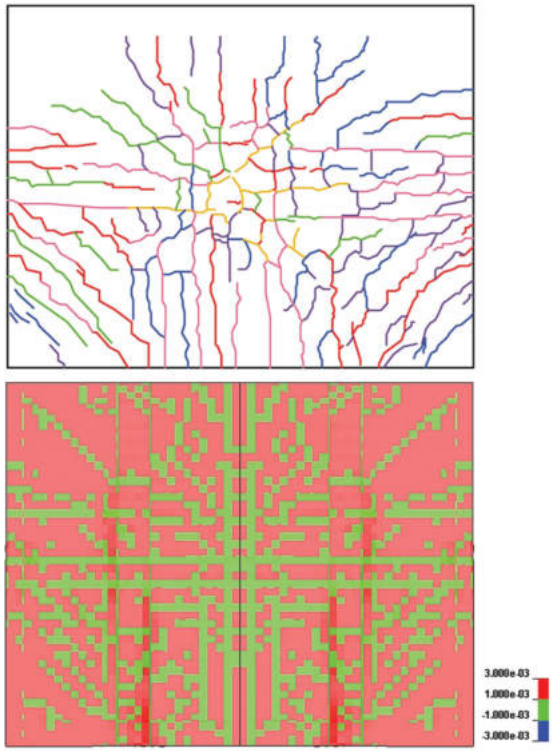


Fig. 2: Comparison of crack patterns at soffit of slab obtained from experiment and finite element analysis for an impact. ▶

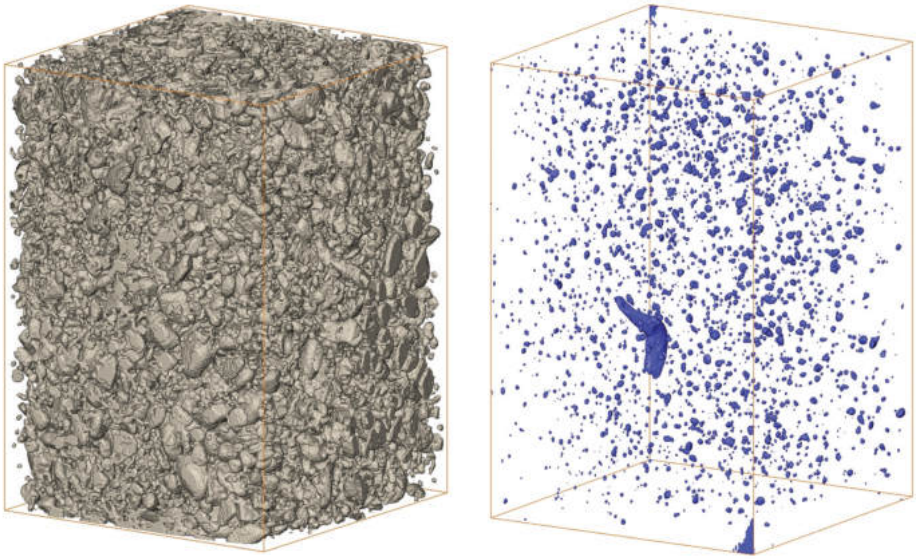


Fig. 3: Two (threshold-) segmented phases of concrete of the X-ray CT slice data: aggregate grains (left) and air inclusions (right).

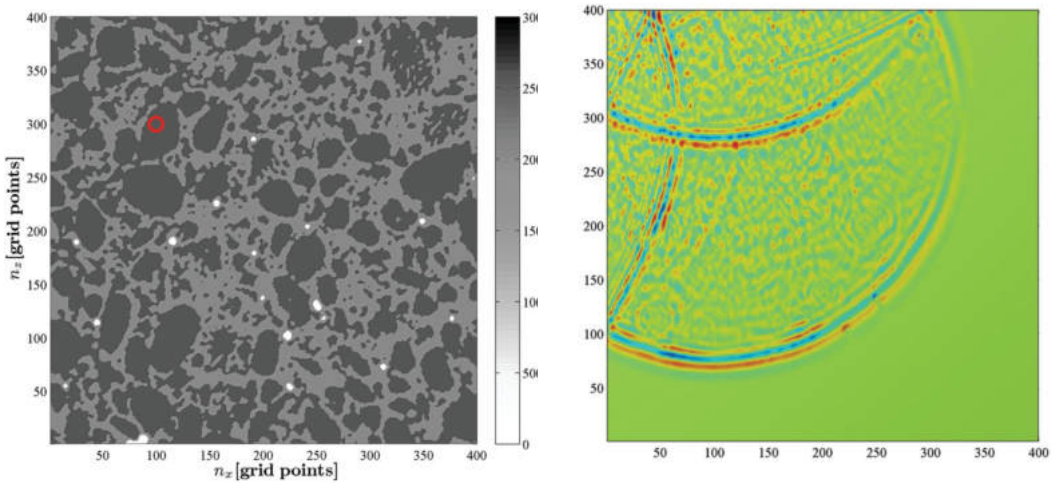


Fig. 4: Segmented CT model (2D) of a concrete cuboid, scanned with X-rays and discretized on 400x400 grid points, displaying the density on a gray scale (left). Snapshot of one time step of the wave propagation (right) excited by an explosion source (red circle in Fig. 2, left).

Renewal of the hydropower station Rüchlig in Aarau

Hybrid investigations to optimize the hydraulic structures of the planned power plant Rüchlig.

by E. Rühli, N. Mache, A. Lais, D. Vetsch / VAW

The hydropower station Rüchlig is situated on the river Aare in Aarau. It is operated by the Nordostschweizerische Kraftwerke AG (NOK). The powerhouse and the main weir are separated by a small island called Zurlindeninsel. In connection with the imminent renewal of the concession, it is intended to rehabilitate the existent power station Rüchlig, to improve the flood protection in the city of Aarau, and to increase the residual flow. The existing powerhouse will be replaced by a new powerhouse with two units on the left hand side of the power channel. On the right hand side a gated flood weir will be built. In the future the flood protection will be improved by discharging a much higher flow through the power channel during a flood event.

Numerical model experiments

The numerical model covers the whole concession area and will provide information on the expected behaviour of the flow during normal operation and in case of a flood. New water level-discharge-relations and net heads will be determined. For flood events the freeboard and bed shear stress in the channel are examined. The extreme situation of an emergency shut-down of the turbines is investigated by means of up- and downsurge calculations (Fig. 1).

The model is calibrated on the basis of measured water level-discharge-relations at six different measuring points.

The simulations are carried out with the software program BASEMENT. BASEMENT has been developed at VAW and is used for the simulation of transient flow in open channels.

Physical model experiments

The physical model of the powerhouse simulates a local section of the channel including the flood weir and the powerhouse at a scale of 1:30 (Fig. 2). The boundary conditions are based on numerical simulation results. The main focus is on the design of the power intake, the weir structures and the dividing pier.

Hydraulics of dike breaching

Flood events during the past years resulted in increased dike failures due to overtopping.

by L. Schmocker, W.H. Hager / VAW

Dikes along rivers are designed to protect a valley including its population and property from floods. However, many dikes have not been maintained during decades and flood events during the past years resulted in increased dike failures due to overtopping. Breaching of a dike can lead to extensive flooding of nearby areas along with both monetary and human losses. An accurate prediction of the dike failure process is essential to develop effective emergency action plans or establish adequate safety measurements.

The dike breach process is therefore systematically investigated in a hydraulic model at VAW. A small scale model dike was inserted in a model channel and subsequently completely eroded due to overtopping. The small scale model allows testing a wide range of parameters affecting the dike breach process with a comparatively small effort. Of particular interest are the dike erosion process, the dike failure time and the resulting outflow. Figure 3 shows a typical temporal advance of the dike breach. The water inflow results in dike crest overtopping at time t = 0 s. Its erosion starts at t = 2 s. At time t = 10 s almost half of the dike is eroded and at t = 100 s the original dike is completely destroyed.

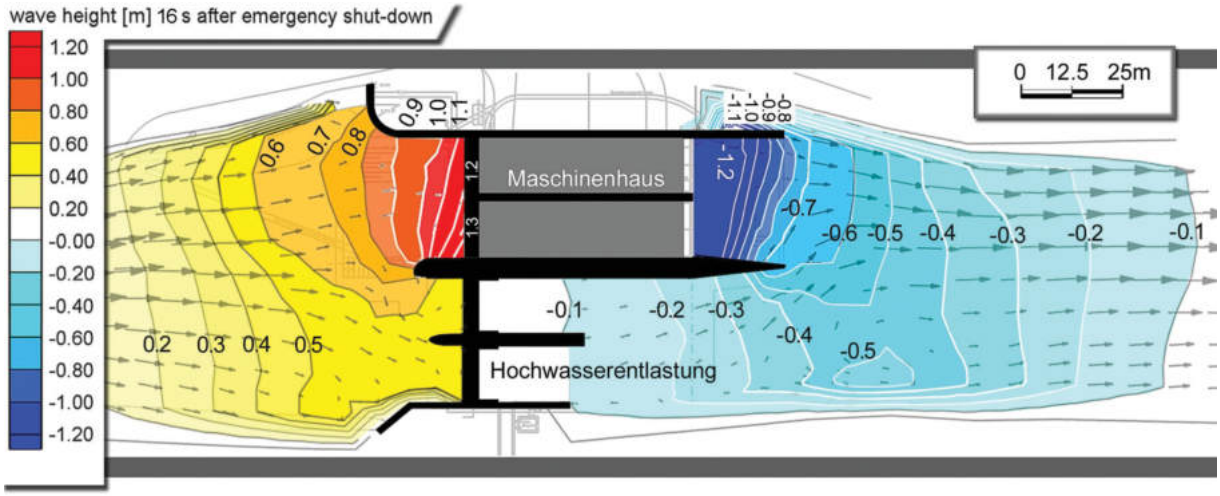


Fig. 1: Wave propagation 16 s after an emergency shut-down of the turbines.

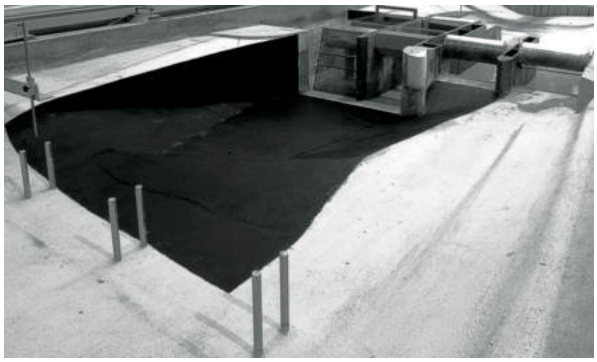


Fig. 2: Final design of the intake.

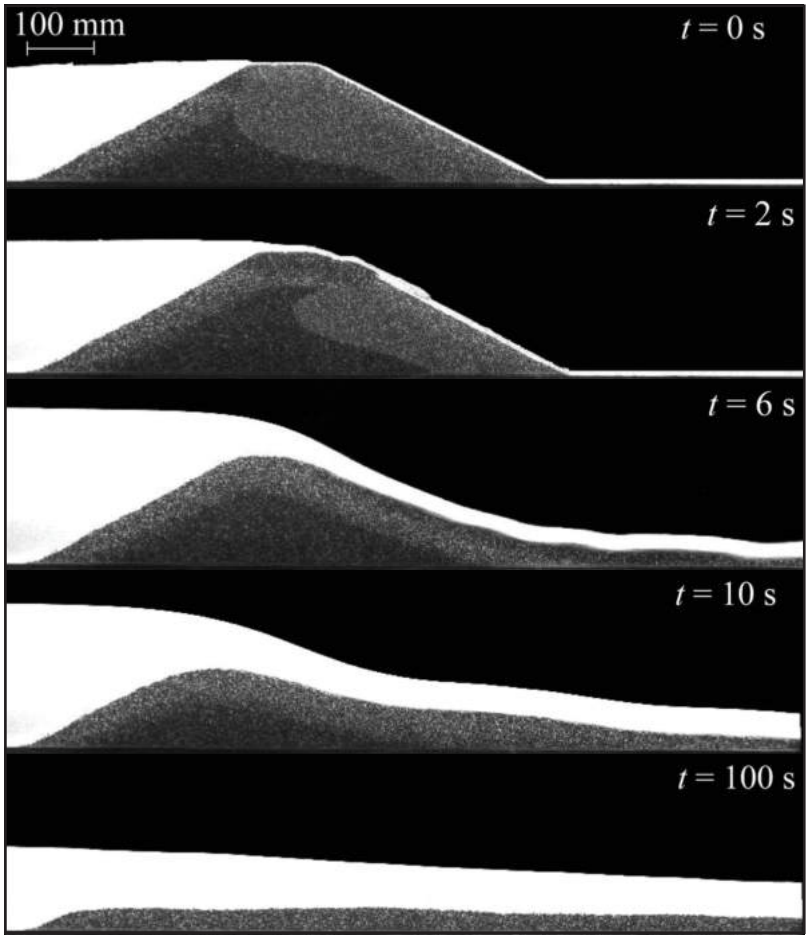


FIG. 3: Advance of dike erosion due to overtopping at various times.

Intake structure of the Handeck 2 power plant

Enhancement of the Handeck 2 power plant's efficiency by increasing the discharge and reducing head losses.

by G. Möller, M. Pinotti, A. Lais / VAW

The Kraftwerke Oberhasli AG (KWO), based in Innertkirchen (BE), plans to enhance the Handeck 2 power plant's efficiency by increasing the discharge from 42.5 to 65.5 m^3/s and reducing head losses in the hydraulic system. This upgrade is part of the project "KWO plus". The project design uses the existing intake structure in the Räterichsboden reservoir. In addition to the existing head race tunnel, a parallel tunnel shall be constructed and connected by a junction to the existing tunnel. The upper edge of the intake cross-section is located about 9.5 m below the existent minimum operating water level.

VAW was commissioned in April 2009 with the construction of a physical model at a scale of 1:35 in order to investigate and analyse the problems related to the vortex formation due to the increased flow velocity at the intake (Fig. 1). In an additional detail model the intake structure was reproduced in a channel at a scale of 1:25. This model should give information about scale effects related to vortex formation.

The model tests show that the formation of vortices with risk of air entrainment would lead to an increase of about 13 m of the minimum operating level. This would negatively affect the efficiency of the hydropower plant. At the moment, anti-vortex devices are tested in order to allow a further lowering of the reservoir water level.

Because of the large number of upgrading projects of existing power plants and the related problem of tightening flow conditions, VAW launched a research project which should investigate the air entrainment rate due to vortices (Fig. 2). With this information it is possible to estimate the consequences of air in the pressure system and, if applicable, to accept air entrainment. The latter would require counter-measures such as de-aeration devices in the system. For a precise design of such de-aeration systems the air entrainment rate as input parameter has to be known.

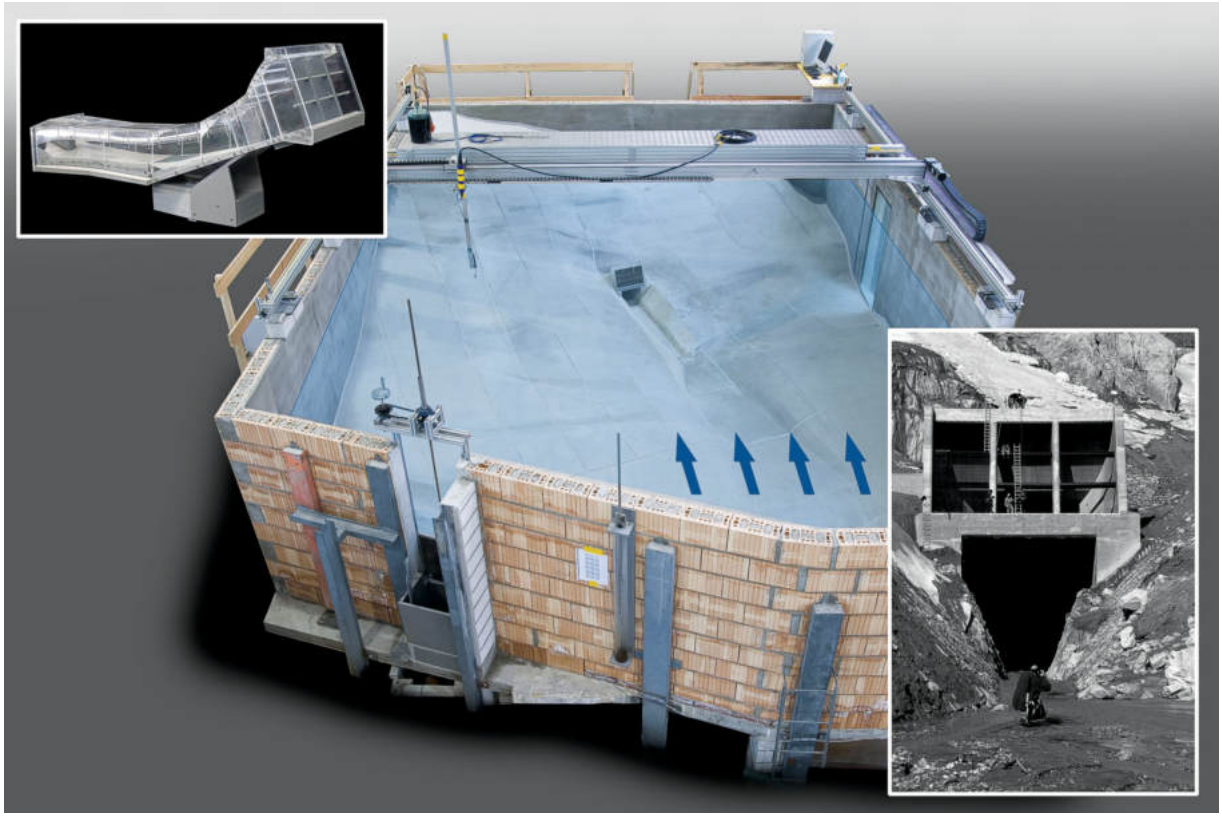
Cracking due to hygric or thermal shocks

Concrete surfaces, such as floors and pavements, develop micro- and macrocracks when exposed to dry air. How can this phenomenon be explained?

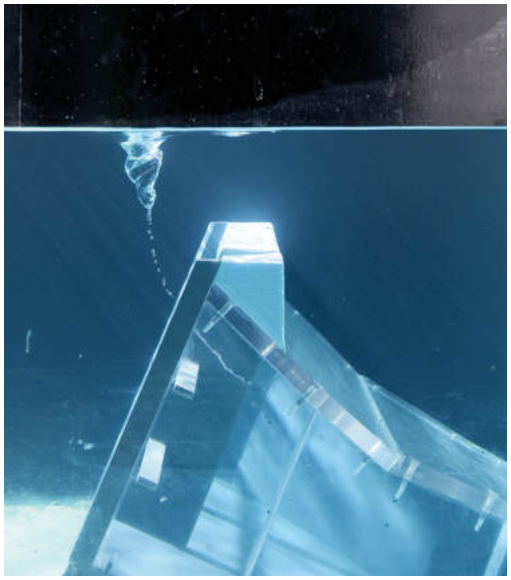
by J. Bisschop, F.K. Wittel / IfB

The life-time of a concrete floor is strongly affected by the amount of surface damage. Pre-existing surface cracks accelerate deterioration of concrete by traffic loading and by the ingress of aggressive fluids. Drying shrinkage has long been recognized as an important cause for cracking of concrete. However, explaining the geometry of drying shrinkage crack-patterns in concrete is a difficult task because the shrinking material is constrained in multiple ways.

In this project we explain a particular type of shrinkage cracks, namely those formed by pure contraction gradients. These form in unconfined samples of hardened cement paste suddenly exposed to severe drying conditions. The surface layers immediately contract, while the inner parts do not, since it takes time for moisture to diffuse out of the material. This problem is equivalent to the formation of surface cracks in certain materials under thermal shock. What has been theoretically predicted, also is confirmed experimentally in this project. The deeper surface cracks propagate into the material driven by the evolution of the contraction gradient, the more cracks are able to interact as explained by a hierarchical 2D model (Fig. 3). From some critical point onwards only every second crack can propagate, shielding the intermediate ones. We showed that this crack spacing doubling can occur once or twice, depending on the drying rate and sample thickness.



▲ Fig. 1: Hydraulic model at a scale of 1:35 at VAW.



◀ Fig. 2: Air-entraining vortex at the intake structure in the 1:25 scale model.

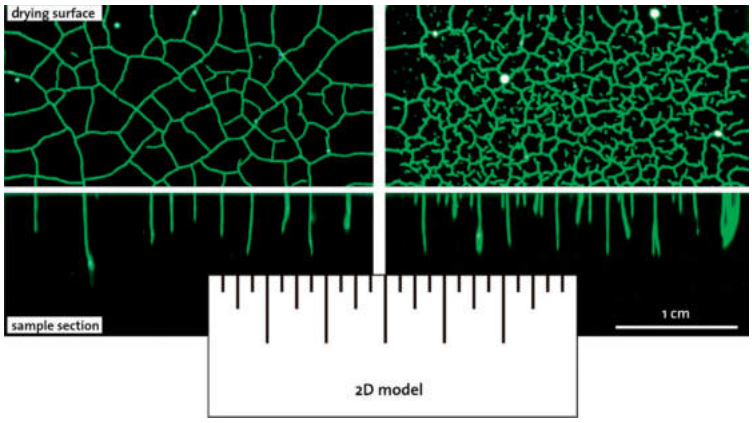


Fig. 3: Desiccation crack-patterns in hardened cement paste after 5 hours drying at 25% relative humidity. Cracks are impregnated with a fluorescent resin. Left images: shock drying at ambient pressure (100 hPa). Right images: shock drying in an Environmental SEM (600 Pa). Section images are stretched in the vertical direction by a factor 4.

In situ tests on steel deck concrete composite slabs at Zurich International Airport

Is the load bearing capacity after 35 years in service still sufficient?

by M. Klippel, M. Knobloch, M. Fontana / IBK

Terminal B at Zurich International Airport has been used by millions of tourists and business people. To implement the European Schengen agreement, the terminal has to be reconstructed after 35 years in service (Fig. 1).

The terminal was built in 1974, basically as a steel frame construction with profiled steel sheeting as supporting structure. Does this structure still meet the current safety and serviceability standards or will it have to be replaced? The decision regarding demolition or modification, with all the associated economic and ecologic effects, has to be based on a firm foundation. Generally, how does the load-bearing behaviour of composite constructions change over the years? How appropriate are our design rules for assessing the capacity of existing and intensely used structures?

The bond between steel sheeting and concrete is the critical factor for the load-bearing capacity of composite slabs. How has the bond between the concrete and the steel changed during 35 years of intensive use? Is it still sufficient? To clarify this and further questions, large-scale tests were performed in situ on the composite slabs at Zurich International Airport (Fig. 2).

Useful data was generated by these tests to enable the assessment of the composite slabs. The tests showed that a sufficient bond still exists between the steel sheets and the concrete and that current design rules properly assess the load-bearing capacity of structures after long-term use.

Shear band propagation in soils as a mechanism of tsunamigenic landslides

Via physical tests an analytical model has been validated which provides an approach to calculate initial landslide velocity of submerged tsunamigenic landslides.

by E. Saurer, A. M. Puzrin / IGT

Conventional geotechnical methods to analyze the failure mechanisms of submerged slides tend to underestimate the real height of the resulting tsunami wave. In this study, an approach has been developed, which includes dynamic analysis of the landslide mechanism. This approach accounts for an initial landslide velocity, which justifies larger tsunami wave height predictions.

The analytical model is based on the phenomenon of progressive and catastrophic shear band propagation in soils and on the energy balance approach from fracture mechanics. In order to validate this model, the rate of the progressive shear band propagation has been studied using physical trapdoor- and shear-blade tests and compared to the analytical solution (Fig. 5a, 5b).

When applied to the dynamic process of catastrophic shear band propagation in slides, this energy balance approach allowed for an analytical solution for the initial landslide velocity to be derived (Fig. 6a).

Application of the obtained analytical solution to historic and recent submerged landslides, such as the Weggis slide in Lake Lucerne (Fig. 6b), confirmed that this approach is an appropriate tool to explain more realistic tsunami wave heights.

Fig. 1: Terminal B, Zurich International Airport, shortly before refurbishment.

Fig. 2: Large-scale in situ tests on composite slabs with profiled steel sheeting – Testing procedure and test set-up.

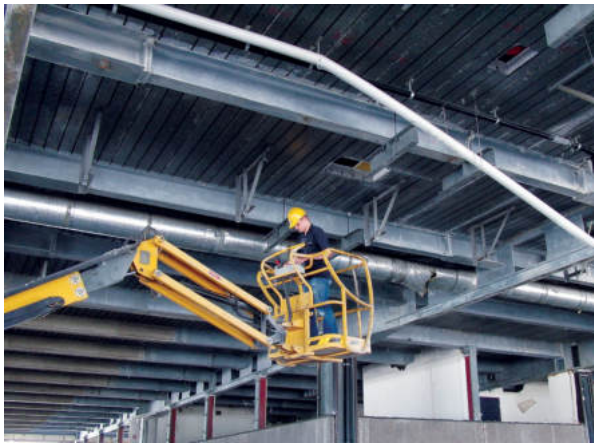


Fig 3: Test preparation (fixing of measuring devices) at the bottom side of the profiled steel sheeting.

Fig 4: In situ tests on composite slabs with profiled steel sheeting – Top view cantilever beam test.

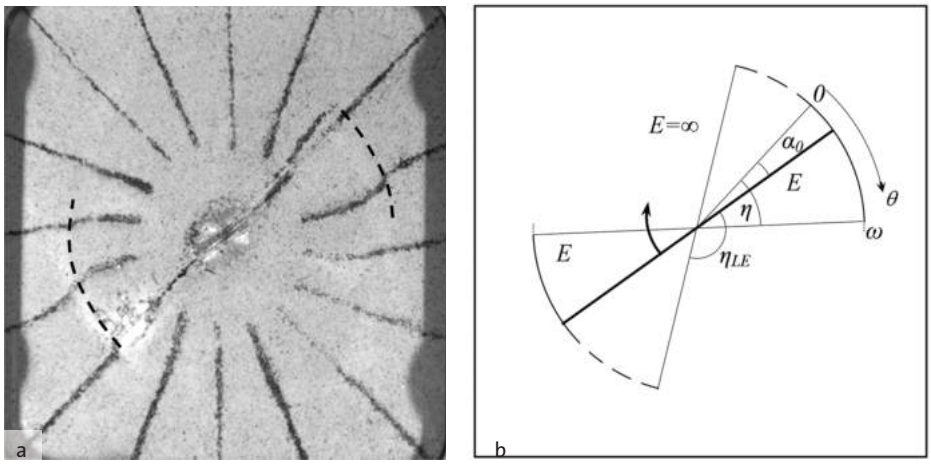


Fig. 5a + 5b: Experiment (a) and analytical model (b) of the shear band propagation in shear-blade test.

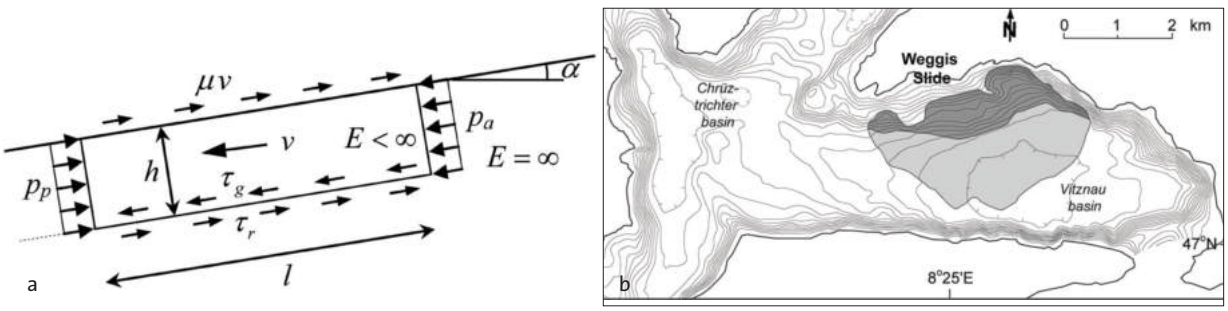


Abb. 6a + 6b: (a) Analytical model for the calculation of the initial slide velocity in a submerged landslide; (b) Weggis slide (from Strasser, Diss. ETH 17285, 2008).

Flood control measures at the "Kleine Emme" River

Physical experiments on drift wood retention at the 'Kleine Emme' River near Malters, Canton Lucerne.

by S. Tamagni, V. Weitbrecht / VAW

The 2005 flood event caused large damages in many regions in Switzerland and so in the area of the Kleine Emme River. Initiated by this event, a combined approach including hydro power production and drift wood retention with a diversion channel and a drift wood rack (Fig. 1) for the Malters river stretch at the Kleine Emme has been projected. The Canton Lucerne has assigned the VAW to test and optimize the given configuration with the help of a physical model on a 1:50 scale with focus on flood protection aspects and the efficiency of the drift wood retention.

The experiments showed that, with the given configuration, the intended efficiency of 50 % of retained drift wood can be achieved; however, certain flood protection aspects were not fulfilled. To improve the situation, a new concept regarding the direction of the approach flow towards the drift wood rack (parallel instead of frontal approach flow) (Fig. 2) has been tested. The parallel approach flow in combination with an area of recirculating flow, led to the same efficiency of retained drift wood, plus strongly improved flood safety conditions. This improvement can be explained by a reduced tendency of the drift wood for piling up in front of the drift wood rack with parallel approach flow, leading to reduced backwater effects.

The final design includes a second drift wood rack downstream of the first one, which increases the drift wood retention efficiency by approximately 10 %, resulting in a total retention efficiency of roughly 2/3 of the oncoming drift wood.

Flood protection project "Linth 2000"

Hybrid modelling of a spillway to prevent dam breaks at the Linth Canal.

by P. Seitz, Th. Berchtold, V. Weitbrecht, D. Vetsch / VAW

Since river engineering and flood protection concepts are designed to work properly not only under design conditions, but as well for the overload scenario, the flood protection project "Linth 2000" is investigated at the VAW using a hybrid modelling approach, where physical and numerical experiments are combined. A regulated overfall weir in an 800 m long newly built local river widening is planned to limit the downstream discharge in the Linth Canal. The spillway is designed to reduce the peak flow of 500 m^3/s in the canal to a maximum of 420 m^3/s. The mean discharge in the Linth Canal is about 54.6 m^3/s.

In the laboratory, the physical model on a 1:30 scale covers 90 m^2. It includes parts of the local widening, the spillway and the runoff in the stream course downstream of the spillway (Fig. 3).

To assess upstream boundary conditions for the physical model, numerical simulations are performed covering a larger flow domain up- and downstream of the local widening (Fig. 3). In the numerical model, the water levels, the bed shear stress and the averaged flow velocities are calculated for several flood scenarios. In the physical model, the functionality of the spillway and the riverbed stability are tested. For the numerical computations, the modular software BASEMENT that has been developed at VAW is used.

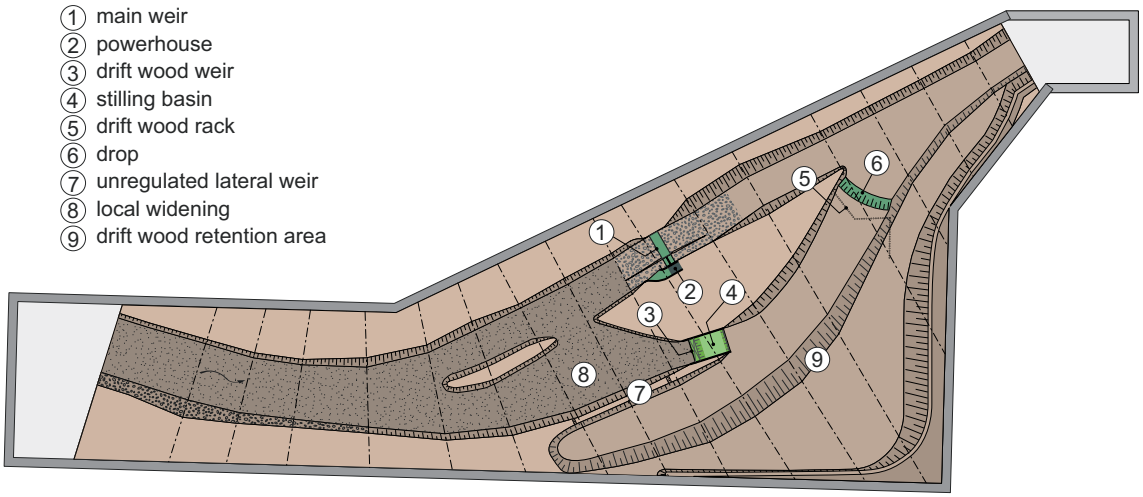


Fig. 1: Initial configuration for the drift wood retention project at the Kleine Emme River near Malters.

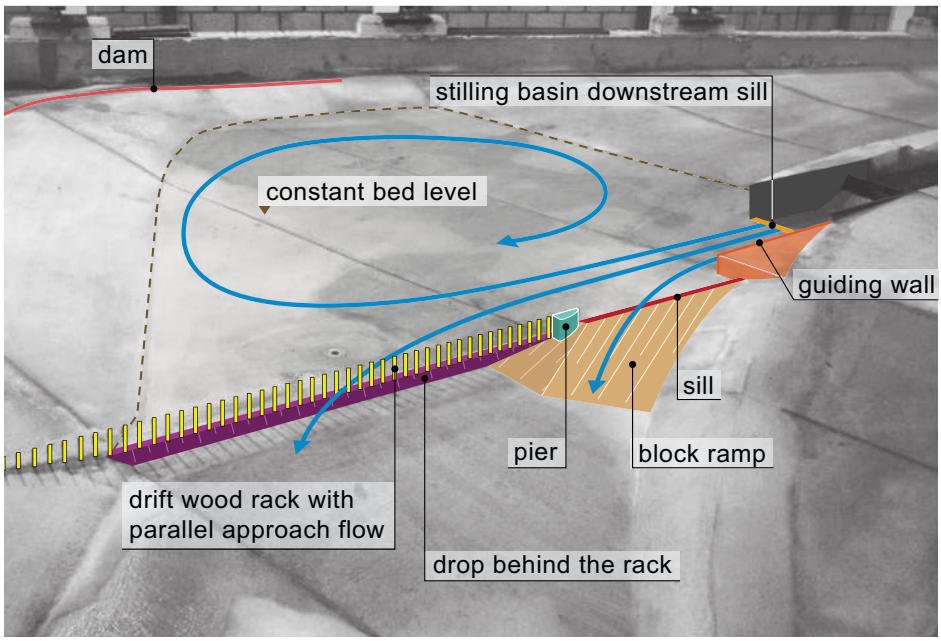


Fig. 2: View of the adapted configuration of the drift wood retention area with parallel approach flow towards the drift wood rack (view against flow direction).

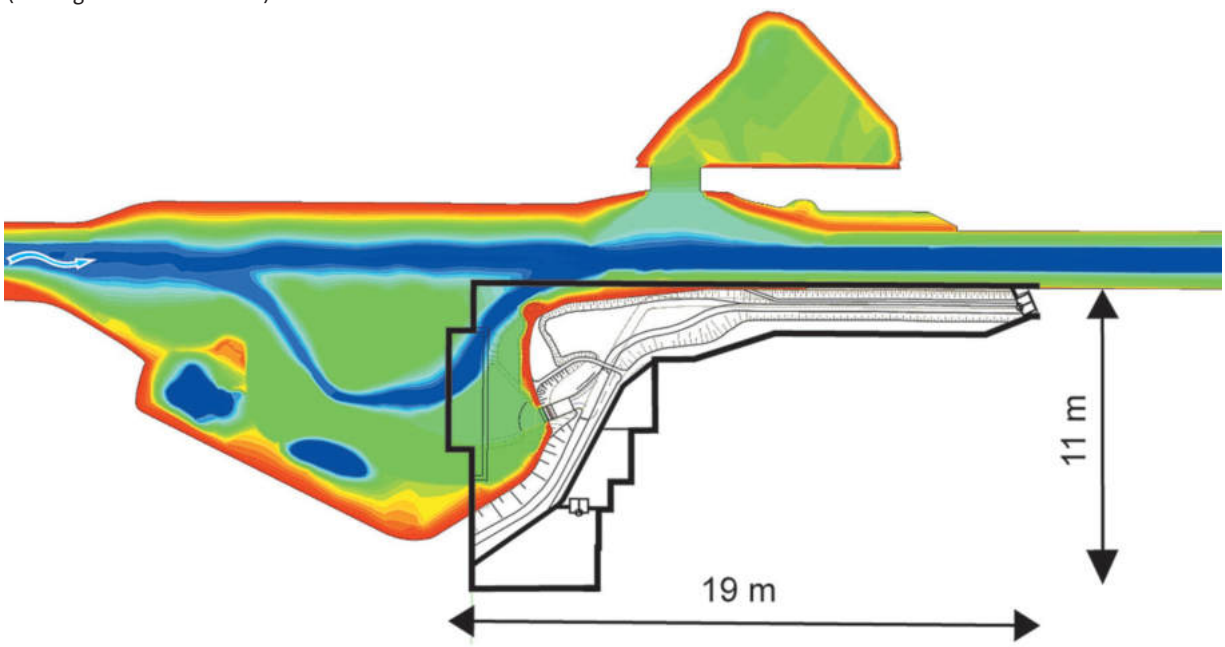


Fig. 3: Perimeter of the numerical model (contour coloured topography) and of the physical model (black lines).

Bacterial biofilms develop heterogeneous structures

Biofilms can be used in biological treatment processes to degrade contaminants.

by E. Morgenroth / IfU + Eawag; K. Milferstedt / INRA LBE, Narbonne, France; N. Derlon / Eawag

Bacteria in biofilms excrete a sticky polymeric matrix composed of polysaccharides, proteins, and extracellular DNA. This polymeric matrix allows the biofilm to remain attached to solid surfaces and protects the bacteria living inside the biofilm from the environment. This protection makes it difficult to remove unwanted biofilms, using disinfectants or cleaning agents in dental hygiene, on heat exchangers, and in drinking water distribution networks. In biological wastewater treatment we are developing reactors that take advantage of biofilms to degrade contaminants. Biofilm performance and persistence is closely linked to biofilm structure. We have developed an imaging technique and quantitative image analysis to monitor large-scale and long-term development of biofilm structures over time.

In controlled growth experiments we initially observed the development of a homogeneous and steadily growing biofilm. When a critical biofilm thickness is reached, detachment occurs, reducing the stability of the remaining biofilm, resulting in subsequent random large scale detachment events that are no longer correlated to biofilm thickness. Our results provide first indications of developmental succession cycles initiated by sloughing of large amounts of biomass. While microscale development of biofilms (Fig. 1a, 1b, 1c) is highly dynamic and unpredictable, the macroscale performance of biofilm reactors (Fig. 1e) is usually quite stable and can be well controlled. We are continuing to develop novel imaging techniques that allow us to monitor biofilm dynamics at relevant length and time scales (Fig. 2).

Note: The majority of this work has been performed at the University of Illinois at Urbana-Champaign supported by a CAREER award to Eberhard Morgenroth from the National Science Foundation under grant No. BES-0134104. Figures are from Morgenroth, E. and Milferstedt, K. (2009) Reviews in Environmental Science and Biotechnology, 8 (3), 203-208.

Turbulence and interfaces

Laboratory experiments and numerical simulations reveal the nature of interfaces at the boundary of turbulent flow regions.

by M. Holzner, B. Lüthi, W. Kinzelbach / IfU

Sharp and strongly contorted interfaces are known to exist at the boundary of clouds, smoke plumes, volcanic eruptions, etc., which separate the turbulent flow from the irrotational ambient flow regions. These interfaces fluctuate vigorously on a wide spectrum of scales and are associated with entrainment and mixing of ambient fluid into the turbulent flow regions. Fundamental understanding of these processes is important, e.g., for the improvement of models for the dispersion of contaminants in the atmosphere.

We conducted experiments by using 3D particle tracking velocimetry, a method that allows measuring in 3D the velocity of tracer particles that are passively advected by the flow. The unsteady turbulent flow of the experiment which had no mean shear and a small Reynolds number, $Re_\lambda = 50$, was also simulated via direct numerical simulations. We measured that the local entrainment velocity, u_a, scales with the smallest velocity scale of the flow, namely, the Kolmogorov velocity, $u\eta$. (Fig. 3) shows a snapshot of the spatial distribution of the magnitude of u_a over the interface between turbulent and non-turbulent regions. On the other hand, globally, the interface propagates with a velocity u_e, that is on the order of the integral velocity scale. We reconcile the two at first conflicting observations by showing that the interface area is strongly deformed by the turbulent eddies to account for the same global entrainment flux with a small characteristic velocity. The measured ratio between the integrated local and the global entrainment flux is close to unity, $Q_\eta./Q_O=1\pm5\%$. (Fig. 3) also shows qualitatively that the magnitude of ua, depends on the large-scale shape of the interface, being higher at the top of outward facing billows and smaller on their sides and inside the crests. Small- and large-scale features hence appear to strongly depend on each other.

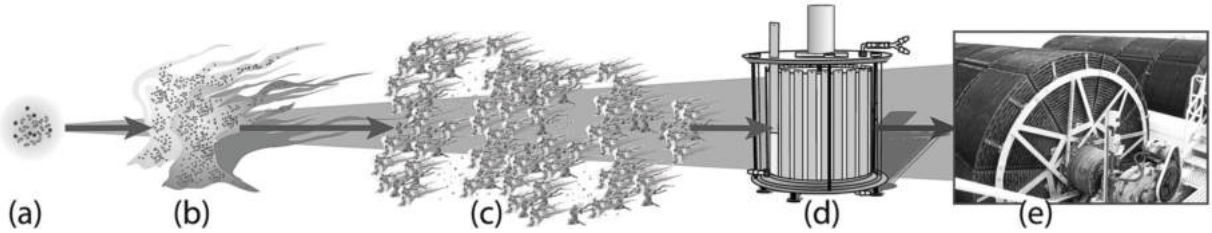


Fig. 1: Biofilm development can be characterized using different length scales: (a) Different types of microbial cells are distributed heterogeneously in different colonies (microscale), (b) internal pores and channels within the biofilm matrix can allow for limited advective flow inside the biofilm (micro- or mesoscale), (c) patchy distribution of biofilm clusters over the biofilm substratum (mesoscale), (d) heterogeneous distribution of biofilm within the overall system of an annular reactor in research (macroscale) and (e) in a rotating biological contactor as example for full-scale biofilm reactors (macroscale) (Photo: Siemens).

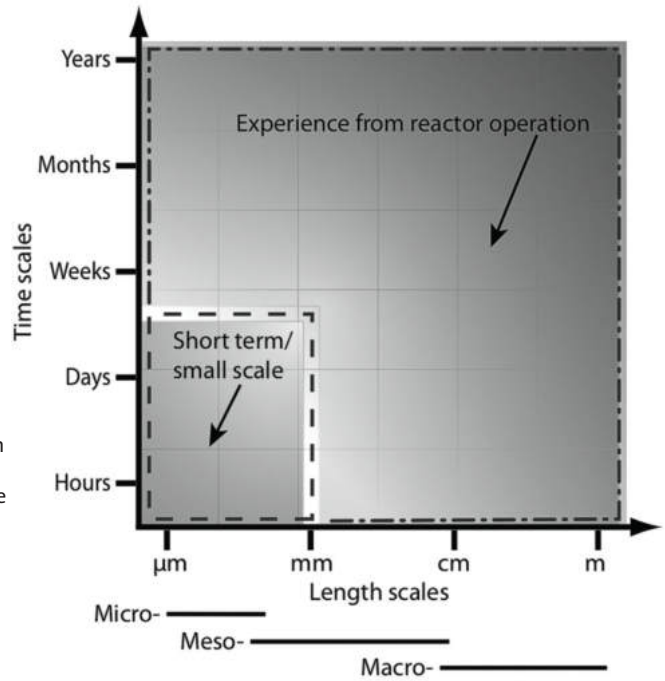


Fig. 2: Experimental systems and biofilm reactors are characterized by length and time scales. Three time scales can be differentiated: Initial attachment (minutes – hours), initial biofilm development (days), growth, detachment, re-growth, maturation (weeks, months, years). Research relevant to biofilm reactors must integrate micro-, meso-, and macroscale and must evaluate long-term biofilm development.

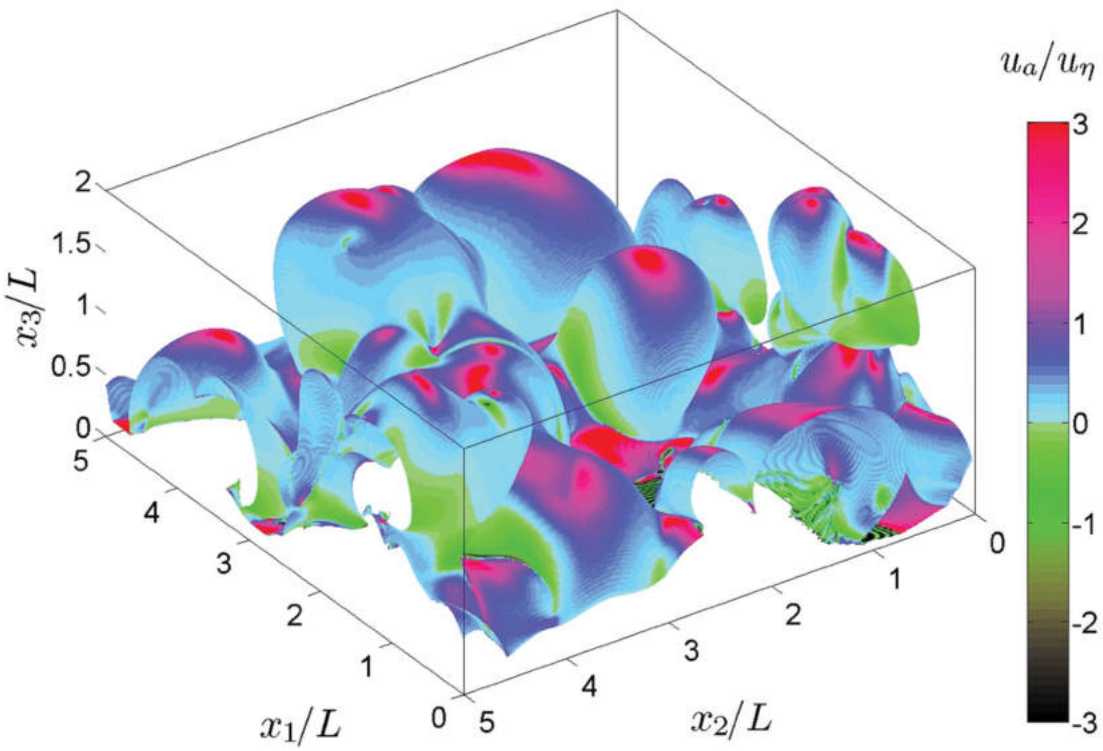


Fig. 3: The local entrainment velocity, u_a, normalized by the Kolmogorov velocity, u_η, is rendered over the turbulence interface visualized by using an isosurface of enstrophy, where the isolevel, c_{ω^2}, normalized by the mean enstrophy in the turbulent region is $c\omega^2 / \langle\omega^2\rangle = 10^{-3}$.

Gornergletscher and Gornersee

'Icequakes': Seismic activity on Gornergletscher during Gornersee outburst floods.

by Fabian Walter / VAW

During the summers 2004, 2005, 2006 and 2007, the Laboratory of Hydraulics, Hydrology and Glaciology (VAW) installed high-density seismometer networks on Gornergletscher in order to study the yearly drainages of the nearby ice-marginal lake Gornersee. Among the record of the nearly 200,000 'icequakes' most seismic events are consequences of crevasse opening near the surface. This is supported by moment tensor inversions which show that source mechanisms are generally tensile dislocations. However, we also identified about one dozen of near-surface icequakes whose moment tensors represent solid evidence for shear fracturing within alpine glacier ice. Icequakes near the glacier bed or at intermediate depths make up only a small fraction of the recorded events. Their source mechanisms are generally tensile dislocations, as indicated by a detailed analysis of several icequake clusters. Qualitative waveform characteristics indicate that other basal icequake sources may also exist.

Subglacial water pressure beneath Gornergletscher is strongly influenced by the daily surface melt cycle and the drainage of Gornersee. We analyzed how subglacial water pressure influences basal fracturing by comparing the activity of basal icequakes to fluctuations in the water table in boreholes drilled to the glacier bed. The results show that basal icequakes occur mainly during low or falling water pressure periods (Fig. 1). This indicates that basal fracturing occurs when the glacier couples to its bed after periods of water-enhanced basal sliding.

Simulation of geodynamic processes

Geodetic measurements provide important boundary conditions for the simulation of geodynamic processes.

by M.D. Müller, A. Geiger, H.-G. Kahle / IGP

The understanding of geodynamic processes such as the deformation of the Earth's crust along plate boundaries is of great importance for seismic hazard analysis. Stress accumulation in the lithosphere and related deformations depend on a multitude of geophysical parameters. Many of them are not directly measurable and therefore only approximately determined.

Numerical simulation enables the reverse engineering of geodynamic processes and their calculation for a well-defined parameter range. A comparison of developed models and used parameters with geodetic and geologic observations yields a plausibility assessment.

For the seismically very active region of the Eastern Mediterranean and especially for Greece GPS measurements provide detailed information about recent crustal deformations. Additionally, seismic and geologic observations are available. Using the Finite Elements method it is attempted to develop tectonic models in such a way that their kinematic patterns concur with existing observations. First models incorporate only the most active seismotectonic structures. They yield promising results and are going to be improved in an iterative process (Fig. 2, 3).

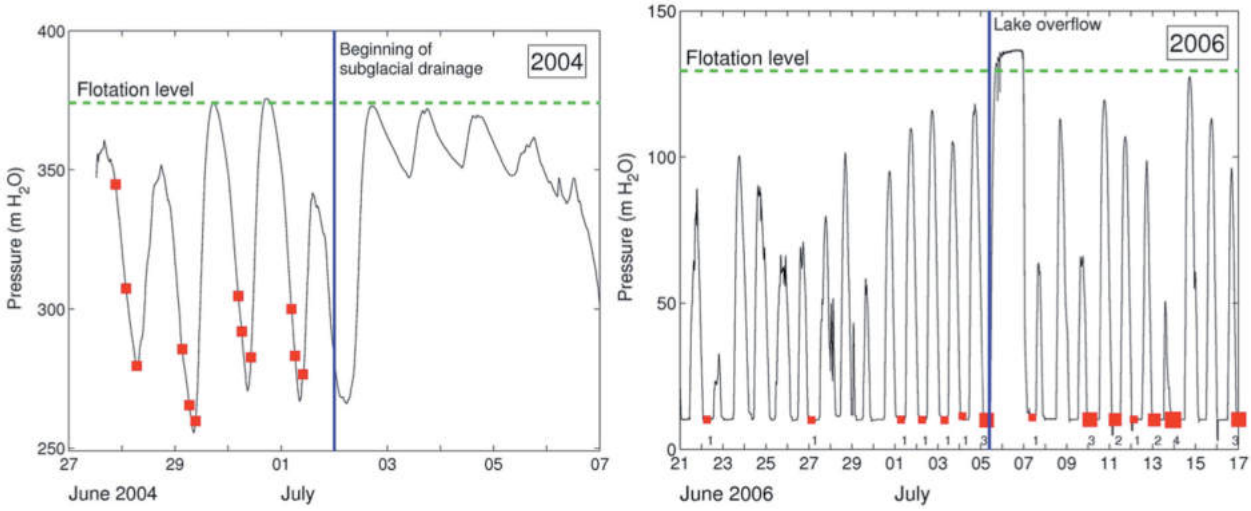


Fig. 1: Subglacial water pressure (black solid line) and basal icequakes (red squares) beneath Gornergletscher. In 2004 (left) a major lake drainage maintained high subglacial water pressures for several days. In 2006 (right) the pressure perturbation was rather minor, as a surface drainage produced only small discharge.

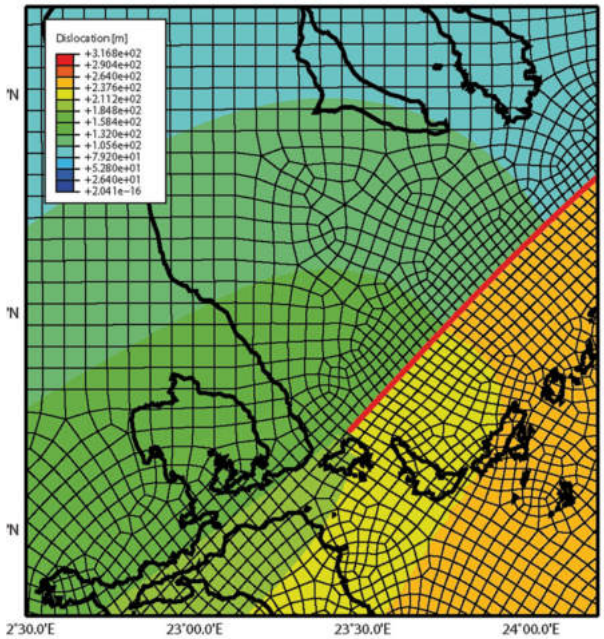


Fig. 2: The North Aegean Trough (NAT) is one of the most active seismo-tectonic structures in Greece. According to GPS measurements the differential velocity across the NAT diminishes towards its western termination. In Figure 1a section of a Finite Elements model developed for the North Aegean sea is shown. The colour scheme corresponds to the calculated continuous dislocation field of this region. The red line indicates the location of the NAT.

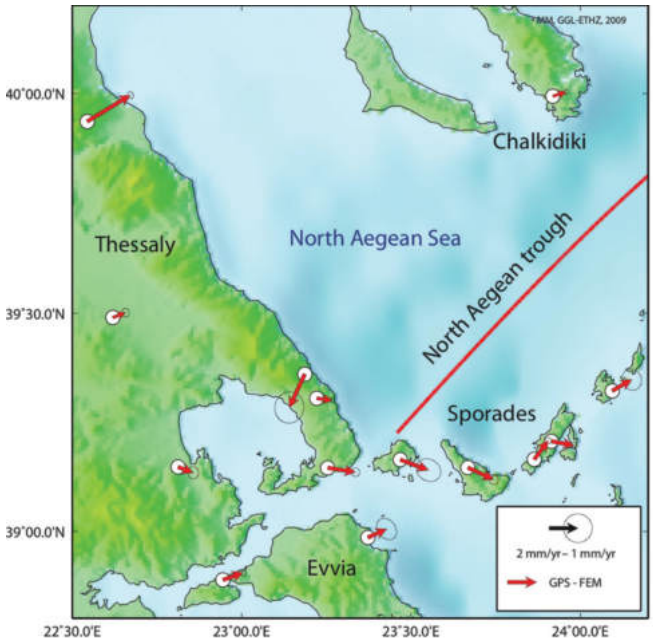


Fig. 3: : Residuals of motion as calculated with the Finite Elements method are shown with respect to a recent GPS velocity solution (red arrows). The red line indicates the location of the NAT.

Alignment of the future 50 km Compact LInear Collider (CLIC) at CERN

What is horizontal ? High-precision determination of the geoid over short distances.

by S. Guillaume, B. Bürki / IGP

Although the world's largest particle accelerator, the LHC (Large Hadron Collider) at the European Organisation for Nuclear Research (CERN), has started its operation only very recently, the next generation of accelerators is already under intensive study. The CERN explores the feasibility of a new electron-positron linear collider of 50 km length called CLIC (Compact LInear Collider). One of the biggest technological challenges is the alignment of all components accelerating and steering the particle beam in a straight line. In fact, these elements must be aligned with a relative accuracy of 10 microns per 200 meters (compared to 0.1 mm per 100 meters for the LHC).

For the vertical component a solution based on a hydrostatic leveling system (HLS) is under study giving promising results. Nevertheless, this technique is limited, amongst others, by the reference of the static water. In fact, the equilibrium state of static water does not coincide with a straight line, but matches the instantaneous equipotential surface of the gravity field, the geoid, which depends on the inhomogeneous density distribution in the vicinity. In other words, the geoid has to be determined with an accuracy of better than 10 microns per 200 meters, if instruments depending on gravity (such as the HLS) are used.

In order to study the feasibility of this geoid determination, extremely dense measurements of the acceleration of gravity and the astro-geodetic deflection of the vertical are carried out at the surface and inside a straight tunnel of 850 metres lengths at a depth of 100 m. The gravity acceleration is measured by the new gravimeter CG-5 with a resolution of one billionth of the Earth's acceleration ($g \approx 9.81$ m/s^2). The deflection of the vertical is determined with an accuracy of better than 0.1 arc second by the astro-geodetic system DIADEM developed at IGP. The combination of these measurements with geological information will be the basis to assess the variations in the gravity field over such short distances.

Interactive Design of World Map Projections

A new software-based approach to the design of projections for world maps.

von B. Jenny, L. Hurni / IKA

The design of new map projections has until now required mathematical expertise that has limited this activity to a small group of specialists. The Institute of Cartography developed a new software-based method, enabling cartographers to easily design new world map projections.

A new projection is designed interactively in an iterative process, which allows the designer to graphically and numerically assess the representation of the continents and the graticule (the network of lines of latitude and longitude upon which a map is drawn).

The devised concepts were implemented in Flex Projector, a specialised free and open-source software application for the design of new world map projections. It enables users to quickly create new map projections and modify or combine existing projections. Flex Projector also offers complementary visualisations and numerical evaluation methods that illustrate the distribution and amount of the inevitable areal and angular distortion and help the projection designer optimize a projection. Flex Projector was used to create various new map projections, for example the Natural Earth projection (Fig. 3), which is a pseudo-cylindrical projection with a balanced appearance of major landmasses. It was decided to give the corners, where the pole lines and bounding meridians meet, a rounded appearance. The rounded corners suggest that the projection represents a spherical earth, and reduce the size of polar areas, thereby reducing the areal exaggeration of Antarctica.

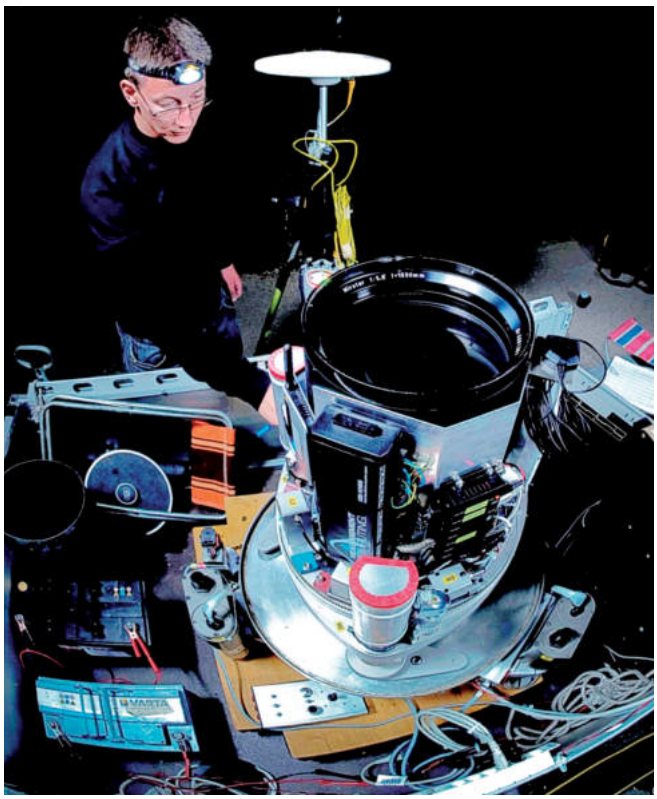


Fig. 1: The Digital Astro-geodetic Deflection Measuring system (DIADEM) is composed of a 1000 mm telescope, a 2184x1472 pixel CCD camera, a digital focuser, 6 ultra-precise tiltmeters, a GPS receiver, 2 computers, and 8 digitally steered DC motors.

Fig. 2: The complete measurement system, ready to be deployed in difficult field areas.

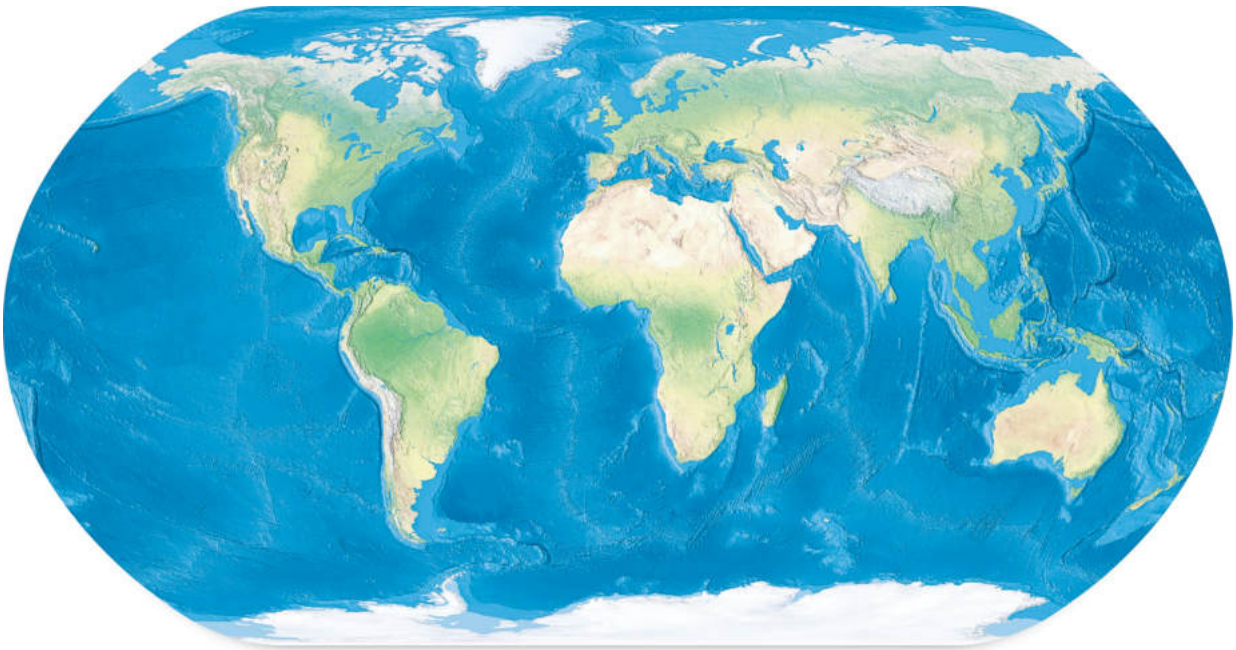


Fig. 3: The new pseudo-cylindrical Natural Earth projection, designed with the Flex Projector software application.

The Web-Based *Swiss World Atlas interactive*

Development of future-oriented teaching material for modern geographic education.

by Ch. Häberling, H. Bär, J. Cron, Ph. Marty, L. Hurni / IKA

The *Swiss World Atlas* is the most widespread printed school atlas in Switzerland and commercially very successful. Since its first publication almost one hundred years ago, it was entirely and partially revised several times. The next edition will also comprise an up-to-date atlas information system. By projecting the atlas maps as wall maps or using them as an individual teaching aid, the screen visualizations offer a broad range of interactive applications.

Besides classic orthogonal map representations (Fig. 1) the *Swiss World Atlas interactive* also consists of virtual globes and interactive block diagrams. The screen-optimized visualisations offer a high standard functionality like layer management or search tools.

With the aid of a special texture mapping method, the virtual globe module is able to display satellite images as well as physical and thematic global maps (Fig. 2). With the integrated block diagrams depicting regionally and topographically interesting landscape models – a novelty among interactive school atlases – the students learn to better interpret contour lines and distinctive landforms (Fig. 3). Additionally developed visualization tools showing the revolution of the earth around the sun (Fig. 4) sharpen the spatial thinking of the students. All those representations are accessible by a functional and easy-to-handle graphical user interface.

After finishing the prototype test phase a beta version will be available in June 2010. The official publication of the first edition of the *Swiss World Atlas interactive* is planned in October 2010 (www.swissworldatlas.ch).

Air invasion structure

Visualization of air injection into liquid-saturated 3D porous media.

by X.-Z. Kong, M. Holzner, W. Kinzelbach, F. Stauffer / IfU

The study of gas movement following injection into liquid-saturated movable porous media is an active area of investigation for theoretical and practical reasons, involving remediation, biological processes, aeration of filters, and others. Practically, most issues involve three-dimensional (3D) systems and therefore a corresponding detailed description in three spatial dimensions is extremely important for a full characterization of the phenomena occurring.

Air injection patterns were investigated in fully 3D laboratory experiments under gravity effects. Using the technique of refractive index matching between the porous medium (crushed silica glass) and the liquid phase (a glycerine-water solution), the air flow patterns are visualized in a non-intrusive way by tomographic laser sheet scanning (Fig. 5). While grains and fluid are completely transparent, air bubbles show by their very clear contrast. By using this technique, a series of preliminary laboratory experiments were performed in a box of the size 20 cm × 20 cm × 30 cm using silica glass grains of size 1.0-1.6 mm as granular material. After subsequent image processing of the 2D slices obtained in a linear sweep of the box, a 3D dynamic air flow pattern (Fig. 6) appears, allowing a quantitative analysis of the air flow dynamics on pore-scale. The temporal resolution of the present configuration is 0.1 s, and the spatial resolution is 0.1 mm in plane and about 1 mm out of plane of the laser sheet .

In (Fig. 6), we can see that the invasion structure shows a fragmentation behavior for small injection rates. Once the air bubble elongates to a certain length, fragmentation occurs. This means that discrete air clusters are driven by their own buoyancy.

Fig. 1: Section of a topographic atlas map of the Moutier Gorge (Switzerland).

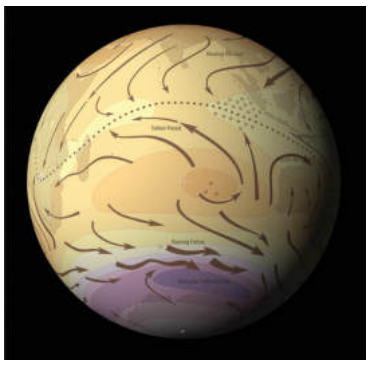


Fig. 2: Interactive virtual globe draped with a thematic representation showing the global atmospheric pressure and main wind directions.

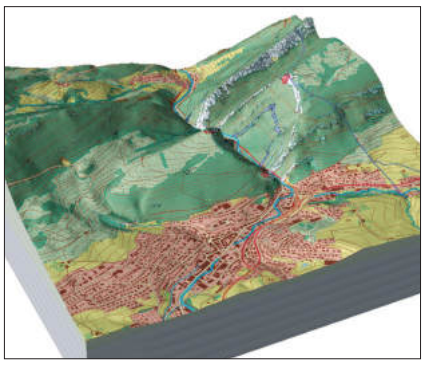


Fig. 3: Block diagram showing a digital terrain model of the Moutier Gorge (Switzerland).

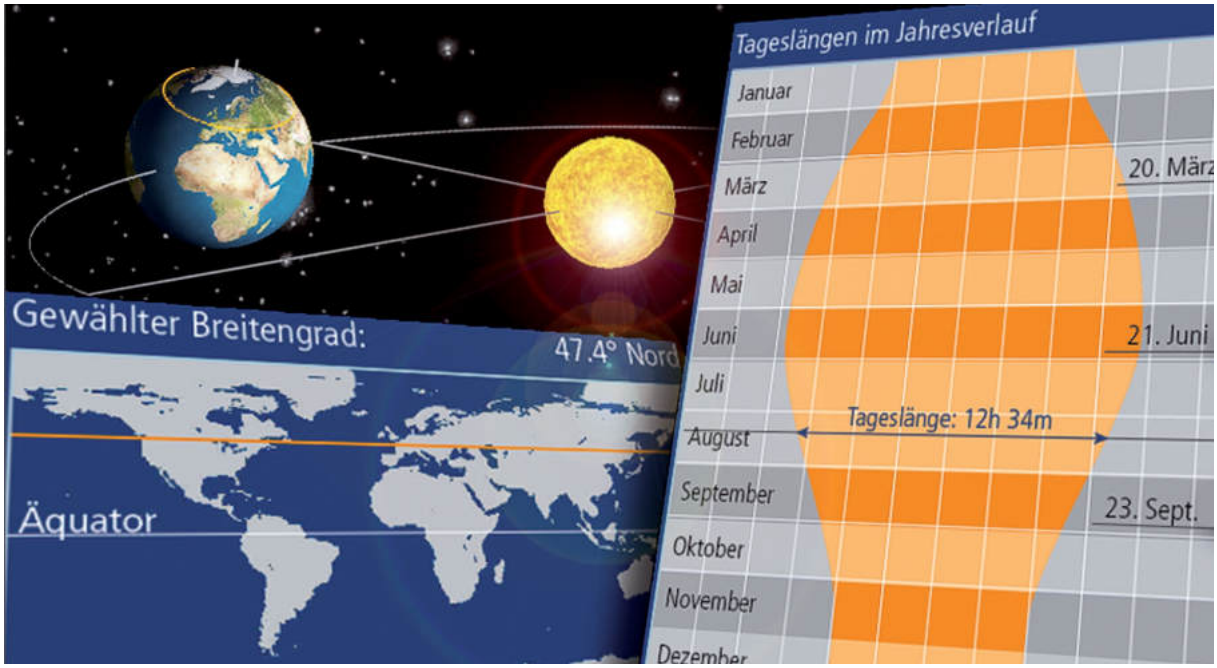


Fig. 4: Dynamic visualisation tool showing the revolution of the earth around the sun combined with an interactive chart to explain the seasonal daylight pattern.

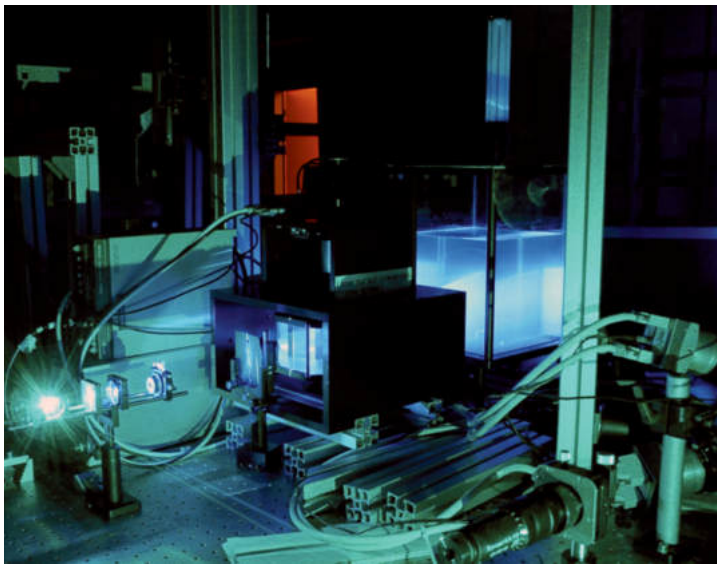


Fig. 5: Experimental configuration in the laboratory: the laser beam is expanded and thinned to a light sheet, then scanned through the observation volume via the rotation of an eight-faced prism.

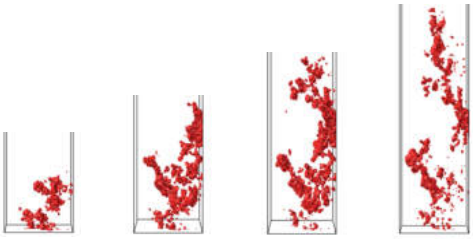


Fig. 6: Images of the air invasion structure in the porous medium at times, from left to right, 2 s, 4 s, 6 s, and 8 s. The height of the packing is 157 mm. The air flow rate is 8.25 ml/min.

Material Research on Game Consoles

First they conquered the playrooms of our children, now they are about to change computational sciences.

by K. Kovacs, F.K. Wittel, H.J. Herrmann / IfB

Game consoles and so called Graphics Processing Units (GPUs) from high performance graphic cards promise an extreme performance leap for numeric simulations. Today the way we program numerical models and run our simulations is changing rapidly. The reason can be found in processors (CPU), that require more complicated cooling concepts due to increase in clock frequency. To deal with this matter, frequencies were reduced in the last years and several processors, so called multi cores were integrated on one chip. CPUs under development will work with up to 64 cores and graphic cards already today work with up to 512 simple processors that share the same memory on one GPU. The theoretical increase in performance of simple integer operations compared to single core CPUs is up to a factor of 200 at a fraction of the energy. To be able to use such processors efficiently, software needs to be tailored to the architecture. Cell CPUs, that are the heart of the PlayStation3, are a promising compromise between CPUs and the cumbersome to program GPUs.

To meet the challenges of high performance simulations on modern shared memory architectures, investments in fast cluster solutions are essential. By extending our cluster to 456 cores with a total of 1.2TB memory, a peak performance of around 5-6 TFlops, fast 40GB/s interlink and a parallel file system with 35TB, we are now able to meet our needs. The multitude of challenging numerical approaches used to simulate building materials was awarded recently by an "IBM Faculty Award". With this award, support in form of cell blade hardware and expertise from developers is granted to facilitate the implementation of our simulation programs to the cell blade architecture (Fig. 1). Using this technology we can expect to run significantly larger simulations up to 10 times faster at 70% energy reduction compared to the newest multi-core processors.

Rockglacier monitoring with low-cost GPS: Case study on the Dirru glacier, Mattertal

Is it possible to detect smallest movements by low-cost GPS receivers?

by P. Limpach, A. Geiger, M. Rothacher / IGP

This question shall be answered by a pilot project on the Dirru rockglacier in the Mattertal, where a test network for GPS monitoring has been installed in June 2009 (Fig. 1a). The goal of the test network is to investigate the potential of low-cost GPS receivers for the precise monitoring of slope instabilities in mountainous areas, in order to strengthen the understanding of processes linked to permafrost-related slope instabilities and to enhance existing monitoring and early-warning systems. The test site was selected by the Alpine Cryosphere and Geomorphology research group of the University of Fribourg and the Swiss Federal Office for the Environment (FOEN), based on displacements detected by SAR interferometry and periodic GPS surveys. This study is financially supported by FOEN.

The GPS test network consists of three permanent GPS stations (Fig. 2a): one reference station (REFD) outside the instable area and two stations (DIR2 and DIR3) on the moving rockglacier. The three stations are equipped with low-cost single-frequency (L1) GPS receivers by Swiss manufacturer μ-blox and powered by solar panels (Fig. 2b). The GPS data processing is based on differential carrier phase techniques. The low-cost GPS system provides continuous observations of surface motions with centimeter accuracy. It allowed to reliably observe station displacements of 2.5 cm/day, which summed up to 3 m over the observation period of 4 months (Fig. 2c).

Fig. 1: Part of the new compute cluster, based on Intel new Nehalem architecture. The inset shows one blade (IBM HS22) in detail, with passive heat sinks.

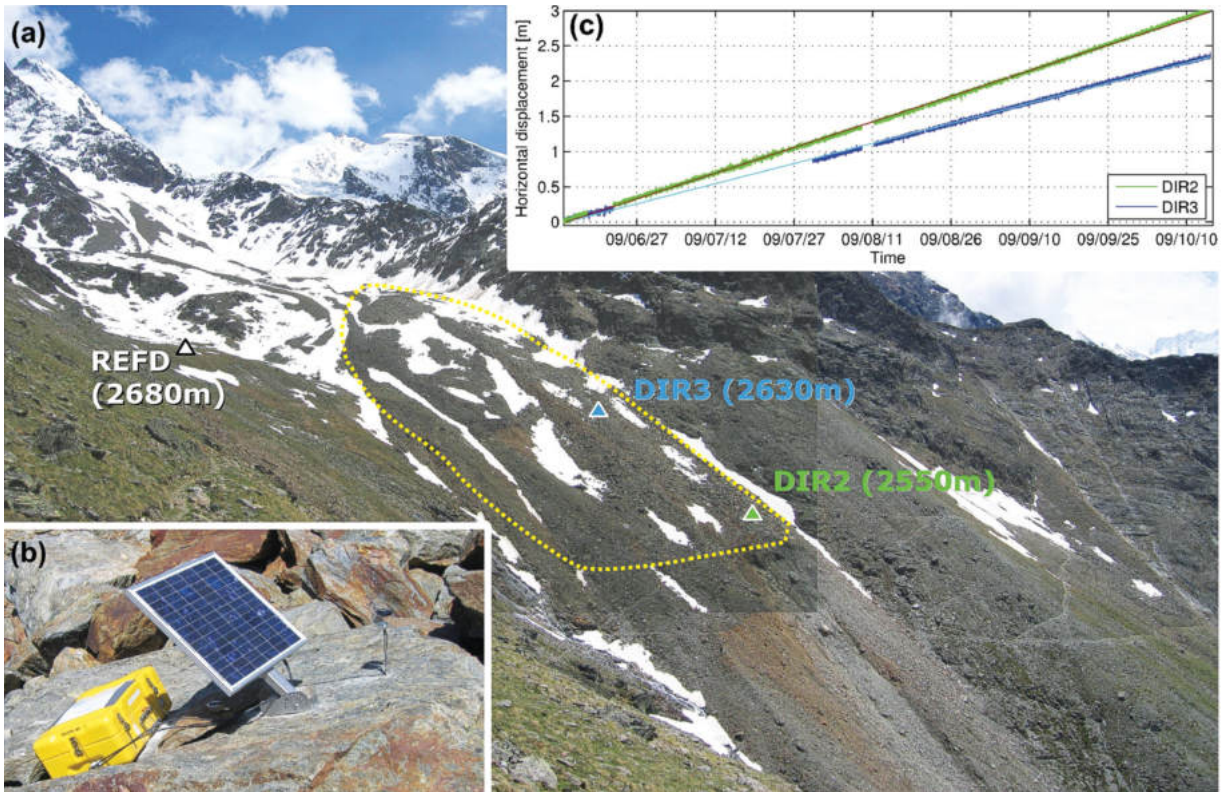


Fig. 2: (a) GPS test network on the Dirru rockglacier, with three permanent GPS stations. The yellow dashed line delimits the rockglacier area. (b) GPS station installed on the rockglacier, including (from right to left) GPS antenna, solar panel and instrument box containing GPS receiver and battery. (c) Time series of horizontal displacements of GPS stations DIR2 (green) and DIR3 (blue), from June 12th to October 14th 2009 (4 months).

GPS as Rotational Sensor

Can GPS be used to estimate the orientation and rotational velocity of the antenna?

by S. Häberling, A. Geiger / IGP

To this day, the satellite-based navigation systems such as the Global Postioning System (GPS) are mainly used for positioning applications. An additional method to retrieve 3D rotation angles from measurements with a single GPS antenna in real-time was demonstrated by a master thesis. This information about the angular velocities and the full 3D rotation in addition to the position would enlarge the applicability of GPS in machine control and air navigation.

The method is using the properties of the circularly polarized electromagnetic waves that are transmitted by the GPS satellites. The rotation of the receiver antenna relative to the satellite antenna generates a phase shift called "phase wind-up" (Fig. 1). Depending on the type of rotation and on the elevation angle of the incoming signal this phase shift, measured from different satellites, allows the description of the full 3D antenna rotation.

For the detection of small phase shifts in GPS raw data it is necessary to build a linear combination between signals with different frequencies to eliminate error sources. After a statistical signal processing with appropriate filtering the results indicate that minimal rotational velocities of 3–3.5 °/s are significantly detected depending on time of day (e.g. ionosphere) and satellite constellation. The algorithm developed for the determination of the full 3D rotation generates stable solutions. This was verified by simulations and real measurements (Fig. 2).

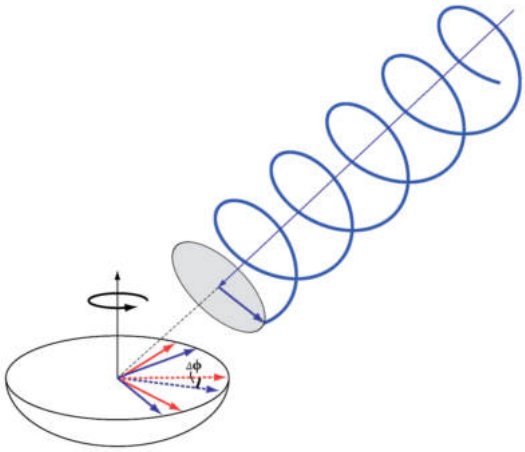


Fig. 1: A simplified schematic illustration of an incoming circularly polarized electromagnetic wave. Due to the rotation of the GPS antenna (blue to red) an angle (phase shift Δφ) occurs between the two dipole vectors (dashed). They can be described as a projection from the polarization plane (grey) onto the antenna plane.

Fig. 2: Measurement setup with the rotation simulator and the mounted GPS antenna.

Facts & Figures 2009

Organisation Chart D-BAUG

Department Conference
Head of Department

- Head of Department
- Curriculum Committee
- Departmental Administration, Offices
- Institute Directors Conference
- Conference on Examinations
- Laboratories, Workshops

Institutes

- IBB Construction Engineering and Management
- IBK Structural Engineering
- IfB Building Materials
- IfU Environmental Engineering
- IGP Geodesy and Photogrammetry
- IGT Geotechnical Engeneering
- IKA Cartography
- IRL Spatial and Landscape Planning
- IVT Transport Planning and Systems
- VAW Hydraulics, Hydrology and Glaciology

Curricula

- Civil Engineering (CE)
- Environmental Engineering (EE)
- Geomatic Engineering and Planning (GP)
- Spatial Development & Infrastructure Systems (SDIS)

Institutes (Date: January 1, 2010)

IBB Institute for Construction Engineering and Management


Prof.
B. Adey


Prof.
G. Girmscheid


Prof.
H. Wallbaum (AP)

IBK Institute of Structural Engineering


Prof.
M.H. Faber


Prof.
M. Fontana


Prof.
P. Marti


Prof.
T. Vogel


Prof.
A. Dazio (AP)

IfB Institute for Building Materials


Prof.
H.J. Herrmann


Prof.
J.G.M. van Mier


Prof.
B. Elsener (TP)


Prof.
P. Niemz (TP)

IfU Institute of Environmental Engineering


Prof.
P. Burlando


Prof.
W. Gujer


Prof.
I. Hajnsek


Prof.
S. Hellweg


Prof.
W. Kinzelbach


Prof.
E. Morgenroth


Prof.
F. Stauffer (TP)


Prof.
F. Siegrist (TP; EAWAG)

IGP Institute of Geodesy and Photogrammetry


Prof.
H. Ingensand


Prof.
M. Rothacher


Prof.
A. Geiger (TP)

IGT Institute for Geotechnical Engineering


Prof.
G. Anagnostou


Prof.
A. Puzrin


Prof.
S.M. Springman

IKA Institute of Cartography


Prof.
L. Hurni

IRL Institute of Spatial and Landscape Planning


Prof.
B. Scholl


Prof.
A. Grêt-Regamey

IVT Institute of Transport Planning and Systems


Prof.
K.W. Axhausen


Prof.
U. Weidmann


Prof.
H.P. Lindenmann
(TP)


Prof.
P. Spacek
(TP)

VAW Laboratory of Hydraulics, Hydrology and Glaciology


Prof.
R. Boes


Prof.
M. Funk (TP)


Prof.
W. Hager (TP)

(AP) = Assistant Professor
(TP) = Titular Professor

Faculty

Retirements and Demissions:

Prof. Hans-Gert Kahle	Mathematical and Physical Geodesy	Jan	2009
Prof. Armin Grün	Photogrammetry and Opical Remote Sensing	July	2009
Prof. Hans-Rudolf Schalcher	Construction Planning and Management	July	2009
Prof. Jan G.M. van Mier	Building Materials	Dec	2009

Appointments:

Prof. Markus Rothacher	Mathematical and Physical Geodesy	Jan	2009
Prof. Robert Boes	Hydraulic Structures	Feb	2009
Prof. Eberhard Morgenroth	Process Engineering in Urban Water Management	Aug	2009
Prof. Irena Hajnsek	Earth Observation	Nov	2009
Prof. Brian Adey	Infrastructure Management	Jan	2010

Students D-BAUG (Date: November 3, 2009)

	BSc		MSc [1]		Total			Doctoral Students			Disser-tations
Curricula	♂	♀	♂	♀	♂	♀	T	♂	♀	T	T
Civil Engineering	373	81	102	28	475	109	**584**	112	26	**138**	
Environmental Engineering	132	67	66	42	198	109	**307**	25	8	**33**	
Geomatic Engineering & Planning [2]	46	14	27	10	73	24	**97**	26	7	**33**	
Spatial Development and Infrastructure Systems			26	13	26	13	**39**				
Total	**551**	**162**	**221**	**93**	**772**	**255**	**1027**	**163**	**41**	**204**	**38**

[1] Without Guest and Mobility Students
[2] Including SDIS for PhD Students

Staff D-BAUG (in capita; ETH and Third Party Funding; Date: End of December 2009)

P	AP	TP	Senior Scientist	Senior Assis-tant	Senior	Technical Staff (incl. ICT)	Admin. Staff	Appren-tices	D-BAUG Staff total (capita)
24	2	9	6	44	277	65	44	4	475

P = Professor
AP = Assistant Professor
TP = Titular Professor
SA = Senior Assistant
Scientific Staff = Doctoral students, Post-Docs, Assistants
Figures without Student Assistants, Hourly Wage Employees, Trainees, "occupied Workplaces"

Master of Advanced Studies (MAS), Certificate of Advanced Studies (CAS), Courses

	Institute	Title
MAS ETH	IBK / HazNETH	Natural Hazards Management
MAS ETH	IfU	Sustainable Water Resources
MAS ETH	IRL / IVT / NSL	Spatial Planning
MAS EPFL	EPFL + VAW / IfU	Hydraulic Engineering
CAS ETH	IBK / IVT et al.	Risk and Safety of Technical Systems (responsible body: D-MAVT)
CAS ETH	IGP / IKA	Spatial Information Systems
CAS ETH	IRL / NSL	Spatial Development
CAS, HTA Luzern	IBK	Seismic design, HTA Luzern
PhD Programme	IRL	International PhD Program 'Perspectives of Spatial Development in European Metropolitan Regions'
Postgraduate Course	IBB	3rd International Summer School for Sustainable Construction
Course	IBB	Management in Construction Firms
Kurs	IBB	Research Methodology in Construction Management
Course	IBK	Earthquake Engineering and Structural Dynamics, invited Contribution on Displacement Based Methods in Earthquake Engineering, Austrian Standards, Vienna, Austria
Course	IBK	Fundamentals of Seismic Design, ROSE School, Pavia Italia
Course	IBK	Seismic Design of Building Structures, University of Stellenbosch, South Africa
Course	IBK / BFH	Fire Safety in Timber Structures, Research Aspects
Course	IGP / IKA	Efficient Work with VBA (Visual Basic for Applications)
Course	IGP / IKA	From GIS Data to Interactive Web Map
Course	IGP / IKA	Introduction to INTERLIS (basic and advanced training course)
Course	IGP / IKA	Introduction to Photogrammetry, Satellite Optical Remote Sensing, Airborne Laser Scanning
Course	IGP / IKA	Model Based Integration of Spatial Data in GIS as Key to their Use
Course	IGP / IKA	Open Source GIS with GRASS and Quantum GIS
Course	IVT / VSS / bfu	Safety Audits for Transport Projects
Course	IVT	Estimation and Implementation of Decision Models
Course	IGP	Introduction to Java for the GIS Development
E-Learning	IGT	GEOTip - Geotechnical Information Platform (former CALICE): Soil Mechanic
E-Learning	IKA / IRL / et al.	GITTA - Geographic Information Technology Training Alliance
E-Learning	IKA / UniZH / FHNW	CartouCHe - Cartography for Swiss Higher Education

Workshops, Symposia, Congresses

Date (in 2009)	Event	Institute	Topic
15 January	Symposium	IfU	Quality Oriented Groundwater Management
22 - 23 January	Congress	IBB	LIVING LAB - Design Study for a EU Research Infrastructure to research Human Interaction with, and Stimulate the Adoption of, Sustainable, Smart and Healthy Innovations Around the Home
24 - 25 January	Workshop	IfB	'Rencontre de Physique Statistique'
26 - 29 January	Congress	ETH / MIT / Uni Tokyo / Chalmers	Annual Meeting 2009, Alliance for Global Sustainability
27 January	Workshop	IRL	Landscape and Renewable Energy
29 January	Workshop	IRL	Sustainability economic hubs - from Masdar in Abu Dhabi to a Swiss hub in Dübendorf
9 - 13 February	Workshop	IGT	Qualitative and Quantitative Analysis of Clay Minerals
10 February	Workshop	IGP	Satellite-Based Photogrammetry
11 - 13 February	Meeting	IVT	RailZurich2009: 3rd International Seminar on Railway Operations Modelling and Analysis
17 February	Seminar	IVT / CCSS	Telematics in Transportation
18 - 20 February	Symposium	IRL	Spaces and Projects of National Importance (SAPONI)
22 - 27 February	Workshop	IfB / IGT	From Shear Bands to Rapid Flow, Monte Verità, Ascona, CH
25 - 28 February	Workshop	IGP	3D-Arch'2009, 3D Virtual Reconstruction and Visualization of Complex Architectures
1 - 3 March	Conference	IRL	Health and Recreation in Forest and Landscape
3 March	Colloquium	VAW	'Kopswerk II - Modellversuche, numerische Simulationen und erste Betriebserfahrungen'
10 March	Colloquium	IBK	Inn Bridge Vulpera
24 March	Seminar	IVT	GSM Data for Transport Planning
31 March	Colloquium	VAW	'Hochwasserschutz für das untere Mangfalltal: Eine integrale Lösung'
2 April	Symposium	IBB	PPP-School projects - Economic efficiency assessment
3 / 6 April	Workshop	IKA	From GIS & sensor data to Web maps, SANY (EU Project)

Workshops, Symposia, Congresses (cont.)

Date (in 2009)	Event	Institute	Topic
7 April	Colloquium	IBK	Hot-galvanising in steel construction
21 - 24 April	Meeting	IVT	MATSim Tutorial and User Meeting 2009
22 - 24 April	Meeting	IVT	D-A-CH EMS Conference
22 - 25 April	Conference	IRL	Advanced analysis of spatial multi-functionality to determine regional potenti als for renewable energies
23 April	Meeting	IRL	Space Plus, Mannheim
24 April	Symposium	IGT	SGBF 2009: Durchmesserlinie SBB Zürich
28 April	Colloquium	VAW	'Hochwasserentlastungsstollen Lyssbach'
30 April	Symposium	IGP	Swiss Geodetic Commission, Spring Conference
7 May	Colloquium	IGT	'Tunnelbau in druckhaftem Gebirge'
7 May	Seminar	IVT	How Does Accessibility Create Value?
11 May	Workshop	IGP	ESRI User Group of ETH Zurich
13 - 16 May	Congress	IBK / University of Tokyo	IFED - 'Engineering Decision Making': viertes Forum - 'Long-term Policy Makings for Sustainable Society', Hakone, Japan
14 May	Symposium	IBB	Contract award process by PPP
19 May	Colloquium	VAW	'Alpenrhein, Rück- und Ausblick'
26 May	Colloquium	IBK	Stability in Steel Construction
3 - 5 June	Symposium	IRL	Higher Education in Spatial Planning (HESP)
8 June	Workshop	IRL	Airport Dübendorf, media information with workshop
8 - 12 June	Workshop	IfB / IVT	Coping with Crises in Complex Socio-Economic Systems
9 June	Workshop	IRL	Securing the Sustainable Provision of Ecosystem Services in the Alps and the Carpathians
9 - 10 June	Workshop	IKA	Design Workshop, 80 Days (EU Project)
9 - 10 June	Symposium	IKA	Internat. Cartographic Assoc. (ICA): 50th Anniversary, Celebration, Bern
11 - 12 June	Seminar	IKA	ICA Committee Meeting
12 - 16 June	Conference	IRL	IALE, Identifying the Regional Potential for Renewable Energy Using Ecosystem Services and Landscape Visualizations
25 June	Meeting	IVT	The Revolution of Automation - Impact on Tranportation and Society in the 20th and 21st Centuries
29 June	Colloquium	IGP	45 Years in the Ivory Tower, Colloquium on Retirement of Prof. Armin Grün
30 June	Congress	IBB	Generating value for sustainable features of properties
2 - 5 July	Conference	IGP	Optical 3D Measurement Techniques
7 July	Seminar	IVT	Cities, Energy, Transportation
16 July	Symposium	IRL / KIT	Airport and Spatial Development
2 - 3 August	Conference	IGP	SPIE - Optics and Photonics, 'Videometrics, Range Imaging, and Applications X'
19 August - 3 September	Exhibition	IGP	Xaver Imfeld (1853-1909) - 'Meister der Alpentopografie'
24 - 28 August	Congress	IBK / EMPA	Research and Innovation in Building and Construction, Timber Structures, CIB-W18
26 - 28 August	Workshop	IfU	COST Experiments in Turbulence
3 September	Meeting	IGP	Geomatic Engineering with Tradition and Future, Anniversary Symposium at ETH Zurich to the 100th Obit of Xaver Imfeld
4 September	Symposium	IfU	Groundwater and More
4 September	Workshop	IGP	INSPIRE Data Harmonisation
8 September	Meeting	IRL	Landmanagement for a Sustainable Spatial Planning and Development
10 - 11 September	Meeting	IBK	11th D-A-CH Conference, Earthquake and Masonry
14 September	Colloquium	IfB	Current Wood Research Questions
17 - 19 September	Congress	IBB	Construction Management Professorship Meeting - Teaching and Research
21 - 22 September	Workshop	IBK / University of Ljubljana	COST Actions TU0601 ('Robustness of Structures') und E55 ('Modelling of the Performance of Timber Structures'), Ljubljana, Slovenia
22 September	Colloquium	VAW	Perils of Glacier dammed Lakes
23 September	Seminar	IVT	Innovatiove Approaches for a Shift in Transalpine Freight Transport
6 October	Colloquium	IBK	MyZeil Frankfurt - 'Planung und Ausführung des avant-gardistischen Freiformdaches'
14 - 18 October	Conference	IRL	Dimensions of Ecology: from Global Change to Molecular Ecology, Linking Bayesian Networks to a GIS for ecosystem service management
19 - 20 October	Workshop	IGP	Airborne Laser Scanning Technology, Data Processing and Applications
20 October	Meeting	D-BAUG	Sponsor's event Excellence Scholarship Programme D-BAUG
20 October	Colloquium	IBK	Findings and Results of Earth Quake at L'Aquila on 6 April 2009
20 October	Colloquium	VAW	'Geschiebeumleitstollen Solis: Bautechnische Herausforderungen im Bereich des Einlaufbauwerks'
28 October	Seminar	IVT	Freight Transport Models

Workshops, Symposia, Congresses (cont.)

Date (in 2009)	Event	Institute	Topic
2 - 6 November	Workshop	IRL	How can cultural ecosystem services better be integrated into the concept of ecosystem services?
3 November	Colloquium	IBK	Melezza Bridge in Borgnone-Palagnedra
5 - 6 November	Symposium	IGP	AHORN 2009: Orientation, Navigation, Exchange in the Alpine Area
6 November	Colloquium	IfB	Physics and Reliablity of Wood and Wood Composites
6 November	Symposium	IGT	Autumn Meeting SGBG: Geotechnical Parameter and Coefficient
12November	Meeting	IRL	Geosuisse: Sustainable planning conditional on soil resources
13 November	Symposium	IfU	39th LCA Discussion Forum, Regionalization in LCA
13 November	Seminar	IVT	Land Use Models
13 November	Conference	IRL	Ecosystem Services for Sustainable Planning
17 November	Colloquium	VAW	River Flows with Curvature
17 November	Colloquium	IBK	Sports Centre Mülimatt, Brugg
19 - 20 November	Symposium	IRL / NSL	Swiss Spatial Sciences Framework (SRF)
24 - 25 November	Meeting	IVT / VöV / KöV / BAV	Public Transport Forum Oberhofen
26 November	Workshop	IRL	Experiences with (participative) methods and integration of methods in spatial planning: Scenario workshop
26 November	Workshop	IRL	3D Visualization for participative landscape development
30 November	Seminar	IVT	ETCS - History, State of the Art and Outlook
2 December	Seminar	IVT	Car Sharing in Japan
3 December	Seminar	IVT	Transportation Models between Planning Pretense and Methodological Advance
10 December	Colloquium	IGT	Urban Tunnelling
10 - 13 December	Workshop	IfU	Precipitation in Urban Areas
11 - 12 December	Workshop	IGP / BKG	Unified Analysis, Germany
15 December	Colloquium	VAW	Flood Water Protection Engelberg

Honours

Name	Institute	
Prof. Dr. Fontana Mario	IBK	IABSE, Invited lecture Public Session, Bangkok
Prof. Dr. Fontana Mario	IBK	Tokyo University of Science, Invited Lecture
Prof. Dr. Grün Armin	IGP	RESGAT - Remote Sensing and GIS Ass. of Thailand, Dr. Boon Indrabarya Gold Medal
Prof. Dr. Kinzelbach Wolfgang	IfU	Fellow of the American Geophysical Society
Prof. Dr. Niemz Peter	IfB	Honorary Doctorate, the University of West Hungary, Sopron
Prof. Dr. Niemz Peter	IfB	Nondestructive Testing and Evaluation of Wood Distinguished Service Award, confered by the International OC of the 'Nondestructive Testing and Evaluation of Wood' Symposium in Beijing
Prof. Dr. Puzrin Alexander M.	IGT	'Golden Owl VSETH 2009' - Excellence in Teaching in D-BAUG
Prof. Dr. Springman Sarah M.	IGT	Fellow of the The Royal Academy of Engineering RAEng
Dr. Akca Devrim	IGP	Carl Pulfrich Award
Dr. Jenny Bernhard	IKA	CaGIS Scholarship Award at PhD Level
Dr. Knobloch Markus	IBK	Tokyo University of Science, Invited Lecture
Dr. Milzow Christian	IfU	Otto-Jaag-Prize for Protection of Waterbodies
Dr. Staub Peter	IGP	Innovation Award e-geo.ch
Dr. Weitbrecht Volker	VAW	ASCE Karl Hilgard Hydraulic Prize
Aemisegger Franziska	IfU	Willi-Studer-Price; ETH-Medal; MSc Diploma with Distinction
Anastasi Andrea	IBK	Culmann Award
Bertsch Jonas	IGP	Geosuisse Award; MSc Diploma with Distinction
Berweger Angelo	IBK	Culmann Award
Braun Bernard	IBK	Culmann Award
Coray Sandra	IBK	SIKA Award for excellent MSc Diploma Thesis
Dalban-Canassy Pierre	VAW	Swiss Society for Snow, Ice and Permafrost, SEP-Award for Young Researchers, 3rd Best Presentation
De Sanctis Gianluca	IBK	Culmann Award
Dieterle Florian	IGT	Culmann Award
Dürrenmatt David	IfU	DWA Award, 'Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V.'
Fehlmann Patrick	IBK	IABSE Photo Contest of Structures, 7th prize
Gartmann Jürg	VAW	IM-Price for MSc Thesis 'Projektierung Kraftwerk Chlus', Ingegneria Maggia

Honours (Forts.)

Name	Institute	
Haeberling Simon	IGP	Willi-Studer-Price; ETH-Medal; MSc Diploma with Distinction
Imre Bernd	IGT	Best Presentation Award, International Conference 'From Shear Bands to Rapid Flow', Centro Stefano Franscini, Monte Verità, Ascona, CH
Iten Michael	IGT	Young Researchers Award, Internat. Symposium, 'Prediction and Simulation Methods for Geohazard Mitigation', IS-Kyoto
Kocher Lorenz	IBK	Culmann Award
Minder Pascal Stefan	IGT	Willi-Studer-Price; ETH-Medal; MSc Diploma with Distinction
Neuenschwander Martin	IBK	Culmann Award
Riesen Patrick	VAW	Swiss Society for Snow, Ice and Permafrost, SEP-Award for Young Researchers, Best Presentation
Rupf Michael	IBK	Culmann Award
Schleifer Vanessa	IBK	Security Award 2009 VBSF
Theiler Matthias	IBK	Culmann Award
Verones Francesca	IfU	Geosuisse Award
Villiger Sebastian	IBK	ETH-Medal
Viry Emmanuel	IBB	Construction Management Award, 'Industrialisierungspotentiale des konventionellen Tunnelbaus am Beispiel des Ceneri-Basistunnels'
Von der Tann Loretta	IGT	Culmann Award
Wendeler Corinna	IBK / WSL	PLANAT Research Award
Werder Mauro Angelo	VAW	European Geosciences Union (EGU), General Assembly, Young Scientists Outstanding Poster Paper (YSOPP) Award 2009
Wiesmann Samuel	IKA	Swiss Society for Applied Geography (SGAG), 3rd price for Master Thesis
Zingg Sara	VAW	Maggia Price

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Date: March 1, 2010

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Masthead

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