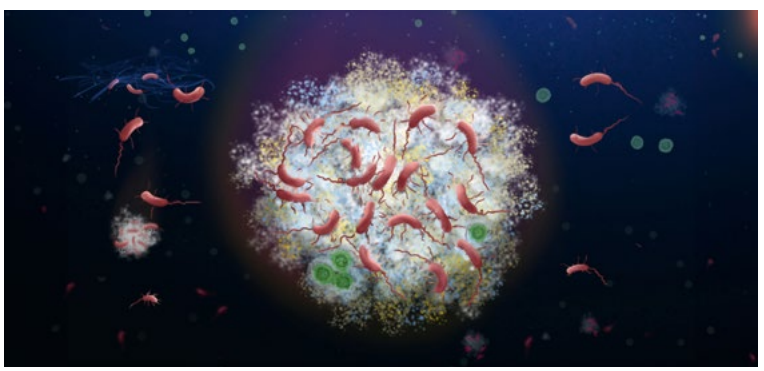
ETH zürich

Dept. of Civil, Environmental
and Geomatic Engineering

D-BAUG
Annual Report 2023

ENGINEERING A SUSTAINABLE WORLD



D BAUG

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Content

Dear Readers

It is a great honour and pleasure to introduce the annual report of the Department of Civil, Environmental and Geomatic Engineering (D-BAUG) of ETH Zurich for the first time. From 1 August 2023, I have taken over as Head of Department from Paolo Burlando, whom I would like to thank for his leadership and commitment.

While still recovering from the pandemic, the recent geopolitical developments bring new challenges that also affect ETH Zurich and our department. This calls for preparedness in adapting to changing boundary conditions. With the contribution of our colleagues, D-BAUG will once again prove its resilience, maintaining and further enhancing its leading position.

The contributions included in the 2023 report offer a glimpse of our high-quality research and teaching, as well as our knowledge transfer and outreach to society. Spanning across disciplines, with a unique combination of fundamental and applied research, D-BAUG contributes to solving vital problems, engineering a sustainable world.

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Prof. Ioannis Anastasopoulos

The past year was marked by several changes in our academic staff. Daniel Farinotti from the Laboratory of Hydraulics, Hydrology and Glaciology (VAW) was promoted to Associate Professor, while Guillaume Habert from the Institute of Construction & Infrastructure Management (IBI) and Jing Wang from the Institute of Environmental Engineering (IfU) were promoted to Full Professor. Moreover, Stephan Pfister was appointed Adjunct Professor, and Eleonora Secchi Senior Scientist, both at IfU.

After 25 years at D-BAUG and a career full of awards and high impact contributions, such as MATSim (the Multi Agent Transport Simulation software used by SBB and VW among others), Kay Axhausen retired in January 2024. We wish him all the best and thank him for his long-standing contributions to D-BAUG. He will be succeeded by Eva Heinen from TU Dortmund, who will join us in the summer of 2024.

Representative of the high quality of our research are the honours and awards received by our faculty. Few examples only: Adrienne Grêt-Regamey from the Institute for Spatial and Landscape Development (IRL) has been elected to the Swiss Science Council (SWR); Martin Raubal from the Institute of Cartography and Geoinformation (IKG) was awarded the "Outstanding Achievement in Urban Informatics Award" from the International Society for Urban Informatics; Catherine De Wolf from IBI was named one of MIT Technology Review's "35 Innovators Under 35"; Thomas Meierhans, received the 2022 ALEA Award, in recognition of his outstanding leadership as manager of our metal workshop.

Further strengthening its activities, our Gender and Diversity Commission (GDK) established the "Spotlight Seminar Series", which brings prominent female academics to ETH. Two successful seminar series were organised in 2023, and more are coming in 2024.

In addition, we are continuously strengthening our media presence, aiming to further improve our outreach to society and to attract talented students. Info screens have been installed around the department to provide up to date information to all our members and visitors.

Following the "E-Bike City" Lighthouse Project, a second inter-disciplinary project was launched in 2023. Funded by the Albert Lück Foundation, the "Extended Reality for Inspection, Assembly & Operation for Net-Zero Carbon Infrastructure" project aims to develop a spatial computing platform to accelerate the transition for a more efficient and environmentally friendly construction industry. The year was marked by generous funding from the Werner Siemens Foundation, which provides decisive support for the Chair of Durability of Engineering Materials, and the work of Ueli Angst on corrosion of reinforced concrete structures.

Another major milestone was the new Fire Simulator of the Institute of Structural Engineering (IBK), which is intended to explore the behaviour of timber structures in fire scenarios with the aim of expanding applications of timber as a safe and sustainable construction material. Europe's largest capacity centrifuge at the Institute of Geotechnical Engineering (IGT) is now operational, offering exciting opportunities to study the effects of natural hazards, such as earthquakes and floods, on new and existing infrastructure. Finally, 2023 also marks the completion of the refurbishment and extension of the HIF building – a major milestone for our experimental research.

In closing, I would like to warmly thank all our colleagues for their commitment and dedication in making these amazing contributions possible. Special thanks go to our partners within and outside ETH, who support us financially and with their ideas!

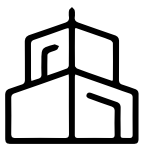
Ioannis Anastasopoulos, Head of D-BAUG

The Department of Civil, Environmental and Geomatic Engineering in Numbers 2023

43
Professors

1149
Students
♀372 ♂777

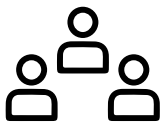
353
Doctoral students
♀129 ♂224



10
Institutes

3 BSc, **4** MSc
Study programmes

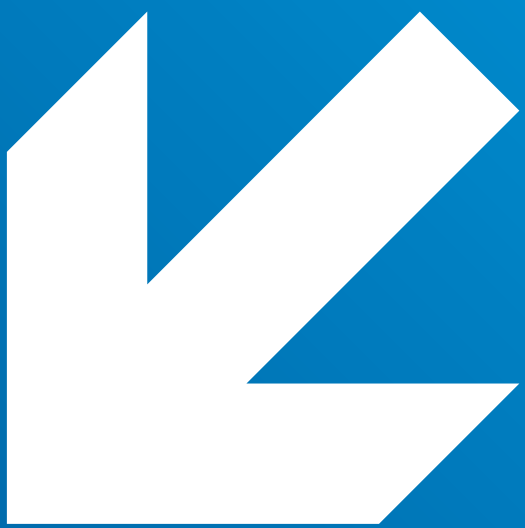
CHF 80.1 Mio.
Total expenditures (of which 34% are third-party funds)



625 FTE
Employees
incl. professors

3 MAS, **1** DAS, **10** CAS
Continuing education

929
Publications



Faculty and Campus

Research for our glaciers

Interview: Iris Mickein

Prof. Daniel Farinotti

Professor Daniel Farinotti investigates the evolution of glaciers and the implications for water resources. On the occasion of his promotion to Associate Professor of Glaciology at the Department of Civil, Environmental and Geomatic Engineering, we asked him what currently drives him in research and teaching.

Professor Farinotti, congratulations on your promotion at ETH Zurich! What are your current research interests?

Thank you! In my research group, we have four main foci. The first is large-scale research into the consequences of glacier changes. For example, we're investigating what the ongoing glacier retreat means for water resources in various regions of the world. The second focus is fundamental glaciological research. Here, we investigate how water is distributed in and under glaciers, and how this influences glacier dynamics, for example. The third area is glacier monitoring: we manage GLAMOS, the Swiss glacier monitoring network, which we operate together with the Universities of Zurich and Fribourg. The fourth area is contract research, where we make our expertise available to private and public entities.

What impact does your research have on society?

The subject of glacial retreat and its consequences is very topical right now. Especially in Switzerland, where glaciers are part of the landscape and most people have a direct connection to them: many people remember how big a particular glacier was when they first saw it years ago. Glacial retreat has become a symbol of ongoing climate change, and our research is in high demand as a result.

Where were you working before you came to ETH Zurich?

That's a bit of a funny question for me, because it feels like I've always been at ETH. I studied here, did my doctorate here and also spent some time here as a postdoc. After that I was at the GFZ German Research Centre for Geosciences in Potsdam, with the British Antarctic Survey in the Antarctic, and at the Swiss Federal Institute for Forest, Snow and Landscape Research (with which the current professorship is shared), but it almost feels I've never been away.

> **Glacial retreat has become a symbol of ongoing climate change, and our research is in high demand as a result.**
>
> Prof. Daniel Farinotti

Which courses are you teaching at ETH?

As a professorship, we offer: Cryosphere (an introductory lecture at B.Sc. level), Physics of Glaciers (teaching the physical principles of glacier dynamics), Applied Glaciology (an M.Sc. lecture dealing with applied glaciological problems), the Glaciological Seminar (in which selected articles from the glaciological literature are read and discussed), and the Glaciology Field Course (in which small groups of students carry out and interpret their own measurements in the field). For some

Daniel Farinotti and doctoral candidate Jane Walden install a mass balance stake at Grosser Aletschgletscher.

years now, we've also been offering the lecture "Solving Partial Differential Equations with GPUs", where we teach methods for carrying out simulations on high-performance computers.

What do you do if you have a few minutes to spare?

Go for a bike ride!

Which book, podcast, or film related to your field of research would you recommend to students and colleagues?

Apart from specialist books, I find the books describing the voyages of discovery made by the first polar explorers absolutely fascinating. The story of Ernest Shackleton's Endurance-Expedition (1914-1917), for example, is one that everyone should hear about at least once. When it comes to documentaries, I find *Between Sky and Ice* (original: *La glace et le ciel*) by Luc Jacquet very exciting. It depicts the history of ice core research. And if you want to see more than ice, then the BBC documentary series *Frozen Planet* has something for everyone. Some of the images in it are simply incredible!

What advice would you give to students who are just starting out in the engineering sciences?

I know it's easier said than done, but you should ask yourself what you want to do later on and then take the subjects you need for it. In other words, you shouldn't see studying as an end in itself, but rather as THE opportunity to acquire the skills that will enable you to have a fulfilling job later on.

“It is possible to build with respect for nature and people”

Interview: Iris Mickein

On the occasion of Guillaume Habert’s promotion to Full Professor of Sustainable Construction at the Department of Civil, Environmental and Geomatic Engineering, we asked him what currently drives him in research and teaching. He also shared with us what he considers the most important things in life and what he would do if he had an extra 53 minutes to spend every week.

Prof. Guillaume Habert

Professor Habert, congratulations on your promotion at ETH Zurich! What are your current research interests?

Honestly, I am interested in trying to find ways to give my children functional buildings and infrastructure. By functional, I mean buildings that do not destroy the planet, but rather repair it, that do not intoxicate the users, but rather improve their health and that do not increase the inequality and the financial accumulation of wealth, but rather try to relocalize the economy and redistribute the benefits of construction. This seems utopian? My work is to demonstrate the opposite, and to show that paths towards a regenerative economy are the most robust, cost-effective and enjoyable alternative we have. In particular, my work is very focused on material choices and the social, environmental and economic consequences of material choices in different contexts.

What is the impact of your research on society?

I’d like to see it bigger for sure! Some results are used in new standards. Some material developments are used in industry or end up being used in new start-ups. It’s too small and it’s much too late, given the climate emergency and the societal collapse. To me, this is a real dilemma in sustainability science. On the one hand, science is about creating new knowledge, and it’s not the role of the academic institution to apply the knowledge created and build a future fair, healthy, respectful society, that is up to all of us as a society.

On the other hand, do we really need to create new knowledge, or should we just spend our time to doing what we know and saving the last bit of nature and humanity? It’s a recurring tension in the work we do in my group. When should we stop and transfer our findings outside ETH to have an impact? In terms of research, I don’t think that we should do research to see the immediate impact of our work on society. Somehow, I think we should do research that will be relevant in the next five to ten years. So in five years, when industry or government comes to us for answers, we don’t suggest that they do new research work, but that they use the work we did five years ago.

For teaching, I see the impact of our work much more directly. When I have 300 students enrolled in my optional master’s lecture on the resources we can use for sustainable construction, and I show them real life, built examples of multi-story buildings made of straw, hemp, massive stone, or mud, I feel I am having an impact. They will leave this institution knowing that it is possible to build with respect for nature and people.

Where were you working before you came to ETH?

I was in Paris, working as a researcher in the laboratory of the National Civil Engineering Institute. That’s where I learned everything about concrete, because my training is far from civil engineering. Until I got my Ph.D., I was just looking at natural rocks and trying to explain the history of the Earth. I stud-

Guillaume Habert was recently hosted by Ambassador Jacques Pitteloud at the Swiss Embassy in Washington, D.C.

ied geology. I was dealing with millions of years as a time scale and hundreds of Kilometres as a length scale. Switching to civil engineering was quite refreshing. We were dealing with human time and space.

What courses are you most excited about teaching at ETH?

I like the courses where I can show very simple things that the students have not thought about. It's a way to open a door and allow them to discover a whole new World. Yes, we can build earthquake resistant 7-story buildings out of straw bales... no it doesn't cost any more than what we are building en masse now... no, it doesn't burn, it doesn't rot, and it doesn't smell. I like it because among the many students I teach, there will be one or two who will pick it up, fall in love with such materials and go to work with them in practice.

What do you do if you have a few minutes to spare?x

Do you know the story of "The Little Prince" by Antoine de Saint Exupery? He once met a seller of advanced thirst-quenching pills, who said "Take these pills once a week and you will no longer feel the need to drink".

"Why are you selling them?" said the little prince.

"It's a great time-saver," says the merchant. "The experts have done the math. You save fifty-three minutes a week."

"And what do we do with those fifty-three minutes?"

"You can do whatever you like with them..."

"As for me," said the little prince, "if I had fifty-three minutes to spend, I'd walk very slowly towards a fountain..."

I'm not the little prince, but what I love to do is to sit on the terrace of a café, drink a coffee, read a newspaper and spend this time not doing much.

Do you have a general philosophy or motto you try to live by?

Donella Meadows, the great scientist and lead author of "Limits to Growth" wrote: "We need to learn, but we need to waste no time with our learning. I really like this idea of not getting lost in the complexity of what we could do, but always think about the why and what is the appropriate level of complexity in our work that can help us to answer the meaningful question.

At ETH, you should focus on learning rules and concepts, but the solutions, they are up to your imagination.

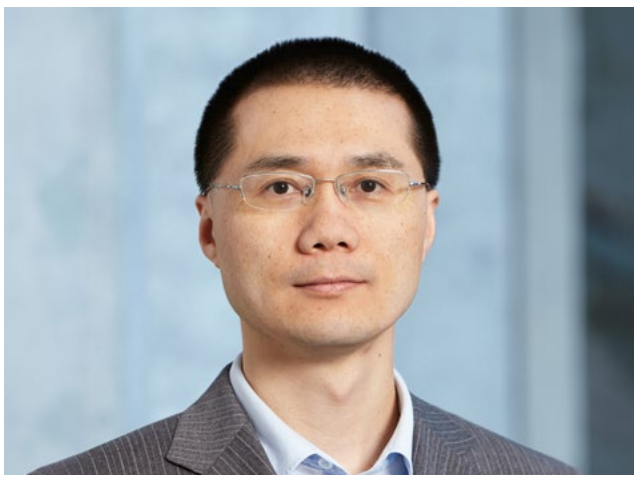
Prof. Guillaume Habert

What advice would you give to students who are just starting out in (civil) engineering?

Be curious. Most of what we (as a society) have built in the last 100 years is horribly wrong. But the laws of physics are still the same and won't change. So you have to know the rules in order to be able to play with them afterward. At ETH, you should focus on learning rules and concepts, but the solutions, they are up to your imagination.

Towards healthy air

Interview: Iris Mickein



Prof. Jing Wang

Professor Jing Wang conducts fundamental and applied research in the field of air quality and its impact on human health and the environment. On the occasion of his promotion to Full Professor of Air Quality and Particle Technology in the Department of Civil, Environmental and Geomatic Engineering, we asked what drives him in research and teaching.

Professor Wang, congratulations on your promotion at ETH Zurich! What are your current research interests?

My main research interests lie in the fields of air quality monitoring and control, aerosol measurement and characterization, biological pathogen detection and treatment, and pollution abatement.

What is the impact of your research on society?

My long-term goal is to establish a world-leading laboratory for remediation of environmental and health threats posed by emerging airborne pollutants. For example, my group has developed a plasmonic biosensor for rapid on-site detection of the SARS-CoV-2 virus, which was applied to provide daily airborne virus monitoring results in the COVID wards of the University Hospital Zurich and nursing homes. Currently we are fabricating a pathogen detection system for the US Army Primary Standards Laboratory.

Where were you working before you came to ETH?

After receiving my Ph.D. in aerospace engineering from the University of Minnesota, I held several positions at the same institution: I started as a postdoctoral associate in the Particle Technology Laboratory. Later, I assumed the position of Lab Manager and the role of Research Assistant Professor. In 2010, I moved to Zurich, where I have since held a joint position between ETH and EMPA.

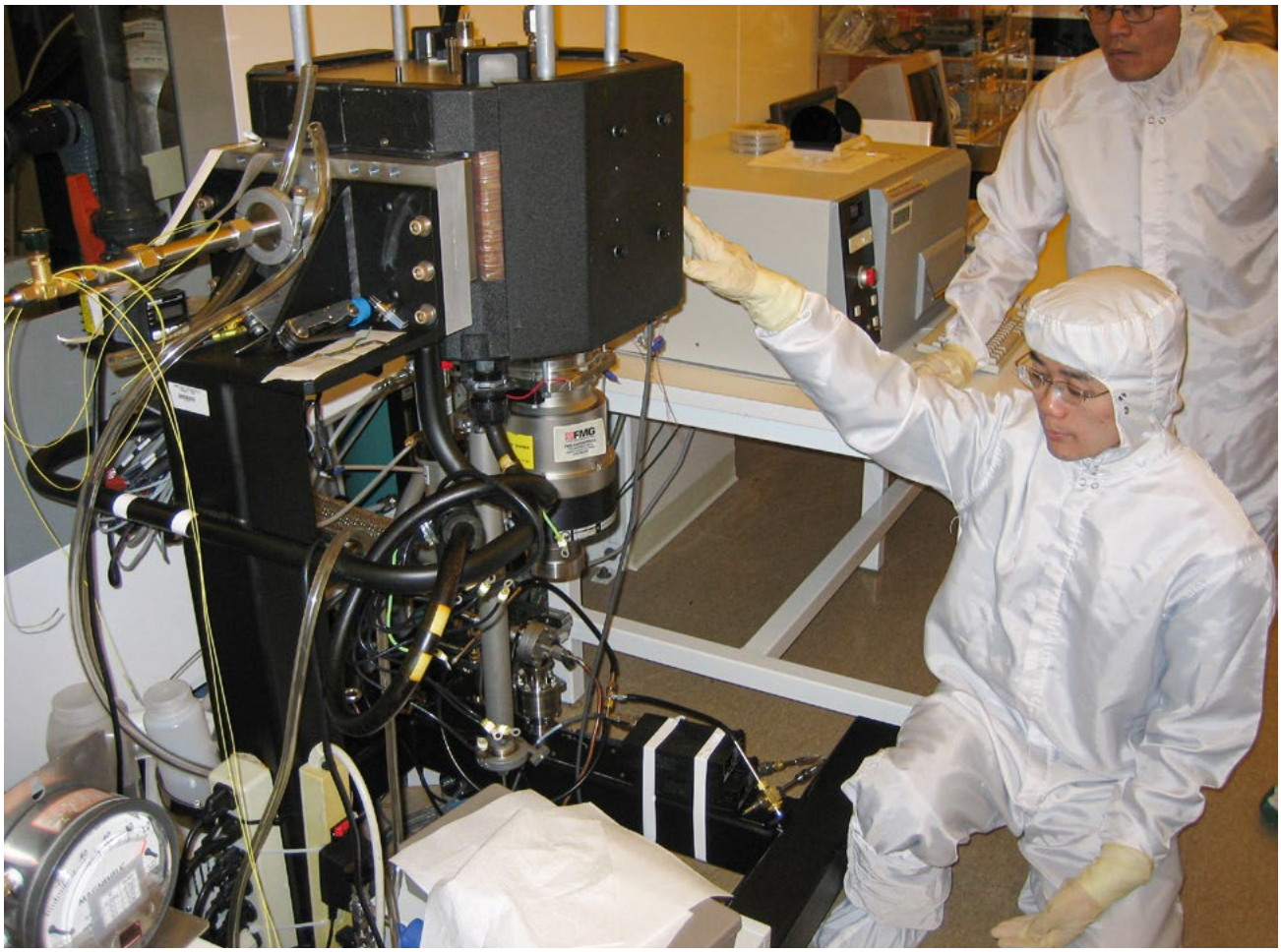
Which courses are you teaching at ETH?

I teach Air Pollution Control, Air Quality Technics, Air Quality and Aerosol Mechanics, Air Quality and Health Impact, the air quality session in the Environment and Computer Laboratory, and contribute to the Introduction into Environmental Engineering and Environmental Engineering seminars.

My long-term goal is to establish a world-leading laboratory for remediation of environmental and health threats posed by emerging airborne pollutants.

Prof. Jing Wang

This semester we are making changes to the lecture Air Quality and Health Impact, adding content on airborne microplastics detection, environmental DNA measurement and analysis, source apportionment and epidemiological studies, etc. I am excited to provide the students with a perspective on these topics of growing concern.



Jing Wang demonstrating a vacuum system for nanoparticle deposition on photomasks in a cleanroom.

You are the owner of three patents, can you tell us a bit more about them?

My most recent patent relates to biosensing using plasmonic effect. When the target genetic materials are captured on the sensing elements, strong electromagnetic near-field responses are generated which enable sensitive and rapid target detection. A specific novelty is the coupling of plasmonic sensing and photothermal effect, which converts the energy of a laser into heat, thereby controlling the local temperature and facilitating bio-interactions. We have used this method to measure the airborne SARS-CoV-2 viruses in COVID wards at the University Zurich Hospital and nursing homes, providing results to patients and staff within hours of sampling.

What do you do if you have a few minutes to spare?

I am happy to have a stroll in fine-art museums.

Do you have a general philosophy or motto you try to live by?

Do the utmost, hope for the best and prepare for the worst.

What advice would you give to students who are just starting out in environmental engineering?

Keep an open mind, start with a broad overview of the field, but identify your focus and develop a specialty once you have chosen your topic.

Which book, podcast, or film related to your field of research would you recommend to students and colleagues?

I recommend →**www.copernicus.eu**. Copernicus is the Earth observation component of the European Union's Space program, providing satellite-based data for our planet and its environment. A wealth of information on climate change, atmosphere, marine, land, etc. can be found.

From Student to Professor

Interview: Iris Mickein

Professor Stephan Pfister has been at ETH Zurich for more than 20 years – first as a student and then as an expert in environmental engineering. On the occasion of his promotion to Adjunct Professor at the Department of Civil, Environmental and Geomatic Engineering, we asked him what currently drives him in research and teaching.

Prof. Stephan Pfister

Professor Pfister, congratulations on your promotion at ETH Zurich! What are your current research interests?

Thank you very much – it is a great honour for me as ETH is definitely one of the best universities in the world, but at the same time it is my home university! In general, my research is in the field of quantitative sustainability assessment, so it is quite broad and interdisciplinary. Many projects are still in the area of sustainable food production and supply chains, which I started during my PhD and postdoc. Current projects focus mainly on (1) improving biodiversity assessment of global land use (with a focus on forestry, agriculture and mining), (2) nutrient cycling in crop production, (3) detailed impact assessment of current and future lithium production from brines, (4) improved methods for assessing impacts along value chains, and (5) coupling life cycle assessment (LCA) methods with system dynamics and integrated assessment models. I am also excited about the start of three new interdisciplinary projects on combining LCA with research on extreme events in urban water systems, agent-based models for land use planning, and sustainable photonic devices.

What can you tell us about the impact of your research on society?

My research on water footprints and food LCA has been widely adopted by the food industry and the ISO standard on water footprints. The research has been used in several reports by the Federal Office for the Environment and by companies. By contributing to UNEP, FAO and IPBES reports, the knowledge is disseminated to society. However, I am aware that as a scientist I only develop knowledge, but society is influenced by many other factors such as economics, culture and beliefs.

Where were you working before you came to ETH?

Technically, I have been working at ETH for almost 20 years (with some breaks in between). After graduating from high school and working for six months to save money for my environmental engineering studies at D-BAUG, I came to ETH in September 2000. I started working as a student assistant during the second part of my studies. After graduation, I did my civil service in a research project in Hanoi, Vietnam, before starting a position as a research assistant at Professor Hellweg's chair of Ecological Systems Design Group (ESD). Shortly after I started my PhD on developing the concept of Water Footprint including water scarcity considerations. In 2011, I went to UC Santa Barbara for a one-year post-doc, where I extended my research to multi-regional input-output assessment, before coming back to the ESD group, where I worked as a post-doc and senior research associate, and was privileged to get a permanent position in 2017.

What courses are you most excited about teaching at ETH?

I really enjoy all of my teaching and tutoring and think it is a great part of my job. In terms of specific courses, I am most excited about the "Environmental Computer Lab I and II",

Field visit to artisanal small-scale gold miners, Zimbabwe (November 2018).

which require students to apply their knowledge from the "Advanced Environmental Assessments" course to practical exercises and assignments that challenge them to think critically and independently.

I am convinced that we need to try to find solutions rather than complain about the problems. This is also at the heart of engineering.

Prof. Stephan Pfister

What do you do if you have a few minutes to spare?

I love spending time with my family and friends, and definitely more than a few minutes a day! I love playing and discussing with my children and watching them grow up. If I have more than just a few minutes, I like to do sports and coach the junior handball team in my hometown.

Do you have a general philosophy or motto you try to live by?

In general, I would say that a problem is just the spark to find a solution. While it is important to look at problems or mistakes, I am convinced that we need to try to find solutions rather than complain about the problems. This is also at the heart of engineering, where the goal is to find solutions to a problem. In my research, this means focusing on finding, combining and advancing the best available knowledge to inform decision-makers and practitioners. Beyond engineering and my research, I think this motto is at least as important in social interactions. If there are problems, I try to address them in a constructive and solution-oriented way. I try to be fair, respectful, open and empathetic. In particular, I try to stand up against unethical and discriminatory behaviour.

What advice would you give to students who are just starting out in environmental engineering?

Be curious and take it seriously. As one of our students, you have the privilege of receiving an almost free education in a very interesting field. You can choose your major or individual courses from a wide range of disciplines. At the beginning it makes sense to get an overview and realise what your main interests are. You can invest in them and start your career path. There is a lot of freedom as a student, which means you also have a lot of responsibility – it is your life and your education. Take the opportunity to talk to older students, both within and outside of your degree programme, and explore other options, such as those offered by the Student Project House or in exchange programmes.

Passionate about exploring different disciplines

Interview: Iris Mickein

Eleonora Secchi has been a Senior Scientist at the Department of Civil, Environmental and Geomatic Engineering since June 2023. She works at the Institute of Environmental Engineering (IfU), where her research focuses on understanding how bacteria organize and interact to form biofilms. Her findings may provide new ways of controlling and engineering biofilm formation – for example on the surfaces of medical devices, where they are a major problem, especially in hospitals.

Dr. Eleonora Secchi

Congratulations on your appointment as Senior Scientist at ETH Zurich! What are your current research interests?

Thank you! Since the beginning of my scientific career, I have been passionate about interdisciplinary work. Currently, I am working at the interface of fluid dynamics, microbiology, and physics to understand the physical mechanisms and environmental factors controlling bacterial surface colonization and biofilm formation in fluids and on moist surfaces. Biofilms are a widespread mode of bacterial growth and have a critical impact in environmental, industrial, and medical settings. My research at ETH has shed light on the bio-physical factors that control biofilm growth and the effect on flow and transport in certain systems. Together with my group, we are building a comprehensive understanding of the different stages of biofilm formation, starting from surface colonization, which lays the foundation for the structure of a biofilm to mature biofilms, in which we characterize their mechanical properties and biochemical composition.

What is the impact of your research on society?

Two of the many crises our society is facing are the declining effectiveness of antibiotics and the lack of access to clean water for more than a billion people. What do they have in common? Biofilms, which, on one end, are inhabited by drug-resistant pathogens and, on the other hand, cause energy-intensive and costly fouling of membranes. The ultimate goal of my research is to provide insight into how we can control the growth of biofilms in industrial and medical applications or exploit their properties in applications such as water filtration systems.

Our work has proven very effective in providing a clear conceptual model of the mechanisms underlying biofilm development and explaining how environmental conditions shape biofilm material properties. I believe that this approach paves the way for novel targeted antifouling strategies applicable in medical, environmental, and industrial contexts.

Where were you working before you came to ETH?

I did my engineering studies and PhD at Politecnico di Milano, with two six-month exchanges at Fermilab in Chicago during my master's degree and at MIT in Boston during my PhD. As a PhD student, my research focused on the development of optical techniques for the characterization of soft and biological materials. After my PhD, I did a postdoc at the École Normale Supériore in Paris, where I developed an optical technique to characterize the flow in carbon nanotubes. These systems are very promising for developing a new generation of water filtration membranes, capable of producing energy while filtering. In 2016, I joined ETH Zurich, first as an ETH Postdoc-

Dr. Eleonora Secchi with her research group.

toral Fellow and then, since 2018, with an SNSF PRIMA grant, which gave me the opportunity to start my research group. At ETH, I have chosen biofilms as my research subject and have studied them using interdisciplinary tools I have developed.

Biofilms are a widespread mode of bacterial growth and have a critical impact in environmental, industrial, and medical settings.

Dr. Eleonora Secchi

Which courses are you teaching at ETH?

I am passionate about teaching! Soon after joining ETH Zurich, I designed and led the course Microfluidics for Microbial Ecology (now called Experimental Microfluidics: A Short Course) for master's and doctoral students because I saw the need to educate students about small-scale fluid transport. Since then, I have organized the course every year. Since the autumn semester of 2020, I am also co-responsible for organizing and teaching the Environmental Engineering Seminars as part of the bachelor programme. I am part of a team of three senior scientists from IfU; together, we prepare, coordinate, and run the course. It is a great experience and allows me to teach students the crucial topic of scientific communication. Since the autumn semester of 2023, I have also been teaching Numerical Hydraulics, a master's-level course in which students learn to solve differential equations numerically for the prediction of hydraulic processes.

What do you do if you have a few minutes to spare?

I like hiking, yoga, and cooking – all these (very different) activities bring me peace of mind! Whenever I can, I leave my desk for a short walk in the Hönggerberg forest; the change of scenery usually clears my mind and helps me to get a new perspective on problems. I love to travel, and whenever possible, I try to combine this with conferences to reduce my carbon footprint. I am also involved in outreach activities; I think our society needs to understand the need and the potential of science to tackle the challenges we face.

What advice would you give to students who are just starting out in environmental engineering?

My advice is to be passionate and to explore. Throughout my career, I have studied different disciplines and technologies and been in contact with several scientific communities. I believe this has made me a better scientist and given me a unique approach to problem-solving. I strongly encourage students to be curiosity-driven and do the same. Also, we unfortunately live in challenging times for our planet – students should focus on relevant problems and be motivated to find solutions to them.

“Imagination is more important than knowledge”

Interview: Iris Mickein

Photo: Jörg-Peter Rau

Prof. Paolo Burlando

On 31 July 2023, Professor Paolo Burlando completed his three-year term as Head of the Department of Civil, Environmental and Geomatic Engineering at ETH Zurich. In this interview, he talks about the highlights and challenges of his tenure, as well as his passion for documentary photography.

Professor Burlando, you have been at ETH Zurich for nearly three decades. What is the first thing that comes to mind when you think of D-BAUG?

D-BAUG has been my academic home since 1997. Home is where one should feel comfortable, surrounded by a positive and warm atmosphere, supported and welcome: this is indeed what I have felt at D-BAUG and, more generally, at ETH. D-BAUG is also a very diverse community, where I have experienced a passion for research, a commitment to educating future engineers who can shape society through fascinating infrastructures, and who can value and respect our natural environment. If I were a student, I would find the diversity of science and engineering topics that characterise D-BAUG a fascinating and challenging environment, where one feels compelled to engage for the future of mankind.

Your tenure has been particularly eventful: you have steered the department through a global pandemic, the periodic academic evaluation, a strategic reorganisation, and some major building renovations – to name but a few of the challenges. What were the most difficult issues to deal with?

Indeed. The past three years have been full of events and challenges. The hardest issue was that of running day-to-day business and planning under the enormous uncertainty caused by the pandemic and by its immediate and long-term impact on operations and resources. However, as artists say, the show had to go on. As on a stage, we had to continue teaching and research activities despite the difficult circumstances, while maintaining the strategic momentum that the department had embraced in recent years and pushing it forward with concrete actions. It was certainly a challenge to conduct the academic evaluation online due to the restrictions imposed by the pandemic, but, looking at the outcome, we managed to persuade the evaluation committee of the high quality of D-BAUG’s research and teaching as well as of its strategy, which together form the basis for further shaping the department’s success and leadership. The major renovation of the laboratory building was certainly a challenging time on top of the rest, but I believe that the department and its staff demonstrated maturity, pragmatism and resilience throughout all the challenges that we had to face.

Both research and photography share a Zen-like approach, in which meditation and intuition play a role.

Prof. Paolo Burlando

What would you say is your most noteworthy achievement as Department Head?

I would prefer this answer to come from the colleagues and staff of the department. If I have to answer from my own point of view, I think that the department is now more consolidated

in its personality and collectively more aware of its strengths than it was a few years ago. I would be happy, if I could objectively demonstrate that I have helped the department to gain more recognition and respect than it has had in the past, and to enhance its strategic momentum. I feel that this would be a noteworthy achievement. Furthermore, if this were to happen, and if the changes that led to it were to be achieved without disrupting the internal harmony of the department, but rather enhancing it, I would feel satisfied with my service to the department.

Do you have a general philosophy or motto you try to live by?

To be honest, I do not have a specific one. However, I can say that both my private and professional life have been driven by some important elements, among which intellectual honesty, perseverance and continuity have played a key role. Moreover, I have been fascinated by a statement that has been attributed to Albert Einstein, which has often been a driver of my research: "Imagination is more important than knowledge". My interpretation of this is that a deep passion for understanding the unknown is an indispensable trigger and driver for research and education, which is deemed to produce meaningful knowledge and impacts.

You are also a photographer and recently you had your second major exhibition at a gallery. How has your passion for humanist and documentary photography influenced your scientific work and vice versa?

Both research and photography share a Zen-like approach, in which meditation and intuition play a role. Documenting life as it unfolds in front of my camera requires sharp observation, the ability to grasp, for example, the essence of a street scene where people and the environment interact, and finally to translate it into a composition that conveys your understanding of that fleeting moment. Research in the field of water science is somewhat similar: you need to observe and understand natural processes, their interaction and intersection with human activities, and abstract the complexity of the processes and physical laws into mathematical models that interpret the actual processes and at the same time provides the most faithful rendition of reality and the scientist's interpretation of it.

Final thoughts?

The last three years have been so intense that I hardly noticed they are already over. In retrospective, they often looked like steering a ship in a storm at sea, which you have to navigate as much as possible following the planned route, sometimes improvising. I hope that I have managed to help guide the department through these challenging times, and I wish my successor and D-BAUG all the best for a brilliant future, rich of recognition and impact.

Photo: Paolo Burlando

Photograph
by Paolo Burlando, shown at his exhibition "Genius Loci" at the Leica Gallery in Konstanz, January – April 2023.

Retirement Kay Axhausen

Text: Florian Meyer

Prof. Kay Axhausen

In 1999, Kay Axhausen was appointed Professor of Transport Planning at ETH Zurich. He earned his reputation as a researcher who gets to the bottom of transport issues with a keen analytical eye and precise economic and mathematical models. The "E-Bike City" project marks the end of his career and at the same time stands for an increased focus on politics and society. Professor Axhausen retired in January 2024.

In view of global warming, we can't continue with our previous approach to transport planning. We need new transport policy ideas for cities.

Prof. Kay Axhausen

One particular achievement was the MATSim transport simulation system, which Kay Axhausen and his research group have helped to develop over the past 20 years. Axhausen says the system has had "a major, resounding impact." Today, MATSim can simulate numerous aspects of traffic behaviour. "The largest application that the system can currently simulate in a reasonable computing time covers the whole of Germany – that's the transport decisions of 85 to 90 million people."

"As a researcher, I've never directly participated in transport policy debates before," says Axhausen. "But with the E-Bike City project it's different; we're actually getting more actively involved in transport policy." For example, the story-map website and the findings of the E-Bike City project were presented last fall to Simone Brander, the Zurich City Council member responsible for transport. This involvement has much to do with climate change, a topic that overshadows many traffic problems, such as the classic traffic jam problem, and requires new solutions.

"In view of global warming, we can't continue with our previous approach to transport planning. We need new transport policy ideas for cities. The E-Bike City is also a model of how the transport sector can reduce its greenhouse gas emissions," Axhausen points out. "This project is intended to show that bicycles and e-bikes can serve as a standard means of transport in the city. Our vision is to make the city more comfortable, quieter, greener and healthier than it is today."

Kay Axhausen will continue to oversee the E-Bike City project (see page 44) after his retirement.

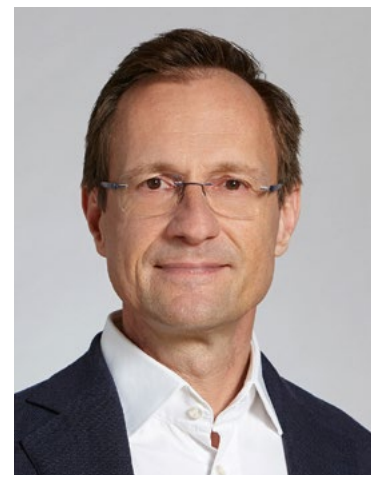
Swiss Science Council

Prof. Adrienne Grêt-Regamey

D-BAUG Professor Adrienne Grêt-Regamey has been elected to the Swiss Science Council (SWR). The Council is a body that advises the Federal Government on issues relating to the continuous improvement of education, research and innovation in Switzerland. The SWR is composed of 15 independent experts who are responsible for making recommendations to the Federal Council.

Urban Informatics Award

D-BAUG Professor Martin Raubal has been awarded the “Outstanding Achievement in Urban Informatics Award” by the International Society for Urban Informatics. The award aims to recognise and celebrate the outstanding contributions of researchers in the field of urban informatics and smart cities. Raubal’s research focuses on spatial decision-making for sustainability, involving the Mobility Information Engineering Lab and the GeoGazeLab at ETH and a research group at the Singapore ETH Centre.



Prof. Martin Raubal

MIT Innovator Under 35

Prof. Catherine De Wolf

D-BAUG Professor Catherine De Wolf has been named one of MIT Technology Review's prestigious "35 Innovators Under 35" for 2023 in the field of artificial intelligence. The global list recognizes her outstanding contributions in using AI to reduce emissions and material waste in the construction industry. Earlier last year, De Wolf won the European version of the award.

The winner Thomas Meierhans (in the middle), surrounded by (from left to right) Charles Ledoux, Lavinia Heisenberg, Mark Tibbitt and Julia Dannath.

Art of Leadership Award

The ALEA – the Art of Leadership Award – has been conferred by ETH Zurich since 2017 in recognition of leaders who facilitate modern and innovative working conditions and who actively encourage and support the reconciliation of work, family, and part-time commitments. In 2023, the winner was Thomas Meierhans, manager of the metal workshop at the Department of Civil, Environmental and Geomatic Engineering.

As manager of the metal workshop at D-BAUG, Thomas Meierhans is in charge of around seven technical staff and responsible for processing customer orders from research. Julia Dannath, Vice President for Personnel Development and Leadership presented the award to the beaming winner. The two other finalists, Professor Lavinia Heisenberg from the Department of Physics and Professor Mark Tibbit from the Department of Mechanical and Process Engineering, were awarded a certificate by AVETH President Charles Ledoux.

The criteria for the selection of the ALEA Award comprised the new ➔**social and leadership competencies**, which have been drawn up for all ETH employees. "I am proud that so many leaders at our university, be this in technical and administrative or in scientific positions, have such a high level of social and leadership competencies," says Julia Dannath. "These individuals serve as valuable role models for us and significantly contribute to a healthy leadership culture at ETH that allows everyone to develop their potential."

ETH members had nominated 48 leaders in advance for the award, for the first time including not only persons with official responsibility for employees, but also those with specialist leadership roles. The jury for selection of the award comprises members of AVETH and representatives of Diversity and Collaboration, the ETH Ombuds Office, HR Consulting, and the Staff Commission.

Partnership with Ziegelindustrie Schweiz

Dr. Marius Weber heads the inter-university masonry group, which is made possible by the support of Ziegelindustrie Schweiz.

With a generous donation, Ziegelindustrie Schweiz (the association of Swiss brickworks) has made it possible to establish an inter-university group for research and teaching in the field of structural masonry both at ETH Zurich and at the University of Lucerne.

The support from Ziegelindustrie Schweiz plays a key role in ensuring the training of civil engineers and strengthening Switzerland as a centre for research in the field of structural masonry. Led by Dr Marius Weber, the group will engage in teaching and research at the Chair of Concrete Structures and Bridge Design at the ETH Department of Civil, Environmental and Geomatic Engineering and at the Institute of Civil Engineering at the Lucerne University of Applied Sciences and Arts simultaneously.

"Through this donation, Ziegelindustrie Schweiz is committed to preserving and advancing research and teaching in the field of structural masonry. Against the backdrop of increasing decarbonisation of the Swiss construction industry and of the Swiss building stock, as well as the growing importance of sustainable building materials, clay has enormous potential as a domestically produced, natural and tried-and-tested building material. It's vital that we maintain and further develop this potential for future generations," says Michael Fritsche, President of Ziegelindustrie Schweiz.

➔ **Blog post by Dr. Marius Weber**

➔ **Ziegelindustrie Schweiz**

Virtual design for real-world buildings

Interview: Andrea Zeller Photo: Daniel Winkler, ETH Foundation

At the Center for Augmented Computational Design in Architecture, Engineering and Construction (Design++), three ETH departments are looking at new ways to innovate the construction industry. Executive Director Dr. Danielle Griego tells us more.

Who are the people behind Design++ and how does the initiative help accelerate a shift in the construction industry towards more resource efficient and productive methods?

DANIELLE GRIEGO – Design++ bridges the domains of architecture, civil engineering and computer science at ETH Zurich. In total, more than fifty professors, scientists and staff members teach courses and conduct research in projects across the interdisciplinary network. For example, a new lighthouse project – which examines how extended reality for inspection, assembly and operations in the buildings and construction sector creates new emission-reducing opportunities – combines the expertise of professors Robert Flatt, Catherine De Wolf, Bernd Bickel, and many more (see page 46). The purpose of our activities is to reduce the ecological impact in the construction sector and increase systematic construction productivity while simultaneously ensuring high quality standards in the built environment.

What methods do you use to pursue these aims?

Our work focuses on developing digital methods and tools using artificial intelligence and extended reality to advance the architecture, engineering and construction (AEC) industry. An important resource is our – globally unique – Immersive Design Lab, pioneered by Gramazio Kohler Research. Here we can merge immersive visualisations and 3D spatial acoustics and test extended reality in architectural and civil engineering projects in an interactive way. This could be a virtual walkthrough of a building project, for example, or intuitive interaction with a 3D design model using gestures or voice commands. Equally important are regular exchanges with industry partners to share information and align objectives.

What form do these exchanges take?

For our research to make a difference to society, it must be firmly anchored in the AEC industry. Important platforms in this regard are events such as the Future of Construction symposium or our seminar series, which we also publish on our YouTube channel. We host exchanges with each of our strategic partners Basler & Hofmann, Hexagon and Halter AG where both sides provide updates on new technological developments from their perspective.

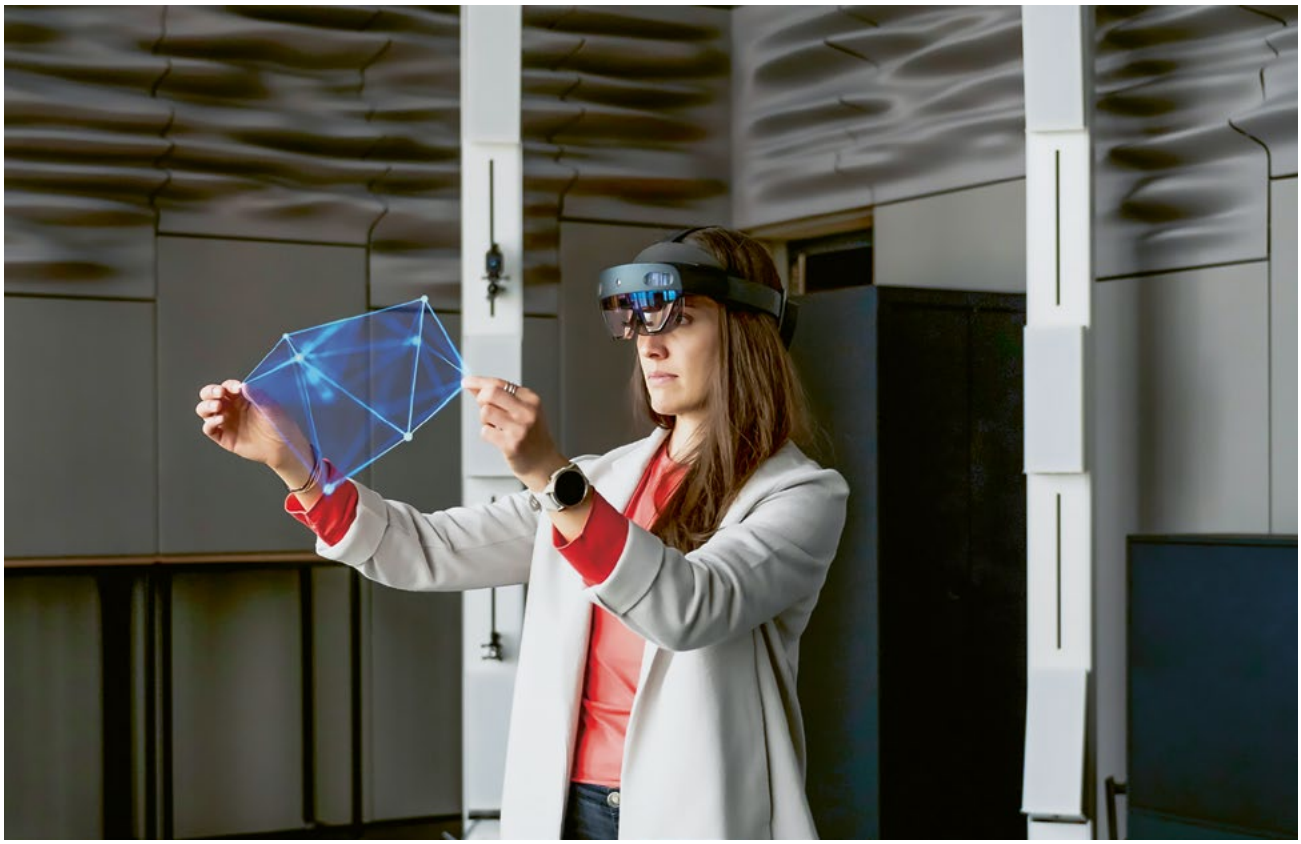
> **We want to empower future engineers and architects to reshape processes in the construction industry with the help of digital technologies.**
>
> Dr. Danielle Griego

Why is this collaboration with partners necessary?

It's thanks to them that we can build and grow Design++! For example, their support made it possible for us to appoint Bernd Bickel, Professor of Computational Design, and to start a fellowship programme for postdocs. At the same time, both parties benefit when the industry can make good use of the results of our projects on digital design, planning and construction. Building projects are usually tightly calculated in terms of time and costs. This often means that innovation falls by the wayside, because new technologies and processes typically require additional time and money when newly introduced. Companies like our strategic partners, who are willing to take risks and support innovation in the AEC industry, are indispensable for driving sustainable construction.

In concrete terms, what applications could emerge from Design++ research?

Take the very promising development of the AI design co-pilot to support bridge design, a collaborative project between Professor Walter Kaufmann's group and the Swiss Data Science



Dr. Danielle Griego has been the Executive Director of Design++ since its foundation in June 2020.

Center. The deeplearning-based software tool isn't bound to a specific structure and supports engineers in the early design stages. By combining AI's computational power with human creativity and an immersive user interface, the design co-pilot contributes to the development of efficient and reliable future structures. This was applied in a real project for a pedestrian girder bridge located in St. Gallen in collaboration with Basler & Hofmann. Another example is the 7DayHouse project, which explores solutions for the exceptionally high demand for housing in urban areas. The overall goal is to create a fully customised home design in just one day while maintaining supply-chain continuity for fabrication and delivery within seven days. The team, led by professors Daniel Hall and Benjamin Dillenburger, is working on AI design methods which incorporate the fabrication and construction process, collaborative AI, and mixed reality. The research utilises digitally fabricated cross-laminated timber (CLT) elements and benefits from the experience and knowledge of Erne AG Holzbau.

Why is ETH the right place to drive innovation in the construction industry?

The potential of digital technologies for the architecture and construction industry is huge, but implementation is still in its infancy. When it comes to infrastructure and expertise, ETH has some of the best resources worldwide. This is also reflected in its graduates. If we can empower ETH's future engineers and architects to challenge conventional design and building processes and use digital technologies to achieve pioneering breakthroughs, we can make a significant difference.

Design ++

At the ETH Center for Augmented Computational Design in Architecture, Engineering and Construction, innovative digital methods and tools for a more sustainable construction industry are being developed, supported by strategic partners Basler & Hofmann, Hexagon and Halter AG.

Design++ is an interdisciplinary research initiative led by the departements of Architecture, Civil, Environmental and Geomatic Engineering, and Computer Science.

Panel discussion moderated by Akanksha Jain with Anne van Loon, Isabella Schalko and Peter Molnar (from left).

Gender and Diversity

Text: Eleni Chatzi / GDK Comic: Maja Molnar

2023 has been a busy year for the Gender and Diversity Commission (GDK) at the Department of Civil, Environmental and Geomatic Engineering with the introduction of three important initiatives.

Spotlight Seminar Series

The first initiative pertains to the launching of the ➔**D-BAUG Spotlight Seminar Series** that aims to highlight forefront work by female academics and to offer a platform for members of the department across different levels. We have had the pleasure of organising two instalments of the series.

On 27 September, the Spotlight Seminar Series focused on environmental engineering challenges, featuring Prof. Anne van Loon (Vrije Universiteit, Amsterdam), elaborating on drought in the Anthropocene, and Dr. Isabella Schalko (ETH Zurich and MIT), discussing the hazards and benefits of wood in rivers.

On 16 November, the Spotlight Seminar Series focused on civil engineering challenges. Prof. Maria Laura Delle Monache (Dept. of Civil and Environmental Engineering, UC Berkeley) offered her vision on the future of mobility: the Gender and Diversity quest for smart and sustainable transportation systems. Prof. Stavroula Kontoe (University of Patras, and Visiting Reader at Imperial College London) presented investigations on seismic and blast loading on underground structures. In both sessions, the presentations were followed by a lively panel discussion moderated by D-BAUG doctoral candidates and staff.

Mentoring Programme

The second important initiative pertains to the launching of a ➔**mentoring programme** for doctoral candidates of all genders. The programme links students with senior individuals from both academia and the industry.

In 2023, we held the kick-off event for the second year of the programme, which will run from January to December 2024. The event featured short inputs from mentors and mentees who participated in the 2023 GDK mentoring programme, as well as roundtable discussions with the mentors volunteering for the 2024 edition. The exchange highlighted the value of this initiative in helping students to clarify questions and queries related to both their academic career and future paths for career evolution.

Comic Series

Beyond these two initiatives, the Committee has revived the GDK website to act as a portal for interacting with and highlighting the diverse and fascinating stories of D-BAUG members, as well as raising awareness with respect to remaining challenges. One such instance is reflected in a ➔**series of comics** that highlight experiences that were shared through an anonymous departmental survey conducted by the GDK.

In an effort to raise awareness and promote respect, the GDK issued a series of comics reflecting stories that were submitted to a departmental survey.

D-BAUG @Scientifica 2023

Text: Iris Mickein Photos: Alexandra Hees, Pallavi Keshri, Ulrike Wissen Hayek

Scientifica is the largest science festival in Switzerland and is organised every two years by ETH and the University of Zurich. In 2023, the overarching theme was "What holds the world together". D-BAUG was present with 13 exciting contributions, including exhibition stands, short lectures, guided tours, a workshop, a film screening on “The Dyatlov mystery” and a high-profile panel discussion on Zurich as an E-Bike City. A few impressions.

E-Bike City panel discussion in partnership with Tages-Anzeiger.

On cost-effective methods to build earthquake-proof buildings.

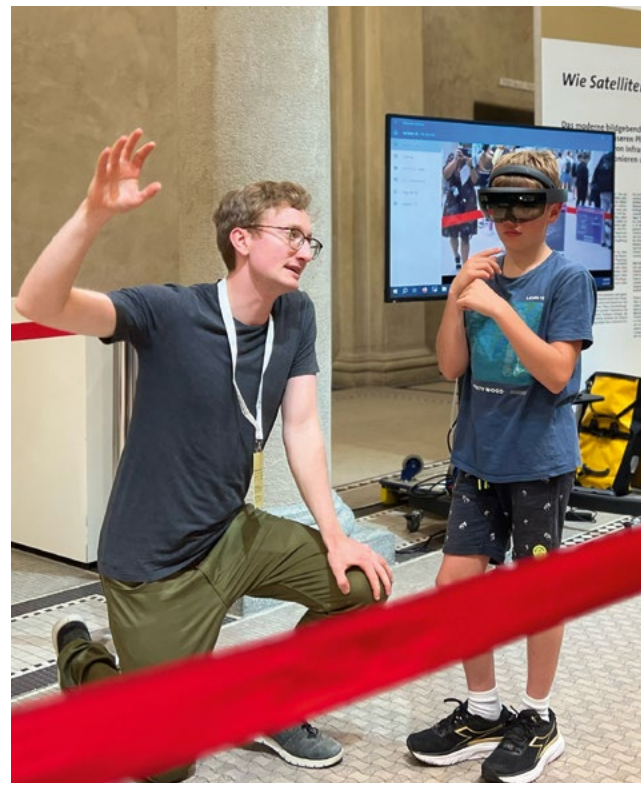
Exhibition on the contribution of space geodesy, and in particular satellite gravimetry, to the analysis of our environment.

Circular economy: How digitization can help to reuse building materials.

Film screening of "The Dyatlov mystery" in the Kino Riffraff.

Playing games to unlock urban neighbourhood transformations.

Workshop for children on the amazing world of microbes.



Learning how satellites work and observing them in virtual reality.

Kangaroo goes D-BAUG

Text: Darcy Molnar, Sabine Schirrmacher Photos: Caroline Palla

On the occasion of the Kangaroo Goes Science Day on 8 June 2023, 100 girls were once again able to visit the ETH Hönggerberg campus together with their parents. The Department of Civil, Environmental and Geomatic Engineering also contributed to the event, offering hands-on activities at the Stocker Lab, the Construction Hall, and the Laboratory of Hydraulics, Hydrology and Glaciology (VAW).

The annual Kangaroo Goes Science (KGS) Day is an event jointly organised by D-BAUG and D-MATH with the support of ➔**500 Women Scientists**, D-HEST, and many volunteers from D-BAUG, D-MATH, D-MAVT, D-PHYS, D-CHAB and D-MATL.

The participating teenagers were the top scoring girls from the ➔**Kangaroo Math Competition** held in March. They were invited to ETH to celebrate their achievements in mathematics and to learn more about the wonderful world of STEM. The event has been organised every year since 2018. The aim is to give girls and their parents an insight into teaching and research at ETH, to introduce them to the many female

scientists and engineers, and to give them the opportunity to hear from female students about how they came to ETH.

As part of the morning programme, a team of female scientists from the Swiss Federal Institute of Aquatic Science and Technology (Eawag), affiliated with the Institute of Environmental Engineering (IfU), presented a video about their research on "How does our drinking water stay clean?" In the afternoon, the girls visited different labs where they engaged in hands-on activities. Meanwhile, their parents took a tour of the campus.

This year, D-BAUG contributed to the KGS event with the following three labs:

- At the Construction Hall (IBK), the girls built small bridges that were later tested for stability.
- At the VAW, the girls experimented with water, creating a step-pool system with stones/blocks in a narrow channel. The stability of their steps was then tested by simulating a flood in the channel.
- At the Stocker Lab (IfU), the girls used microscopes to learn all about microbes.

At the end of the day, during the final apéro, which brought the girls and parents together again, the strength of the four bridges built by the girls was tested and a a winning team was declared.

This event was a great opportunity to introduce the girls to activities at D-BAUG and perhaps inspire them to study civil or environmental engineering one day. Many of the parents also very much appreciated the opportunity to learn more about ETH.

A big thank you goes out to the lab coordinators Dominik Werne (Construction Hall), Katharina Sperger (VAW), Ela Burmeister (IfU) and to their teams of helpers who dedicated their time to making the lab visits a great success. Darcy Molnar, Sabine Schirrmacher and Caroline Palla were part of the D-BAUG organising team that made the event possible.

Further details about the 2023 event can be found on the KGS website ➔**here** or in ➔**this article**.

D-BAUG team

Donators 2023

The Department of Civil, Environmental and Geomatic Engineering would like to thank all institutions, companies and private individuals who have supported it financially or in-kind during the year for their generous contributions. The list does not claim to be complete. Many donors wish to remain unnamed.

Partners, companies, and foundations

- Albert Lück-Stiftung
- AMAG Group
- Dr. Alfred und Flora Spälti-Fonds
- Basler & Hofmann
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- Holcim Schweiz
- Implenia
- Ricola Foundation
- La Prairie
- SBB
- Siemens
- Ziegelindustrie Schweiz

Many graduates stay in touch with the ETH Zurich and our department by giving donations. We'd like to thank all of them for their loyal support!

List of donators:

➔ **https://ethz-foundation.ch/en/thank-you/**

Students, Young Researchers, Alumni

Scholarships for three Master's students at D-BAUG

Interviews: Iris Mickein Photos: Hannes Heinzer, ETH Foundation

ETH Zurich supports outstanding Master students with the Excellence Scholarship & Opportunity Programme (ESOP). It covers tuition fees and living expenses, and includes a mentoring programme and access to the ETH Foundation network. In 2023, 53 students from 23 countries received an ESOP scholarship. Three of them are students in the Department of Civil, Environmental and Geomatic Engineering: Livio Aemmer, Lionel Gilliar-Schoenenberger and Katrin Jodocy.

Katrin Jodocy

Where are you from?

I am from Luxembourg. But I'm also half Belgian.

What led you to environmental engineering?

I was looking for a study programme that combined different disciplines from the natural sciences and engineering, as I was equally interested in both fields and did not want to get bogged down in one. At the same time, I am also interested in social problems. In my opinion, environmental engineering fulfils precisely these criteria of interdisciplinarity. What I particularly like about this programme is that it actively seeks concrete solutions to minimise the negative impact of human infrastructure on the environment and human health.

Why did you choose to do your Masters at D-BAUG?

I already completed my Bachelor's degree in environmental engineering at D-BAUG. As I am particularly fascinated by the topic of water and as a lot of research is done in this area at the department, it was a relatively obvious choice for me. D-BAUG also offers a specialisation in hydrology and modelling, which really appealed to me.

What are your plans for after graduation?

First of all, I want to travel around the world a bit. After that, anything is possible. Maybe I can imagine doing a PhD if I feel like delving into a specific topic. But maybe I'll also start working, preferably for an NGO that advises regions on their water management and also has an eye on the environment.

Livio Aemmer

Where are you from?
From Baden in the Swiss canton of Aargau.

What led you to civil engineering?
My grandfather and my father both studied civil engineering at ETH Zurich. So you could say that I was influenced by them. Even as a child, I was allowed to go to construction sites and was fascinated by the large machines and structures. This fascination has remained to this day.

Why did you choose to do your Masters at D-BAUG?
After completing my Bachelor's degree at D-BAUG, it was clear to me that I wanted to do my Master's degree here as well. The wide range of lectures in the Master's programme and the high level of student engagement at ETH are among the reasons for this.

What are your plans for after graduation?
In the future, I see myself working as an engineer on interesting and large infrastructure projects. One of my dreams is to work on projects abroad. I don't have a favourite country, I'm generally fascinated by anything new and different.

Lionel Gilliar-Schönenberger

Where are you from?
I am from the United States, specifically New York City.

What led you to civil engineering?
My interest in materials, logistics and the optimal balance between form and function inspired me to study civil engineering.

Why did you choose to do your Masters at D-BAUG?
D-BAUG combines technically challenging subjects with creative and sustainable thinking. This motivates me to use my skills in practice and research to find innovative solutions for the challenges of today and tomorrow.

What are your plans for after graduation?
After my Masters I plan to work with alternative and sustainable materials. My goal is to improve the feasibility and efficiency of building renovation with these materials and processes.

Vice Rector for Study Programmes

“Quality is everything”

Interview: Isabelle Herold

Prof. Lorenz Hurni

Before a young person with talent is awarded a scholarship or fellowship from ETH Zurich, they must first cross the hurdles of a multi-stage selection process. D-BAUG Professor Lorenz Hurni, long-standing Vice Rector for Study Programmes at ETH until 2023, provides insight into how the process works in the case of Excellence Scholarships.

Lorenz Hurni, as Vice Rector for Study Programmes, you chaired the ESOP Commission for five years. What does it do exactly?

After the almost one thousand applications have been reviewed and prioritised by the departmental admissions committees of the respective degree programmes, the ESOP Commission is tasked with drawing up an overall nominations list. Each prioritised dossier is then reviewed once more by two people on the basis of the following criteria: potential and motivation, quality and originality of the project proposal, exceptionality, and special qualities. Our eleven-member commission is made up of professors from different fields, two students and two doctoral students, as well as the Head of International Affairs. The varying complementary perspectives are very enriching and raise the quality of the selection.

When does the Commission not follow a department‘s proposal?

Often the departments find themselves in a quandary because they receive a higher number of excellent applications than their quota of scholarship places. In rare cases, we adjust their rankings if, in addition to a candidate’s performance track record – which is at a similarly top level for all – someone stands out thanks to a particularly interesting profile or special effort, for example. In the end, when a selection must be made between two multi-talented people of equal standing, origin can also be the deciding factor. We then tend to give a chance to someone from a disadvantaged background who would otherwise not be able to afford to study at ETH.

In your opinion, what distinguishes the ESOP programme from scholarship programmes at other universities?

In terms of numbers, we’re unfortunately nowhere near the level of other universities: the top American universities, for example, award merit scholarships on a much larger scale. But because our programme is so competitive, the talented students we finally select really are the very best. Not only in terms of their subject, but also of their personality and broad horizons. In my eyes, the name Excellence Scholarship is absolutely justified.

More information about the → **Excellence Scholarships**

ETH Medal und Culmann Prize

Awards for doctoral theses

Text: Iris Mickein

In 2023, six doctoral students from the Department of Civil, Environmental and Geomatic Engineering were honoured for their outstanding achievements: four received ETH Medals, two of them the Culmann Prize.

ETH Medal

Livia Cabernard, thesis title:
➔**Creating Transparency in Global Value Chains and Their Environmental Impacts to Support Sustainability Policies**
Supervisor: Prof. Stefanie Hellweg

Livia is now an Assistant Professor at the Technical University of Munich, where she heads the Chair of Sustainability Assessment of Food and Agricultural Systems.

Zan Gojcic, thesis title:
➔**Benefiting from local rigidity in 3D point cloud processing**
Supervisor: Prof. Andreas Wieser

Zan is now a senior research scientist at Nvidia, working on 3D computer vision for capturing objects and environments.

Tsokanas Nikolaos, thesis title:
➔**Real-Time and Stochastic Hybrid Simulation**
Supervisor: Prof. Bozidar Stojadinovic

Tsokanas currently works as a catastrophe researcher for Zurich Insurance.

Barbara Ward, thesis title:
➔**Settling and Dewatering of Fecal Sludge: Building Fundamental Knowledge for Improved Global Sanitation**
Supervisor: Prof. Eberhard Morgenroth

Barbara currently works as a Water/Wastewater Designer at HDR Engineering in Virginia Beach, USA.

Culmann Prize

Dominik Gräff, thesis title:
➔**Small-Scale Processes at the Glacier Bed: Stick-slip, Crack Waves and Sliding from Surface and Borehole Observations**
Supervisor: Prof. Fabian Walter

Dominik now is a postdoc at the University of Washington, where he works with fiber-optic sensing to study dynamic processes in the Earth's cryosphere.

Nico Lang, thesis title:
➔**Mapping Vegetation Height - Probabilistic Deep Learning for Global Remote Sensing**
Supervisor: Prof. Konrad Schindler

Nico is currently a postdoc at the Department of Computer Science, University of Copenhagen, and is affiliated with the Pioneer Centre for AI.

Swiss Arc Award

Text: Michel Büchel Photo: Elias Knecht

In a practical teaching project, ETH students used materials from the demolished Huber Pavilions to construct a building in the spirit of the circular economy. In October 2023, the Re-Use Pavilion on the ETH Hönggerberg campus was honored with an Arc Award. The project was led by professors Catherine De Wolf (D-BAUG) and Momoyo Kaijima (D-ARCH).

In summer 2022, three temporary wooden buildings – the Huber Pavilions – had to make way for a new building on the ETH Hönggerberg campus. The CircÛbi teaching project took advantage of this opportunity: under the co-leadership of two ETH professors, civil engineer Catherine De Wolf and architect Momoyo Kaijima, students collected the construction elements (or components) of the dismantled teaching buildings in order to reuse the materials according to the principle of the circular economy.

For an entire semester, around 30 students from the fields of civil engineering, architecture, mechanical engineering, computer science and materials science worked together on issues relating to the reuse of building materials. In order to master the logistical Herculean task, they inventoried the components with lasered QR codes and thus created a digitalised interface – which enabled them to create a new building from reused wooden components: the Re-Use Pavilion on the ETH Hönggerberg campus. A few months later, the work of art of the circular economy was honoured with the Swiss Architecture Prize Arc Award in the "Next Generation" category.

The jury paid particular tribute to the fact that this study project was developed in collaboration with various disciplines and also recognised that it is a prime example of circular economy methods and the reuse of building materials.

"Circular construction requires collaborative creation: bridging various disciplines and harnessing digital technologies is urgently needed to scale circular economy principles in the construction sector. As engineers, we therefore collaborate with various stakeholders to facilitate and realize the potential of reuse and regeneration," says De Wolf.

The project was made possible thanks to the cooperation with external partners, including Barbara Buser, Pascal Angehrn from "Baubüro in situ", Mathis Jedele and Christoph Angehrn from B3 Kolb, and Michael Wick from "Wiederverwekle".

Colonnetti Medal for Franco Zunino

Photo: SNF

Dr. Franco Zunino

Franco Zunino, project leader of "Ultra-green concrete", has been awarded the Gustavo Colonnetti Medal from RILEM (International Union of Laboratories and Experts in Construction Materials, Systems and Structures).

Zunino receives the medal in recognition of his research aimed at developing innovative solutions for low-carbon, high performance concrete by combining blended cements with optimized admixtures. He is also honored for his activities in science dissemination through instructional videos and seminars, including the RILEM ROC @TOK series, and his involvement in a panel of experts from the United Nations Environmental Protection Agency (UNEP), as the →**press release states**.

As part of the award ceremony, Zunino was invited to give a lecture during the RILEM Spring Convention in Marocco which is now →**available online**.

The RILEM Colonnetti Medal is awarded to researchers of less than 35 years, who have made an outstanding scientific contribution to the field of construction materials and structures.

SNSF portrait of →**Franco Zunino**

Harry Zekollari receives Arne Richter Award

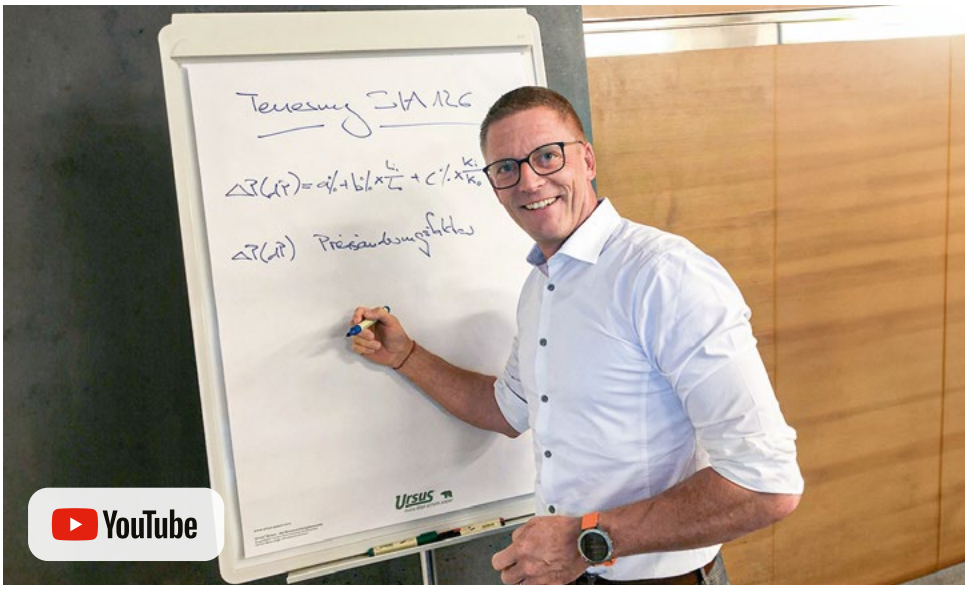
As an early career scientist, Harry Zekollari has already made outstanding contributions to glaciology, for which he has received the 2023 Arne Richter Award from the European Geosciences Union (EGU), the most important organisation in the geosciences in Europe.

Zekollari has made particularly significant contributions to research in the following areas: The modelling of large-scale ice dynamics, the description of glacier response times, and the interpretation of interactions between glaciers and climate in paleo-conditions.

Beyond his scientific achievements, Zekollari is also recognized for his active engagement within the scientific community.

Photo: EGU

Dr. Harry Zekollari (second from right) with (l-r) Jürg Schweizer, former President of the Cryosphere (CR) Division of the EGU, Carleen Tijm-Rejmer, current President of the CR Division, and Daniel Farinotti, who nominated Zekollari.



Dr. Stefan Moser

“I mostly talk about the failures, the bad luck and the mishaps”

In 2023, D-BAUG students awarded Dr. Stefan Moser the "Golden Owl" for his dedication to teaching. He has been a lecturer in civil engineering for many years and is a member of the management of the engineering firm Basler & Hofmann. In this interview, he talks about what he likes about being a lecturer and what it takes to make a successful start in the profession.

Mr Moser, congratulations on winning the "Golden Owl"! What is your recipe for success as a lecturer at D-BAUG?

You would have to ask the students. The jury's statement says: "Great practical relevance with many examples." What I can say is that I do not offer a blue sky vision of construction sites, but mostly the failures, the bad luck and the mishaps – what we had hoped for and what went wrong. I try to convey that you always need a Plan B, because a project just can't go right. I try to show the students how costs, deadlines, clients and contractors interact, and who plays what role. And why, even with great people involved, a project can still fail.

Why do you teach?

I am motivated by the fact that I have a lot of freedom at ETH Zurich. The freedom to teach. I can decide for myself what to teach, what documents to distribute and who to invite to give a guest lecture. I try to give the students the knowledge that I, as an employer, expect from graduates. As a student myself, I always appreciated it when someone with practical experience taught. So I am happy to share my experience as long as it is welcome.

Your advice to aspiring civil engineers?

Go through the world with your eyes open. If you pass a construction site, ask yourself: Why is that scaffolding there? And why is that crane there? What are those silos? You want to understand. And that the students then try to put what they have seen into the context of the whole backpack that they have been given and come up with a theory as to why something is the way it is. Maybe it's right, maybe it's wrong. And that they try to go in a certain direction out of curiosity. You're young, you can try anything. If you realize after two years that the path you've taken isn't the right one, then you make a cut and try something else. I think the current market allows you to do that. So my recommendation is to go for it, jump into the deep end and keep your eyes open.

“We must have the courage to question our own values”

Interview: Iris Mickein

Prof. Adrienne Grêt-Regamey

The 2023 Dandelion Entrepreneurship Award goes to Adrienne Grêt-Regamey, D-BAUG Professor of Landscape and Urban Systems Planning. The award recognises professors for their outstanding commitment to promoting entrepreneurship at ETH Zurich and beyond. In this short interview, Adrienne Grêt-Regamey talks about the role of entrepreneurship in her teaching and research.

Professor Grêt-Regamey, congratulations on winning the Dandelion Entrepreneurship Award! What does entrepreneurship mean to you?

If we are not just aiming for gradual progress, the overall impact of our work must be greater than the sum of our individual research. The group must evolve together and create a culture of strength that dares to tackle difficult and socially relevant issues. This is urgently needed in landscape planning, where the barriers to implementing new solutions are strongly rooted in societal values. It requires proactive and joint action, also with society. Entrepreneurship is the collaborative and courageous implementation of surprising solutions.

What role does entrepreneurship play in your research and teaching?

Alongside teaching and research, entrepreneurship is an essential part of landscape development. It is about managing the interactions between people and nature and placing solutions in a spatial context. Entrepreneurship is a crucial link in this tension field, and requires us to engage with society and its values and to exercise our social responsibility in research and teaching.

In 2018, the ETH spin-off "Incolab" emerged from your PLUS group. What services does it offer?

Incolab puts the findings and tools developed in our research group into practice. In this way, landscape development can be managed concretely and effectively. For example, innovative visioning tools based on artificial intelligence, make it possible to conceive and negotiate radical changes in our landscape. Such approaches allow the ETH spin-off to actively support the transformation of the landscape.

Is entrepreneurship more of a virus or a gene?

It is contagious like a virus! Entrepreneurship in landscape planning can be seen as a culture that can be learned and is based on continuous progress. This culture is dynamic and aims not only at incremental adjustments but also at profound transformations and changes. In the process, we must have the courage to question our own values. Only with such a transformative attitude will we be able to take important radical steps.

How do you encourage entrepreneurship among your students, doctoral students and postdocs?

Everyone in the group or even in the lecture should take initiative. Our aim is to achieve something together and to join forces. Our projects, which are anchored in current events, require the collaboration of doctoral students, postdocs, students and often stakeholders, who all contribute to the final outcome. New smaller sub-groups are constantly forming, supporting each other and developing their own solutions. This kind of collaboration is infectious and inspiring! It fosters learning and agility, which are essential for rapidly introducing new solutions and managing sustainable landscape development.

Hands-on teaching in the field

Text: Corinne Johannssen Photos: Annick Ramp / ETH Zurich

Forest instead of laboratory and lecture hall: Lucien Biolley instructing master students of the environmental engineering program during the field course.

ETH students are mapping the groundwater in an area of forest near Bern. This fieldwork will give them the skills they need for a career in environmental engineering.

Today's task is to measure the quality of the groundwater here in Kappelen, a municipality in the canton of Bern. It's only been a few hours since Carole, Gianna, Raffaele and Robyn arrived. The four ETH students are here to complete a three-day module towards a Master's degree in Environmental Engineering – a course offered by the ETH institute of the same name.

The group's first job is to measure the water table and the depth of each borehole. For this purpose, Dr. Matthias Willmann has brought two water-level meters from the equipment tent, which are similar in appearance to cable reels. In this case, however, the cable is a measuring tape attached not to a plug but rather to a thin metal rod – the measurement probe. He instructs the students to lower this carefully into the borehole.

A feel for fieldwork

It doesn't take long for the four Master's students to get the hang of the meter. Initially, they work as a group. Raffaele slowly lowers the cable into the hole, with Carole lending a helping hand. At borehole 3.1, the water table is at a depth of 3 metres and 95 centimetres. Gianna records the precise measurement. Raffaele then lowers the cable further until he detects slight resistance, which indicates the bottom of the borehole. "You develop a feeling for this," says Willmann.

Later, the four students will map the boreholes and plot the level of the water table. This will tell them in which direction

the groundwater is flowing. Just like a river above ground, groundwater flows downhill. "The module gives students a feel for the reality of working in the field," says Willmann. "The insights they get out here are really useful."

Professor Jimenez-Martinez works as a group leader at ETH Zurich and the Swiss Federal Institute of Aquatic Science and Technology (Eawag). He recently teamed up with ETH's administrative department for Educational Development and Technology to take a closer look at the role of fieldwork. "The whole teaching process feels different when you have that connection to nature," he explains. "As teachers, we give a quick introduction but then step back and let the students get on with it – taking measurements, trying stuff out, learning in the field."

As teachers, we give a quick introduction but then step back and let the students get on with it – taking measurements, trying stuff out, learning in the field.

Prof. Joaquin Jimenez-Martinez

Meanwhile, the group is busy using a probe to measure groundwater temperature and conductivity. At a depth of 10 to 12 metres, the water has a temperature of 11 degrees Celsius. The vertical hydraulic conductivity of the groundwater reveals certain details about its composition. Here in Kappelen, everything is as it should be.

Big science

With the first experiment now completed, the students join Lucien Biolley, employee at the Institute of Environmental Engineering. Together with Dr. Marius Floriancic, he is responsible for ensuring that field instruments remain in perfect working order throughout the year.

Carole, Gianna, Raffaele and Robyn use a wheelbarrow to fetch a 1,000-litre water tank – still empty, fortunately. They position it next to one of the boreholes and fill it with groundwater using a pump. "The great thing about fieldwork is that everything's on a big scale, including the equipment," says Biolley. "That makes it much easier to figure out what's going on."

Forest or meadow?

For the next experiment, the students meet up with Marius Floriancic. His job is to teach them how to measure the amount of water the soil can hold. For this purpose, tensiometers are used. The students insert the tubes to different depths in the forest floor. The readings show the water retention curve, a measure of the soil's ability to absorb water.

Dr. Marius Floriancic (left) instructs students before the experiment in the forest.

A second instrument, shaped like a large fork, measures soil moisture. Floriancic asks where we think soil moisture will be higher: in the forest or in the open meadow? The answer is unanimous: the forest! To our great surprise, the measurements show the exact opposite. Together with the students, Floriancic explores the reasons why: when it rains, the tree canopy and natural debris on the forest floor prevent some of the water entering the soil; also, trees extract more moisture from the soil than grass does; and, finally, forest soil is more permeable than compact meadow soil, which means it lets through more water.

"Computing and modelling – that's something ETH students are good at. But working out here in the field gives them a practical edge to that knowledge," says Floriancic with a grin. "It's an expensive module, but definitely worth the investment," he adds. The students have completed enough practical work for the day. Later on, they'll be taking a closer look at the data on a laptop. Gianna, who holds a scholarship from the ETH Excellence Scholarship & Opportunity Programme, also likes the variation. For her, it's "the combination of technology and nature that makes environmental engineering so appealing".

Innovative teaching Courses offered by the Laboratory for Environmental Engineering are being supported by the ***→Innovedum Fund*** *which fosters innovative teaching, i.e., through implementation of novel environmental sensing techniques and data evaluation with Jupyter Notebooks.*

Urban Water Adventures

Tales from the 42nd Assistants' Meeting

Text: Akanksha Jain, Rachel Wenger

On Wednesday, 13 September 2023, the first participants from across Germany and Vienna arrived in Zurich for the 42nd Assistants' Meeting.

The programme kicked off with a city rally with various stations scattered around Zurich. Here teams could solve fun tasks – serving as an excellent ice-breaker. These stations were designed by ETH and Eawag doctoral students and focused on supply of water and resources during a 'zombie apocalypse'. The weather cooperated and the promised rain held off until the evening, when everyone gathered for dinner at ETH Hönggerberg. Eberhard Morgenroth, ETH Professor of Process Engineering in Urban Water Management, warmly welcomed all participants and shared some memories about his days at the past Assistants' Meetings.

On Thursday, participants shared their research foci through insightful short presentations and a poster bingo. After lunch, there was a walking tour of ETH Zurich led by one of the Swiss doctoral students. The conference concluded with a closing speech by Max Maurer, ETH Professor for Urban Water Sys-

Participants work together to navigate a maze of real and fake pipe connections, testing their problem-solving skills in a fun way.

tems, where he highlighted the relevance of this event in nurturing research collaborations. The evening programme kicked off with a private concert by the jazz band Counting Daisy, whose lead singer is a scientific employee of Eawag. Throughout the evening, the participating institutes presented their rehearsed performances and games, culminating in the awarding of TU Braunschweig as the best university to host the 43rd Assistants' Meeting in 2024.

On Friday morning, participants joined for an excursion that took them through NEST: the modular research and innovation building of Empa and Eawag. In the afternoon, the participants explored Zurich's blue-green infrastructure (BGI) under the guidance of Eawag experts. They visited rainwater infiltration trenches, the artificially generated cooling mist cloud on "Turbinenplatz", and a park, 30 meters above ground, on the roof of the Zurich University of the Arts. The excursion groups concluded the official part of the Assistance Meeting in the park "Platzspitz" with a well-deserved ice cream.

A challenging hike was planned as a Saturday activity. Starting just half an hour from Zurich, the 4-hour hike took participants through Lägern to Baden (AG). Lägern marks the beginning of the Jura range and offers a challenging ridge hike at times. However, our German, Austrian, and Swiss colleagues successfully tackled this challenge with sturdy footwear. Back in Zurich, some even took a refreshing plunge into the "Limmat" river, providing a fitting end to the 42nd Assistants' Meeting in Zurich.

Assistenztreffen der deutschsprachigen siedlungswasserwirtschaftlichen Institute

Since 1980, the annual meeting showcases research on water resources, urban hydrology, and wastewater treatment by German-speaking institutes. It's a key platform for doctoral students and assistants to network, discuss, and advance careers. The "Bunter Abend" features institute performances, with the winner organizing the next Assistants' Meeting. We as ETH/Eawag are very grateful that we were given this unique opportunity in 2023 and that 25 of our doctoral students and assistants could host 45 people from across Germany and Vienna.

“Every structure deserves a digital twin”

Interview: Isabelle Vloemans Photo: Valeriano Di Domenico, ETH Foundation

Much has changed since his student days: Dominik Courtin in the Bauhalle, the experimental research lab of the Institute of Structural Engineering.

Dominik Courtin, CEO of the engineering company Basler & Hofmann and D-BAUG alumnus, explains why digitalisation in his industry is not driven by productivity and talks about his many connections to ETH.

What do we need to understand about digitalisation in the construction industry?

DOMINIK COURTIN – That it's not just about digital planning and building per se, but about future operations. I always say that every structure deserves a digital twin to serve as a source of information and a platform for communication beyond the conventional end of the project. It could provide answers to very simple questions such as when apartment owners are renovating and would like to know how much wall surface needs to be painted. Or in more complex questions such as when the ecological footprint of different conversion options needs to be assessed. In order to make the right judgements and effective interventions, a sound basis of information is required. There should be a requirement that all data generated in the building process remains available for future users. In the cruise industry today, new ships already have digital twins, providing access to all conceivable information. You have to bear in mind that we construct a building for two years and then use, manage and repurpose it for decades. In my opinion, this is what counts – and not the increase in productivity during the planning and construction processes, even though this is often claimed. Buildings are prototypes; unlike other industries, scaling is only possible to a limited extent. I advise building owners to stick to CAD if they have no interest in using a digital model for operations.

The way of thinking is what I gained most from ETH.

Dominik Courtin

Why does Basler & Hofmann support research into digital design, planning and construction at the ETH Zurich Design++ centre?

For one thing, we've held close relations with ETH for many years. Konrad Basler senior was a member of the ETH Board, for example, and we also employ large numbers of ETH graduates and offer internships. Secondly, digital construction is a topic of importance we recognised years ago. We believe that it requires a holistic approach, which is why we helped with the "birth" of Design++: when asked at the time by ETH whether we would support a centre that would operate across departmental silos, we immediately saw the huge opportunity it represented. This interdisciplinary thinking is entirely in keeping with the way Basler & Hofmann works: we have experts from over 30 disciplines collaborating on projects in the fields of engineering, mobility, energy, safety and the environment.

In this context, what's your opinion on the selection of Bernd Bickel, the new Professor of Computational Design funded by Basler & Hofmann, among others?

He's a very good fit. Bernd Bickel brings a lot of added expertise and already knows the university well through his studies at ETH and his time at Disney Research Zurich. His vision of how we'll interact with the digital twin of our built environment corresponds to our vision and matches the expectations that our clients have of us: How do you make these things not only available, but also really tangible? Bernd Bickel's background means he can bring a lot to the table – it's not for nothing that he received an Oscar in 2019 from the Academy of Motion Picture Arts and Sciences for his technical successes.

How do you remember your time as a student at the ETH Department of Civil, Environmental and Geomatic Engineering (D-BAUG)?

As one of the best phases of my life. I was away from home. Students came from all over and spent a lot of time together. That broadened my horizons immensely. It was also very intense – we sat in the technical drawing rooms from early in the morning until late at night. Time and time again, we asked ourselves whether we would ever manage to finish our studies at all.

What did you take away from this time for your future career?

A way of thinking. One of my professors once said: A good engineer solves a problem they've never seen before. So it's not about applying a standard procedure, but learning ways and methods of approaching problems. This way of dealing with things is what I gained most from ETH.

Today you're a honorary consultant on the Advisory Board of D-BAUG – what do you notice when you compare past and present?

I see an openness, a willingness to let go of the familiar. This generation is really interested in developing itself, there's a great desire to change. I think that's great. If I could express another wish, it would be that the full professors at ETH were more vocal in public – they have nothing to lose! I'd like to see them get involved in debates more often in a provocative but, of course, constructive way and initiate changes.

You support the ETH Excellence Scholarship programme as a private individual – why?

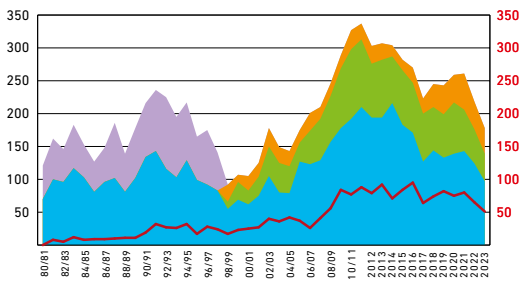
I do this with great passion because I'm very grateful for my education and want to give something back to ETH. I also donate because I find it valuable to stay connected with young people and gain new impulses.

Autumn Semester 2023

Student Numbers

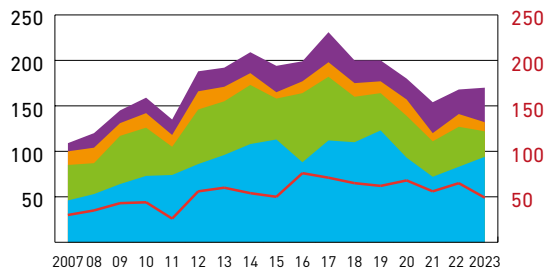
Data: Patrick Dilger

New Bachelor's Students



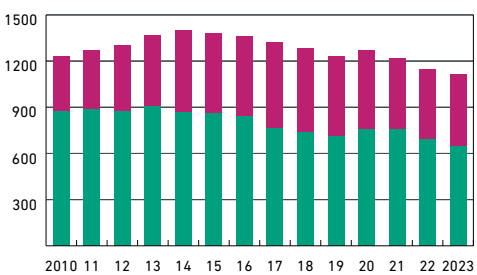
- Cultural Engineering and Surveying
- GsE
- EE
- CE
- BSc New female students

New Master's Students



- MSc SD&IS
- MSc G
- MSc EE
- MSc CE
- MSc New female students

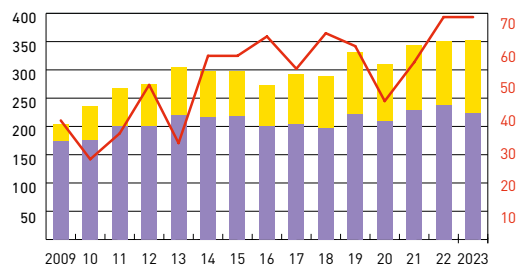
Student Numbers BSc and MSc Level*



- Master's Students
- Bachelor's Students

* Figures exclude: visiting/mobility students, CAS/DAS/MAS students

Doctoral Students and Doctorates



- Female Doctoral Students
- Male Doctoral Students
- Doctorates (right-hand scale)

CE	Civil Engineering
EE	Environmental Engineering
GsE	Geospatial Engineering
G	Geomatics
SD&IS	Spatial Development & Infrastructure Systems

Research Highlights

What Zurich has to change to have more space for e-bikes

Text: Florian Meyer Illustrations: Lukas Ballo

What happens when cities allocate their road space primarily to the needs of cyclists and e-bikers? On a new popular-science website, ETH researchers from the Department of Civil, Environmental and Geomatic Engineering use examples from the city of Zurich to show what such an "E-Bike City" could one day look like.

What would the streets look like if a city took half its road space and gave it to cycling and e-biking? Would city dwellers use their bikes more often? Might the concept of an "E-Bike City" even be a way to help reduce transport-related CO_2 emissions?

Nine professorships at ETH Zurich and EPF Lausanne have been investigating these questions for a good year and a half. This research initiative is led by transport researcher Kay Axhausen (see page 14). The initial findings are now available, and the researchers have visualised their solutions and published them on a story-map website in fall 2023. Story mapping presents the vision of the E-Bike City as a story in text and images, making it easy to understand.

View of an intersection in the E-Bike City: Two-wheelers will have their own double lane and public transport will have its own lane as well. Cars drive on one-way streets.

In a future E-Bike City, people will be able to use half the city's road space when they are out and about on foot or travelling by bicycle, e-bike, cargo bike, e-scooter or other small modes (what's known as micromobility). Today, over 80 percent of Zurich's urban street space is reserved for cars and car parking; only about 11.7 percent is earmarked for e-bikes and bicycles. For the most part, cyclists and e-bikers share the roads with cars.

More space for people instead of cars

In the E-Bike City, by contrast, the lanes for cars, public transport (trams, buses), two-wheelers (bicycles, e-bikes) and the pavement for pedestrians would generally be separated from each other. Rather than widening roads or building new ones, this would involve repurposing the existing space. The E-Bike City's road network would largely consist of single-lane, one-way streets, with lanes for bikes and e-bikes usually located to the left and right of the one-way lane. Public transport, meanwhile, would continue to use its existing separate lanes. "A redesign like this would give more space back to people," Axhausen says.

To present the innovations of the E-Bike City as realistically as possible, the researchers selected three typical examples from the city of Zurich: Bellevue square and Quaibrücke bridge near Lake Zurich, Birchstrasse in north Zurich and Winterthurer-/Letzistrasse in the Oberstrass district. Using these examples, they show how different a street would look if it were designed to be bike-friendly instead of car-friendly. An image comparison slider can be used to directly compare the current road space and its possible future state.

The design of the E-Bike City follows certain principles. Based on the existing road network, one half of each road is converted into a safe and comfortable cycle lane that can be used by bikes, e-bikes, cargo bikes, e-scooters, etc. The other half of the road is still used for cars (petrol- or battery-powered), so access to residential and office buildings is guaranteed.

In the E-Bike City, the urban road network for cars consists largely of one-way streets, whereas two-wheelers have dedicated lanes for both directions of travel.

Four steps to an e-bike-friendly Bellevue

On their →**story-map website**, the ETH researchers use the example of Zurich's Bellevue square and Quaibrücke bridge to show how the E-Bike City principles could be implemented in four steps:

- Step 1: Public transport, which currently crosses the Quaibrücke bridge in one lane in the middle, will still have right of way. Most of the tram tracks and bus lanes remain unchanged. Where separate tram and bus lanes are not possible, shared lanes with cars ensure a seamless public transport network.
- Step 2: The road network for cars provides access to every building so that all important access routes (e.g. for tradespeople, people with mobility issues or physical disabilities), emergency services (ambulance, fire brigade, police) and deliveries are possible.
- Step 3: The remaining street space is used for micromobility as well as for wider pavements and new green spaces. The ETH researchers found that 37 percent of Zurich's streets today are suitable for conversion along these lines.
- Step 4: The more city dwellers who subsequently decide to live car-free, the more parking spaces can gradually be converted into bicycle parking, greenery and playgrounds. Sufficient loading zones and short-term parking spaces ensure access for emergency, delivery and other essential vehicles.

Dynamic road use combats congestion

In addition to these key actions, the ETH and EPFL researchers are investigating further measures. For example, the switch to a one-way urban road network might cause congestion, but dynamic road use could reduce the probability of that happening. Depending on the time of day, traffic signals could be used to control the direction in which cars and bicycles use the road and how many lanes they can occupy. The team is also looking into how road users will accept the E-Bike City; for example, motorists may feel disadvantaged if cyclists are given priority. "In the research project, we're examining how viable and cost-effective the basic assumption and principles of the E-Bike City are, and what conditions are necessary for possible conversion," Axhausen says.

D-BAUG Lighthouse Project

The lighthouse initiative helps establish beacons for societal transformation and development associated with the three grand challenges of 1) urbanisation, 2) future-oriented infrastructure, and 3) the changing environment.

In the future, planning and construction processes could be controlled by spatial computing platforms that offer real-time decision-making options to all inolved parties.

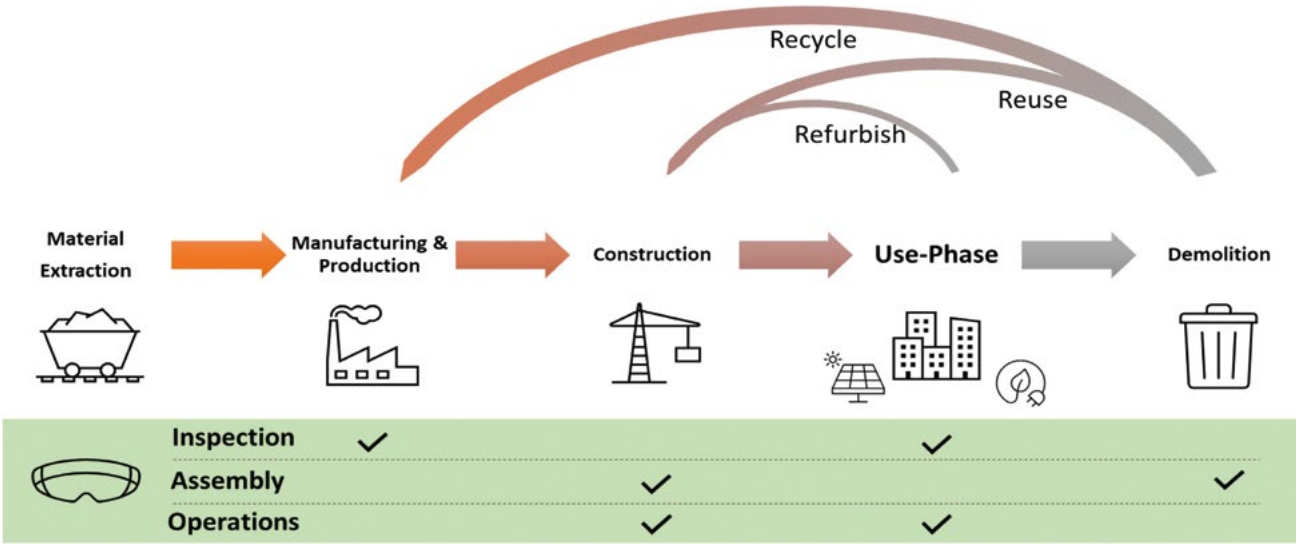
Carbon neutral construction through Extended Reality (XR)

Text: Iris Mickein Image: Orkun Kasap

How can the construction industry improve its carbon footprint to net zero by 2050? What contributions can digital solutions make? These questions are central to the new lighthouse project of the Department of Civil, Environmental and Geomatic Engineering, which is hosted by Design++. The aim is to develop a spatial computing platform to accelerate the transition for a more efficient and environmentally friendly construction industry. The interdisciplinary project is funded by the Albert Lück Foundation.

The construction sector is responsible for about 40 percent of global CO_2 emissions, with about 10 percent coming from building materials and the remaining 30 percent from building operations. In Switzerland, the construction sector alone is responsible for 80 percent of waste. The need for action is clear: to meet climate change targets, the architecture, engineering and construction (AEC) industry must significantly reduce its CO_2 emissions. In the face of this pressure to change, the use of digital technologies is becoming an indispensable prerequisite.

The goal of the lighthouse project is to develop an innovative spatial technology – a spatial compute platform – that could fundamentally change processes and communication in the



Schematic overview for how XR can support processes to minimize embodied and operational emissions by maximizing a low-carbon life cycle through XR supported inspection, assembly, and operations.

AEC industry. In essence, spatial computing provides an immersive experience that uses sensors and cameras to create a digital model of objects, environments and machines. Digital content merges seamlessly with physical space. Direct human-machine interaction facilitates collaboration between decision-makers, optimises multiple tasks in real time, and creates the framework for a sustainable, carbon-neutral AEC industry.

Focus on inspection, dis/re-assembly and operation

The main focus of the project is the development of Extended Reality (XR) tools for the inspection, dis/re-assembly and operation of existing or new digitally fabricated buildings and infrastructure.

In the area of inspection, the focus is on quality control in order to extend the service life of structures while minimising the use of new raw materials. In the area of assembly, particular attention is paid to the efficient disassembly of reusable components during refurbishment in order to support the concept of circular construction and reduce waste. Another goal of the platform is intelligent building operation. This includes minimising energy consumption and increasing the use of renewable energy in order to maximise the energy efficiency of buildings.

In this project, the development of the spatial compute platform is specifically tailored to the needs of the AEC industry and is designed to facilitate the adoption of sustainable technologies and practices.

Interdisciplinary and open-source

This four-year D-BAUG lighthouse project is funded by the Albert Lück Foundation and hosted by Design++, the Center for Augmented Computational Design. In addition to novel applications for XR in the AEC industry, a key outcome of the project will be an open source platform that can be used by other reseachers at ETH.

The project is led by four Co-PIs: Dr. Danielle Griego, Prof. Robert J. Flatt, Prof. Catherine De Wolf, Prof. Bernd Bickel and undertaken by three researchers: Dr. Bhartath Seshadri, Dr. Eleftherios Triantafyllidis and Stefan Zimmermann. Project collaborators include faculty from the Departments of Civil, Environmental and Geomatic Engineering and Architecture: Prof. Ueli Angst, Prof. Benjamin Dillenburger, Prof. Fabio Gramazio & Prof. Matthias Kohler, and Prof. Arno Schlüter.

D-BAUG Lighthouse Project

The lighthouse initiative helps establish beacons for societal transformation and development associated with the three grand challenges of 1) urbanisation, 2) future-oriented infrastructure, and 3) the changing environment.

Reinforced concrete, corrosion and climate change

Text: Brigitt Blöchlinger Photo: WSS / Oliver Lang

Concrete is the most widely used man-made material in the world and its production releases huge amounts of CO_2 into the atmosphere. Reinforced concrete structures can only be made climate-friendly by overturning an old dogma: that only highly alkaline concrete protects the reinforcing steel from corrosion. This is exactly what Ueli Angst, a materials scientist at ETH Zurich, is aiming to do in a research project supported by the Werner Siemens Foundation.

Across the globe, 600 gigatonnes of concrete – enough to build ten Matterhorns – have been used so far in construction projects. Several reasons account for concrete's popularity. For instance, the substances needed for its manufacture occur naturally almost everywhere. What's more, when reinforced with steel, concrete is very strong and durable, making it ideal not only for constructing residential and office buildings, but also major infrastructure projects like bridges and tunnels.

On the downside, producing these amounts of concrete is bad for the climate: concrete manufacturing is responsible for up to eight percent of anthropogenic CO_2 emissions, and it releases three times more CO_2 into the atmosphere than global air traffic. This problem is recognized in the concrete and construction industry, where various climate-friendlier concretes are being developed.

Reinforced concrete has a weakness

Civil engineer and materials scientist Ueli Angst, professor at the Department of Civil, Environmental and Geomatic Engineering at ETH Zurich, is familiar with the technical and economic obstacles to making concrete a sustainable building material while also retaining its durability. His investigations are centred on corrosion of the steel reinforcements in concrete, as reinforcement steel is susceptible to corrosion (rusting), which, over time, can cause considerable damage. Angst therefore sees preventing corrosion, and hence the deterioration of reinforced concrete structures, as the key goal. Otherwise, the consequences are immense costs, safety hazards and environmental pollution. As an example: in Switzerland, roughly 500 million Swiss francs are spent every year on corrosion prevention measures and repairing damaged traffic infrastructure.

The most effective approach to improve the environmental impact of concrete is to change the composition of the raw materials. "Ecological cements may well present similar or even better mechanical properties than those of conventional types," he explains, "but still today there's a persistent belief that cement manufactured using less CO_2 is also less durable, because it is less efficient in protecting embedded steel from corrosion." Traditional Portland cement-based concrete has a significant advantage: conventional concrete is highly alkaline, with pH values around thirteen, and the high alkalinity causes a so-called passive film to form on the steel's surface, inhibiting iron dissolution and thus protecting the rebar from corrosion.

> **We want to achieve a paradigm shift: rather than striving to stabilise alkalinity levels in concrete for a hundred years, we want to control corrosion.**
>
> Prof. Ueli Angst

Alkalinity as an article of faith

Angst explains that this "high-alkaline corrosion protection is attained only at the price of major CO_2 emissions during concrete manufacturing". If calcination is carried out without the CO_2-emitting "bad guy" limestone, or even if less is used, the inevitable result is less alkalinity. "This is the dilemma we're facing in research and industry."

Electrochemical measurements are carried out in the Corrosion laboratory of Professor Ueli Angst (centre), who heads the Durability of Engineering Materials group at D-BAUG.

Angst stresses that while it is correct that high alkalinity in conventional concrete prevents corrosion, "the general conviction that concrete has to be highly alkaline to protect against corrosion poses an obstacle in the search for less carbon-intensive alternatives".

His theory that corrosion prevention is possible without high alkalinity is based on numerous observations. "A few years ago, we conducted a detailed analysis of studies made on nearly four hundred buildings in Switzerland, Finland and Japan, all of which were older structures whose concrete was no longer alkaline due to exposure to ambient exposure, thus CO_2. Nevertheless, only five to ten percent of these buildings presented significant corrosion problems," Angst explains. "We interpret this as clear empirical evidence that protection from corrosion can be guaranteed in concrete that is not highly alkaline. The critical question is how to avoid corrosion in the problematic five to ten percent."

Prevention first

But what is it that really protects reinforced concrete and other porous building materials from corrosion? And how can this knowledge be used in ensuring durable structures for the century? This is what Angst and his interdisciplinary team plan to find out in the next ten years – with funding from the Werner Siemens Foundation. Although the problem has been known for decades, a fundamental and detailed understanding of corrosion in reinforced concrete is still lacking.

Angst and his team are adopting a comprehensive, interdisciplinary approach to investigate the various complex and interdependent processes, including chemical reactions, electrochemical processes, changes in pore structure, and the transport of various substances and gases dissolved in the concrete pore water.

"We want to achieve a paradigm shift: rather than striving to stabilise alkalinity levels in concrete for a hundred years, we want to control corrosion," Angst says. To realise this shift, the research focus must be placed on corrosion. Only then will it be possible to develop viable forecasting models and new testing methods to ensure both the durability of concrete and climate-friendly manufacturing.

Angst hopes that the answers to his central research questions will find application in industry and education as quickly as possible, and he's convinced that the information on corrosion prevention currently found in textbooks, technical manuals and industry standards will have to be revised.

How microbial communities shape the ocean's ecology

Text: Michael Keller Image: Lambert, Fernandez, Stocker

A research collaboration led by ETH Zurich and MIT has received a further USD 15 million from the New York-based Simons Foundation to investigate the behaviour of marine bacteria and microalgae. The research focuses on microbial communities that impact the ocean's carbon cycle.

Without microorganisms, higher life forms would not exist. Bacteria and single-celled algae form dynamic communities that drive fundamental ecological processes: they build biomass, break down dead organic matter and recycle the elements of life. "Despite their huge importance, little is known about the principles and functions of microbial communities in the environment," says ETH Professor Roman Stocker from the Institute of Environmental Engineering.

Since May 2017, Stocker and his team have collaborated with nine research groups from Switzerland and the US to research the underlying functional principles of microbial ecosystems in the ocean. The Principles of Microbial Ecosystems (PriME) project is financially supported by the US-based Simons Foundation (see press release: ➔**Focus on microbial communities**). Stocker is a Co-Director of PriME and co-founded the project seven years ago. In 2022, PriME entered its second phase, with the Simons Foundation once again supporting the consortium by providing USD 15 million to deepen our knowledge of the interactions of marine bacteria and single-cell algae in the sea.

Engineering knowledge for new research tools

The dynamics of microbial communities are determined by the behaviour of their members, who are often anything but passive. "Many microbes can swim. They actively perceive and interact with their environment, and their movements are deliberate," Stocker explains.

However, making the interactions of these cells visible is challenging. A single drop of seawater is teeming with nearly a million microbes. "The scale of bacterial interactions is so small that we simply cannot investigate them with the usual oceanographic methods," explains the environmental engineer. In his laboratory at the Department of Civil, Environmental and Geomatic Engineering, he develops technology that closes this methodological gap.

Stocker is a pioneer in the field of environmental microfluidics. His team uses microfluidic techniques that are otherwise used by chemical engineers to handle tiny amounts of liquids, and combines them with modern microscopy and imaging to study microbial ecosystems.

To better assess the consequences of climate change on key ecological processes, it is crucial to understand how the many species in microbial communities interact with one another.

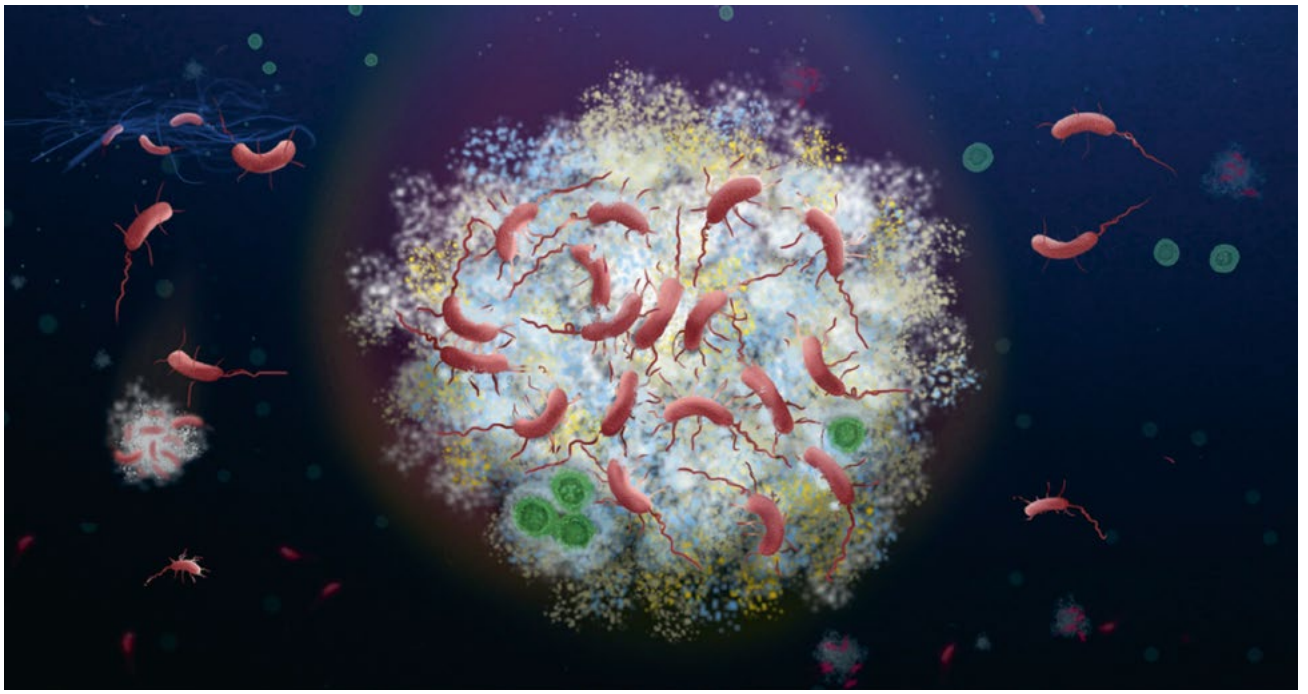
Prof. Roman Stocker

Behavioural tests for individual microbes

Environmental microfluidics enables high-resolution visualisation of microbes and quantification of metabolic processes. "We can track how individual cells move and make decisions, and sometimes also infer why they do it," explains the environmental engineer. One example is a chemical preference test for microbes that Stocker's group developed specifically for use in the ocean. The "in situ chemotaxis assay" (ISCA), a credit-card-sized plastic assay with tiny chambers filled with chemicals, each chamber acting as a microscale lobster trap. Bacteria swim in, attracted by the "smell" of the attractant, a behavior called chemotaxis which Stocker has extensively investigated in marine microbes. Until recently, though, this behaviour had only been observed in laboratory tests.

Marine microbes find food chemotactically

With the ISCA chip, Stocker's team and their Australian colleagues were able to investigate how marine bacteria search



Marine bacteria colonise a sinking nutrient particle and break down the organic material. Recycling of marine snow is a key process in the ocean's carbon cycle.

for food in the ocean. In a recent study published in Nature, the researchers showed that marine bacteria pervasively use chemotaxis to find phytoplankton, which absorb CO_2 and produce organic matter through photosynthesis. Some of that organic matter is released into the seawater, forming a favourite food for bacteria.

It had been suspected that bacteria find food via chemotaxis, but this had never been confirmed in the open ocean. These findings have ecological relevance; when bacteria purposefully search for food, their success rate increases. This allows microbes to gather in large numbers around a food source. Numerous bacterial species teem around phytoplankton cells, feeding on the synthesis products. This interaction is important in the sea – the collective metabolism of this microbial community recycles CO_2, driving the ocean carbon cycle.

When phytoplankton dies, it falls in the form of marine snow. The phenomenon stems from the billions of single-cell algae that grow in the upper layers of the ocean, then die and sink as organic particles. This "biological carbon pump" transports carbon to the depths. However, an inverse process slows the carbon flow. As snow particles sink, they are colonised by bacteria, which decompose most of the organic material.

"Even if only a fraction of the carbon reaches the ocean floor and is stored, the biological carbon pump still results in the oceans absorbing large amounts of CO_2 from the atmosphere," explains Stocker. His team found that bacteria decompose sinking particles up to ten times faster than previously assumed. A high-resolution look at the microscale dynamics revealed the reason: the flow caused by sinking washes away byproducts of decomposition. This reduces the amount of carbon that reaches the ocean floor. The increased particle decomposition reduces the carbon pump's transport efficiency by half, correlating with measurements of real carbon transport in the ocean.

Focus on key ecological processes

Over the past seven years, the PriME consortium has produced more than 120 publications – most of them illuminate how microbes find and utilise food. In the follow-up project, the partners now want to focus more closely on the two ecologically significant micro-ecosystems around phytoplankton and marine snow particles. Specifically, their aim is to conduct more in-depth research on the interactions between bacteria and single-cell algae, and between bacteria and marine snow.

"To better assess the consequences of climate change on key ecological processes, it is crucial to understand how the many species in microbial communities interact with one another," explains Stocker.

Fire simulator to test timber components for the construction of buildings.

A furnace for safe timber buildings

Text: ETH Editorial team Video: Michael Steiner

Timber construction is undergoing a renaissance in Switzerland. ETH researchers led by Professor Andrea Frangi are using a fire simulator to test timber components for the construction of buildings of all sizes. The custom-built oven permits simulations of realistic fire scenarios.

Not all building fires develop in the same way. The flammable material catches fire, the temperature rises, and the fire grows and spreads. The compartment size and properties, the fire load, the temperature, and the oxygen concentration in the burning room influence its development. The most recent acquisition of the Institute of Structural Engineering in the Department of Civil, Environmental and Geomatic Engineering at ETH Zurich is intended to show how timber structures behave in different fire scenarios. The insights gained from this will help to expand the potential applications of timber as a safe and sustainable construction material.

Precisely simulating fire scenarios

Including building renovation measures, the oven developed especially for fire simulations costs around CHF 2.5 million, looks robust, and is housed in the heating building of the Hönggerberg campus. It comprises a metal cube reinforced with steel girders with a combustion chamber that is one metre high, one metre wide, and almost 1.7 metres long. The fire simulator is controlled by ten gas burners attached in equal halves to the two long sides. They can heat the oven up to over

1,400 degrees Celsius. The tests are recorded with several cameras outside the combustion chamber, and the composition of the combustion gases can also be analysed.

With our research, we can help to ensure that even more of the renewable and CO_2-saving resource timber is used as a construction material.

Prof. Andrea Frangi

"We can program the oven's temperature precisely to three degrees and do the same with the oxygen in the furnace," explains Andrea Frangi proudly. The timber components and other common construction materials can also be encumbered with up to 50 tonnes during the test. The Professor for Timber Structures initiated the procurement of the fire simulator and was involved in determining its specifications. "The furnace allows us to simulate various fire scenarios and study their impact on the timber structures."

Sustainable and safe construction material

Timber construction is booming in Switzerland, and the buildings are growing. Timber high-rise buildings ranging from 75 to 108 metres in height are currently planned or already under construction in Regensdorf, Zug, Winterthur, and Zurich. The fact that this is at all possible is also due to research work spanning decades, such as that carried out by Frangi's group with the fire simulator. New construction products and technologies for connecting timber components also facilitate increasingly larger and unusual constructions.

Prior to 2004, only two-story buildings with timber structures were permitted in Switzerland. From 2005 the threshold was raised to six stories, and since 2015 there has effectively no longer been an upper limit. "The planned high-rise buildings are undoubtedly flagship projects," says Frangi. "However, timber has long established itself as a construction material for buildings of medium height and is attractive due to its good price-performance ratio, sustainability, and safety." The latter may come as a surprise, but while steel beams can deform and accordingly become unstable in the event of a fire, timber constructions can retain their structural integrity for longer.

The load-bearing capacity of a timber beam in the event of a fire is fundamentally determined by its size. If the beam burns, around four centimetres per hour, are converted from wood to charcoal on the sides exposed to the fire. Potential weak points are connecting elements and constructional details. To expand the potential applications of modern timber construction, Andrea Frangi and his team wish to investigate further the combustion behaviour of structural timber elements and connections under realistic conditions. "The construction sector causes a large share of climate-damaging emissions. With our research, we can help to ensure that even more of the renewable and CO_2-saving resource timber is used as a construction material," says Frangi.

After 90 minutes the wooden piece is removed from the furnace and extinguished.

Rethinking wastewater management

Text: Michael Keller Photos: Lucky Lugogwana, Max Maurer

Sewer systems and centralised treatment plants are one solution, but not necessarily a sustainable one, for managing the world's wastewater. Environmental engineers at ETH Zurich and Eawag have been helping to develop decentralised, closed-loop modular systems.

Out of sight, out of mind: we've been flushing away human waste ever since sewers were invented, using copious amounts of fresh water to expel it from our homes and cities as fast as the pipes can carry it. Modern urban water systems provide us with clean drinking water, channel our wastewater to treatment plants and divert rainwater away from built-up areas. "As a result, we enjoy dry and hygienic living conditions, two of the mainstays of public health in densely populated urban areas," says Max Maurer, Professor of Urban Water Systems at ETH Zurich and Eawag, the Swiss Federal Institute of Aquatic Science and Technology, which is part of the ETH Domain.

Only conventional urban water systems are not sustainable.

Prof. Max Maurer

To achieve this, industrialised countries have built extensive infrastructure – some 230 billion Swiss francs' worth in Switzerland alone. Laid end to end, Switzerland's 200,000-odd kilometres of water and sewerage pipes would encircle the globe five times. The extensive network of underground sewers carries wastewater to nearly 800 centralised treatment plants.

This approach has proved its worth in industrialised countries – and for decades, it was also regarded as a benchmark for the rest of the world. "But the truth is that 'one-size-fits-all' conventional urban water systems are no longer sustainable," says Maurer.

From waste to resource

Kai Udert, Professor at the Institute of Environmental Engineering at ETH Zurich and Senior Scientist at Eawag, is equally sceptical about conventional water infrastructure. "We use drinking water to dilute faeces, urine and slightly dirty water from bathrooms and kitchens and move them through the sewerage system – that's patently absurd!" he says.

Udert sees sewage not as waste that needs to be disposed of, but rather as a valuable resource. "Wastewater is one of the last linear waste streams," he says. "We dispose of everything in the same way, regardless of whether it's clean or dirty. That's inefficient, and it creates all sorts of problems.

Maurer and Udert call for a paradigm shift towards a more decentralised system of wastewater treatment. This would give us a more efficient and effective means of managing urban water resources.

Recycling at source

"Think compact, highly efficient, decentralised systems that offer flexible wastewater treatment on a local level – that's the alternative we're proposing," says Maurer. He and Udert

The "Autarky" toilet developed at Eawag (right), shown here in a field test in Durban, South Africa next to a dry toilet. Autarky treats the three separate streams – water, urine and faeces – in situ.

Beneath the Bahnhofstrasse in Zurich, a sewer conveys wastewater to the treatment plant. Rainwater is channelled through a separate pipe.

have spent years developing suitable processes for small-scale treatment facilities based on three key principles for a closed-loop sanitation system designed to conserve and recover resources.

> **Wastewater is one of the last linear waste streams.**
>
> Prof. Kai Udert

Separation at source – also known as NoMix sanitation – seeks to segregate wastewater into its different fractions, because human waste and water are easier to treat and recycle if they are not mixed together.

Resource recovery takes various forms: nutrients such as nitrogen and phosphorus can be obtained from urine and faeces, while greywater – slightly dirty wastewater from kitchens, bathrooms and washing machines – can be treated and reused multiple times. Thermal energy is also recovered. Similarly, applying recovered nutrients as fertiliser closes the nutrient cycle, thereby benefiting the environment and reducing dependence on mineral phosphorus fertilisers.

The third principle, *decentralisation*, seeks to eliminate the costly transport of water through central pipes by ensuring that wastewater and waste can be treated as close to source as possible.

Well-known examples include Vuna and Blue Diversion Autarky, which provide a safe and affordable way to dispose of wastewater without requiring a combined sewerage system and centralised treatment plants.

Switzerland as a development and test market

Water poses one of the biggest challenges of the future. Using this resource intelligently and sparingly is essential. "The concepts we developed for poorer countries 15 years ago are becoming increasingly relevant to Switzerland. We're now reaping the rewards of this knowledge," says Udert.

Maurer and Udert believe we will soon be seeing modular treatment plants in urban areas and compact reactors to treat wastewater in homes. The COMIX research project, co-led by Maurer, recently examined the potential use of modular technologies in the Swiss water management sector. Its results suggest that the proportion of decentralised wastewater treatment plants could rise from 2.5 percent to 50 percent in the long term.

This is not about abolishing existing sewer networks. They are a robust and functioning technology that enables enormous quality of life in many places. The aim must be to complement and improve existing approaches with new concepts. Like other critical infrastructures – electricity, communications, transport, etc. – wastewater management must not stand still. The researchers also see an opportunity for Switzerland to make its water infrastructure climate-friendly and position itself as a lead market for modular water systems.

It would take a concerted effort by research, industry, and the public sector to conduct the pilot projects required to demonstrate the feasibility of these innovations and to create an initial market.

Where should wind turbines be constructed in Switzerland?

Text: Christoph Elhardt Photo: Olivier Marie, Keystone

A research team led by Adrienne Grêt-Regamey, Professor of Planning Landscape and Urban Systems (PLUS), shows for the first time how a relaxation of Swiss spatial planning policy would affect the locations of wind turbines. If the aim is to have as few wind turbines as possible in the Alps and in Switzerland in general, it would be worth considering using windy agricultural areas on the western Swiss Plateau.

By 2050, wind power is set to provide around 7 percent of Switzerland's electricity, amounting to around 4.3 terawatt-hours (TWh) per year. Currently, the country's almost 40 existing wind turbines produce only 0.14 TWh, or 0.3 percent of its power. Policymakers now want to accelerate energy production from wind power, especially in winter, to prevent a shortfall. But where is the best place to generate wind power in Switzerland?

A study by ETH Zurich researchers, led by Adrienne Grêt-Regamey, shows for the first time different scenarios of how wind turbines could be distributed to meet the target set out in the Swiss Energy Strategy 2050. The study also takes into account areas where the construction of wind turbines is currently prohibited. "If we used particularly good farmland,

known as crop rotation areas, on the windy Swiss Plateau to generate wind power in addition to producing food, we would have to build far fewer wind turbines in the Alps," Grêt-Regamey says.

760 wind turbines in the reference scenario

The study authors' reference scenario is based on the Swiss federal government's wind energy concept, which defines the areas where wind energy may be harnessed. It specifies that no wind turbines should be built in forests, on crop rotation areas or in the vicinity of heritage sites. To generate 4.3 TWh of wind power per year in this scenario would take about 760 wind turbines. The researchers assume that as few wind turbines as possible should be built in only a handful of particularly windy locations.

Since it is neither reasonable nor technically feasible to build the same turbines at all locations, the study considers smaller ones for the Alps, medium-sized ones for the foothills of the Alps and the Jura Mountains, and the largest and most powerful wind turbines for the plains of the Swiss Plateau. At full capacity, a large turbine on the plains of the Swiss Plateau generates over twice as much electricity as a small turbine in the Alps.

If we relaxed the spatial planning regulations, we would need almost 200 fewer wind turbines in the Grison and Pennine Alps than in the reference scenario.

Prof. Adrienne Grêt-Regamey

Significant development necessary in the Alps

Of the approximately 760 wind turbines required, some 40 percent would be located in the Grison and Pennine Alps. But these 300 or so small turbines would generate only about 20 percent of the annual output. "This is suboptimal, as the construction and operating costs of wind turbines tend to be higher in the mountains than on the plains, and the people of Switzerland find the thought of wind turbines in unspoiled, natural landscapes in the Alps particularly disturbing," Grêt-Regamey explains.

About half of the 4.3 TWh would be generated by some 260 of the largest turbines on the plains of the Swiss Plateau – 80 percent of them located in the cantons of Bern, St. Gallen, Lucerne and Fribourg. The remaining 30 percent of the wind power projected annually until 2050 would be met by around 180 turbines in the foothills of the Alps, most of these located in the cantons of Bern, Fribourg, St. Gallen and Appenzell Ausserrhoden. Based on these calculations, the researchers →**created a map** showing the approximate distribution of wind turbines. "The points should be read as national focus areas and not as exact locations for wind turbines," says Reto Spielhofer, the lead author of the study, who is also a researcher in Grêt-Regamey's research group.

Make use of particularly windy areas

As part of the reference scenario, the researchers also identified 36 sites that would be particularly suitable for generating wind power. Without having to adjust spatial planning policy, these sites together could meet just under 5 percent of annual demand. Nine of these sites are located in the cantons of Graubünden and Valais, six in St. Gallen, five in Bern, two each in Vaud and Fribourg, and one in the canton of Uri.

300 fewer turbines with crop rotation areas

The study by the ETH researchers also examines the effect of relaxing spatial planning on wind turbine distribution. In one scenario, crop rotation areas may be used for wind power. "We're aware that such use of this land is extremely controversial, as it's very good agricultural land that produces high agricultural yields," Grêt-Regamey says.

Nevertheless, the researchers wanted to show the scope for expanding wind power in crop rotation areas, especially ones with frequent and strong winds. Compared to the reference scenario, 300 fewer wind turbines would be needed throughout Switzerland to generate the planned wind power of 4.3 TWh per year.

Concentration on the western Swiss Plateau

"If we relaxed the spatial planning regulations as they relate to crop rotation areas, we would need almost 200 fewer wind turbines in the Grison and Pennine Alps than in the reference scenario," Grêt-Regamey says. Only just over 3 percent of the annual target of 4.3 TWh of wind power would have to be generated in the Alps and less than 1 percent in the foothills of the Alps and in the Jura Mountains. Meanwhile, more than 96 percent would come from the largest turbines on the plains – and in particular the western Swiss Plateau. Of the total of about 460 wind turbines in this scenario, just over 40 percent would be located in the canton of Vaud and about 13 percent each in the cantons of Fribourg and Bern.

"There's a trade- off between the number of wind turbines and their distribution," Grêt-Regamey says: "If we want to have as few wind turbines as possible – both in general and in the Alps in particular – we have to build large, highly visible wind turbines where there is the most wind: on the western Swiss Plateau. If, on the other hand, we prioritise the protection of crop rotation areas, we will not be able to avoid expansion in the Alps. Finally, our very recent work shows the importance of also integrating social acceptance considerations into the siting of renewable energy systems. It gives a more comprehensive view on where implementation conflicts can be minimized."

The Big Blue

Text: SNSF / Florian Wüstholz Photos: Markus Bertschi

The research centrifuge with the highest capacity in Europe has been in operation at the ETH Hönggerberg campus since June 2023. It's used to investigate the effects of earthquakes and floods on buildings, bridges and dams. A visit with Professor Ioannis Anastasopoulos, Head of the Geotechnical Centrifuge Center at the Department of Civil, Environmental and Geomatic Engineering.

Elegant, futuristic and a luminescent blue, ETH Zurich's new research centrifuge floats almost weightlessly in space. It's enclosed in a concrete housing weighing 245 tonnes, and it's now ready for its first experiments.

The centrifuge is still rotating very slowly here. When it runs at full power, the doors are closed. The experiments it can carry out include testing the impact of an earthquake on certain soils.

An earthquake that lasts 30 seconds in reality can be simulated here in 0.3 seconds.

Prof. Ioannis Anastasopoulos

Since June 2023, models weighing up to two tonnes can be accelerated up to 250 g. "But we won't run the centrifuge at its limit", says Professor Ioannis Anastasopoulos. "Our experiments are mostly in the 100 g range", adds Ralf Herzog, who's responsible for the technical installation and has to make sure all the systems run smoothly. All the same: when the centrifuge picks up speed and is spinning at some 250 km per hour, it's still scary. Its hydraulic oil pumps alone make an immense racket, generating 1,000 hp.

Heavy lifters had to be brought in before the centrifuge was installed. Switzerland's biggest crane lifted the concrete housing into the excavated pit. This housing rests on four steel springs and constitutes the centrifuge's foundations. When the centrifuge starts to spin, the springs and housing soak up the smallest vibrations, isolating them from the outside world. This means that none of the highly sensitive experiments in the neighbouring laboratories are in any way affected.

It took a year to install this 20-tonne beam centrifuge. It had stood for years in a storage facility in Bochum, after serving researchers there for 20 years. It has since been restored extensively. "When we first saw it, I didn't think it would ever run again", admits Herzog. "Apart from its massive steel beam, almost everything about it is new: bearings, motors, hydraulics, electronics, and sensors".

100 times smaller, but 100 times heavier

"We are currently using it to simulate soil-structure systems", explains Anastasopoulos. "These are structures anchored in the ground, like a building's foundations, a dam, or a bridge". One good example would be a bridge that is anchored with several columns in a liquefiable soil. It is difficult to analyse how the ground and a building standing on it will behave in an earthquake, for example. "We can't build a layer of soil that's 30 metres thick here in the lab. We have to scale it down and work with models". The research centrifuge allows simulation thanks to artificial gravity. When rotating, the force of

gravity exerted on the model is 100 times normal. This means that the model can be 100 times smaller and lighter than would be the case in the real world. This balances out the weight, the forces involved, and the load.

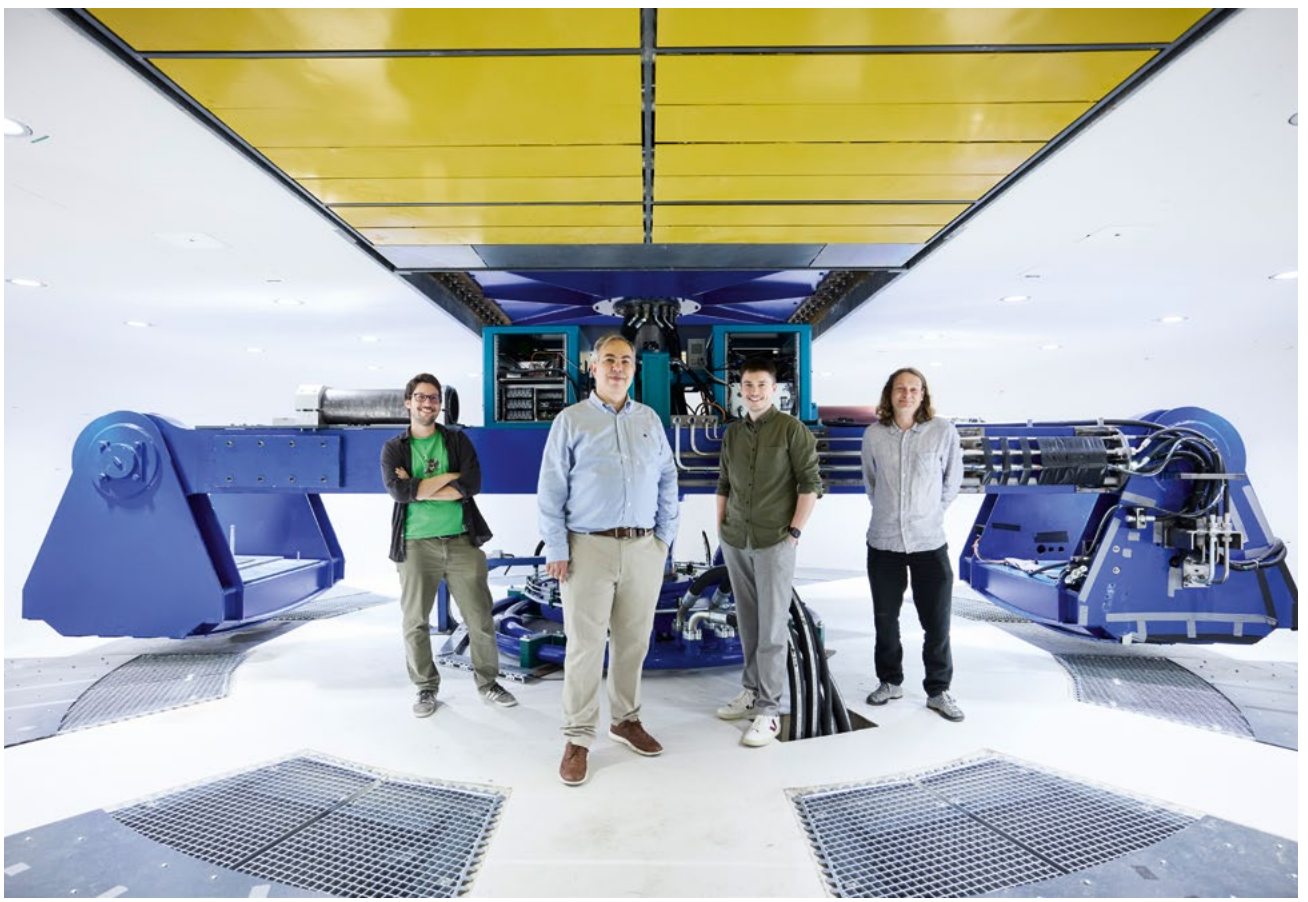
Another field of application for the centrifuge is the study of tsunamis and flood disasters. “In such events, structures and their foundations often fail because the seabed or the riverbed are washed away in a short space of time”, says Anastasopoulos. With the aid of a special apparatus, the centrifuge at Hönggerberg can simulate a continuous flow of water like the one that led to the disastrous floods in Germany in 2021.

20 earthquakes per minute

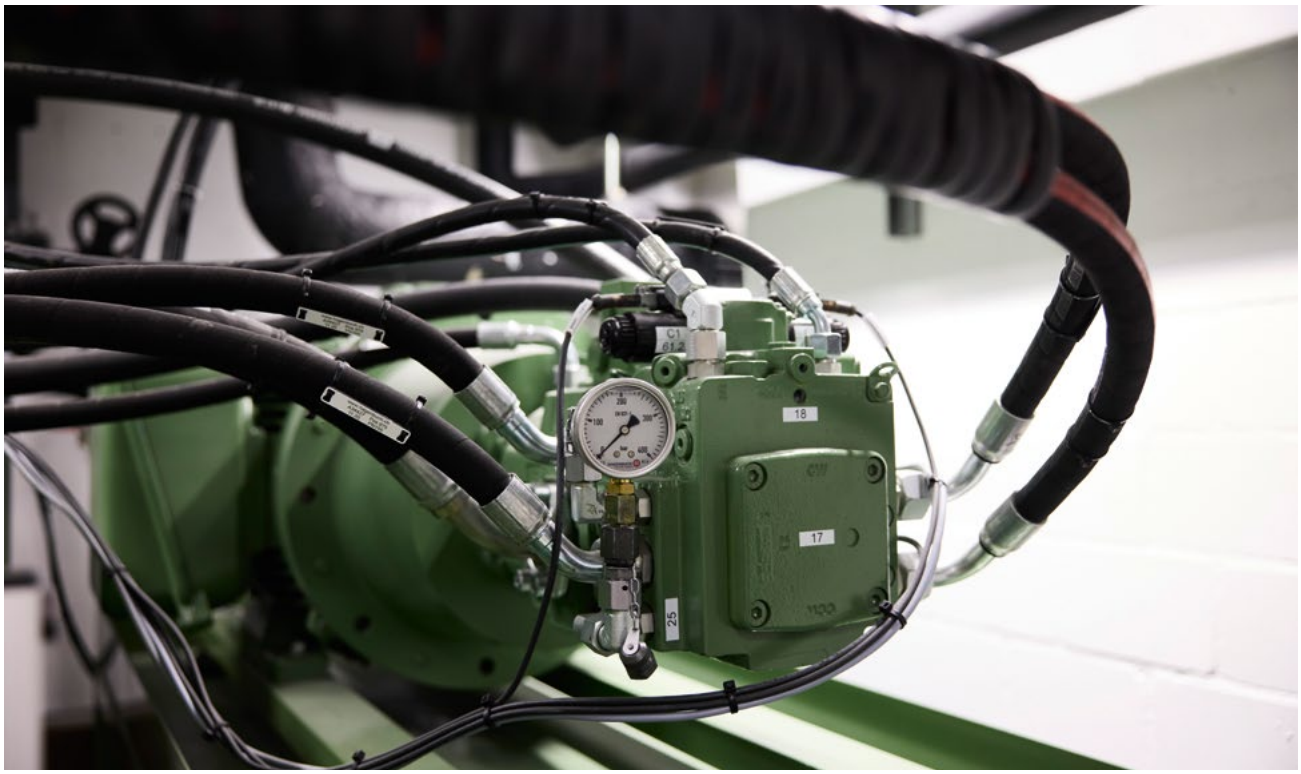
“It’s the preparation that requires the biggest efforts when you’re doing an experiment”, says Anastasopoulos. "The models have to be constructed precisely and meet specific parameters so that we can use them for the simulations”. A machine piles up the sand to serve as a soil model. The 3D-printed models of bridges and foundations are checked for structural comparability. Even the water that's used in the model is special: it comprises a highly viscous mixture of water and methyl cellulose that will behave exactly as needed when subjected to the high g force.

Once prepared, the model is placed on one of the centrifuge arms. It takes 10 to 15 minutes to reach the required velocity. Then come the earthquake simulations that are created by the shaking table on which the model stands. This is a unique construction that allows the research team to generate ‘earthquakes’ a hundred times quicker than in the real world and on a scale a hundred times smaller.

“This equipment was especially made for us, because the vibrations we need have to be very fast and very small”, says Anastasopoulos. “An earthquake that lasts 30 seconds in reality can be simulated here in 0.3 seconds”. The measuring devices employed have to be accordingly sensitive – including the cameras that document what’s happening in the centrifuge. “A normal high-speed camera might take some 10,000 pictures per second”, says Herzog. “But ours manage up to 10 million images per second”.



The interior of the centrifuge is impressive, even when it's at rest. The team posing here (from left to right) are Lampros Sakellariadis, Ioannis Anastasopoulos, Liam Jones and Ralf Herzog.



The oil pumps drive the centrifuge and make an immense racket – they run at 1.000 hp.

There is hardly anywhere else that offers this combination of centrifuge and shaking table that exists at ETH Zurich. In Japan, you can find huge earthquake shaking tables. And larger centrifuges exist elsewhere too. But it is the combination in Zurich that makes the magic happen. "Thanks to this centrifuge, we can simulate soil thicknesses of 40 metres. This would be impossible or far too expensive to realise with ordinary shaking tables", says Anastasopoulos.

When we first saw it, I didn't think it would ever run again.

Ralf Herzog

Less cement and greater security

Anastasopoulos also wants his centrifuge research to make a contribution to combating global warming – though he is not too fond of the phrase, or of the other buzzwords that are bandied about in the world of science and politics today. "Our research can help us to optimise the earthquake resistance of buildings", he says. "This can enable us to reduce the consumption of climate-damaging cement and steel when restoring bridges or building new dams". This can reduce both a project's costs and its ecological footprint.

On the other hand, global warming is increasing the frequency of extreme events such as flood disasters. "This is why the foundations of bridges and dikes are being exposed to far more powerful washout processes", says Anastasopoulos. "We can simulate these in our centrifuge and thus optimise adaptation measures".

These practical aspects were what triggered Anastasopoulos's fascination for geotechnics, almost 30 years ago now. Back then, an earthquake measuring 7.3 on the Richter scale shook the centre of the city of Kobe in Japan. Many bridges collapsed, more than 60,000 buildings were completely destroyed, and 6,500 people died. Anastasopoulos still goes to Japan with his students almost every year to exchange ideas with researchers on the ground. "Earthquake safety is an optimisation issue in Switzerland", he says. "But for countries like Turkey and Japan, it's a matter of survival".

More on the ➔ ***Geotechnical Centrifuge Centre***

Research Flashlights

There are fewer options for historic buildings

Following the devastating earthquakes in Turkey and Syria in February 2023, Professor Božidar Stojadinović was a sought-after expert for the media. In interviews with Tages-Anzeiger and 20 Minutes, Stojadinović explained that the buildings were not designed to withstand an earthquake of this magnitude and that older construction methods and inadequate construction played a role. He also explained how buildings should be constructed to ensure earthquake resistance and discussed the possibility of retrofitting older buildings, also in the Swiss context.

➔ **Full news article**

Photo: Erdem Sahin (EPA, Keystone)

Photo: Keystone

Accurate snow measurement thanks to AI and satellites

Measuring snow has never been faster or more accurate: Researchers at ETH Zurich, led by Professor Konrad Schindler, have developed an artificial intelligence that can determine snow depths across Switzerland using satellite images. In this way, snow depths can be determined without having to collect new data on the ground. The technology was developed in collaboration with ExoLabs and is relevant to the winter tourism industry as well as hydroelectric power plant operators.

➔ **Full news article**

Danger of landslides at dams

Research into the safety of dams is an ongoing task. A recent study led by Professor Alexander Puzrin and Marc Kohler investigated whether earthquake-induced landslides could cause dams to overflow and endanger downstream populations. The case study of a dam in Ticino shows that, in certain cases, geotechnical conditions counteract the probability of such a catastrophe.

➔ **Full news article**

Photo: IGT, D-BAUG

Sensor measures concentration of coronaviruses in air

Researchers led by environmental engineer Professor Jing Wang have developed a biosensor that detects aerosols in the air to which coronaviruses adhere. This allows real-time monitoring of virus levels in indoor environments. The aim is to apply the principle to other viruses to detect and stop epidemics at an early stage. In fall 2023, the project was presented today in the Synthesis Report of the National Research Programme "Covid-19" of the Swiss National Science Foundation.

➔ **Full news article**

Start-up DuraMon raises 1 million Swiss Francs

DuraMon AG develops the world's first sensor technology and smart analytics solution for precise and reliable monitoring of the corrosion status of reinforced and prestressed concrete. This technology enables the timely detection of deterioration in infrastructures such as bridges, tunnels and parking garages. In a seed financing round, the ETH spin-off has raised one million Swiss francs in 2023. Congratulations to the D-BAUG co-founders Dr. Yurena Seguí Femenias and Professor Ueli Angst!

➔ **Full news article**

Green change in a grey industry

ETH researchers from the Department of Civil, Environmental and Geomatic engineering are developing a low-carbon cement with a significantly lower embodied CO_2 content than traditional cement. The Ultra Green Concrete (UGC) project is led by materials' scientist Franco Zunino and aims to make low- carbon, high-performance concrete widely accessible.

➔ **Full news article**

Photo: Franco Zunino

Global warming accelerates CO_2 emissions from soil microbes

When Microorganisms decompose organic material in the soil, they actively release CO_2 into the atmosphere. This process is called heterotrophic respiration. A novel model shows that these emissions could surge by up to 40 percent by the end of the century – most significantly in the polar regions. The research collaboration was led by Professor Peter Molnar and Dr. Alon Nissan.

➔ **Full news article**

Photo: Keystone / Eye of Science:

Photo: Juergen Freund

A world in flux

Heavier rain, longer droughts, melting glaciers: climate change has a dramatic impact on the global water cycle. For example, the contribution of glacial meltwater is decreasing, and by 2100 Switzerland's glaciers may only hold 40% of their current volume. Professor Daniel Farinotti emphasises the need for accurate hydrological forecasts and the significant consequences of the melting of the polar ice sheets, which could raise sea levels by up to one metre by the end of the century, affecting millions of coastal residents.

➔ **Full news article**

A contested resource

The expansion of hydropower generation often leads to conflicts of interest, both in Switzerland and beyond. Research teams led by professors Robert Boes and Paolo Burlando are exploring ways to balance these interests. Their studies aim to harmonize energy production with conservation, influencing government policy and promoting sustainable water resource management through integrated and participatory approaches.

➔ **Full news article**

Photo: Wikimedia Commons / Mimi Abebayehu

It starts with a glance. How ETH researchers contribute to sustainable campus mobility

They come to ETH Zurich almost daily by bike or e-bike: Michael Wicki, David Zani, and Clarissa Livingston. They are transport researchers at D-BAUG involved in the "E-Bike City" project. Besides investigating how an e-bike-friendly city works, they are also committed to a safe, sustainable, and CO_2-reducing campus mobility at ETH Zurich.

➔ **Full news article**

From space to place: Against urban homogenisation

Globalisation is leading to the homogenisation of urbanized landscapes, which has a direct impact on our ability to create affective ties to place. This demonstrates the EU-funded project "GLOBESCAPE" (2018-23), led by Professor Adrienne Grêt-Regamey. Using empirical cognitive-psychological data, innovative land-use modeling methods and 3D point-cloud based cutting-edge technologies, the project has developed new tools for urban and landscape planning processes to promote inclusive, sustainable and resilient cities.

➔ **To the website of the European Research Council (ERC)**

New housing developments displace vulnerable persons

Photo: Keystone-SDA

Focusing exclusively on new housing developments to counter the housing crisis is not sustainable, says Professor David Kaufmann. His research group has been able to show that vulnerable persons are displaced to a much greater extent than previously thought in the Swiss canton of Zürich. Kaufmann therefore argues that densification, as it is currently being implemented, should be accompanied by social and environmental regulations to better support and protect vulnerable groups.

➔ **Full news article**

The strength of nature's weakest force

Gravity keeps our feet firmly on the ground and Earth in its orbit around the Sun. Meanwhile, satellites in space measure the acceleration caused by the Earth's gravitational pull. Professor Benedikt Soja analyzes data from NASA's GRACE Follow-On mission (GRACE-FO), which uses twin satellites to map Earth's gravity with unprecedented accuracy. This mission helps track changes in Earth's mass distribution, crucial for monitoring climate change effects like melting ice sheets and groundwater depletion.

➔ **Full news article**

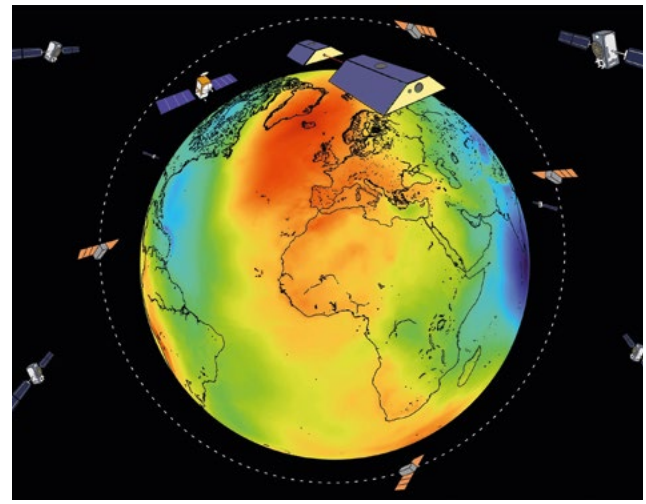


Photo: Chair of Space Geodesy

Photo: Michel Roggo

Interdisciplinary research on rivers

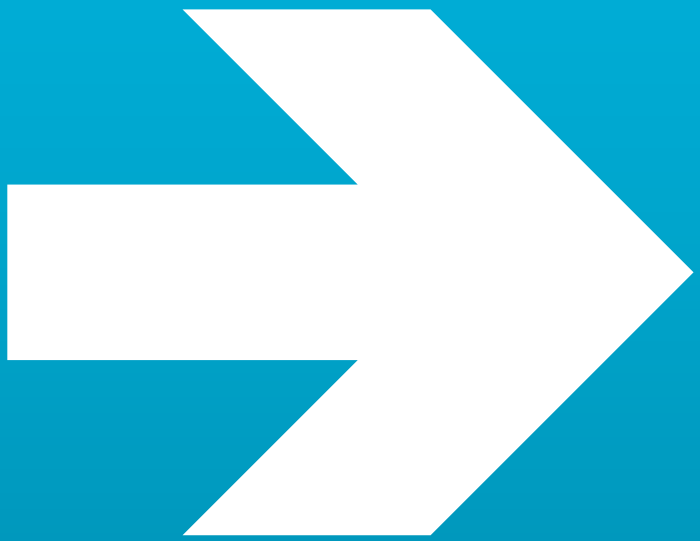
Restoration and nature conservation projects have the great potential to restore and maintain important functions of our watercourses for future generations. Researchers from four research institutes of the ETH Domain, in collaboration with the Federal Office for the Environment (FOEN), have investigated how sediment transport and connectivity affect flood safety and river ecology. They have now compiled the scientific results from the research project for a broad audience.

➔ **Full news article**

Following the water cycle in the forest

Extreme weather events are likely to become more frequent as a result of climate change. At the Forest Laboratory "Waldlabor" on Hönggerberg, researchers led by Dr. Marius Floriancic and Professor Peter Molnar are studying the effects of drought on trees. Recently, they showed that forest floor litter and deadwood store a significant proportion of annual precipitation and thus have a much greater influence on forest water balance than previously thought.

➔ **Full news article**



Facts & Figures

31 December 2023

Institutes and Professors

IBI	Institute of Construction and Infrastructure Management	→ibi.ethz.ch
Prof. Bryan T. Adey	Infrastructure Management	
Prof. Guillaume Habert	Sustainable Construction	
Prof. Catherine De Wolf (AP TT)	Circular Engineering for Architecture	

IBK	Institute of Structural Engineering	→ibk.ethz.ch
Prof. Eleni Chatzi	Structural Mechanics and Monitoring	
Prof. Walter Kaufmann	Concrete Structures and Bridge Design	
Prof. Bozidar Stojadinovic	Structural Dynamics and Earthquake Engineering	
Prof. Bruno Sudret	Risk, Safety and Uncertainty Quantification	
Prof. Andreas Taras	Steel and Composite Structures	
Prof. Michalis Vassiliou (ERC AP)	Seismic Design and Analysis	
Prof. Andrea Frangi (TP)	Timber Structures	

IfB	Institute for Building Materials	→ifb.ethz.ch
Prof. Ingo Burgert (with Empa)	Wood Materials Science	
Prof. Robert J. Flatt	Physical Chemistry of Building Materials	
Prof. Ueli Angst (SNSF AP)	Durability of Engineering Materials	
Prof. David Kammer (AP TT)	Computational Mechanics of Building Materials	
Prof. Pietro Lura (TP; only Empa)	Concrete Technology	

IfU	Institute of Environmental Engineering	→ifu.ethz.ch
Prof. Paolo Burlando	Hydrology and Water Resources Management	
Prof. Irena Hajnsek (with →DLR)	Earth Observation and Remote Sensing	
Prof. Stefanie Hellweg	Ecological Systems Design	
Prof. Max Maurer (with Eawag)	Urban Water Systems	
Prof. Eberhard Morgenroth (with Eawag)	Process Engineering in Urban Water Management	
Prof. Roman Stocker	Groundwater and Hydromechanics	
Prof. Jing Wang (with Empa)	Air Quality and Particle Technology	
Prof. Peter Molnar (TP)	Hydrology and Fluvial Systems	
Prof. Stephan Pfister (TP)	Quantitative Sustainability Assessment	
Prof. Kai Udert (TP; only Eawag)	Resource Recovery from Wastewater	

IGP	Institute of Geodesy and Photogrammetry	→igp.ethz.ch
Prof. Konrad Schindler	Photogrammetry and Remote Sensing	
Prof. Andreas Wieser	Geosensors and Engineering Geodesy	
Prof. Benedikt Soja (AP TT)	Space Geodesy	

IGT	Institute for Geotechnical Engineering	→igt.ethz.ch
Prof. Georgios Anagnostou	Underground Construction	
Prof. Ioannis Anastasopoulos	Geotechnical Engineering	
Prof. Johan Gaume (with WSL SLF Davos)	Alpine Mass Movements	
Prof. Alexander Puzrin	Geomechanics and Geosystems Engineering	

IKG	Institute of Cartography and Geoinformation	→ikg.ethz.ch
Prof. Lorenz Hurni	Cartography	
Prof. Martin Raubal	Geoinformation-Engineering	

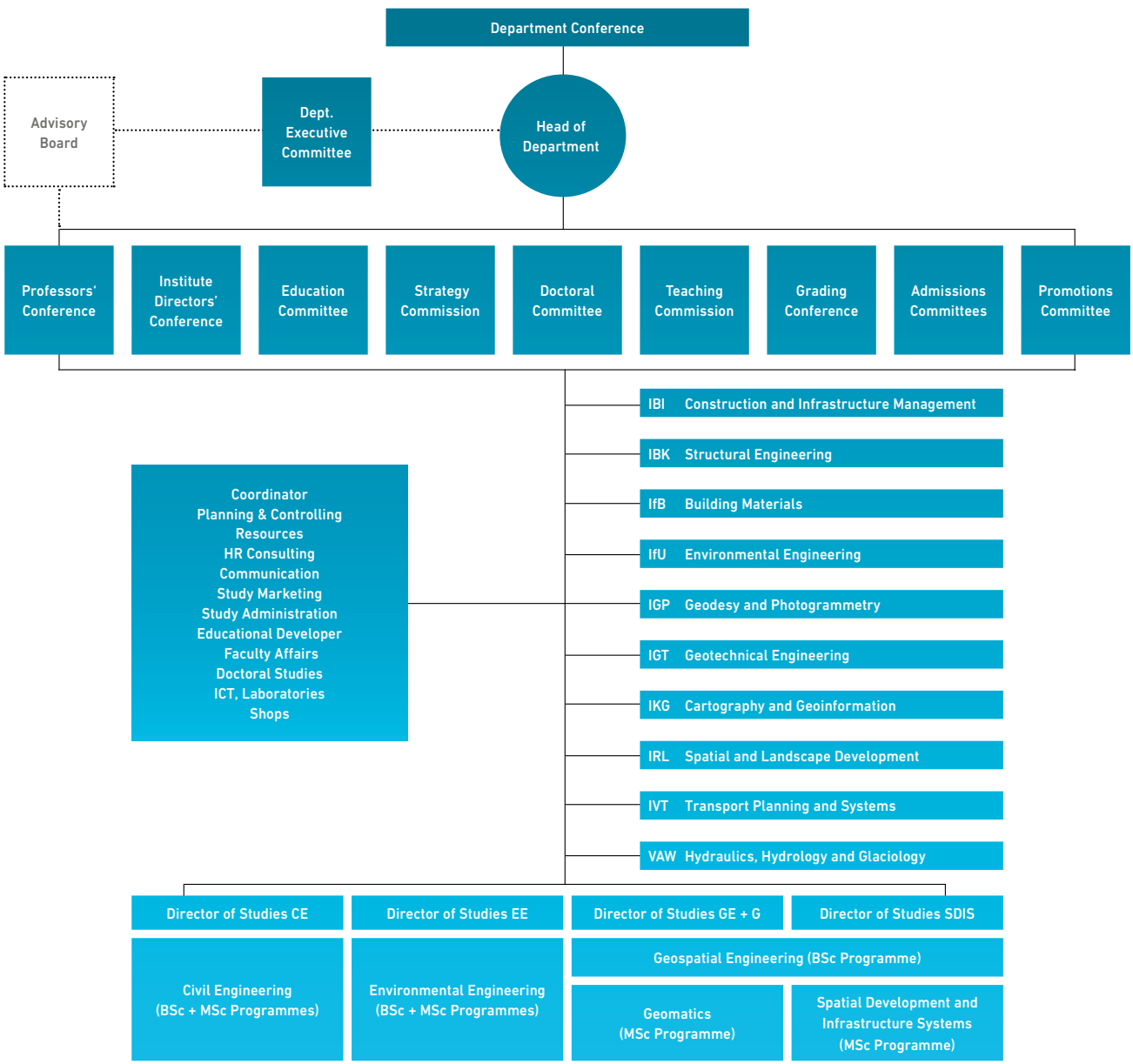
IRL	Institute for Spatial and Landscape Development	→irl.ethz.ch
Prof. Adrienne Grêt-Regamey	Planning of Landscape and Urban Systems	
Prof. David Kaufmann (AP TT)	Spatial Development and Urban Policy	

IVT	Institute of Transport Planning and Systems	→ivt.ethz.ch
Prof. Kay W. Axhausen	Transport Planning (until 31-Jan-2024)	
Prof. Francesco Corman	Transport Systems	
Prof. Ulrich Weidmann	Transport Systems – Public Transport (member of ETH board (VPIN) since Jan 2016)	

VAW	Laboratory of Hydraulics, Hydrology and Glaciology	→vaw.ethz.ch
Prof. Robert M. Boes	Hydraulic Structures	
Prof. Daniel Farinotti (with WSL)	Glaciology	
Prof. Jürg Schweizer (TP; only WSL SLF Davos)	Snow Avalanches and Prevention	

D-BAUG

Organisation chart



Established in 2013

Advisory board D-BAUG

Members as per 31 December 2023

- Dr. Burkhard Boeckem (CTO, Hexagon AB)
- Prof. Dr. Joel Conte (Structural Engineering, University of California, San Diego)
- Dominik Courtin (CEO, Basler & Hofmann AG)
- Olga Darasz (Chairman (president) of the Board of Directors, CSD Management SA)
- Dr. Matthias Haldimann (CEO, Emch+Berger Immoconsult AG)
- Dr. Peter Jäger (Managing Director, ESRI Schweiz AG)
- Prof. Dr. Antonio Krüger (Director, German Research Center for Artificial Intelligence [DFKI])
- Dr. Maria Lezzi (Director Federal Office for Spatial Development ARE, UVEK)
- Prof. Dr. Nicolas Roussel (Université Gustave Eiffel, Marne la Vallée, France / President RILEM)
- Dr. Franziska Schwarz (Vice Director, Federal Environment Office [BAFU])
- Prof. Dr. Georg Teutsch (Managing Director, Centre for Environmental Research [UFZ])

➔ **http://www.baug.ethz.ch/departement/advisory-board.html**

Faculty

Professorial appointments

Appointments and Promotions 2023

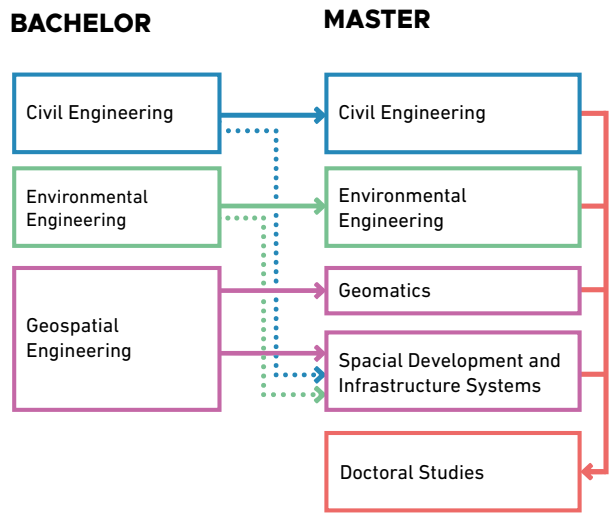
Prof. Dr. Francesco Corman	Transport Systems	1-January-2023
Prof. Dr. Stephan Pfister	Quantitative Sustainability Assessment	1-April-2023
Prof. Dr. Daniel Farinotti	Glaciology	1-August-2023
Prof. Dr. Guillaume Habert	Sustainable Construction	1-August-2023
Prof. Dr. Jing Wang	Air Quality and Particle Technology	1-August-2023

Fall semester 2023

Students at D-BAUG

Discipline	Total students*) Fall Semester 2022	2023
Civil Engineering (CE)	**832**	**798**
Civil Engineering BSc	395	352
Civil Engineering MSc	215	233
Civil Engineering (Guest/Mobility)	17	8
Doctoral Students CE	205	205
Environmental Engineering (EE)	**391**	**366**
Environmental Engineering BSc	171	160
Environmental Engineering MSc	129	110
Environmental Engineering (Guest/Mobility)	8	3
Doctoral Students EE	87	93
Geospatial Engineering (GE)	**295**	**304**
Geospatial Engineering BSc	127	125
Geomatics MSc	29	31
Geomatics (Guest/Mobility)	3	5
Spatial Development and Infrastructure Systems MSc	77	88
Doctoral Students G + SDIS	59	55

*) without MAS/DAS/CAS students; more student figures and charts: see pages 42.



→ **www.baug.ethz.ch/en/studies.html**

Expenditures, in millions of CHF

Financial means

Year	ETH Basic Funding	ETH Additional Funding	Third Party Funding[1]	Total
2017	47.8	6.6	19.7	74.1
2018	49.9	3.5	21.0	74.3
2019	47.7	4.7	22.3	74.8
2020	47.7	3.9	24.2	75.1
2021	47.1	5.5	25.5	78.1
2022	46.7	6.2	24.9	77.8
2023	**47.1**	**5.9**	**27.1**	**80.1**

[1] SNSF, Innosuisse (KTI), ERC, Industry, Federal Agencies, etc.

Total ETH- and third party funding; in FTE (as per 31-Dec)

Employees D-BAUG

Year (average FTE)	FP	AP	TP, Senior Scientists (permanent)	Senior Research Fellows (OA)	Post-docs	Doctoral Students, Assistants	Technical & ICT Staff	Administrative Staff	Apprentices	D-BAUG Total (FTE)
2019	27.3	8.5	18.5	63.8	63.8	265.9	55.7	37.2	0.7	590.6
2020	27.4	9.7	19.8	61.7	68.7	283.4	54.8	37.6	0.0	603.0
2021	26.4	9.6	20.2	58.7	80.1	293.7	55.6	40.4	0.0	619.4
2022	25.6	8.0	21.0	65.3	74.5	281.8	55.8	36.6	0.0	568.4
2023	**28.2**	**6.0**	**19.9**	**78.0**	**73.0**	**280.1**	**57.6**	**40.3**	**0.0**	**583.0**

FP = Full Professor, AP = Assistant Professor, TP = Titular Professor, OA = Senior Research Fellow [DE: Oberassistent/in]
Figures without Student Assistants, Hourly Wage Employees, Trainees, „occupied Workplaces"
FTE = Full Time Equivalent

Master of Advanced Studies (MAS), Diplomas of Advanced Studies (DAS), Certificates of Advanced Studies (CAS)

Continuing education

Category	Responsible Institute	Title
MAS ETH	IBK	Fire Safety Engineering
MAS ETH	IfU	Sustainable Water Resources
MAS ETH	IRL / NSL	Spatial Development
DAS ETH	IBI	Regenerative Materials
CAS ETH	IBI	Regenerative Materials: Essentials
CAS ETH	IBI	Regenerative Materials: Hygrothermal Specialisation
CAS ETH	IBI	Regenerative Materials: Structural Specialisation
CAS ETH	IRL / IBI	Regenerative Systems: Sustainability to Regeneration
CAS ETH	IBK	Natural Hazard Risk Management
CAS ETH	IBK	Seismic Evaluation and Retrofitting
CAS ETH	IKG	Geographic Information Systems and Analysis
CAS ETH	IRL / NSL	Spatial Development and Planning Practice
CAS ETH	IRL / NSL	Spatial Development and Process Design
CAS ETH	IRL / NSL	Future of spatial development

For all D-BAUG courses → **https://baug.ethz.ch/en/continuing-education.html**
For all ETH BSc and MSc courses (incl. D-GESS) → **vvz.ethz.ch**
For short Courses, E-learning andn MOOCs → **https://sce.ethz.ch/en/programmes-and-courses.html**

In alphabetical order

Master's Student Awards 2023

Last Name	First Name	Institute	Award / Prize (short description)
Baumann	Antonia	VAW	Culman Prize for excellent Master's thesis
Bender	Joel	IVT	Willi-Studer-Prize for the best graduate of the year
Bianchi	Davide	IBK	Willi-Studer-Prize for the best graduate of the year ETH silver Medal for excellent Master's thesis
Brunner	Johannes	IVT	ETH silver Medal for excellent Master's thesis
Brunschweiler	Eva	IGT	Gruner Geotechnik Prize for excellent Master's thesis
Buff	Carmen	IGT	Culman Prize for excellent Master's thesis
Clerc	Auélien	IBK	Culman Prize for excellent Master's thesis
Fässler	Roger	IFB	Sika-Award for excellent Master's thesis
Hänsli	Flavia	IFU	Culman Prize for excellent Master's thesis
Käslin	Simon	IGT	Culman Prize for excellent Master's thesis
Lisser	Michael	IBK	Culman Prize for excellent Master's thesis
Meierhans	Sascha	IFU	Culman Prize for excellent Master's thesis
Milliet	Alexandre	IBK	SGEB-Prize for excellent Master's thesis
Montalbetti	Gioele	IBK	Culman Prize for excellent Master's thesis
Peng	Sidi	IFU	Culman Prize for excellent Master's thesis
Pleisch	Anian	IVT	Culman Prize for excellent Master's thesis
Schütze	Till	IVT	Culman Prize for excellent Master's thesis
Siegrist	Armin	IFU	Willi-Studer-Prize for the best graduate of the year
Wittmann	Joel	IFU	ETH silver Medal for excellent Master's thesis
Yue	Yuanwen	IGP	Geosuisse Award for excellent Master's thesis
Zhu	Liyuan	IGP	Culman Prize for excellent Master's thesis

In alphabetical order

Doctoral theses 2023

NAME, First Name	Supervisor	Thesis
ANTONIOU, Maria	Prof. Dr. Ioannis ANASTASOPOULOS	Next-Generation Offshore Wind Turbine Foundations under Seismic and Environmental Dynamic Loading
ARSLANTÜRKOGLU, Safak	Prof. Dr. Bozidar STOJADINOVIC	Risk-Based Seismic Assessment of Existing Unreinforced Masonry Buildings in Switzerland
BAUMANN-OUYANG, Andreas	Prof. Dr. Andreas WIESER	Experimental Investigation of the Applicability of W-Band MIMO-SAR for Structural Health Monitoring
BISCHOF, Patrick	Prof. Dr. Walter KAUFMANN	Rethinking Structural Concrete for Digital Fabrication
BISSIG, Dominik	Prof. Dr. Andrea FRANGI	Design of a biaxial hollow core timber flat slab system
BLAGOJEVIC, Nikola	Prof. Dr. Bozidar STOJADINOVIC	A Framework for Probabilistic Resilience-based Assessment and Design of the Built Environment
BODENMANN, Lukas	Prof. Dr. Bozidar STOJADINOVIC	Data-Efficient Learning Techniques to Improve Regional Earthquake Risk Models
CAO, Jianpeng	Dr. Daniel HALL	Intelligent Configurator: seamless integration of design and manufacturing for industrialized building design optimization by graph-based algorithms and technologies
CHAUDHARY, Priyanka	Prof. Dr. Konrad SCHINDLER	Deep Learning for Urban Flood Depth Estimation
CLERC, Estelle Emilie	Prof. Dr. Roman STOCKER	Unraveling Bacterial Chemotaxis in the Ocean via in situ Microfluidics
DE LUTIO, Riccardo	Prof. Dr. Konrad SCHINDLER	Exploiting Multimodal Data in Computer Vision with Applications to Super-Resolution and Classification
DE SCHAETZEN, Frédéric	Prof. Dr. Roman STOCKER	Imaging-Based Solutions to Observe Ecological Processes at Different Length Scales
DEL GIUDICE, Lorenzo	Prof. Dr. Michalis VASSILIOU	Physical Modelling of Masonry and Reinforced Concrete Using 3D Printing
DING, Yong	Prof. Dr. Ingo BURGERT	Wood Membranes with Tailored Water Transport Ability Toward Energy-Efficient Smart Building Materials
DISSEGNA, Maria Angela	Prof. Dr. Adrienne GRÊT-REGAMEY	Evaluating the effect of vegetation in urban microclimate using remote sensing technologies
DRDOVA, Sarka	Prof. Dr. Jing WANG	Integrated photocatalytic systems for VOCs control: Innovative light-driven catalyst-embedded membrane pump, enhanced activity of spark-ablated nanoparticles, and insight into catalyst immobilization.
DU, Yi	Prof. Dr. Guillaume HABERT	A New Low Carbon Clay Based Concrete with Improved Water Resistance
DUQUE VILLARREAL, Natalia	Prof. Dr. Max MAURER	Transitions in Urban Networks: Towards Decentralised Wastewater Infrastructure
FAUST, Valentin	Prof. Dr. Kai M. UDERT	Effects of pH on Urine Nitrification: From Microbial Selection to Process Performance

NAME, First Name	Supervisor	Thesis
GALKOVSKI, Tena	Prof. Dr. Walter KAUFMANN	Distributed fibre optical sensing in structural concrete – exploring its potential to improve the mechanical modelling of bond
GEBHARD, Lukas	Prof. Dr. Walter KAUFMANN	Reinforcement strategies for digital fabrication with concrete
GRASER, Konrad	Dr. Daniel HALL	From Invention to Innovation: Socio-technical Processes in the Adoption of Digital Fabrication to Architecture, Engineering and Construction Praxis
GULIAEV, Roman	Prof. Dr. Irena HAJNSEK	Integrating Polarimetric, Interferometric and Tomographic SAR Information for Improving Forest Structure Estimates
HÄFLIGER, Severin	Prof. Dr. Walter KAUFMANN	Load-Deformation Behaviour of Reinforced Concrete Structures Affected by Local Corrosion
HETTELINGH, Roman	Prof. Dr. Alexander PUZRIN	Principles of Construction on Slow-Moving Landslides
HOELZL, Cyprien	Prof. Dr. Eleni CHATZI	On Board monitoring for railway infrastructure condition assessment
KAGHO, Grace Orowo	Prof. Dr. Kay W. AXHAUSEN	Planning for the Future of Transport with Agent-Based Modelling: The Role of On-Demand Mobility Services
KLEIN, Boaz	Prof. Dr. Alexander PUZRIN	The Dynamic Evolution of Submarine Landslides: From Propagation of Shear Bands to Catastrophic Failure of Subaqueous Slopes
KLEIN, Noëlle	Prof. Dr. Adrienne GRÊT-REGAMEY	The role of agricultural landscape structure in predicting bird and butterfly diversity
KLOTZ, Magdalena	Prof. Dr. Stefanie HELLWEG	Design and environmental impact assessment of a circular plastics material flow system
KOCH, Sophie	Prof. Dr. Ingo BURGERT	Towards Bio-Based Delignified Wood-Reinforced Composites with Aqueous Matrix Systems
KOHLER, Marc	Prof. Dr. Alexander PUZRIN	Effects of Earthquakes on the Mechanics of Active Landslides
KOMKOVA, Anastasija	Prof. Dr. Guillaume HABERT	Enabling circular economy: An evaluation framework based on alkali-activated materials – from material environmental impacts to regional integration through supply chain optimization and stakeholder perspectives
KOUREAS, Ioannis	Prof. Dr. David KAMMER	Fundamentals of failure in topologically interlocked structures
KURZ, Dorothee Luise	Prof. Dr. Roman STOCKER	Biofilms in porous media: a pore-scale investigation of the interplay between biofilm development and local hydrodynamics
LEMCHERREQ, Yasmin	Prof. Dr. Walter KAUFMANN	New Insights in Bond and Tension Stiffening of Reinforced Concrete under Monotonic and High-Cyclic Loading
LEONE, Thomas	Prof. Dr. Georgios ANAGNOSTOU	Effects of creep on the interaction between TBM, lining and rock
LI, Lingzhen	Prof. Dr. Eleni CHATZI	Bond behavior and debonding failure in Fe-SMA strengthened steel members
LUTNYK, Luis	Prof. Dr. Martin RAUBAL	Pilot Decision-Making Support through Intelligent Cockpit Technologies
MARKALE, Ishaan Hari	Prof. Dr. Roman STOCKER	Impact of Phases Saturation on Effective Reaction Kinetics in Porous Media
MARKIC, Tomislav	Prof. Dr. Walter KAUFMANN	Structural behaviour of partially loaded areas and concrete hinges
MARTIN, Henry	Prof. Dr. Martin RAUBAL	Computational Methods for Sustainable Mobility - Interpretation and Prediction of Tracking Data using Graphs and Machine Learning
MICHEL, Lucas	Prof. Dr. Ueli ANGST	Automated Local Electrochemical Characterization (ALEC) as a new investigation method to study localized corrosion of steel
MORAGA NAVARRETE, Jorge Sebastián	Prof. Dr. Paolo BURLANDO	Impacts and uncertainty of climate change on mountain hydrology and its extremes: An approach using high-resolution stochastic climate simulations

NAME, First Name	Supervisor	Thesis
MÜLLER, Andreas	Prof. Dr. Andreas TARAS	Advanced Inelastic Analysis and Design of High Strength Steel Structures with Machine-Learning-Derived Predictive Methods
PFÄNDLER, Patrick	Prof. Dr. Ueli ANGST	Corrosion diagnosis of reinforced concrete structures using autonomous robotic inspection systems and artificial intelligence
PIRES MARTINS, Natalia	Prof. Dr. Guillaume HABERT	Use of calcium sulfoaluminate binder chemistry for sustainable cement
REYNAERT, Eva	Prof. Dr. Eberhard MORGENROTH	Risk-based evaluation of the microbial water quality in on-site non-potable water reuse systems
ROMBACH, Katharina	Dr. Olga FINK, D-MTEC	Fault Diagnostics under Label and Data Scarcity
ROSSI, Yara	Prof. em. Dr. Markus ROTHACHER	Next Generation Monitoring of Strong Ground Motions and Structural Vibrations - Combining Accelerometer, GNSS and Rotation Sensors
RÜEGG, Nadine	Prof. Dr. Konrad SCHINDLER	Monocular 3D Shape and Pose Estimation for Humans and Animals
SAM, Stanley Bortse	Prof. Dr. Eberhard MORGENROTH	Solid-Liquid Separation of Faecal Sludge: Understanding the Governing Mechanisms for Improved Global Sanitation
SCHATZMANN, Thomas	Prof. Dr. Kay W. AXHAUSEN	Measuring change in behavior: Stated choice experiments in transportation
SCHNÜRER, Raimund	Prof. Dr. Lorenz HURNI	Storytelling with Animated Interactive Objects in Real-time 3D Maps
SHEHAJ, Endrit	Prof. em. Dr. Markus ROTHACHER	Space Geodetic Techniques for Retrieval of High-Resolution Atmospheric Water Vapor Fields
SIMPSON, Thomas	Prof. Dr. Eleni CHATZI	Developing Hybrid Simulation for Virtualisation
SPANNINGER, Thomas	Prof. Dr. Francesco CORMAN	Uncertainty-aware predictions of train delay in real-time
ŠTEFKO, Marcel	Prof. Dr. Irena HAJNSEK	Applications of bistatic Ku-band radar in snow-covered environments
STUCKER, Corinne	Prof. Dr. Konrad SCHINDLER	Refining Earth Observation Products with Deep Machine Learning
SWITALSKI, Michal	Prof. Dr. Adrienne GRÊT-REGAMEY	Advancing Theory of Place and Place-Making for Landscape Science Using Big Data and Machine Learning in the Urban-Rural Gradient
TAO, Yile	Prof. Dr. Jing WANG	Detection of nucleic acids as the biomarkers of hazardous agents in Bioaerosols
TIAN, Yuan	Dr. Olga FINK, D-MTEC	Prescriptive Maintenance and Operation with Deep Reinforcement Learning
TÜRKOGLU, Mehmet Özgür	Prof. Dr. Konrad SCHINDLER	Deep learning for vegetation classification from optical satellite image time series
VAN EDE, Meeke Carline	Prof. Dr. Ueli ANGST	Electrochemical tomography - a new NDT technique to detect and quantify localized corrosion in porous media
VETTORI, Silvia	Prof. Dr. Eleni CHATZI	Development of Virtual Sensing Techniques for Dynamic Virtualization
WYDLER, Jonas	Prof. Dr. Andrea FRANGI	Stress-Based Failure Model for Dowelled Steel-to-Timber Connections under Eccentric Loading
XIANG, Binbin	Prof. Dr. Konrad SCHINDLER	Instance Segmentation of Point Clouds: from City Roads to Forest
XU, Weiqing	Prof. Dr. Robert J. FLATT	Sweet answers to the decades-long debates on the sucrose retardation
ZHAO, Yibo	Prof. Dr. Jing WANG	Development and Evaluation of Sampling and Electrochemical Detection Techniques for Airborne Soluble Metals

31 December 2023

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31 December 2023; in alphabetical order

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Educational Developer

Dr. Darcy Molnar
Gender & Diversity D-BAUG Programme Coordinator (IfU)

ClimatePartner project supported

Forest protection, Cujubim, Brazil

This REDD+ project is located in the State of Rondônia, Brazil. The project's 72,843 hectares area acts as a guardian of the rich biodiversity of the region, also serving as an ecological corridor between the local conservation areas.

Training local stakeholders how to manage forests sustainably

The aim is to improve the quality of life, offering social empowerment by training farmers in sustainable farming practices and forest management. There are some important biodiversity conservation goals, including the maintenance of forest coverage and the protection of several wildlife species.

It's been recognized by the Food and Agricultural Organization of the United Nations as being an exemplary case of sustainable forest management in Latin America and the Caribbean (2010) and is certified by the Forest Stewardship Council (FSC), as a world reference in sustainable timber production. By preventing unplanned deforestation, about 7,457,910 tonnes of CO_2 emissions will be avoided during the project lifetime (30 years).

One of the prize-winning photos in the SNSF Scientific Image Competition 2024: "Follow the water" by Leo Hösli (MSc Student D-BAUG). The image shows a tracer experiment near the Findel glacier in Valais.

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Feedback or queries can be directed to ➔**Iris Mickein, D-BAUG Communications.**

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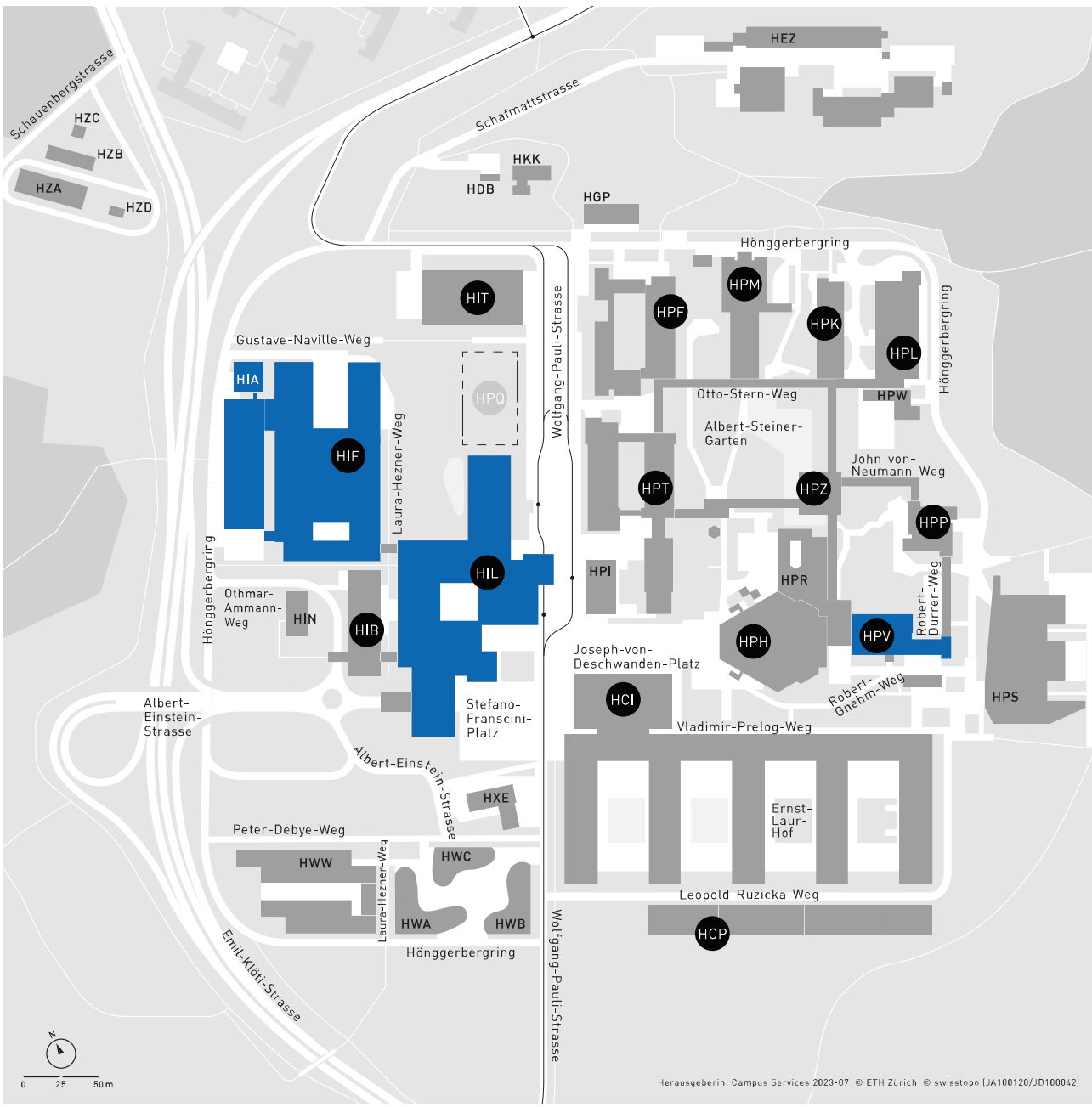

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