Eawag
Swiss Federal Institute of Aquatic Science and Technology

Annual Report 2021

eawag
aquatic research

Tobias Ryser, Eawag

Science that matters

Contents

Cover photo and opposite page In collaboration with the Federal Office for the Environment and scientists at the University of Zurich, members of Eawag's Surface Waters Research & Management department have surveyed all the glacial lakes that have developed in the Swiss Alps over the past 170 years or so, recording various indicators: Remote Sensing Group Leader Daniel Odermatt (right), Pascal Rünzi (centre) and Michael Plüss. For more information see p. 13.

Aldo Todaro Servizi

Eawag

Eawag's research activities focus on how to ensure a balance between humanity's use of water resources and the preservation of resilient aquatic ecosystems. Eawag offers 40 professors and lecturers and over 300 scientists a unique environment for pursuing research to generate new scientific findings and develop solutions for fundamental societal challenges. Here, an important role is played by an interdisciplinary approach and knowledge transfer with authorities and stakeholders from business and society. The 5,000-plus teaching hours at Swiss higher education institutions and the supervision of over 140 bachelor's and master's theses and 143 doctoral theses per year make an important contribution to the education of young professionals for the Swiss water sector.

Photo opposite Forum Chriesbach, constructed by Eawag in 2006, is a highly energy-efficient building, noted for its pioneering approach to water management and sustainability. It is set in largely natural surroundings, with the Chriesbach river forming an integral part of the campus.

Moving forward with change – despite uncertainty.

Eawag

As researchers, we accept the need to deal with uncertainty. We recognise that science is always imperfect, and that, as our understanding evolves, we should adapt our decisions and plans. In early March 2020, Eawag instituted a volunteer programme to disinfect surfaces, such as doorknobs and banisters, in our buildings. Now we realise that such "high-touch" surfaces carry low viral loads of SARS-CoV-2 and are unlikely to lead to infection with Covid-19 (p. 8). Although the earlier decision may not have protected our health, it was made with the best available knowledge at the time. Eawag promotes evidence-based decision-making, but we recognise that some decisions must be made even as the evidence base is being developed.

Our capacity to acquire data is expanding rapidly, as is the resolution – in both space and time – of the data we collect. The abundance of data – e.g. plankton images from an underwater camera (p. 12), noble gas concentrations in groundwater (p. 15), fish genetics (p. 16) or chemical concentrations from a mobile mass spectrometer (p. 17) – poses huge challenges for data management and interpretation. Machine learning methods (p. 12) help to meet the challenge of transforming data into usable information. Through Eawag's platforms for open research data (ERIC) and open access to publications (DORA), we support the principle of making research results freely accessible (p. 9).

Some of our research is documenting changes. Tracking the formation of new lakes in the Swiss Alps shows a rapid increase in lake formation between 2006 and 2016 (p. 13). These new lakes offer opportunities for hydropower but also pose flood risks. The changes in lake formation are themselves a sign of global climate change. Change occurs not only in natural systems, but also in social systems. A new methodological framework illustrates the level of support for established and novel technologies among wastewater professionals and experts (p. 18); over the past 25 years, the acceptance of modular wastewater treatment systems has increased substantially. Change also occurs in how scientific work is conducted; citizen science plays an increasing role and was instrumental in identifying a new amphipod species (p. 14).

Eawag itself is constantly undergoing change, with the natural turnover in our staff. All of these changes challenge us to seek out the new opportunities that change brings, and to deal appropriately with uncertainty as we move forward.

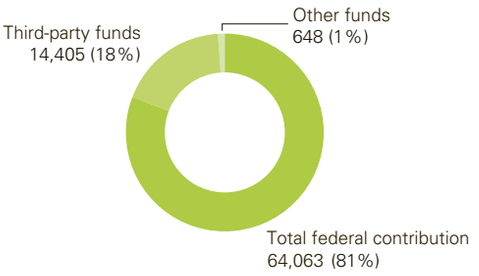
Janet Hering
Eawag Director

Eawag in figures

Finances

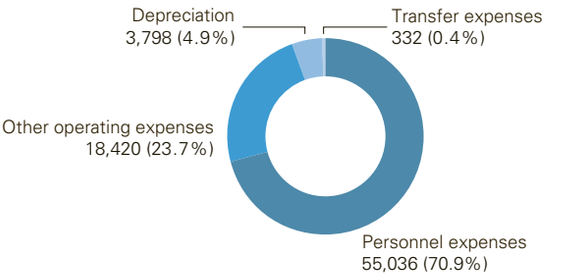
Operating revenue (CHF thousand)

79,116



Operating expenses (CHF thousand)

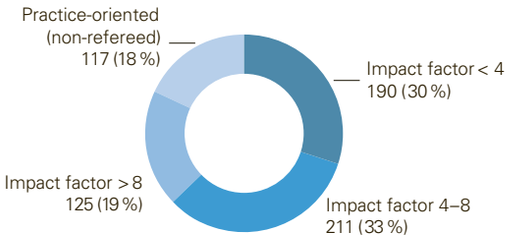
77,586



Research

Publications

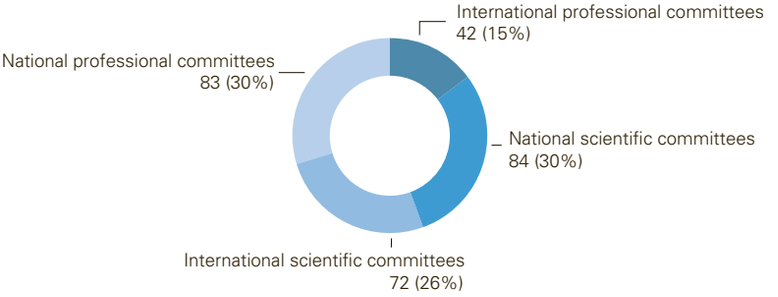
643



The higher the impact factor of a scientific journal, the greater its impact.

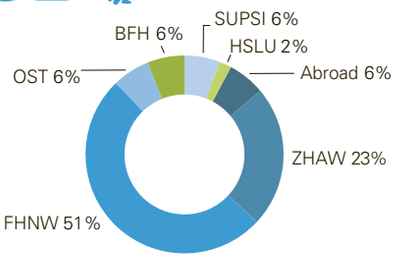
Committee memberships

281



Joint activities with universities of applied sciences

51

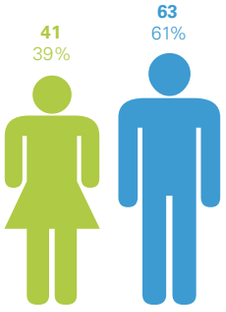


Due to rounding, individual figures may not sum to the totals shown.

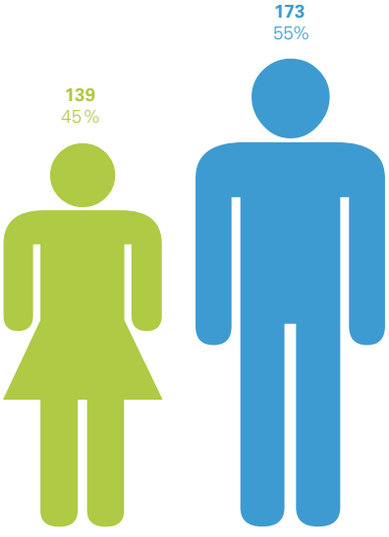
Personnel

Employees by function

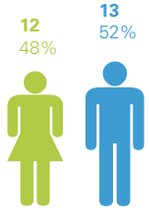
517 49 % 51 %



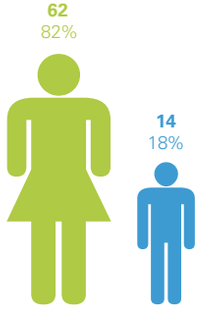
Technical 104



Science 312



Apprentices 25



Administration 76

Annual financial statements
View online

Spotlight

Andri Bryner, Eawag

Low risk of infection from contaminated surfaces: "High-touch" surfaces such as door handles, bin lids, ATM keypads or buttons at pedestrian crossings may be contaminated with the coronavirus. Genetic material from the Covid-19 pathogen was found in 29 (approx. eight per cent) of 348 surface samples collected by researchers. However, the concentrations were so low that transmission via this route is believed to be unlikely.

ETH Library

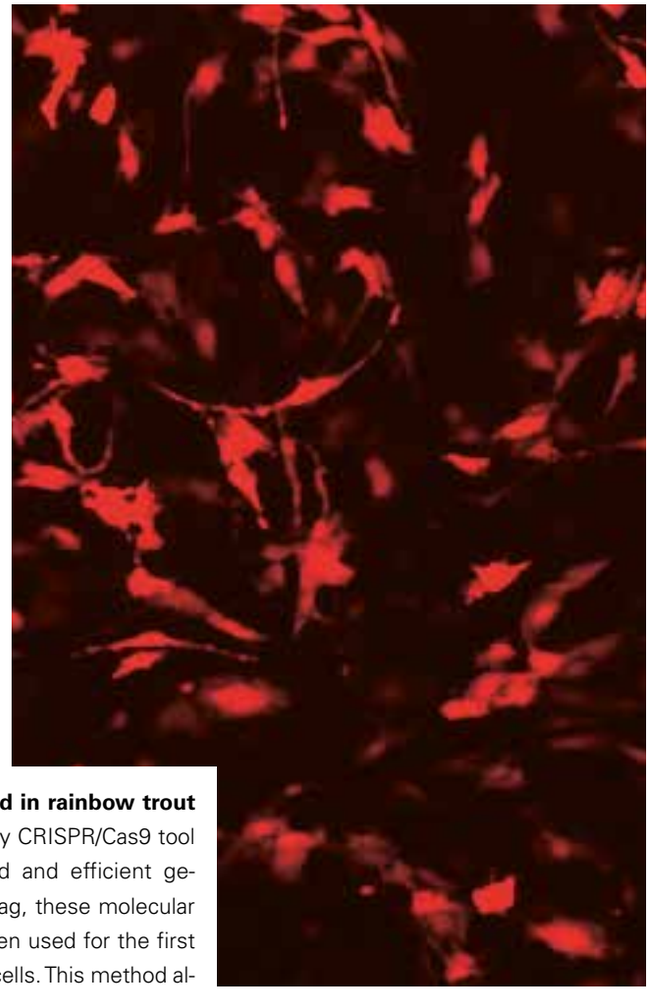
History of Swiss water protection: With around 200 pictures and texts, an online "Water Timeline" – developed by Eawag scientists – documents 200 years of the eventful history of water protection in Switzerland. The aim is to show professionals, government agencies, educational institutions and the public how a transition can be effected towards more sustainable management of natural resources.

Water Timeline
View online

New multifunctional building: After two years' construction work, the FLUX building at Eawag's Dübendorf site was completed in spring 2021. This new building provides spaces for offices and tertiary education, as well as housing special laboratories such as the training labs for vocational training courses. It also accommodates the Ecotox Centre. New systems, including decentralised filter fan units for laboratory ventilation, will ensure significant energy savings. The building is certified according to the Minergie ECO standard.

Shutterstock

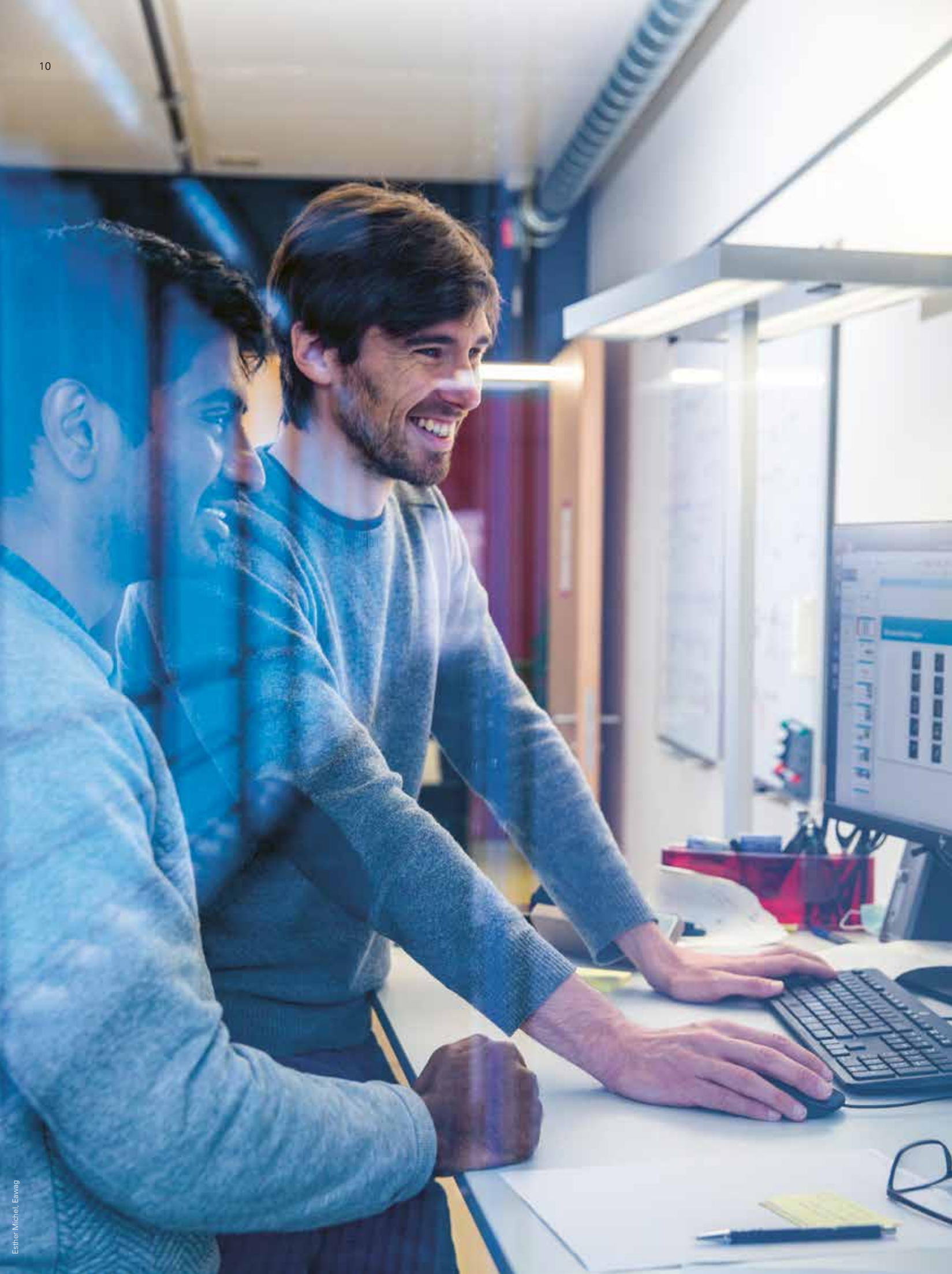
Open access to research findings: Eawag supports the principle of open science, with the results of research being made freely accessible. Accordingly, it operates two platforms designed to strengthen cooperation both within the research community and with external actors (e.g. government and industry) – DORA for scientific publications and ERIC for measurement data, images or software.



Marina Zoppo, Eawag

Genetic scissors used in rainbow trout cells: The revolutionary CRISPR/Cas9 tool permits precise, rapid and efficient genome editing. At Eawag, these molecular scissors have now been used for the first time in rainbow trout cells. This method allows scientists to culture cells for use in ecotoxicity studies, as an alternative to experiments on live animals.

Alessandro Della Bella, Eawag



Esther Michel, Eawag

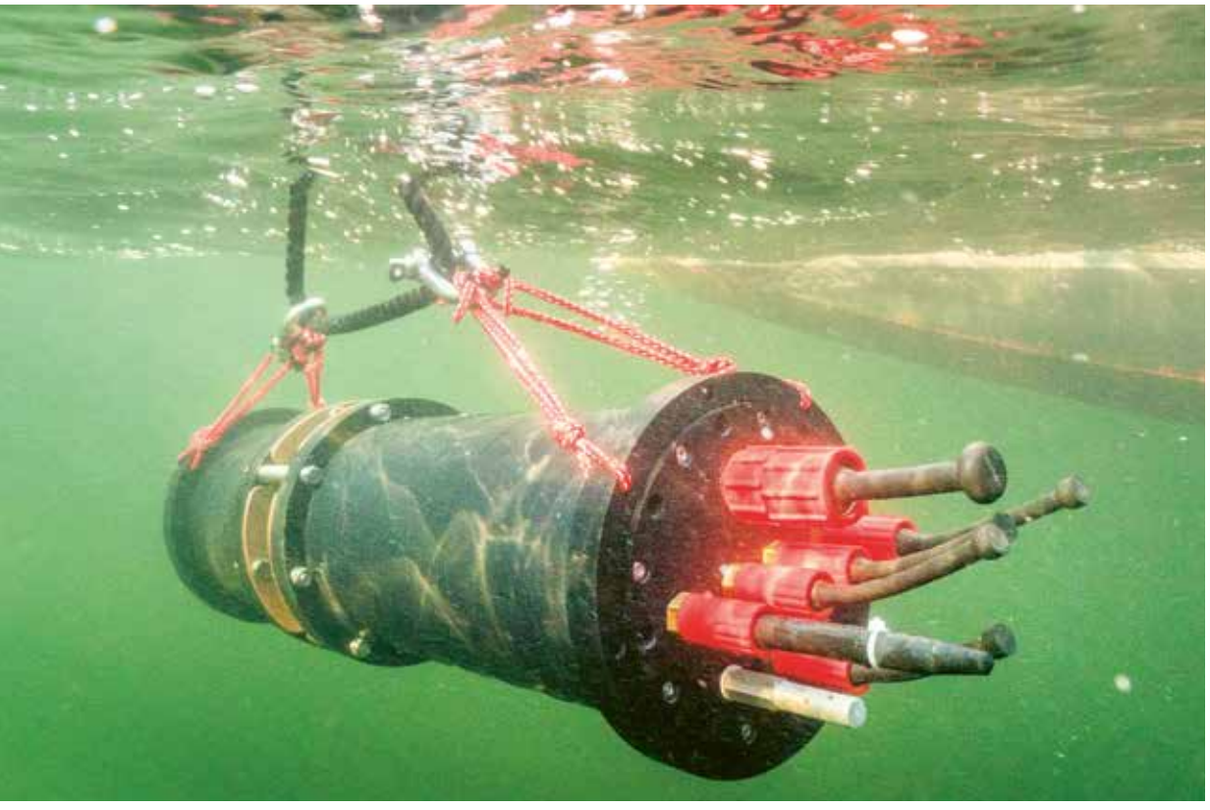
Research

Practical issues and societal challenges are central to Eawag's research, which focuses on water for human welfare and ecosystem function, as well as strategies for resolving resource-use conflicts. Eawag researchers pursue a systems approach, seeking a holistic understanding of processes and relationships. These efforts are supported by transdisciplinary collaboration in national and international research networks, as well as contacts with water professionals and authorities.

Photo opposite "Our goal is to be able to correctly identify as many plankton species as possible in a short period of time," says physicist Marco Baity-Jesi (right), a group leader in the Systems Analysis, Integrated Assessment and Modelling department. For this purpose, researchers led by Baity-Jesi and Sreenath Kyathanahally (left) are using machine learning methods. For more information see p. 12.

Using machine learning to monitor plankton communities

Reliable automatic classification of microscopic organisms detected in Swiss lakes is now possible thanks to machine learning methods. In the future, these systems should help, for example, to forecast toxic blooms of cyanobacteria.



Jonas Steiner, Eawag

Photo The underwater camera Aquascope records a wide variety of plankton species in Lake Greifen.

With the aid of specially designed underwater cameras, Eawag scientists are studying the diversity of microscopic organisms in Lakes Greifen and Hallwil. "We observe plankton communities in their natural environment – without interfering with interactions between different species," says Francesco Pomati, the leader of Eawag's Aquascope project, in which several thousand photos per day are provided by an underwater camera combined with a microscope.

Highly accurate and no signs of fatigue

Previously, human experts looking at these images managed to identify all the organisms on perhaps a few dozen photos each day. But now, algorithms developed by Group Leader Marco Baity-Jesi and his team in the Systems Analysis, Integrated Assessment and Modelling department allow classification to be performed automatically by a machine, which can identify about a million plankton per day – with a high level of accuracy and no signs of fatigue. The team's deep learning models were first exposed to training examples, i.e. thousands of photos in which all the plankton species that appeared had been identified by experts. With each labelled example, the models progressively learned to recognise relevant features and patterns, thus refining their capacity to classify plankton species.

Diverse applications in aquatic research

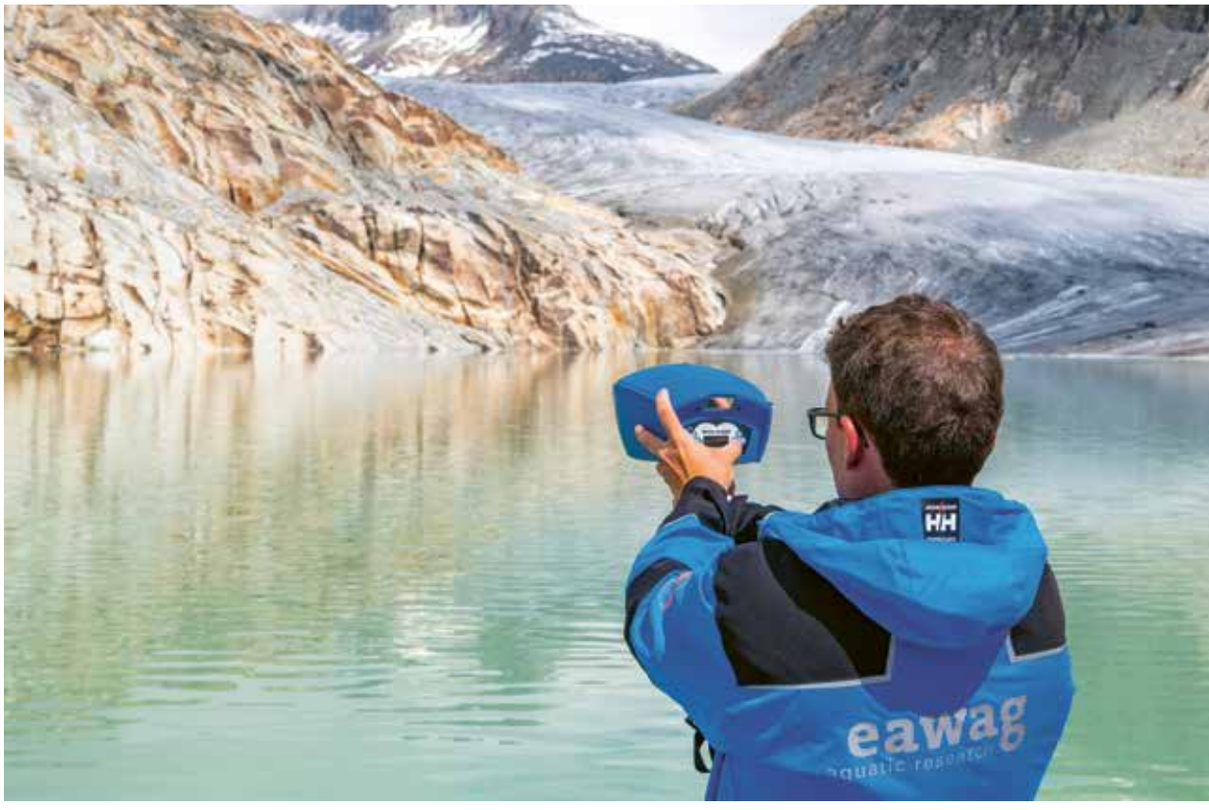
"We've now achieved 98 per cent accuracy," says Baity-Jesi. In the Aquascope project, machine learning is currently being used to help understand plankton growth dynamics, with forecasting of toxic cyanobacterial blooms being just one potential future application. Machine learning methods are also increasingly being applied in other areas of aquatic research. For example, they are being used to improve flood forecasting or to determine the effects of chemical substances on fish cells.

Aquascope project website

Images of plankton

1,200 new glacial lakes formed

As a result of climate change, Alpine glaciers are melting, thus creating profound changes in Switzerland's mountain lake landscape. This was shown by a newly compiled, comprehensive inventory of Swiss glacial lakes.



Tobias Ryser, Eawag

Photo This lake below the Rhône Glacier arose as a result of climate change.

As massive glacier ice fields retreat, they often leave behind depressions and natural dams in the exposed landscape. The basins may then be filled with meltwater, forming new glacial lakes. Since the end of the Little Ice Age around 1850, this process has led to the formation of 1,200 new lakes in the Swiss Alps. Almost 1,000 of these lakes still exist today, as shown by a new, comprehensive inventory of glacial lakes in Switzerland.

Comprehensive inventory

"We were surprised by the sheer number," says Daniel Odermatt, leader of Eawag's Remote Sensing research group. In collaboration with scientists at the University of Zurich and the Federal Office for the Environment, his team analysed data ranging from measurements made by naturalists in the mid-19th century to high-quality aerial photographs from Swisstopo. They were thus able to determine the location, elevation, outline and area of each new lake at seven points in time between 1850 and 2016. As a result of sediment transport, a quarter of the new lakes have shrunk or even disappeared altogether. In some cases, outbursts have occurred or lakes have been artificially drained.

Clear evidence of climate change

Between 2006 and 2016, however, a marked increase was seen in the rate of lake formation. On average, 18 new lakes arose each year, with annual growth of over 150,000 square metres in the total water surface area – clear evidence of climate change in the Alps. On the one hand, the new lakes pose a risk of sudden outbursts and dangerous floods. On the other hand, they are attractive for tourists – and offer new opportunities for the hydropower sector. Indeed, on the basis of these findings, a postulate was submitted to the Federal Council in August 2021, calling for an assessment of the hydropower potential of glacial meltwater and the measures required to exploit the potential of glacial lakes.

Photo An amphipod of the *Niphargus* genus.

Teo Delić

Aquatic life underground

In terms of biodiversity, groundwater is largely uncharted territory. In a pilot study, Eawag scientists have now documented the diversity of life in Swiss groundwater, discovering previously unknown species of amphipods in the process.

According to biologists Roman Alther and Florian Altermatt (Group Leader at Eawag and Associate Professor at the University of Zurich), "Knowledge of the diversity of subterranean organisms is still fragmentary, even in a country like Switzerland where the fauna is relatively well researched." Together with colleagues at the University of Ljubljana and with the assistance of well managers in Switzerland, these two researchers have laid the foundations for a nationwide survey.

Newly described: the Aare groundwater amphipod

Groundwater samples collected at 313 sites in the cantons of Aargau, Basel-Landschaft, Solothurn and Zurich revealed a diverse range of undocumented aquatic fauna, including eight different species of minute (one- to ten-millimetre) amphipods of the genus *Niphargus,* two of which had not previously been reported in Switzerland. In addition, one new species has now been formally described – the Aare groundwater amphipod *(Niphargus arolaensis).* In the sampling process, a key role was played by well managers acting as citizen scientists: filter bags attached by the managers to groundwater draining pipes were used to collect all the material washed in from the aquifer to the well over a one-week period. Any organisms observed were then transferred to ethanol-filled tubes and sent to Eawag. "The well managers' interest and willingness to help was fantastic," says Alther.

Successful citizen science approach

The citizen science approach will also be pursued when the project is expanded: over the next few years, additional data is to be collected from several hundred wells across Switzerland. The aim is to use the occurrence of amphipods as a possible bioindicator of groundwater quality. To date, bioindicators have only been employed in the monitoring of surface water quality.

Amphipods
More on the project

Noble gas analysis sheds light on groundwater flows

A recently developed method can provide a better understanding of groundwater. Tests carried out in Emmental showed that a large proportion of the groundwater comes from the River Emme – and that travel times within the aquifer are much shorter than previously assumed.

Switzerland's aquifers store around 150 billion cubic metres of groundwater. These vast water resources are of immense social, economic and natural value. For example, groundwater accounts for roughly 80 per cent of our drinking water. Hydrologist Andrea Popp says, "If we want to ensure secure water supplies, we need to understand how surface water and groundwater mix, and how quickly water travels through aquifers."

Andrea Popp, Eawag

Photo Fieldwork in the streambed of the Emme at Aeschau.

Like a bathtub filled with gravel

For her doctoral thesis at Eawag and ETH Zurich, Andrea Popp developed a new approach to improve our understanding of groundwater: together with Rolf Kipfer, Group Leader at Eawag and Adjunct Professor at ETH Zurich, and other scientists, she conducted in-situ measurements of dissolved noble gases, using a portable mass spectrometer. The results of this analysis were combined with modelling to track groundwater flows through the aquifer.

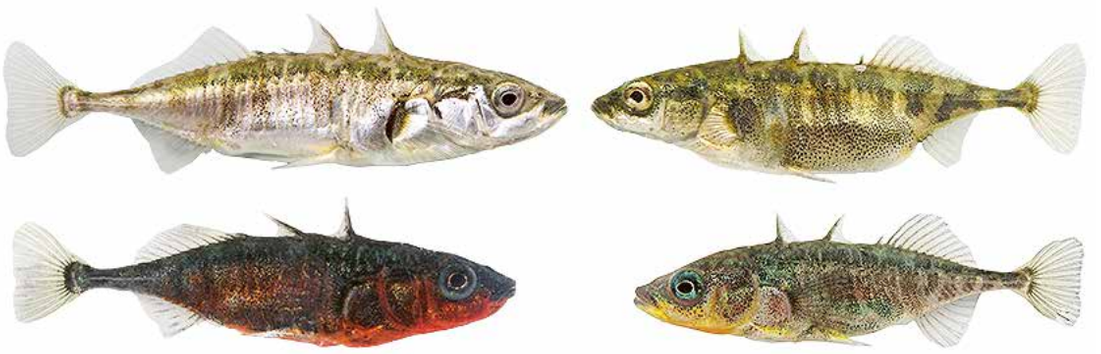
In the Emmental case study, the new method showed that around 70 per cent of the groundwater infiltrates from the Emme river – and that the water travels relatively quickly underground. "We can think of Emmental as a bathtub largely filled with sandy gravel," says Popp. This explains the travel times of just 7 to 14 days.

Identifying risks to water supplies

These results are important not least in the context of climate change, as the Emme's annual discharge declined by 20 per cent between 1999 and 2018 – and is likely to decrease further in coming decades. Popp concludes, "Our approach can highlight the risks and vulnerabilities of drinking water supplies, thus helping to improve water resource management."

Unique genetic diversity of invasive sticklebacks

In Switzerland, sticklebacks are found in many streams and in most of the large lakes, but they have only become invasive – also colonising new habitats – in Lake Constance. An Eawag study suggests that this can be explained by contacts between three different stickleback lineages in this lake.



David Marques, Eawag

Photo Lake (left) and stream ecotypes of threespine stickleback in Lake Constance differ in numerous traits, such as body size, colouration of females (top) and nuptial colouration of males (bottom).

In Lake Geneva, stickleback populations exploded during the period of eutrophication. Today, however, thanks to the construction of wastewater treatment plants, sticklebacks – as in the lakes on the foothills of the Jura Mountains – live relatively inconspicuously in the littoral zone and in some tributaries. Only in Lake Constance are populations of these fish found not only along the shoreline, but also in the open water, recently at depths of up to 47 metres. Over the last decade, they have become invasive, as shown by the large numbers of these small spiny fish caught as by-catch in the nets of professional fishers since 2013.

These colourful creatures are the descendants of aquarium fish, which were frequently released into Swiss lakes in the nineteenth century, often deriving from originally widely separated populations. Thus, while sticklebacks in the lakes of French-speaking Switzerland originate mainly from the Rhône, those found in Lake Constance exhibit a unique diversity, as was revealed by genetic analyses of 1,600 specimens carried out by a team led by Eawag Group Leader Blake Matthews and Ole Seehausen, Head of Eawag's Fish Ecology & Evolution department and Professor at the University of Bern. The genetic material of Lake Constance sticklebacks derives from the Rhine, from the Rhône and – unlike elsewhere in Switzerland – predominantly from a Baltic lineage.

Well-armoured fish

In contrast to other freshwater sticklebacks, those from the eastern European lineage have lost neither their bony lateral plates nor their long spines, which means that, in open waters, they are better protected against the numerous predatory fish and piscivorous birds. These large, well-armoured lake sticklebacks also prey on nutrient-rich zooplankton, as was shown by analysis of the stomach contents of 253 individuals.

In contrast, the smaller stream and littoral sticklebacks mainly feed on insect larvae, which, though less nutrient-rich, are a reliable food source. Evidently, the Lake Constance sticklebacks utilise their unique gene pool for adaptations to a wide variety of habitat types. Indeed, the biologists have already observed genetic fixation of various specialisations – the beginnings of the development of new species.

The department of Fish Ecology & Evolution at Eawag and the University of Bern have been studying sticklebacks in Lake Constance since 2005. The most recent study was co-financed by the "See-Wandel" (lake transformation) project. This interdisciplinary project – involving seven research institutes from Germany, Austria, Liechtenstein and Switzerland – is investigating the impacts of the decline in nutrients, climate change and non-native species on the Lake Constance ecosystem.

Photo As well as a mass spectrometer (the core element), the mobile water lab houses a sampling and filtration unit, a liquid chromatography system and a computer for data analysis and transmission.

Aldo Todaro/Eawag

Pesticides: real-time data providing a basis for action

The mobile measurement system MS²field can provide data on concentrations of chemical substances in water practically in real time. These datasets reflect the risks to which aquatic organisms are actually exposed and improve our understanding of the processes occurring when, for example, pesticides end up in waterbodies. They thus provide a basis for measures aimed at reducing such contamination.

Sensors deployed in a stream can directly supply real-time data on physical parameters such as water levels or temperature for evaluation by authorities or researchers. This is much more difficult in the case of chemicals, such as pesticides: for this purpose, composite samples have to be collected and transported to a laboratory for analysis. In recent years, an automatic measurement platform has therefore been developed by an interdisciplinary Eawag team. The mobile water lab, installed in a trailer, is known as "MS²field," with "MS" referring to the integrated mass spectrometer, and the suffix indicating the scope for flexible use in the field (e.g. at a wastewater treatment plant or waterbody).

Acute toxic peaks

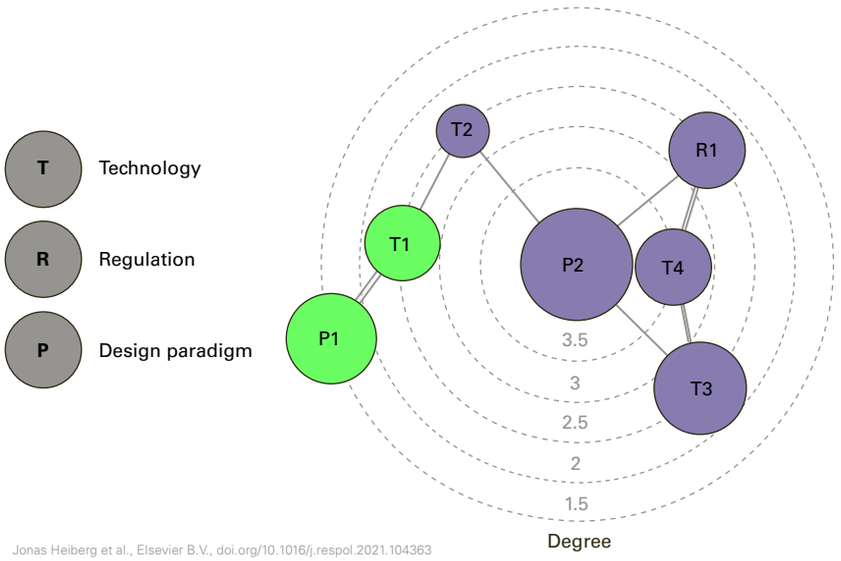
The system has already produced uncomfortable data: in one project, samples collected from a small stream every 20 minutes over a 40-day period were analysed for 60 substances. The results indicate the extent to which short-term peak concentrations are underestimated by conventional sampling methods: in some cases, legally specified quality standards for individual substances were exceeded by a factor of up to 32. Christian Stamm of the Environmental Chemistry department says, "There is no doubt this has adverse effects on certain aquatic organisms. And if peak concentrations occur repeatedly, a second or third wave can have an even greater impact, as the organisms won't have had time to recover."

Specific measures based on process understanding

Stamm also emphasises another point: "If, as well as data at high temporal resolution, we have detailed knowledge of the catchment, weather conditions and the agents used, then we can understand what processes occur and by what routes substances enter surface waters. That's a prerequisite for efficient control measures." And such measures are urgently required: in 2021, a 50 per cent reduction by 2027 in the risks of pesticide use was adopted as a binding legal target by the Swiss Parliament.

Better understanding of innovation dynamics

25 years ago, urine-diverting toilets were no more than an idea, challenging the central paradigm of wastewater treatment plants. Since then, however, modular water technologies have become increasingly important. Using a new method, scientists at Eawag have mapped the dynamics of this transition.



Jonas Heiberg et al., Elsevier B.V., doi.org/10.1016/j.respol.2021.104363

Figure Represented in this network are the concepts of technology (T), regulation (R) and design paradigm (P) associated with wastewater treatment plants (violet) and with urine source separation (green). Located at the centre are established technologies, while new technologies are more peripheral. The larger a node is, the more actors support the concept concerned.

"For a long time, the collection of wastewater at treatment plants was the central paradigm for urban water management in Switzerland, even though the sewer system accounts for 80 per cent of the total costs, with only a fifth of the money actually being spent on treating wastewater," says Bernhard Truffer, Head of Eawag's Environmental Social Sciences department and Professor at the University of Utrecht. "The assumption that this is the best solution is increasingly being called into question."

Visualising links among concepts

Of growing importance as a possible alternative are what are known as modular water technologies. In Switzerland, 25 years ago, an initial publication by Eawag researchers on urine-diverting toilets helped to launch a sector in which, today, important roles are played not only by a number of start-ups but also by international actors such as the Bill & Melinda Gates Foundation.

This shift has now been mapped by Jonas Heiberg, Christian Binz and Professor Bernhard Truffer on the basis of interviews with experts, using a new methodological framework developed by the research team: while "socio-technical configuration analysis" may sound as complicated as the graphs of interconnected circles at first glance appear, these networks essentially visualise which actors support similar concepts – and the ties that link them.

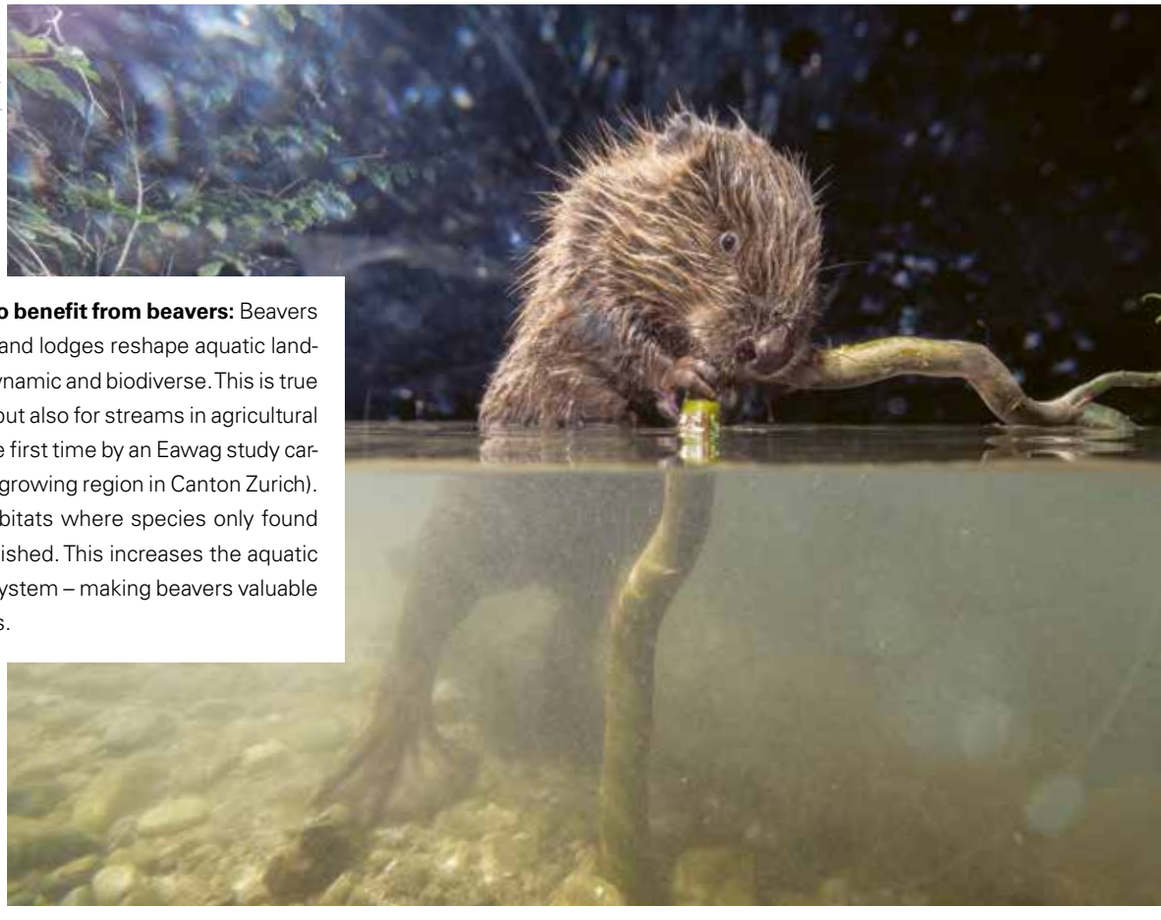
Mediating between opposing camps

"Environment-oriented actors find urine source separation attractive, as it is compatible with low-tech processes such as the composting of faecal sludge," Truffer's team reports. "But the BMGF – due to a corporate culture based on software development – has always favoured high-tech solutions." It was only when water experts collaborated with a design team – and proposed a significantly improved toilet design which is also compatible with high-tech treatment – that the BMGF recognised the commercial potential of urine source separation. "This dual orientation made it possible for the experts to mediate increasingly between the opposing camps."

News in brief

Markus Holzner

Finding mates in turbulent conditions: Because copepods – a species of zooplankton – are poor swimmers, it was always assumed that they would have to seek out calmer waters (e.g. deeper layers of a lake) for reproduction. But it has now been shown that these minute crustaceans can mate successfully even in turbulent conditions. Markus Holzner, whose team at Eawag and WSL used high-speed cameras to record the motion of copepods in a water tank, explains, "Males can differentiate between the hydrodynamic signal generated by a conspecific and the background noise caused by turbulence – and move actively towards a nearby organism."



benny337/Shutterstock

Streams in agricultural areas also benefit from beavers: Beavers are master builders, whose dams and lodges reshape aquatic landscapes, thus making them more dynamic and biodiverse. This is true not only for natural watercourses, but also for streams in agricultural areas, as was demonstrated for the first time by an Eawag study carried out in Zürcher Weinland (wine-growing region in Canton Zurich). Beaver ponds give rise to new habitats where species only found in calm waters can become established. This increases the aquatic biodiversity of the overall stream system – making beavers valuable partners for enhancement projects.

Peter Penicka, Eawag

Teaching

Eawag's teaching activities extend beyond the ETH Domain and are based on the institute's own research. They cover specialised fields, considering the effects of various types of water use on ecosystems. As well as supervising undergraduates and doctoral students, Eawag scientists make a valuable contribution to practice-oriented training at higher education institutions. Eawag is also committed to providing continuing education for water professionals, as well as vocational education and training.

Photo opposite Since 2020, the outcome evaluation for river restoration projects has been based on procedures and methods standardised at the national level. In PEAK courses run by Christine Weber (left) and Lucie Sprecher (not in the picture), practitioners are introduced to the new system, which they then learn how to implement. The picture shows Christine Weber and Nathalie Friese doing field work in the context of a research project.

Our apprentices: tomorrow's skilled workers

Eawag has been involved in vocational training for many years. In 2021, nine young people successfully completed their apprenticeship, and another eight began their training in August. In its programme for trainee laboratory technicians, Eawag collaborates closely with external partners such as Bachema, Biotronik, Coca-Cola, Niutec and Labor Veritas.

Peter Penicka, Eawag

Mohammad Reza Rezaii: Laboratory technician EFZ specialising in chemistry, third-year trainee

Mohammad Reza Rezaii uses various analytical methods to determine the chemical composition of water samples. "I find methods such as mass spectrometry fascinating," he says. Understanding the theoretical foundations of these measurement techniques is a particular challenge: "I just keep at it until I've understood, and otherwise there are always people at Eawag who are prepared to help." When he has qualified, he'd like to train as a chemist, but he could also imagine working in the medical field.

Peter Penicka, Eawag

Lara Widmer: Laboratory technician EFZ specialising in biology, third-year trainee

"At Eawag's Info Day, I did a guided tour and got an impression of the practical work; then, during my taster days, I was attracted by the relaxed and friendly atmosphere here," says Lara. Now in her third year of training, she is carrying out toxicity tests on fish cells and studying the effects of various substances on organisms. "What I also appreciate about the training is the educational support – help is available if you need it," she says. She doesn't yet have any precise plans for the future, but she knows she would like to continue working as a lab technician.

Peter Penicka, Eawag

Shannon Urech: Business administrator EFZ, third-year trainee

For a KV trainee focusing on administration and services, adaptability is essential, as you switch to a new department every six months. Shannon found this both challenging and rewarding: "At Eawag, you're a real all-rounder – covering everything from event organisation to finance and personnel administration." She likes the fact that, despite the large number of people working here, everything is very personal. When she qualifies, she hopes to train as a nursery and primary school teacher.

Peter Penicka, Eawag

David Erni: ICT specialist EFZ, second-year trainee

"In 2020, Eawag was one of the few employers offering training for ICT specialists in German-speaking Switzerland," David reports. What he particularly enjoys at Eawag are his contacts with lots of different people: "Every day, you meet new people and have new problems to solve." In IT support, these problems range from a loose network cable connection to systems that need to be set up from scratch. Especially important, from his perspective, are efficient time management and a capacity for multitasking. His professional dream is to set up his own business when he has completed his training.

Photo Crayfish play an important role in river ecosystems: these omnivorous creatures decompose leaf litter or the remains of dead fish.

What can be done to protect native crayfish?

Native species of crayfish – formerly widespread – have now almost completely disappeared from large rivers in Switzerland. To help preserve surviving populations, Eawag is reaching out to experts with a practice-oriented (PEAK) course.

Crayfish are among the largest invertebrates found in Swiss waters, but people's knowledge of these nocturnal river dwellers remains limited. For thousands of years, native species such as the stone, white-clawed and noble crayfish were widely distributed throughout Europe. Today, these species have almost completely disappeared from large waterbodies in Switzerland. What exactly has happened? And what measures is Switzerland taking to support the surviving populations?

Dramatic decline

These questions were discussed by practitioners attending a PEAK course in Tolochenaz (by Lake Geneva) entitled "Protection of native crayfish." It was explained that, in many waterbodies, there is a lack of natural structures to provide shelter for crayfish. Also problematic is the contamination of rivers with pesticides and heavy metals.

The situation deteriorated sharply when, from the 19th century onwards, North American species such as the signal or red swamp crayfish were introduced to Europe. These invasive species not only outcompeted native crayfish for habitat, but also brought crayfish plague to Europe.

Enhancement measures

Today, native crayfish are only to be found in the upper reaches of certain rivers, surviving in largely isolated residual populations. However, according to Christoph Vorburger, Head of the Aquatic Ecology department, Adjunct Professor at ETH Zurich and organiser of the PEAK course on crayfish, "It is possible for waters to be enhanced in such a way that they become habitable for crayfish again. To preserve the remaining populations, there is a need for protection efforts – and dialogue with practitioners, which we facilitate through our course."

PEAK
Programme

It’s important for me to pass my knowledge on to the next generation.

Professor Kristin Schirmer has been Head of Eawag’s Environmental Toxicology department since 2008. Since 2011, she has been Adjunct Professor at EPFL, teaching ecotoxicology to undergraduates studying Environmental Sciences and Engineering. She also supervises master’s and PhD students in the field of ecotoxicology. In 2020, she was appointed as Adjunct Professor in the Department of Environmental Systems Science at ETH Zurich.

Peter Penicka, Eawag

Each year, PolySphère awards are granted by EPFL students to selected professors for outstanding teaching. Among the recipients in 2021 was the Head of Eawag's Environmental Toxicology department.

Kristin Schirmer, what does this award mean to you?
A great deal. I value my interactions with young people, and it's important for me to pass my knowledge on to the next generation. I want them to be well prepared to pursue ecotoxicology as a discipline – also at Eawag, if possible. At the same time, I try to address students' needs and work with them as a team. So I'm delighted that my dedication is recognised and appreciated.

What does good teaching involve in your view?
I want to connect with students' everyday experiences – how ecotoxicology relates to their daily lives. For example, who hasn't stood in the shower in the morning, reading the ingredients on the label of the shower gel and wondering what impact these substances have on the environment when they disappear down the plughole? That's my starting point. I also believe that people learn best when they have to work things out for themselves. For this reason, I usually take an interactive approach, with exercises, discussions and surveys.

Can you tell us about any special experiences you've had in connection with your teaching?
I always encourage students to let me have their feedback – both positive and negative. Very often, I've been touched by this feedback and it's stuck in my mind. For instance, I've been told that my course was the highlight of the week, or even the semester. I'm also particularly pleased to see students taking something with them that they can apply in their subsequent careers. One former student, for example, wrote to thank me, saying that he was on a work placement with an engineering firm in Brazil and he'd been able to apply certain things from our course when performing a sediment assessment. That gives you a real boost!

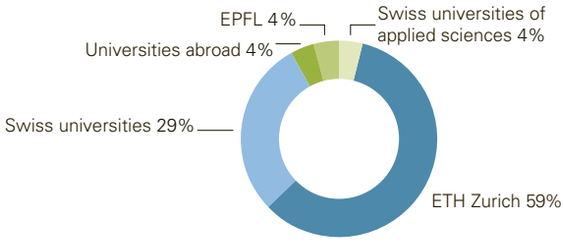
Master's students closely involved in research

Each year at Eawag, around 150 master's and bachelor's students are supervised and often directly involved in research projects. Again and again, this collaboration – as well as Eawag's flat hierarchies and interdisciplinary culture – leads to outstanding master's theses.

At Eawag, master's theses are normally integrated into research projects, which gives students the advantage of working within a set framework but still having the flexibility to inject their own perspective. Capucine Marion, whose master's thesis concerns the measurement of gases in plants and trees, greatly appreciates the working atmosphere at Eawag: "I have a lot of freedom, but at the same time I'm very well supervised. I can investigate the topics that interest me." Students interact closely with researchers at Eawag. "It gives you a real insight into how scientists operate," says Marion. The supervisors also benefit from collaboration with the students, who always bring enthusiasm and fresh perspectives. For Rolf Kipfer, a research group leader at Eawag and Adjunct Professor at ETH Zurich, the supervision of master's theses provides substantial added value: "I'm particularly fascinated by the exploratory aspect of a master's thesis, from which the whole group can learn and benefit." Direct contacts with research group members make it easy for master's students to pick up the necessary technical and theoretical knowledge. "Integration into relatively small working groups is a distinctive feature of master's research conducted at Eawag." To promote the transfer of knowledge to students, Eawag maintains a number of joint professorships with ETH Zurich and EPFL, as well as with other higher education institutions in Switzerland and abroad.

Tertiary-level teaching

5,079 h



Lecturers

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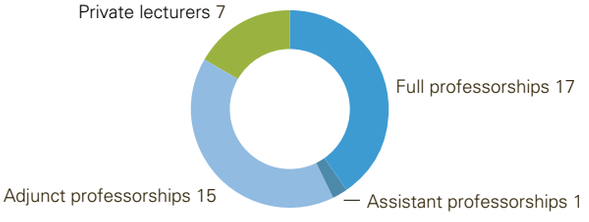
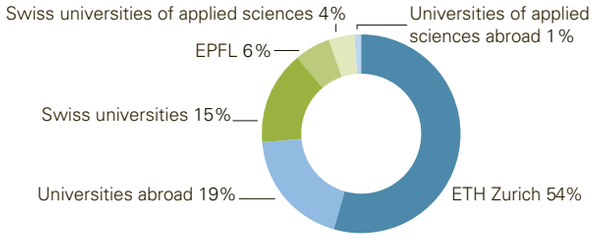


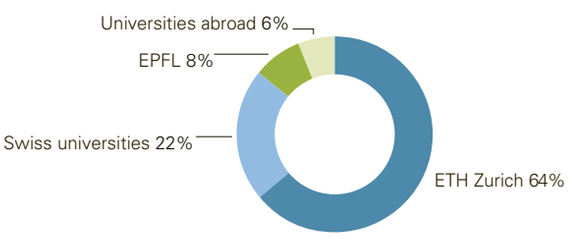
Bachelor's and master's theses supervised

146



Doctoral theses supervised

143



Digital learning formats to plug capacity gaps

Over the last six years, more than 160,000 people around the world have participated in online courses offered by Eawag, thus acquiring valuable knowledge about, for example, sanitation systems or municipal solid waste management.

Fabian Suter, Eawag

Photo Since 2021, MOOCs have been recorded at the video studio in the new FLUX building.

Many middle- or low-income countries suffer from a lack of personnel suitably trained in, for example, the maintenance of urban drinking water systems or composting of organic waste. To enable people in these regions to access high-quality training, a series of Massive Open Online Courses (MOOCs) has been developed by Eawag's Sanitation, Water and Solid Waste for Development department (Sandec).

Free access, any time, anywhere

With their promise of free access to education worldwide, MOOCs have become increasingly popular since 2012 and now complement traditional education models. In Switzerland, Sandec scientists were among the pioneers of this approach in 2014. Initially, however, these courses were only accessible for six weeks per year. It was only when they began to be offered continuously – from 2016 – that "the full potential of our MOOCs was realised," says Fabian Suter, manager of Sandec's digital learning programme. Since then, the courses have been available free of charge to anyone interested, any time, anywhere. From January 2016 to February 2020, an average of 1,581 new learners enrolled each month. Then, from March 2020, the Covid-19 pandemic led to a fourfold increase in enrolment numbers. "With an additional investment of one or two hours a week, we were supervising 6,000 instead of 1,500 learners," says Suter. In 2021, the figures gradually returned to pre-pandemic levels.

Learners from Asia, Latin America and Africa

Sandec's MOOC series attracts, in particular, young, well-educated, employed learners from Asia, Latin America and Africa. The course content has been expanded by numerous local partners to provide a contextualised learning experience. And, above all, the platform enables numerous learners from around the world to interact and help each other. "In this way, a community is formed," says Suter.

MOOCs
Programme

Esther Michel, Eawag

Consulting

Eawag scientists collaborate with water professionals in numerous projects and provide technical input to a wide variety of national and international bodies. In addition, they serve on expert committees and take on consulting contracts. Eawag also operates various Competence Centres, further promoting exchanges between research disciplines and practice. Eawag disseminates the latest research findings in application-oriented publications, thus ensuring knowledge transfer to practitioners.

Photo opposite As heavy rainfall events become more common in Switzerland, urban drainage systems will come under increasing pressure. Solutions are offered by blue-green infrastructure – an approach currently being investigated by Lauren Cook, a group leader in the Urban Water Management department. For more information see pp. 30 and 31.

Cooling potential of urban wetlands

As well as longer heatwaves, climate change will lead to more intense local rainfall, increasingly pushing traditional urban drainage systems to their limits. There is thus a need to adopt the blue-green infrastructure approach, developing strategies that both enhance biodiversity and improve the quality of urban life.

Climate models all point to an increase in the duration and intensity of heatwaves and dry spells in Switzerland. Also likely to increase, however, are heavy rainfall events, creating major problems for urban drainage systems. One idea currently being promoted as a way of addressing both of these challenges is blue-green infrastructure. Put simply, this comprises waterbodies and green spaces in urban areas – including trees and green roofs or facades. As this approach involves the retention and delayed release of rainwater, the term "sponge city" is sometimes also used or, more broadly, nature-based solutions.

Evaporation: a crucial cooling mechanism

As now understood, blue-green infrastructure encompasses more than individual trees or fountains in parks: rather, this approach should be based on strategic planning, taking advantage of the potential to improve urban ecology. A central role is thus played by a near-natural water cycle, with watercourses and open expanses of water in the urban environment. This is particularly important because evaporation of water is the predominant cooling mechanism in urban areas and because waterbodies are vital both for biodiversity (serving as connectivity and migration corridors) and for the community's quality of life.

These findings emerged from a review of the literature on blue-green infrastructure conducted at Eawag in 2021. In this study, not only vegetation (trees, green roofs, etc.) and areas of water (pools, fountains, etc.) but also special surfaces (e.g. permeable asphalt) and practices designed to promote cooling (creation of cold air corridors, irrigation, etc.) were analysed and ranked according to their urban cooling potential.

Integrated approach still lacking

The greatest cooling effects are produced by irrigation of surfaces and green spaces and the creation of cold air corridors. One particularly attractive option are urban wetlands – a combination of vegetation and open expanses of water – which not only offer a cooler natural area for the population but also contribute to aquatic and terrestrial biodiversity. "The multifunctional aspect of these facilities has previously often been overlooked," says Peter Bach of the Urban Water Management department.

Whereas plans for urban drainage often date back many years, an integrated approach to blue-green infrastructure development is widely lacking. Though isolated measures may be evaluated, the integration of an overall scheme into existing planning is the exception rather than the rule. Some cantons (e.g. Geneva, Lucerne and Aargau) have indeed developed climate adaptation or heat reduction strategies, and technical planning has been pursued in individual cities (e.g. Zurich heat reduction planning and the Winterthur urban climate blueprint); in most cases, however, such instruments have yet to be enshrined in legislation or standards. Likewise, support programmes are rare, even though the problems likely to arise from climate change and urbanisation would need to be tackled now. Bach concludes, "Unless blue-green infrastructure is systematically taken into account, we will no longer be able to meet the demands of urban stormwater management."

Photo Lauren Cook is investigating green roofs that combine various types of vegetation with photovoltaic arrays.

Multifunctional green roofs

Green roofs in urban areas can reduce runoff, lower temperatures, save energy in buildings and promote biodiversity. On the ETH Zurich Hönggerberg campus, Lauren Cook, a group leader in the Urban Water Management department, is investigating the benefits of multifunctional green roofs, which combine vegetation with photovoltaic arrays: while the photovoltaic cells provide shelter for the plants, the vegetation cools the panels, thus increasing their efficiency.

Green light for animal-free ecotoxicity testing

In 2021, a toxicity assay developed at Eawag using rainbow trout gill cells was adopted in the OECD guidelines for the testing of chemicals. This paves the way for authorisation procedures not requiring the use of live animals.

ETH Board

ETH Board

Photo The results of the fish cell-based toxicity assay are comparable to conventional tests on live fish.

To obtain authorisation for the market, manufacturers are required to demonstrate that their substances are safe for humans and the environment. To date, this has involved toxicity tests using live animals. In tests to assess the effects of chemicals on aquatic invertebrates, thousands of fish die every year. In 2019, ecotoxicity tests were carried out on almost 8,000 fish in Switzerland alone.

Consistent results obtained with the new method

This situation is likely to change soon, thanks to a test method developed at Eawag over the last ten years by a team led by Kristin Schirmer, Head of the Environmental Toxicology department and Adjunct Professor at ETH Zurich and EPFL. Schirmer originally had the idea for the method as a PhD student in Canada in the mid-1990s. She explains, "By observing how the gill cells are damaged by a chemical, we can predict how the substance would affect a live fish."

In a 2013 study, the researchers first showed that, for over 30 chemicals, the toxicity values obtained with the fish cell line assay were the same as in the conventional test. "We then had to show that the method was repeatable and reproducible at other laboratories," says Schirmer. Data from an international round-robin study provided the basis for ISO certification in 2019. Over the past two years, the method has once again been revised, taking account of input received from numerous international experts.

World's first alternative to live fish tests

Finally, in June 2021, the toxicity assay was adopted in the OECD guidelines for the testing of chemicals, representing the first alternative to live fish experiments worldwide. This means that the fish cell assay can now be included by manufacturers in dossiers submitted for the approval of chemical products. "There is great interest in non-animal tests on the part of industry," says Schirmer.

Using wastewater to track the course of the pandemic

Detection of coronavirus fragments in wastewater represents a valuable addition to clinical testing. In the medium term, the research project currently being pursued by Eawag, EPFL and ETH Zurich is to be expanded into a routine monitoring programme.

Esther Michel, Eawag

Photo If drug residues in wastewater can provide evidence of drug consumption, why not use coronavirus concentrations to track the pandemic?

If conclusions about drug consumption in society can be drawn from drug residues found in wastewater, why not use the presence of coronavirus material to track the pandemic? As early as February 2020, scientists at Eawag, EPFL and ETH Zurich began to develop a method for detecting genetic material from the SARS-CoV-2 virus in wastewater and using the findings to track infection levels, independently of the results of clinical tests; after all, everyone goes to the toilet.

Goal: covering 70 per cent of the population

Until the end of 2020, the method was refined and optimised in the laboratory. Despite a number of obstacles, the various waves could thus be successfully traced. From February 2021, with support from the Federal Office of Public Health (FOPH), the researchers were able to process samples collected daily not only from wastewater treatment plants in Zurich and Lausanne, but also from four others (Altenrhein, Chur, Lugano and Laupen). Together, these six plants serve more than 1.2 million people. During the summer, the team also developed plans for expanding the research project into a routine monitoring programme involving at least 100 plants and thus covering around 70 per cent of the Swiss population. Routine monitoring, coordinated by the FOPH, has now begun in individual cantons.

R value and mutations

Two further challenges are being addressed by the researchers: firstly, the estimation of the reproduction number R irrespective of tests; here, it was shown for the first time that R values can be reliably estimated on the basis of wastewater analyses. Secondly, the detection of virus mutations from wastewater data. For this, the researchers are developing and using variant-specific PCR tests (e.g. adapted to Omicron), which make it possible to determine more rapidly whether one variant is starting to be displaced by another.

Wastewater monitoring
More on the project

Alessandro Della Bella, Eawag

Photo Nathalie Hubaux, CEO of the Neugut wastewater treatment plant at Dübendorf, and Marc Böhler, a group leader in the Process Engineering department, inspect and discuss the operation of the long-established sand filtration process at the plant. As well as serving the existing function of removing solids from biologically treated wastewater (thus increasing the retention of nutrients), the filtration process is now also being used for biological post-treatment of wastewater that has undergone ozonation, serving to eliminate unstable transformation products arising from this recently introduced process.

From research to practice

Eawag and its Competence Centres actively promote knowledge transfer from research to practice. Scientists collaborate with water professionals in numerous projects, provide expert input to national and international bodies and maintain extensive networks. Another priority for Eawag is the provision of support for young entrepreneurs.

Field-testing off-grid toilets

The Autarky toilet cabin was tested for three months by a large household in South Africa. All the members of the extended family were satisfied with the system – though there is still room for improvement of the urine treatment module used for fertiliser production.

Autarky, Eawag

Photo The Blue Diversion Autarky toilet (right) was field-tested in a garden in Durban, beside an existing urine-diverting dry toilet.

Worldwide, one in three people lack access to adequate sanitation. To help improve this situation, Eawag scientists have developed the Blue Diversion Autarky toilet, which does not require piped water or sewers. Thanks to the separation and treatment of flushwater, urine and faeces, the system also allows valuable resources – such as water or nutrients (phosphorus or nitrogen) – to be recovered.

14-person household

The toilet has now been successfully field-tested over a period of several months. "The technology worked very well," says doctoral student Eva Reynaert, who – with colleagues from the Process Engineering department – installed the Blue Diversion Autarky toilet in the garden of a 14-person household in South Africa. This extended family, living outside Durban, had previously only had access to a dry toilet.

By comparison, the Blue Diversion Autarky toilet offers a number of advantages: it is equipped with a door which can be locked from the inside, electric light, a window and a washbasin (with soap dispenser and mirror). The water-flush ensures an odour-free environment. "This was particularly appreciated by the residents," says Reynaert.

Nitrogen lost during urine treatment

The system components were checked by an engineer two or three times a week. The water module, which treats the flushwater, was highly effective. The urine treatment module, used to convert source-separated urine into fertiliser, also operated smoothly. However, according to Reynaert's colleague Michel Riechmann, "In terms of the quality of the final fertiliser, we identified some room for improvement, as a substantial proportion of the nitrogen was lost in the treatment process." The faeces treatment module could not be evaluated in this field test, as it is still under development.

Autarky
Watch video

Cornelia Wiekort

eCompendium
Online tool

Decision support for emergency sanitation technologies

Humanitarian crises call for effective solutions along the entire sanitation service chain – from the toilet, through collection, transport and treatment, to safe disposal and reuse. An online decision support tool has now been created by a global network of experts, with the participation of the Sanitation, Water and Solid Waste for Development department. The eCompendium (emersan-compendium.org) is a systematic compilation of all relevant emergency sanitation technologies. The tool allows appropriate technology combinations to be identified for a given context and emergency scenario. The eCompendium platform is already available in English and French, and an Arabic version will be added soon.

High water temperature prevents contamination with legionella

In a case study, scientists from Eawag and the Lucerne University of Applied Sciences (HSLU) showed that the growth of pathogenic bacteria in drinking water pipes can be effectively controlled by maintaining a high boiler temperature.

Dmitry Kalinovsky, Shutterstock

Photo Legionella can proliferate in plumbing systems at temperatures between 35°C and 40°C.

Legionella bacteria are named for the fact that they are the causal agent of Legionnaires' disease, a severe form of pneumonia. These pathogens are reliably removed at central water treatment plants, and concentrations also remain low in the distribution networks that convey drinking water to buildings. "But then things becomes more problematic," says Frederik Hammes, Head of the Environmental Microbiology department.

Hazardous shower droplets

In buildings where water is heated, legionella can colonise hot-water systems at temperatures between 35°C and 40°C. Then showers, in particular, can become a source of infection, if contaminated fine water droplets are inhaled. Around a third of all cases of Legionnaires' disease in Switzerland are attributable to contaminated drinking water. And the prevalence of this condition is increasing: in 2021, 667 cases were recorded by the Federal Office of Public Health – almost three times more than ten years ago.

In a case study, Hammes and colleagues at Eawag and HSLU investigated what measures were most effective in preventing legionella contamination in plumbing systems. As the scientists report, the study was carried out in Eawag's research building, which contains around 150 taps on six floors.

Boiler temperature of 60°C

To save energy, the temperature of the boiler in this building was first set at 40°C, with the water being heated to 70°C for four hours each Wednesday. However, this was not sufficient to ensure effective control of legionella. Maintaining a constant temperature of 60°C was, however, found to be highly effective.

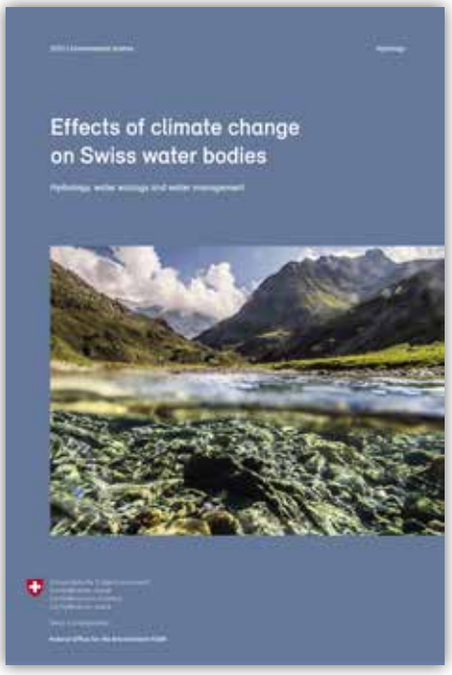
News in brief

Dean Shirley, Eawag

Online biomonitoring of treated wastewater: At present, to ensure that treated wastewater can be safely released into receiving waters, treatment plants normally use grab samples, which have to undergo time-consuming laboratory analysis. Now, scientists from Eawag, FHNW and the Ecotox Centre have tested new methods, using living organisms, to permit continuous, real-time monitoring of treated wastewater quality. Since water fleas, freshwater shrimps and unicellular green algae react rapidly and sensitively to contaminants, the researchers hope that these biomonitors can be used in the future as early-warning systems.

Biomonitoring
Watch video

Climate change and its consequences for water use: How will climate change affect Switzerland, Europe's "reservoir"? The effects will be even greater than previously supposed, according to the results of the recently completed research project "Hydrological principles of climate change" (Hydro CH2018), which was led by the Federal Office for the Environment within the National Centre for Climate Services (NCCS). The key findings: while there will be no general water shortage, regional and seasonal scarcity may occur. At the same time, flooding will increase as a result of more intense local rainfall. Such marked changes will require adaptations in water use. The detailed report is available from the NCCS.



Hydro CH2018
Read report

Christian Dinkel, Eawag

Institution

Eawag is committed not only to excellence in research, teaching and consulting, but also to creating a motivating and supportive working environment. Contributing to this attractive environment are the various support departments, which ensure smooth operations, as well as the outstanding infrastructure available at the Dübendorf and Kastanienbaum sites. Great importance is attached to work-life balance, equal opportunities and mutual respect at Eawag.

Photo opposite Aquatic physicist Professor Alfred (Johny) Wüest retired in 2021, having helped to shape Eawag's development for 38 years, most recently as a member of the Directorate. The verdicts of his colleagues and decades-long companions are unanimous: Wüest is a thoroughbred researcher, who has always been driven by his curiosity and passion for science. He never tired of standing up for his ideas, convictions and values, and was not afraid to pose critical or sometimes uncomfortable questions.

Awards

Elisa Calamita wins the Otto Jaag Water Protection Prize

Environmental engineer Elisa Calamita received the Otto Jaag Water Protection Prize for her doctoral research. This ETH Zurich award recognises outstanding doctoral and master's theses in the field of water protection and hydrology. As part of the Horizon 2020 project DAFNE, Calamita investigated the effects of large dams on water quality in tropical rivers.

ETH Zürich

Janet Hering elected as IAGC Fellow

Eawag Director Professor Janet Hering was awarded the honorary title of IAGC Fellow by the International Association of Geochemistry for her contributions to the field of geochemistry. This honour is bestowed on no more than two scientists each year. Hering's work showed how the molecular perspective of chemistry can elucidate processes occurring in environmental systems.

Alessandro Della Bella, Eawag

Urs von Gunten receives ACS Award

Eawag scientist and EPFL professor Urs von Gunten received the prestigious American Chemical Society (ACS) Award for Creative Advances in Environmental Science and Technology. His research on oxidative processes in water has led to practical applications and improvements in both drinking water and wastewater treatment.

Timo von Gunten

Member of the Academia Europaea
Professor Janet Hering

Design Prize Switzerland for the save! toilet
Professor Tove Larsen (in collaboration with Laufen Bathrooms and EOOS Design Studio)

Silver Medal of ETH Zurich for outstanding doctoral theses
Aryeh Feinberg, Moritz Gold, Barbara Günthardt, Matthew Moy de Vitry, Marius Neamtu-Halic

Bern University Faculty Prize for the best doctoral thesis in biology
Anna Feller

Neuchâtel University "Prix Léon Du Pasquier et Louis Perrier" for an outstanding doctoral thesis
Max Ramgraber

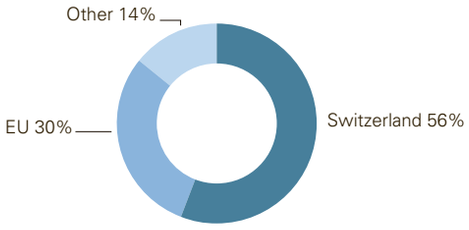
Headcount and personnel structure

As of 31 December 2021, Eawag's headcount (excluding interns, visiting academics and temporary staff) was 517 people (462.7 full-time equivalents/FTEs), distributed among the following functions: scientific, technical and administrative staff, and apprentices. Women account for 49.1% of the total (including apprentices). Eawag continues to provide training for 25 apprentices – chemical and biological laboratory technicians, business administrators and ICT specialists.

Eawag's international character as a world-leading aquatic research institute is reflected by the diverse origins of its employees, who come from 42 different countries.

Origin of employees

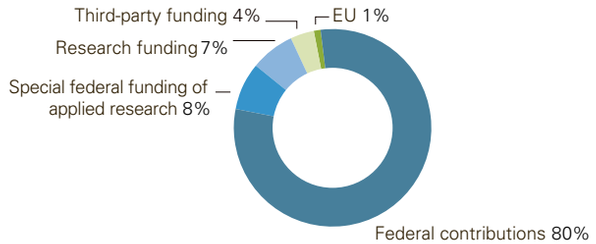
517



Financing for staff derives not only from federal contributions but also from research funding obtained on a competitive basis. As of 31 December 2021, the financing of the FTEs (excluding apprentices) breaks down as follows:

Sources of funding for personnel (CHF thousand)

55,036



Personnel policy and career development

Eawag is a socially responsible employer, deploying modern personnel policy instruments which make it possible to maintain high levels of performance and motivation. In addition, Eawag promotes equal opportunities for men and women. For this purpose, it offers flexible working time models, integrated health management and training opportunities so as to ensure the retention of first-class employees, and to enhance employability, both in research and in the technical and administrative areas.

Internal training focuses in particular on the areas of management development, workplace health management and occupational safety. For many years, Eawag has also invested in language courses, reflecting the institute's international ethos. Training measures are reviewed and fine-tuned each year. Financial support is also provided for individual external courses, so that employees' qualifications are maintained at a high level.

For its 74 doctoral students, Eawag provides excellent infrastructure, specific training options and tailored information platforms. For scientists with fixed-term project appointments, Eawag organises career planning workshops and offers academic transition grants to develop their qualifications for the labour market.

The Eawag Partnership Programme for Developing Countries (EPP) offers students from these countries the opportunity to carry out research at Eawag, establish contacts and transfer the expertise acquired to their home countries. The Eawag Postdoctoral Fellowship for outstanding young scientists is also an established part of Eawag's efforts to foster talents and expand research networks.

Eawag and Covid-19

Throughout the year, Eawag's Covid-19 Task Force monitored the situation, adapting the strategy and measures in a forward-looking manner. The goals of avoiding infections within the institute and minimising disruption to research operations were achieved. Around four fifths of planned internal training events took place, either in person or online. In addition, courses on mental health were held, and numerous aids were made available.

Personnel news

Alfred Wüest retires

Aquatic physicist Alfred Wüest – better known to his colleagues as Johny – joined Eawag in 1983 to carry out doctoral research on mixing processes in lakes. After a spell as a postdoc in the USA, he returned in 1989 to become a group leader at Kastanienbaum, where – as a passionate thoroughbred researcher – he helped to shape the development of Eawag, most recently as a member of the Directorate. Wüest also served as a professor at EPFL, where he was Head of the Centre for Limnology.

Eawag

Alfred Wüest

Carsten Schubert appointed as member of the Directorate

Carsten Schubert studied geology at the Justus-Liebig University in Giessen (Germany). After working as a postdoc at the Alfred Wegener Institute for Polar and Marine Research and a research scientist at the Max Planck Institute for Marine Microbiology, he joined Eawag as leader of the Biogeochemistry group in 2001. From 2012, he served as Head of the Surface Waters Research & Management department. Since 1 April 2021, he has been a member of the Directorate, representing Eawag's Kastanienbaum site. Schubert is an Adjunct Professor at ETH Zurich.

Peter Penicka, Eawag

Carsten Schubert

Nele Schuwirth new Head of Siam department

On 1 January 2021, geologist Nele Schuwirth became Head of the Systems Analysis, Integrated Assessment and Modelling department. She joined Eawag as a postdoc in 2006 and has been leader of the Ecological Modelling group since 2012. From now on, she will be focusing increasingly on Eawag as a whole and is looking forward to developing shared visions and discussing overall strategy with her team.

Raoul Schaffner, Eawag

Nele Schuwirth

Helmut Bürgmann new Head of Surface Waters department

On 1 April 2021, geoecologist Helmut Bürgmann, having led the Microbial Ecology group for many years, became Head of the Surface Waters Research & Management department. During his scientific career, he has become increasingly interested in environmental microbiology, specialising in interdisciplinary ecosystem research. From his perspective, collaboration beyond institutional and disciplinary boundaries will remain a key concern in the future.

Christian Dinkel, Eawag

Helmut Bürgmann

New director of the Ecotox Centre

Benoît Ferrari joined the Ecotox Centre as Group Leader for Sediment and Soil Ecotoxicology in 2013. On 1 July 2021, he took on the directorship of the Ecotox Centre, a post he had already held ad interim for the past two years. In this role, he will continue to be supported by Deputy Director Etienne Vermeirssen.

Oekotoxzentrum

Property

New multifunctional FLUX building

On the site occupied until the start of 2019 by a teaching pavilion for ETH students, there now stands – after two years' construction work – the FLUX building. With five floors and a basement, it offers spaces for teaching, training and continuing education and also houses a photo and video studio, where e-learning courses, project videos or interviews can be recorded. An innovative laboratory ventilation system will ensure significant energy savings, and the entire building is certified according to the Minergie ECO standard.

Alessandro Della Bella, Eawag

Handover of the keys to Eawag's new building. From left: Resal Bangoj, Construction Manager, Halter AG; André Ingold, Mayor of Dübendorf; Rik Eggen, Eawag Deputy Director; Janet Hering, Eawag Director; Hannes Pichler, Head of Empa Property Management; Maik Neuhaus, CEO of Halter AG Gesamtleistungen; Alexander Christen, fsp Architekten AG.

Broad dialogue

Members of parliament visit Dübendorf

On 19 August, seven National Councillors from the Finance Committee paid a visit to Eawag and Empa. In her introductory address, Eawag Director Professor Janet Hering highlighted the effectiveness of collaboration between institutions within the ETH Domain – for instance, with WSL in the Blue-Green Biodiversity programme, or with ETH Zurich and EPFL in Covid-19 wastewater monitoring. Eawag scientists then explained the challenges and opportunities of closing material cycles at the local level, taking the grid-free Autarky toilet as an example.

Andri Bryner, Eawag

National Councillors from the Finance Committee find out how the urine-diverting toilet bowl works.

Eawag looks to the future

As Eawag Director Professor Janet Hering is due to retire at the end of 2022, a 12-strong appointment committee has been tasked with finding a successor. This committee, chaired by ETH Board President Michael Hengartner, is composed of representatives of the institutions of the ETH Domain, stakeholders and external experts.

Partly to help ensure a smooth transition, a 14-strong Strategy Group was established at Eawag early in 2021, bringing together representatives of the research departments and the current Directorate. Professor Christian Zurbrügg, a member of the Directorate, explains, "The goal was both to take stock and to look ahead: What do we expect of our research? What role does Eawag play within the ETH Domain? How do we contribute to society?" This input from the workforce should provide a starting point for Janet Hering's successor.

Blue Green Biodiversity (BGB) initiative: workshop and initial results

Phase 1 of the Eawag-WSL research initiative concluded with a workshop attended by almost 100 scientists. The two Directors – Professor Janet Hering (Eawag) and Professor Beate Jessel (WSL) – emphasised the importance and the success of close collaboration between the two research institutes.

> Find out more about the BGB initiative at: eawag.ch/bgb

25th anniversary of Mont Terri rock laboratory

Experiments concerning deep geological disposal of radioactive waste have been carried out for 25 years at the Mont Terri rock laboratory in the canton of Jura. Over the past few years, the facility has also been used for research on underground storage of CO_2. For these experiments, Eawag has performed gas measurements using its own miniRuedi technology. To celebrate the 25th anniversary in November 2021, Federal Councillor Viola Amherd and Cantonal Environment Minister David Eray visited the laboratory and had a closer look at the ongoing experiments.

Radio Fréquence Jura

Uzbek ambassador visits Eawag

In October, Nabijon Kasimov – the Ambassador of Uzbekistan in Berlin – visited Eawag as part of a tour of various research institutes in German-speaking areas. During this visit, Eawag Director Professor Janet Hering and departmental heads Christoph Lüthi and Professor Eberhard Morgenroth explained how closed water and nutrient cycles can contribute to sustainable water management. Their presentation included in particular the off-grid Blue Diversion toilet.

Equal opportunities

The Equal Opportunities Committee (EOC), which includes representatives from all staff groups, seeks to prevent discrimination of any kind at Eawag and within the ETH Domain. In 2021, Eawag participated not only in the ETH Domain's long-running "Fix the leaky pipeline" programme but also in the third round of the swissuniversities CONNECT programme, which aims to connect women's careers in academia and industry. Members of the EOC also contributed to the development of the ETH Domain's Gender Strategy 2021–2024.

From September 2021, the joint efforts of Eawag and PSI in the area of equal opportunities were expanded to include Empa, with the establishment of the overarching Centre of Competence for Diversity and Inclusion PSI-Empa-Eawag. The aim is to exploit synergies and to facilitate regular exchanges on this topic between the three research institutes.

In 2021, the EOC focused on the revision of Eawag's internal directives and on enhancing the committee's visibility. Particular attention was paid to the development of plans for the continuation of the Respect campaign.

The compatibility of family and career is a permanent fixture on the agenda. Under the Tailwind programme, grants are available to support mothers returning to work. The term of employment for tenure-track female scientists is automatically extended if they start a family. On request, new fathers can temporarily reduce their working hours. An adaptation of the successful Tailwind programme is currently being evaluated at PSI.

The proportion of women in management positions at Eawag remains relatively high (36 per cent).

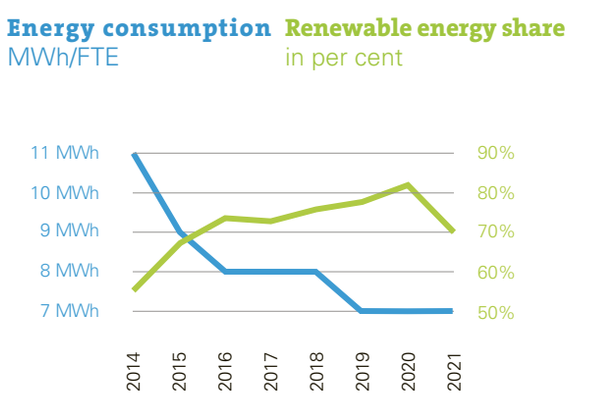
As well as supporting the Empa-Eawag nursery, Eawag contributes to the childcare costs of low-income parents.

Environment

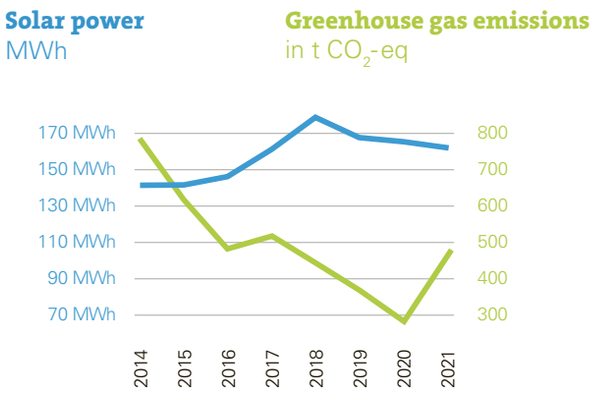
It's a well-known dilemma: international research activities are of vital importance for scientists, but aircraft emissions contribute to climate change. As an environmental research institute, Eawag therefore wishes to reduce business air travel.

Since 2020, under an internal directive, staff have been required to travel by rail rather than air for journeys of up to 1,000 kilometres. And since 2019, Eawag has had its own videoconferencing facility, making it much easier for researchers to conduct remote meetings.

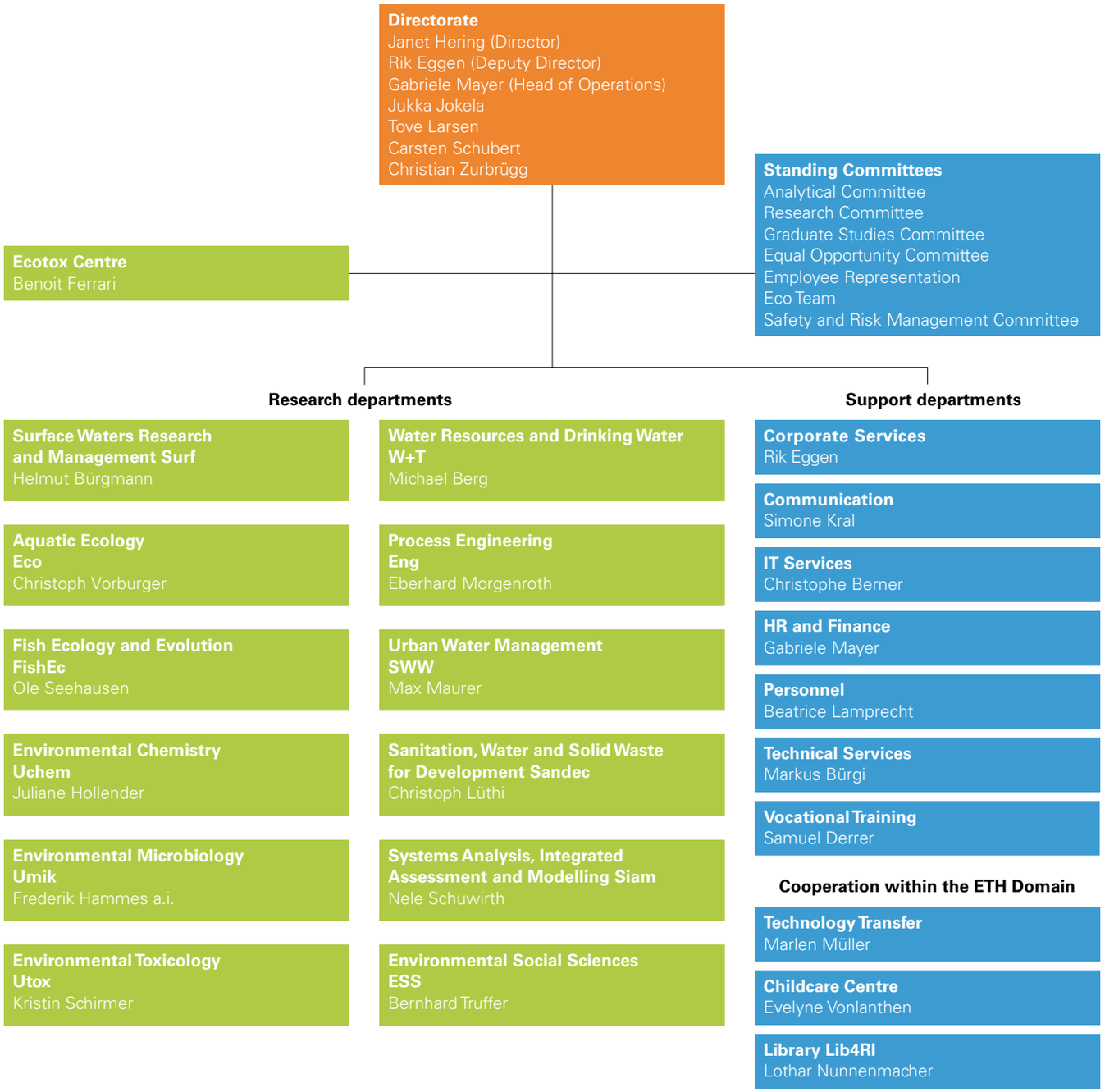
Energy consumption per capita



Electricity generation and greenhouse gas emissions



Organisation



As of 31 December 2021

Directorate

Janet Hering Director
Janet Hering, a chemist, is an expert in processes for the treatment of contaminated water and in the biogeochemical behaviour of trace metals. She is Professor of Environmental Biogeochemistry at ETH Zurich and Professor of Environmental Chemistry at EPFL. She is also a member of various national and international bodies. In 2015, she was inducted into the US National Academy of Engineering.

Rik Eggen Deputy Director
Rik Eggen, a biologist, is particularly interested in the effects of aquatic chemical pollution on environmental and human health, the underlying mechanisms and the development of mitigation strategies. He is Adjunct Professor of Environmental Toxicology at ETH Zurich.

Gabriele Mayer Head of Operations
Gabriele Mayer, a business manager, has considerable experience in the fields of internal control systems and international accounting. She has held executive positions with US and Swiss corporations. At Eawag, she is responsible for the support departments and cross-institutional infrastructure. This includes the operation and further development of the SAP system used by the four research institutes within the ETH Domain, as well as projects such as the changeover to International Public Sector Accounting Standards (IPSASs).

Jukka Jokela Group Leader Eco
Jukka Jokela is an internationally renowned expert on the evolution of aquatic organisms and on coevolutionary host-parasite interactions. In his applied research, he develops management methods to control the spread of invasive species and pathogens. He is Professor of Aquatic Ecology at ETH Zurich and a member of the Directorate and the Advisory Board of the ETH Zurich Genetic Diversity Centre.

Tove Larsen Group Leader SWW
Tove Larsen, a chemical engineer, works on sustainable urban water management. Her research focuses on technologies for source separation and on-site wastewater treatment. For example, she led the award-winning Blue Diversion project (development of a grid-free urine-diverting toilet). She is Adjunct Professor at the Technical University of Denmark and a member of the Advisory Boards of the FHNW School of Life Sciences and the ZHAW School of Life Sciences and Facility Management.

Carsten Schubert Group Leader Surf
Carsten Schubert, a geologist, conducts research on organic geochemistry and isotope geochemistry in lakes and marine systems. He is particularly interested in the global methane cycle, methane formation in relation to the origin of the organic material and methane oxidation processes. As a member of the Directorate, he represents Eawag's Kastanienbaum site. In addition, he has been a lecturer at ETH Zurich since 2004 and Adjunct Professor since 2019.

Christian Zurbrügg Group Leader Sandec
Christian Zurbrügg, an expert in water supplies, sanitation and waste management, studies concepts and technologies for upgrading infrastructure and services in urban areas of low- and middle-income countries. He has led several international programmes and projects in this field. Christian Zurbrügg teaches at ETH Zurich and EPFL and is an Adjunct Professor at the Swedish University of Agricultural Sciences.

Risk management at Eawag

Background
Requirements for the management of risks are specified in the ETH Board's directives of 4 July 2006 (revised version: 16 May 2018) on risk management at ETH and its research institutes. These directives regulate the essential aspects of risk management and define the goals of the risk policy pursued by the ETH Board. They regulate in particular:

- the goals of risk policy and responsibilities
- risk identification
- risk assessment
- risk minimisation and financing
- risk controlling

The goal of Eawag's risk policy is, in a prudent and timely manner, to identify, assess and draw attention to any material risks threatening Eawag's operations and activities, and to take appropriate measures – adapted to the institute's cultural diversity and organisation – to absorb or mitigate such risks.

Responsibility and risk management processes
In accordance with the autonomy granted to ETH's six institutions under the Federal Act on the Federal Institutes of Technology, which is fundamental to their work in the fields of teaching, research and knowledge/technology transfer, each institution is responsible for managing the risks existing in its own sphere of operations. The Presidents of the Federal Institutes of Technology and the Directors of the research institutes thus have overall responsibility for risk management within their respective institutions.

The two Federal Institutes of Technology and the four research institutes have each introduced their own risk management processes, based on the requirements specified by the ETH Board. These include the identification and assessment of individual risks, risk minimisation strategies and risk controlling. Eawag has a risk manager, who coordinates and controls the risk management processes. The risk manager is supported by the other individuals responsible within Eawag's risk organisation. The implementation of risk management is periodically reviewed by the Directorate and by the ETH Board's internal audit, which reports to the ETH Board's Audit Committee.

Risk situation

Risks
Eawag's individual profile is reflected in its risk catalogue; its core risks and the assessment thereof are influenced by the fact that Eawag is relatively small compared to the other institutions within the ETH Domain.

The risks identified, and the potential consequences thereof, are described in detail in the risk catalogue and assessed in terms of likelihood of occurrence and financial impact. In addition, particular attention is paid to the potential impact of risks on Eawag's reputation.

Eawag updates its risk catalogue at least once a year, taking account of new developments and changes in the risk situation. The catalogue comprises the following risk categories:

- financial and economic risks
- legal risks
- property, infrastructure and natural hazard risks
- personnel and organisational risks
- technological and scientific risks
- social and political risks
- environmental and ecological risks
- specific real estate risks

Classified as core risks are those with a potentially high financial impact and an above-average likelihood of occurrence which may pose a direct threat to the fulfilment of the institute's legal duties. The risk organisation (internal risk committee) meets at least once a year to discuss the risk situation at Eawag and, under the leadership of the risk manager, prepares a risk report. In 2021, as in previous years, the risk report was submitted to the Eawag Directorate for consideration and approval. As part of its annual reporting, Eawag informs those responsible within the ETH Board as to its core risks, and in particular the current extent and potential impacts thereof. In the event of any exceptional changes to the risk profile or exceptional loss events, the ETH Board, as the supervisory body of the ETH Domain, is directly informed in a timely manner.

Eawag's core risks have been identified in the following areas:

- quality of teaching, research and services
- scientific misconduct
- damage to or loss of test systems/samples
- accidents suffered by employees or visitors
- IT risks (data loss, unauthorised access, etc.)

Risk management instruments and measures
As a fundamental element of risk management, subsidiary to other measures, Eawag is required to obtain insurance covering possible losses, with the institute's individual risk situation being taken into account.
With regard to insurance policies, an appropriate cost-benefit ratio must be aimed for and the relevant provisions concerning federal public procurement must be complied with. These policies must meet the usual standards of the Swiss insurance market and must be issued by an insurance company licensed in Switzerland.

Eawag is responsible for taking out its own insurance policies and managing its own insurance portfolio. In its directives, the ETH Board merely specifies that, in addition to the insurance required by law, the two Federal Institutes of Technology and the four research institutes must obtain basic coverage by taking out the following types of insurance:

- property and business interruption insurance
- general liability insurance
- insurance policies required to provide the broadest possible coverage of core risks

It should, however, be borne in mind that not all core risks can be insured, or that such insurance may not be affordable. Eawag has taken out property and liability insurance policies covering losses or damage. Eawag also has smaller policies covering specific business risks, as required by the directives.

Disclosure of risks

In the preparation of the annual accounts, it is ensured that risks are fully recognised within the existing reporting. Based on the estimation of the likelihood of occurrence, risks are reported either under "Provisions" (more than 50-per-cent likelihood of occurrence) or in the Notes under "Contingent liabilities."

Internal control system

In accordance with the requirements specified by the ETH Board, Eawag operates an internal control system (ICS) that promptly identifies and assesses the relevant financial processes and risks related to bookkeeping and the rendering of accounts and incorporates appropriate key controls to cover those processes and risks. The ICS encompasses those procedures and measures that ensure proper bookkeeping and rendering of accounts and accordingly form the basis of all financial reporting. It thereby ensures that financial reporting is of a high quality. Eawag sees the ICS as an activity aimed at the continuous improvement of processes.

Annual financial statements
View online

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