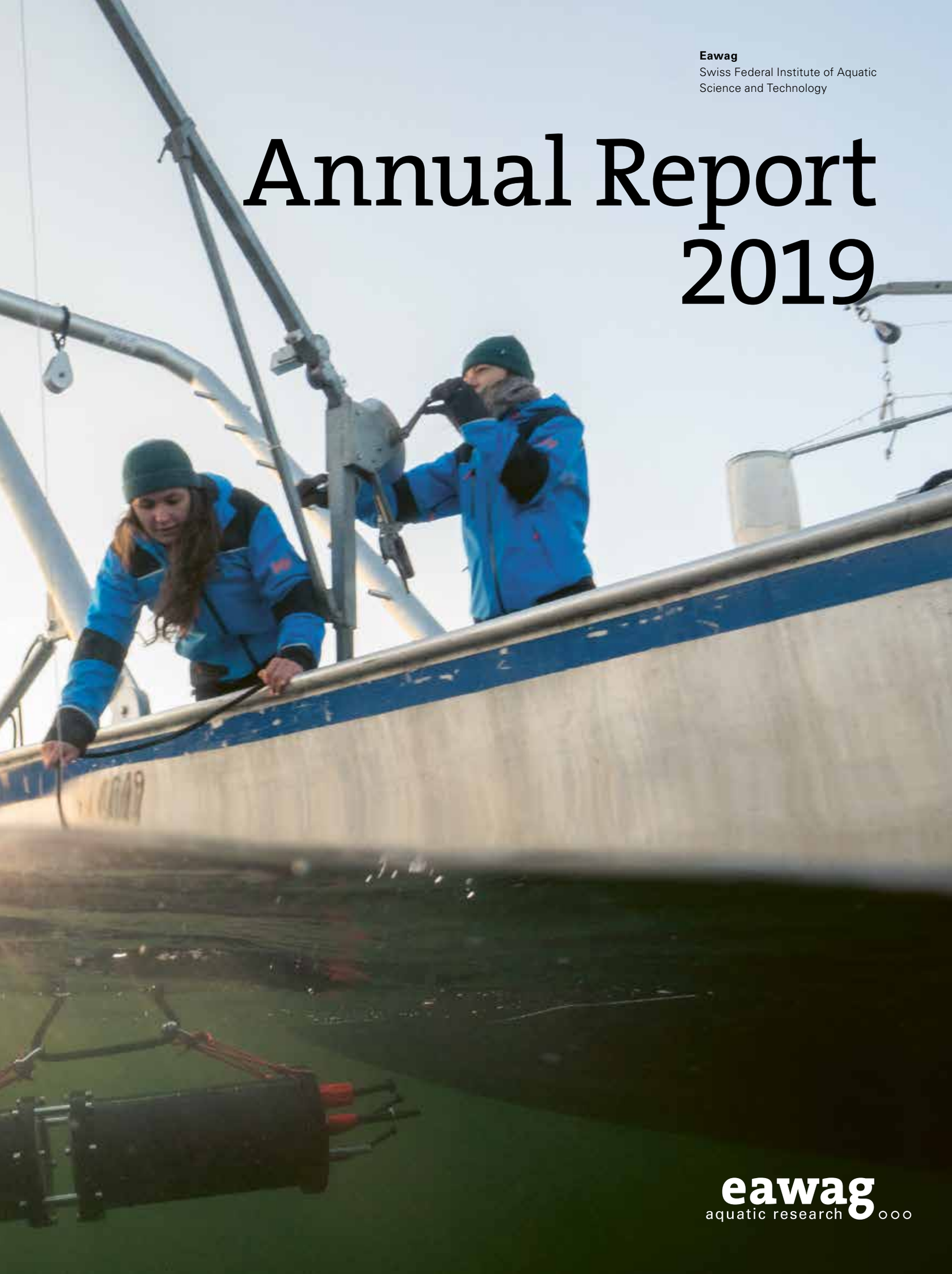
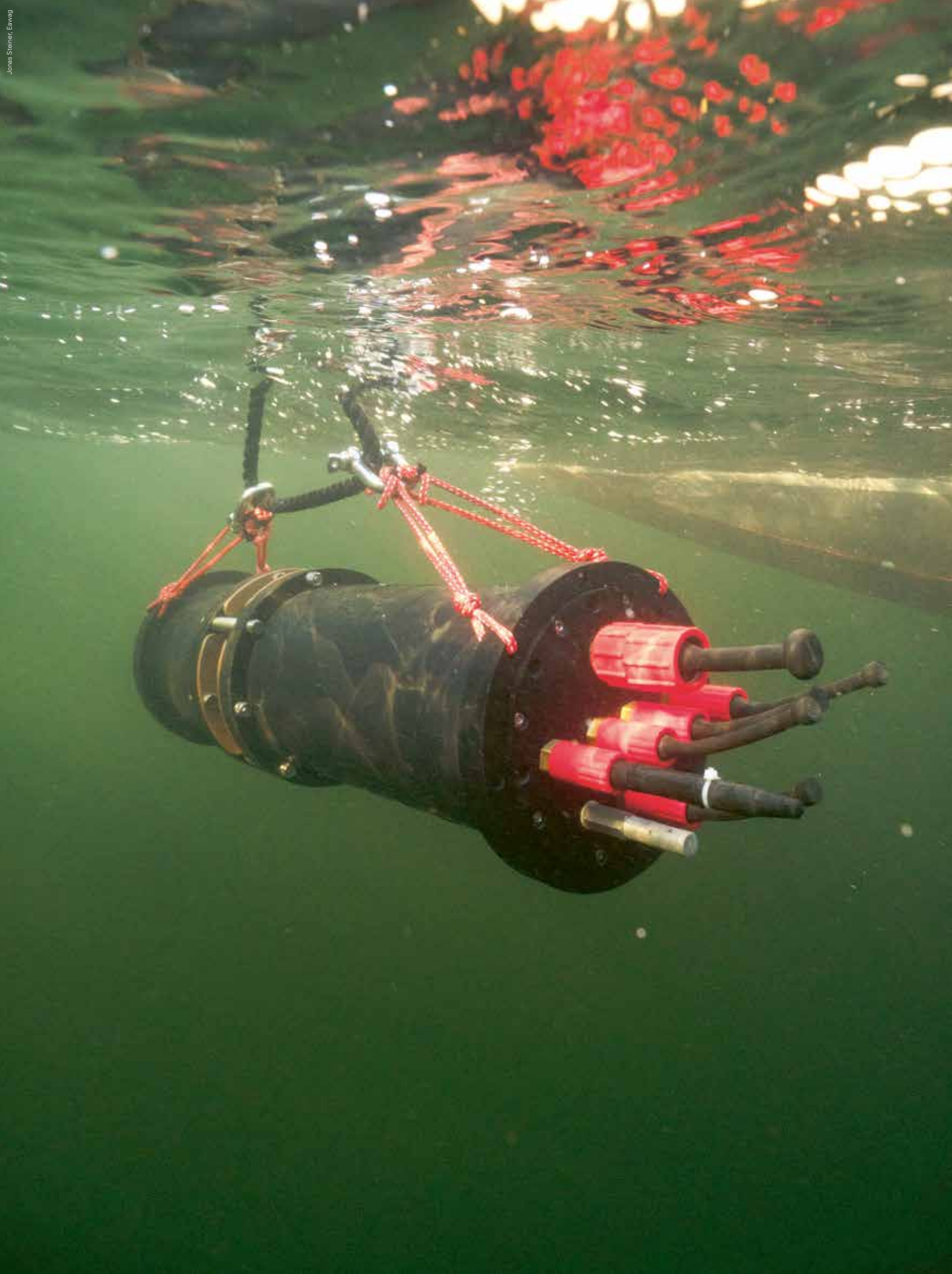
Eawag
Swiss Federal Institute of Aquatic
Science and Technology

Annual Report 2019



eawag
aquatic research



Jonas Steiner, Eawag

Contents

Cover photo Aquatic ecologists Ewa Merz and Thea Kozakiewicz conducting fieldwork on Lake Greifen (canton of Zurich). Visible in the lake is the Aquascope – an underwater camera recording planktonic organisms in their natural environment in real time. For more information see p. 20.

Aldo Todaro, Eawag

Eawag

Eawag's research activities focus on how to secure a balance between humanity's use of water resources and the preservation of resilient aquatic ecosystems. Eawag offers 32 professors and over 200 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 to authorities and stakeholders from business and society. The 4,500-plus teaching hours at Swiss higher education institutions and the supervision of almost 160 Bachelor's and Master's theses and 135 doctoral theses per year make an important contribution to the education of young professionals for the Swiss water sector.

Water research for sustainability and the Sustainable Development Goals

In 2019, many scientists joined young people in protesting against government inaction on climate change. Several major scientific reports concluded that the world is not on track to achieve the Sustainable Development Goals (SDGs) by 2030 and highlighted the lack of progress on the environmental SDGs, including SDG 13 on climate action.

How is Eawag contributing to a sustainable future? How does our work support the SDGs?
Eawag's work is directly relevant to SDG 6 "Ensure availability and sustainable management of water and sanitation for all". Our Department of Sanitation, Water and Solid Waste for Development (Sandec) made major contributions to the advances achieved under the Millennium Development Goals and continues to work towards SDG 6. Sandec has released the new compendium "Drinking Water Systems and Technologies from Source to Consumer" (p. 39) and expanded its offering of massive open online courses (p. 29). Eawag is also developing new methods and technologies to assess water quality, including the occurrence of pesticides and other micropollutants in surface and groundwater in Switzerland (p. 12).

Water is the focus of SDG 6 and also a blue thread that runs through the SDGs. The systematic assessment of amphipods (p. 20) and the development of new technology to quantify algal species (p. 20) help us to understand and protect freshwater biodiversity, addressing SDG 15 "Life on land". Building a circular economy by recovering the nutrients nitrogen and phosphorus from urine (p. 37) will decrease demands on natural resources (addressing both SDG 12 "Ensure sustainable consumption and production patterns" and SDG 11 "Make cities and human settlements inclusive, safe, resilient and sustainable").

The SDGs point the way to a sustainable future, but this will not be a simple journey. The challenge of controlling the pathogen Legionella in building plumbing (p. 32) illustrates the trade-offs between SDGs. Energy conservation for SDG 13 "Climate action" creates risks for human health, compromising progress toward SDG 3 "Good health and well-being". Addressing such trade-offs requires insight and engagement with political and social systems (p. 34).

Eawag's engineers and natural and social scientists, cooperating with colleagues within and beyond the ETH Domain, are continuing their research for a sustainable future for Switzerland and the world.

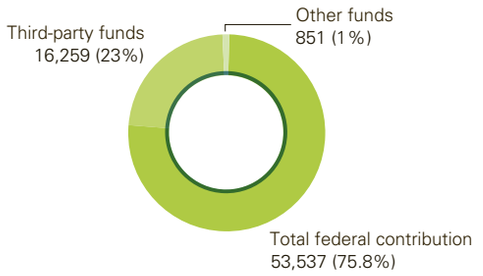
Janet Hering
Eawag Director

Eawag in figures

Finances

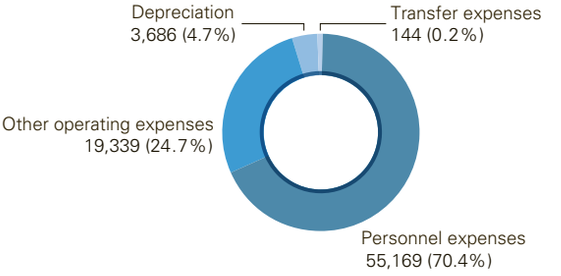
Operating revenue (CHF thousand)

70,647



Operating expenses (CHF thousand)

78,338

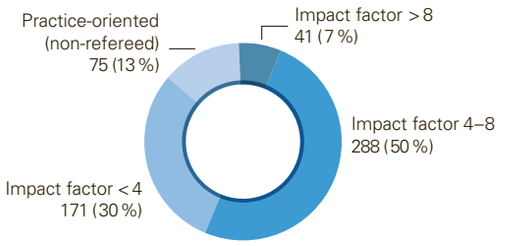


Due to rounding, individual figures may not sum to the totals shown (see Annual financial statements 2019, published separately).

Research

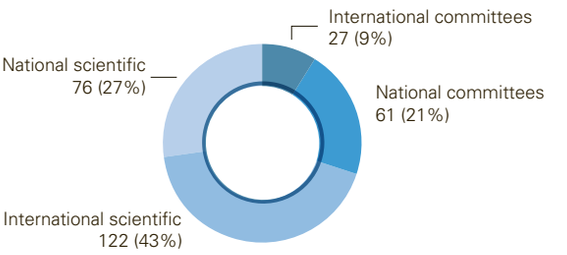
Publications

575



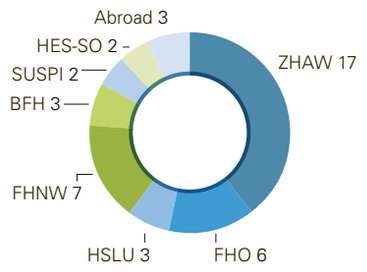
Committee memberships

286



Joint projects with universities of applied sciences

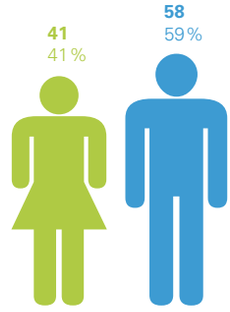
43



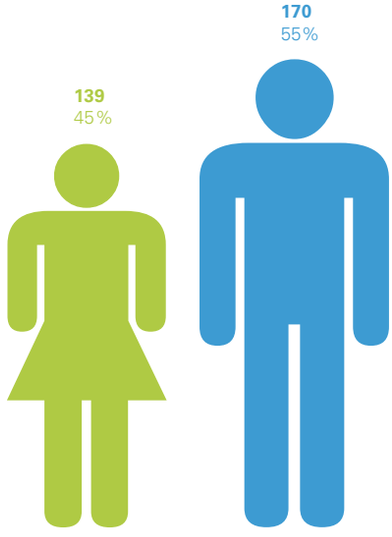
Personnel

Employees by function

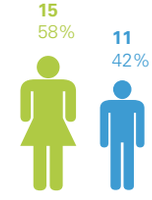
507 49.7% 50.3%



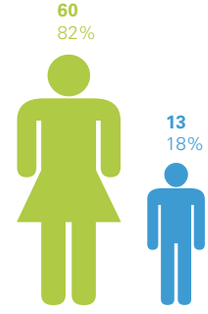
Technical 99



Science 309



Apprentices 26



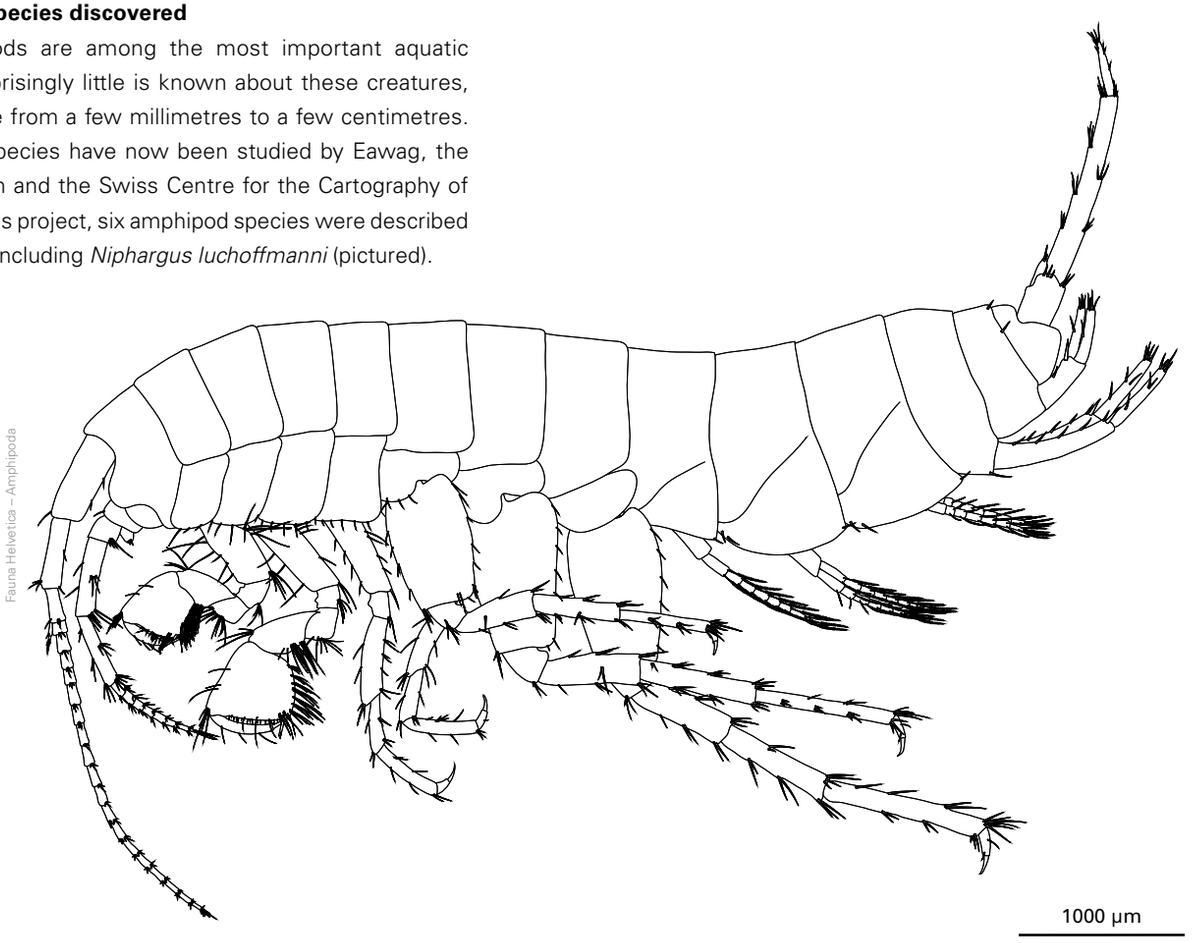
Administration 73

Annual financial statements: eawag.ch/annualreport

Highlights of 2019

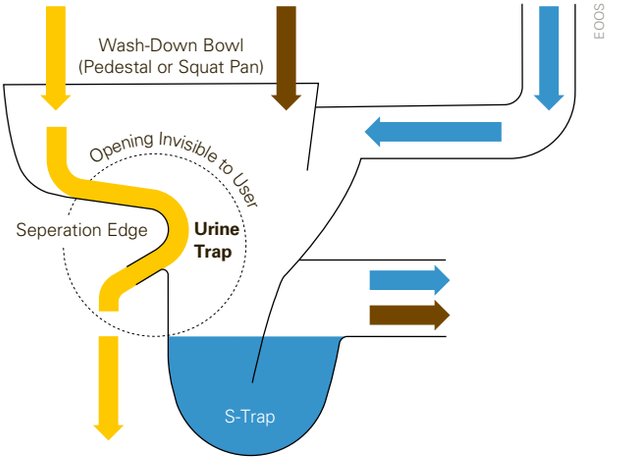
New amphipod species discovered

Although amphipods are among the most important aquatic invertebrates, surprisingly little is known about these creatures, which range in size from a few millimetres to a few centimetres. Over 40 distinct species have now been studied by Eawag, the University of Zurich and the Swiss Centre for the Cartography of Fauna (CSCF). In this project, six amphipod species were described for the first time – including *Niphargus luchoffmanni* (pictured).



Latest NoMix toilet launched

Urine contains valuable nutrients, which are usually flushed away in wastewater. For some years now, engineers at Eawag have been investigating ways of separating urine at source. The new urine diverting toilet known as "save!", developed in partnership with EOOS and Laufen, employs the breakthrough "urine trap" technology: using the teapot effect, urine is conveyed across the inner surface of the toilet bowl into a separate, concealed outlet.



“LéXPLORE” platform installed on Lake Geneva

Since February 2019, Lake Geneva has been home to a 100 m2 floating research station. On board “LéXPLORE” are a wide variety of probes and sensors, which should help scientists at Eawag, EPFL and the Universities of Lausanne and Geneva to gain a better understanding of ecological processes in the lake.

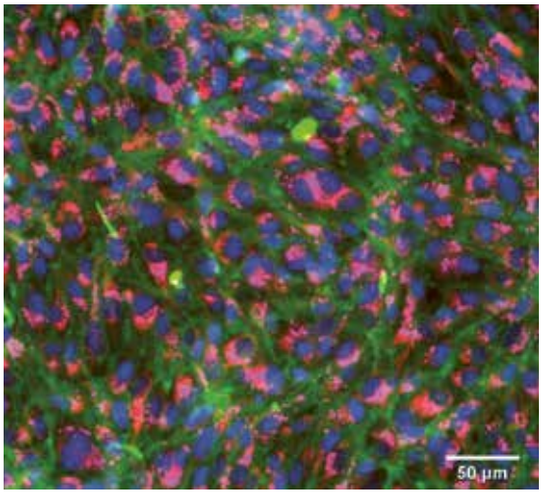
Natacha Pasche

Fish cell test internationally certified

For some years, Eawag has been exploring methods that would allow experiments with live fish to be reduced or even replaced. Now, for the first time, a toxicity test using a cultured gill cell line has received ISO certification. This test is designed to determine the acute toxicity of water samples and chemicals to fish.

Aquascope underwater camera surfaces at WEF

At an exhibition in Davos entitled “Innovation from Switzerland, for Switzerland”, Eawag, as part of the ETH Domain, welcomed WEF delegates from Swiss political and business circles. Francesco Pomati presented the Aquascope, an underwater camera which can record and automatically process images of plankton in lakes. For more information on the Aquascope, see p. 20.



Vivian Lu Tan, Eawag

Simone Kral, 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.

Pictured opposite Environmental engineer Christoph Ort (front) and environmental chemist Heinz Singer deploy a hose which will convey water directly from a stream to the trailer in the background. The trailer is equipped with a mass spectrometer which can measure micropollutants in source water almost in real time.

Mobile system measures water quality in real time

Thanks to a new instrument, water pollutants can be measured automatically over a period of weeks – directly in the field, rather than in the laboratory. The mobile mass spectrometer is housed in a trailer and can be remotely controlled by smartphone.

Aldo Todaro, Eawag

Christoph Ort (left) and Heinz Singer in the MS²field trailer.

Rain enables crops to grow, but it also causes the run-off of pesticides to rivers and streams. Concentrations of these substances in surface waters can be monitored by means of regular sampling. However, with the traditional approach – grab sampling and determination of mean values – it is rarely, if ever, possible to measure the peak concentrations associated with heavy rainfall. To address this problem, a project was launched in 2017 by Christoph Ort of the Urban Water Management department and Heinz Singer of the Environmental Chemistry department: their aim is to use a highly sensitive instrument (mass spectrometer) mounted in a trailer to measure substances automatically, almost continuously and directly in surface waters or sewers, rather than performing measurements on samples in the lab. This explains the name of the project – "MS²field" (mass spectrometer to field).

Thanks to the mobile unit, water samples no longer need to be individually collected, transported and stored at the laboratory. Instead, using a hose, the water to be analysed is continuously pumped through the trailer. Here, every few minutes, samples (a few millilitres in each case) are automatically prepared for analysis in the mass spectrometer. The instrument can identify a broad spectrum of pollutants in the water sample. Christoph Ort is enthusiastic: "This means we can follow highly dynamic processes live – even on a smartphone!"

On an initial field test in February 2019, the team led by Ort and Singer studied wastewater from the treatment plant at Fehraltorf (canton of Zurich). Over a 4-week period, the unit analysed around 2000 raw wastewater samples, revealing previously unsuspected variations and diurnal patterns. As Ort points out, "With conventional sample collection and preparation, this would have taken several months."

The measurements showed, for example, that certain substances occur in daytime during the week, but not at the weekend, indicating industrial wastewater

discharges. The temporal patterns generated by the mobile unit can also help to identify other sources of pollution, or to ensure that peak concentrations of pollutants in wastewater are not overlooked. Ort explains: "The system could also be used in future in cases where a treatment plant cannot treat all the wastewater arising during wet weather; heavily contaminated wastewater could then be retained, rather than being inadvertently discharged into receiving waters."

Ann-Kathrin McCall, Eawag

The MS²field in operation in Saint-Ursanne (JU).

What may sound straightforward is in fact a feat of engineering: operating a highly sensitive mass spectrometer in a trailer is far from trivial. According to Heinz Singer, "The system is designed for operation under optimal laboratory conditions." But temperature or moisture, for example, will be much more variable in the trailer than in the lab. Likewise, continuous power supplies and nitrogen generation need to be assured. The researchers were pleased that the mobile unit was already functioning reliably just half a year after the start of the project. That could not be taken for granted, and was largely due – Ort and Singer are both convinced – to the interdisciplinary nature of Eawag's team. In the future, the experience gained in this project should help to make mass spectrometers even more compact. Singer says: "We've learned a lot about which components can be installed in a more space-saving way and operated more energy-efficiently. The next version of our system could be less than half the size of this one." And he is sure that portable mass spectrometers for environmental applications can be expected to be available in a few years' time: "For that, we've taken an important step in this project – from the lab to the field."

Precious metal used to track nanoplastics

Tiny plastic particles about 100 nanometres (millionths of a millimetre) in diameter are used in numerous products – for example, as additives in shampoos and cosmetics. Many of them enter wastewater streams as soon as the products are used and, together with other plastics, end up in treatment plants. Here, however, it has not previously been possible to measure them. Unlike larger particles (microplastics), they cannot simply be sieved out and weighed or counted. It has therefore not been clear, except on the basis of modelling, how much nanoplastic is retained at wastewater treatment plants.

Now a group of researchers from Eawag and ETH Zurich have developed a method which allows nanoplastics to be tracked: for this purpose, they synthesised nanoplastic particles doped with the precious metal palladium. In an article published in Nature Nanotechnology, they describe how this approach was used to study, at laboratory scale, the behaviour of nanoplastics in the activated sludge process of a wastewater treatment plant. According to project leader Denise Mitrano, nanoplastic particles bind rapidly to the sludge flocs, with an elimination rate of over 98 per cent. She says: "As long as the sewage sludge is not spread on fields, but incinerated, as it is in Switzerland, very little nanoplastic material will enter the environment via treatment plants."

This is a positive finding. However, Mitrano adds: "Even if only a small percentage ends up in surface waters, this can add up to higher concentrations downstream" – especially as loads are increased by diffuse sources, such as tyre abrasion.

In an ongoing project, Eawag scientists led by Ralf Kaegi are collaborating with Zurich Waterworks (WVZ) to study the retention of nanoplastics at various drinking water treatment steps. Kaegi says: "We want to find out whether nanoplastic particles can pass through drinking water treatment at all." Laboratory experiments are currently under way; these are to be followed by experiments in WVZ pilot plants.

New pesticide detection method developed

Pesticides, insecticides, fungicides and other chemicals affect organisms in Swiss surface waters. Substances of particular concern were highlighted by various Eawag studies carried out in 2019 – partly thanks to a newly developed analytical method.

Alessandro Della Bella

Selective and sensitive analysis of pyrethroid insecticides using gas chromatography coupled to tandem mass spectrometry. Pictured here: scientific assistant Michael Patrick.

In Switzerland, watercourses in agricultural catchment areas are often heavily contaminated with plant protection products (PPPs). This was first shown in 2014 by special studies conducted by Eawag as part of the National Surface Water Quality Monitoring (NAWA) programme. In 2019, further results were presented by Eawag and its partners. The NAWA Spez programme – sponsored by the Federal Office for the Environment (FOEN) – was carried out by Eawag and the Ecotox Centre, with support from five cantons and the Water Quality Platform of the Swiss Water Association (VSA).

New measurement campaign initiated in 2017

From March to October 2017, samples collected from five small streams in a variety of agricultural catchment areas were analysed for PPPs by the NAWA Spez team. Between 71 and 89 active ingredients were detected at each site, and 145 substances altogether. Water quality criteria, derived from ecotoxicological tests for each substance, were exceeded in all five streams. For 3.5–6.5 months, stream organisms were exposed to a risk of chronic toxicity. Acute quality criteria were exceeded for between 14 and 74 days. The limit (0.1 µg/L) specified for organic pesticides in the Waters Protection Ordinance was exceeded at least once by 66 substances, including the herbicides glyphosate and mecoprop.

Analytical breakthrough

Pyrethroid and organophosphate insecticides, for instance, have neurotoxic effects even at extremely low concentrations. To date, as it has been virtually impossible to detect these substances, they have slipped through the net in water quality monitoring. Sampling and analytical procedures have to be specially tailored to these compounds – for example, significant degradation occurs within a few days in uncooled water samples.

Scientists in the Environmental Chemistry department have developed a method which permits the measurement of trace concentrations of neurotoxic insecticides: to keep losses to a minimum, the samples have to be cooled during transport to the laboratory. Here, they are prepared in such a way as to ensure detection not only of the dissolved insecticides but also of the fraction bound to particles. Gas chromatography coupled to mass spectrometry is then used to quantify the individual substances.

Measurements obtained with the newly developed method have now been published. These show that, while – in quantitative terms – pyrethroid and organophosphate insecticides account for less than one per cent of all pesticides used as PPPs in Switzerland, they are more toxic than all other PPPs combined. In five of the six Swiss streams investigated, environmental quality standards were regularly exceeded, indicating chronic and in some cases even acute risks to aquatic organisms. In the light of these findings, the federal authorities have already taken action: the use of insecticides containing the organophosphate compounds chlorpyrifos and chlorpyrifos-methyl has been banned.

Sediments also contaminated

Depending on their physicochemical properties, PPPs may also bind to stream sediments. These serve as a habitat and spawning site for many aquatic organisms and play a vital role in the nutrient cycle. However, they also appear to act as a sink for contaminants.
Because little was known about the concentrations or toxic effects of PPPs in sediments, Eawag and the Ecotox Centre also assessed the quality of sediments in the streams investigated in the 2017 NAWA Spez study. The results show that PPPs can also cause adverse effects on benthic organisms in stream sediments, with crustaceans being particularly affected.

Limit introduced for chlorothalonil metabolites in drinking water

Pesticide metabolites (transformation products) are present not only in surface waters and stream sediments, but also in groundwater. This was revealed by extensive screening of Swiss groundwater samples carried out by Eawag and ETH Zurich.

The metabolites derived mainly from pesticides used in agriculture. Thirteen were detected for the first time in groundwater, while 15 were found in concentrations above 0.1 µg/L – the limit specified for pesticides in the Waters Protection Ordinance. The scientists' attention was drawn in particular to transformation products of chlorothalonil, a fungicide used to protect cereals, vegetables, vines and ornamentals. One chlorothalonil metabolite was detected in all samples. Since 12 December 2019, all chlorothalonil metabolites have been subject to the limit of 0.1 µg/L specified for pesticides in drinking water.

Andri Bryner, Eawag

Collection of sediment samples on the Hoobach (Schaffhausen)

The presence of pesticides in streams, groundwater and drinking water is currently a contentious political matter. Two popular initiatives are seeking to improve the situation. An action plan has been adopted by the Federal Council. As an independent research institution, Eawag does not issue recommendations for referendums. However, as the sustainable management of water and waterbodies is part of its mandate, experts from Eawag are regularly invited to provide scientific advice to Parliament.

Experimental ponds: between test tube and lake

Findings from basic research in the laboratory are often not directly applicable to natural waters. At the same time, it is rarely possible to conduct controlled and replicable experiments in lakes. For these reasons, Eawag has constructed an experimental pond facility – the only one of its kind in Europe. In 2019, for the first time, biologists from the Aquatic Ecology department presented the results of research conducted at this facility.

1. The researchers created twenty miniature ecosystems, with the individual ponds containing only zebra mussels, only Eurasian watermilfoil (an aquatic plant), both of these species, or neither. Every two weeks, increasing amounts of nutrients (phosphorus and nitrate) were added to the ponds. Ponds containing neither of the species and not receiving nutrients were used as controls.

2. In the single-species ecosystems, algal growth increased (compared to the control ponds) shortly after the addition of nutrients, but then rapidly declined. But in the ponds containing both species, turbidity was significantly higher after nutrient additions, and algal growth was persistently increased. Here, cyanobacteria were also found to be more abundant than relatively harmless green algae.

3. How are these findings to be explained? Eawag biologist Narwani says: "We assume that the mussels and aquatic plants do purify the water, but mainly by removing green algae." Cyanobacteria, in contrast, are more resistant, and their growth increases as the presence of green algae decreases.

Thomas Kläper

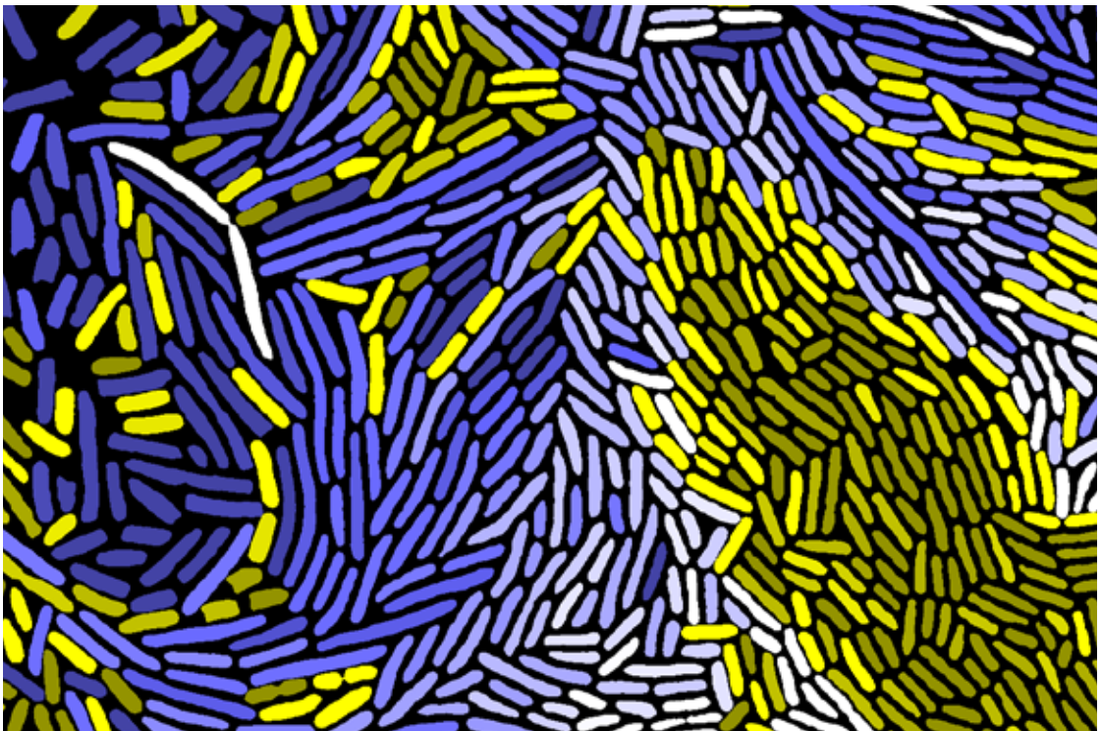
Measuring interactions in microbial communities

Microbial communities play important roles in aquatic systems. These functions generally emerge from interactions between different organisms within the community. Microorganisms are known, for example, to exchange metabolites or signalling molecules: some bacteria synthesise amino acids that others are unable to produce. These substances, required for growth, are exchanged through diffusion. However, this is only possible up to a certain distance between individual bacterial cells. The size of the interaction range was not previously known, but Alma dal Co, Martin Ackermann and colleagues from the Environmental Microbiology department have now developed a method for quantifying the strength of interactions between cells.

The new method combines microfluidics, microscopy and automated image analysis. The scientists constructed a device in which cells can grow in a controlled manner and their growth rates can be measured. Initial measurements show that bacterial cells often only interact across distances of a few thousandths of a millimetre, with the interaction breaking down almost completely beyond a range of a few cell lengths. Ackermann says: "This means a microbial community is not always able to perform metabolic processes collectively, as its activities depend almost exclusively on interactions between individual, neighbouring bacterial cells."

To make it easier to understand these interactions and how they shape the properties of microbial communities, the team also developed a mathematical model for predicting growth rates based on the amino acids present. With this approach, almost all microbial communities can be investigated: for example, the researchers are now applying the method to study microorganisms involved in the carbon cycle in aquatic ecosystems.

Alma dal Co et al. (2020)



Colour-coded microscopic image of two different bacterial strains (yellow and purple). Brighter colours indicate higher growth rates; these cells grow faster as they obtain amino acids from cells of the other type.

Origins of stickleback diversity in Lake Constance revealed

While genetic mutations are rare, new species sometimes arise fairly rapidly. How is this possible? An unexpected answer is provided by recently evolved lake and stream ecotypes of stickleback from Lake Constance.

Most fishermen barely notice the threespine stickleback – it is too small and spiny to make a good meal. But some years ago, it became impossible for fishermen on Lake Constance to ignore it, as the stickleback population exploded, and their nets were sometimes clogged with this species. The stickleback is a relatively new arrival. Historically, it was not recorded in the Lake Constance catchment; it was introduced in the 19th century, at a time when the colourful males were popular as pets.

Differences in phenotype

Today, not only have stickleback proliferated in the lake, but they can grow to a length of 11 centimetres. Their bony lateral plates and long dorsal and pelvic spines provide protection against predatory fish and piscivorous birds. Over a decade ago, Professor Ole Seehausen of Bern University (head of the Fish Ecology department at Eawag) began to investigate Lake Constance stickleback with biology students.

They were soon struck by the major differences between stickleback from the lake and those from tributary streams: stream stickleback are smaller, have reduced armour, and feed on benthic invertebrates rather than plankton.

A genome-wide analysis conducted by David Marques of the Fish Ecology department showed that the lake and stream ecotypes are not strongly differentiated genetically, except for a number of short segments across multiple chromosomes. This suggests that the ecotypes have only arisen since stickleback became established in Lake Constance about 150 years ago. But how could these genetic differences arise in such a short time?

West-East hybrids

The scientists' analyses revealed a new phenomenon in stickleback biology. Two isolated freshwater lineages evolved independently of each other over thousands of generations. These lineages colonised different catchments and had been classified as different species (the West European Gasterosteus gymnurus and East European G. aculeatus). When the lineages came into contact in the middle of a continent (the Lake Constance region), a hybrid zone formed at the boundaries between lake and stream habitats.

However, not all the streams around Lake Constance are occupied by the same type of stickleback. In the streams north and west of the lake, stickleback are of mainly West European origin. Those from streams south and east of the lake, as well as those in the lake itself, show a predominantly East European origin. Exchange of genes between West and East European stickleback in the lower reaches of streams south of Lake Constance led to the relatively rapid evolution of a new stream-adapted hybrid within the East European lineage.

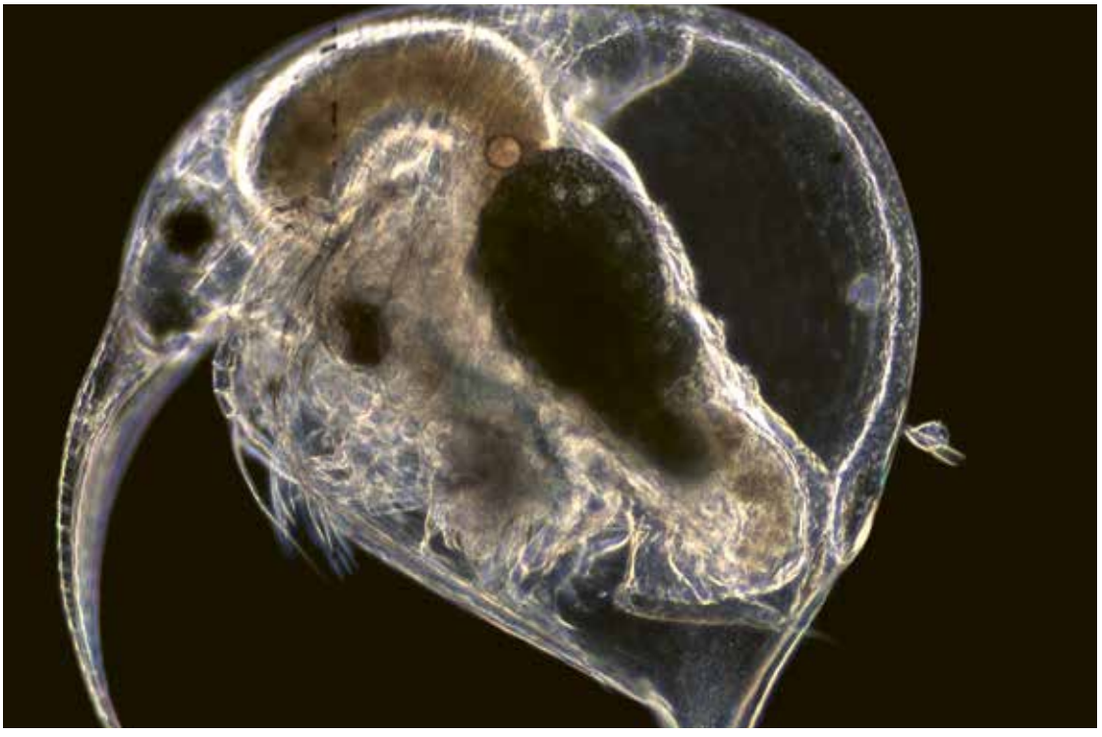
David Marques

Lake (left) and stream (right) ecotypes of threespine stickleback in Lake Constance differ in many phenotypic traits, such as body armour, feeding morphology, coloration of females (top) and nuptial coloration of males (bottom).

Aquascope: shedding light on underwater life

Since spring 2018, the newly developed underwater camera Aquascope has been recording a wide variety of plankton species in Lake Greifen. These sensitive organisms can thus, for the first time, be observed undisturbed in their natural habitat – an important step towards automated monitoring of water quality and aquatic biodiversity.

Eawag



The water flea Bosmina under the microscope. Its size is 500 to 1'000 microns.

The live images from the Aquascope reveal an amazing underwater world. Lake Greifen is home to a smorgasbord of wonderful creatures – star-shaped, cylindrical, horned or extravagantly coiffed. But as well as stimulating the imagination, the phyto- and zooplankton floating in water serves as an indicator of the ecological status of surface waters. Plankton observation is therefore of crucial importance in the monitoring of surface water quality. Here, the Aquascope can make a significant contribution. It is based on the Scripps Plankton Camera (SPC, developed by the Jaffe Laboratory for Underwater Imaging at the University of California, San Diego), consisting of a powerful LED light source and a dual-magnification underwater imaging microscope. Water, together with drifting plankton, flows freely through the space between the light source and the lenses, so that the life-forms can be observed undisturbed in their natural environment. This is a major advantage, as the sensitive organisms no longer need to be captured and removed from their habitat, with the natural aggregation of species being disrupted as a result.

Sharp images in spite of murky waters

The SPC, originally developed for marine ecosystems, was adapted for use in lakes by biologist Francesco Pomati and colleagues from the Aquatic Ecology department: "We modified the configuration of the instrument, incorporating two lenses of different magnifications and shortening the distance between light source and camera. This was to ensure that, even in turbid lake water, sufficient light reaches the objective lenses to produce sharp images." As only scattered light from the objects detected is imaged, the microorganisms appear bright against a dark background.

Since April 2018, the Aquascope has been deployed for a trial period at the research platform on Lake Greifen.

All year round, it produces one image per second for ten minutes of every hour. A computer embedded in the Aquascope transmits high-resolution images in real time to Eawag. Here, Pomati's group can analyse the images on a screen just a few minutes later.

Pomati is already looking to the future: "If the trial is successful, the Aquascope can replace the conventional method, whereby samples have to be manually collected and then sorted, identified and counted under the microscope in the lab." The researchers will thus gain new insights into the underwater world: "We can observe biodiversity and plankton community dynamics directly in the lake, with an automated, real-time procedure providing much more information." But surface water monitoring should also be simplified, as the Aquascope permits daily forecasting of biological water quality and toxic algal blooms.

Machine learning to replace time-consuming analyses

The huge volume of data, however, also creates new challenges for researchers. Pomati explains: "If we classify the plankton images by eye, we can only analyse a proportion of them." For this reason, he recently started a machine learning project, involving the physicists Thomas Lorimer, Carlo Albert and Marco Baity Jesi of the Systems Analysis, Integrated Assessment and Modelling department. The aim is to make automated classification possible in the future. For this purpose, algorithms are being developed and trained on imaging data to identify species and interesting properties of plankton. But, as Pomati notes, "Rare plankton species, in particular, are not easy to cover, as here we only have a few images."

Jonas Steiner

Eawag researchers sink the Aquascope in Lake Greiffen, to capture the underwater life.

Swiss freshwater ecosystems and climate change

Climate change is leading to increased temperatures in surface waters. At the same time, associated shifts in seasonality affect the mixing of lakes. Such direct physical effects of climate change are scientifically well understood and predictable. But how will biological systems react to these changes? And how will indirect effects, such as altered land use, affect surface waters? On behalf of the Federal Office for the Environment, Florian Altermatt of the Aquatic Ecology department and Christian Stamm of the Environmental Chemistry department investigated the impacts of climate change on freshwater ecosystems in Switzerland. For this study, they conducted extensive literature surveys – also considering international studies of ecosystems similar to those in Switzerland – and expert interviews.

Altermatt says: "The report summarises available knowledge, for example, on how rising water temperatures can affect the distribution of fish species and other aquatic organisms, or how algal blooms can occur as a result of changes in lake mixing." No less important, however, than direct effects of climate change, though more difficult to assess, are indirect impacts: will a warmer climate lead agriculture to shift increasingly towards crop production rather than livestock farming, with new material flows or pesticide inputs arising as a result?

Although considerable efforts are being made in Switzerland, the impacts of climate change on flora and fauna can scarcely be prevented. There is no doubt about the consequences for biodiversity: species tolerating warm and dry conditions are more likely to flourish. The retreat of cold-adapted species to higher elevations will only be possible if the connectivity of watercourses is assured. The findings of the report are applicable to alpine systems worldwide.

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.

Pictured opposite The now traditional forest project week in Bergün (canton of Graubünden) gives new apprentices an opportunity to get to know each other and their supervisors. During this week, the apprentices work hard, repairing game reserve fences, for example, or old paths. The project week is organised each year by the Vocational Training department together with the Mountain Forest Workshop Foundation.

Our apprentices: tomorrow's skilled workers

For many years, Eawag has provided vocational training for laboratory technicians, business administrators and computer scientists. In its training programme for laboratory technicians, Eawag collaborates with external partners such as Bachema and Coca-Cola. In 2019, nine young people successfully completed their apprenticeship, and ten apprentices started their training at Eawag in August. *The profiles were written by second-year trainee business administrator Melanie A. Gonzalez.*

Peter Penicka, Eawag

Ifedayo Ogunsola
Computer scientist (Federal Certificate of Proficiency/EFZ) Systems engineering third-year trainee

When Ifedayo (better known as Dayo) is not setting up computer systems for Eawag staff or monitoring networks, you'll find him on a football pitch. He plays on the A Junior team at FC Kilchberg-Rüschlikon, where he also referees games for the D Junior team. He chose to train as a computer scientist because he likes to see the results of his work at the end of the day – for example, newly developed software. "I particularly like the open and friendly working environment at Eawag," says Dayo.

Peter Penicka, Eawag

Soraya Oesch
Business administrator EFZ Services and administration, third-year trainee

A leaflet about Eawag's research and environment-friendly attitude made Soraya curious enough to apply. Now in her third year, she especially appreciates the good preparation for the final exams – as well as the new friendships, which, she says, "will certainly continue after the apprenticeship". To de-stress from her office work, she goes dancing five times a week (jazz, dancehall, locking and ballet). When she finishes her training, she'd like to do a three-year dance course, and then travel round the world as a professional dancer.

Peter Penicka, Eawag

Severin Stierli
Laboratory technician EFZ Specialising in Biology second-year trainee

"Ever since I was a child, I've wanted to be a marine biologist," says Severin. He'd always been interested in biology and, after a few taster days at various institutes, he chose to train at Eawag – attracted by the welcoming working environment. Now he enjoys being part of a team collecting water samples from Lake Greifen, and then analysing the zooplankton they contain. After his apprenticeship, he'd like to do the "passerelle" (bridging) programme, so he can then study Biology and realise his childhood dream abroad.

Peter Penicka, Eawag

Nadine Fritschi
Laboratory technician EFZ Specialising in Chemistry second-year trainee

"My mum did her apprenticeship at Eawag, too," says Nadine. And it was on National Future Day that she decided to follow in her mother's footsteps. Now she assists researchers, for example, in collecting water samples, preparing solutions and processing sediment cores. But what she enjoys most is working with the ion exchange chromatograph. In her free time, Nadine – a member of the Turnverein Volketswil – is a keen gymnast. After her apprenticeship, she'd like to go to Australia to improve her English.

First Swiss Machine Learning Workshop

Machine learning has become indispensable for environmental research. But as well as opening up exciting new possibilities, this approach poses certain risks.

In January 2019, over 120 scientists attended the first Swiss Workshop on Machine Learning for Environmental and Geosciences (MLEG), which was organised by Eawag, together with ETH Zurich, WSL and other partners. The two-day event was designed to promote networking within the Swiss scientific community in this field. The first day consisted of a machine learning tutorial, including hands-on programming. On the second day, international experts discussed the opportunities arising from machine learning in environmental and geoscience research.

Emerging data protection risks

Machine learning relies on large volumes of data; in the area of urban water management, for example, this may include images of flooding, rainfall data, or wastewater data from individual households. However, the use of these huge data troves poses risks to personal privacy, as noted by researchers from the Urban Water Management department in their publication "Smart urban water systems: what could possibly go wrong?". For water and wastewater data provide information on, for example, users' habits – when they are at home, how much water they consume and at what times, and even highly sensitive matters such as what medications or drugs are used in a household. Such data needs to be securely transmitted and, above all, protected against unauthorised third-party access.

Peter Penicka, Eawag

One of the organisers of the Workshop was João Leitão of the Urban Water Management department. In his research, he focuses, for example, on the development of urban flood models to improve the assessment of flood risks, using large amounts of data.

Machine learning is becoming an increasingly important research topic – why is that?

It's not in fact a completely new research field – initial efforts date back to the 1950s – but recent advances in data collection and computing capacity permit ever more interesting and diverse applications. Environmental and geoscientists have now started to recognise and exploit the potential of machine learning.

What's the difference between machine learning and artificial intelligence?

These are two fundamentally different approaches. Artificial intelligence means that computers are programmed so that they can adapt to different situations. In contrast, machine learning concentrates on the idea of training computers to process data without constant human supervision.

In your view, what new opportunities does machine learning create for aquatic research?

Firstly, repetitive tasks can be automated, such as recognising objects in images. Secondly, data-driven models can be developed which can deliver results much faster than physical models. But it's important not to underestimate the amount of high-quality data these models require. That's essential to enable generalisation.

At Eawag, I learned to take the initiative if necessary.

Matteo Bonalumi (38), a Ticinese, studied Geology at ETH Zurich. After writing his doctoral thesis at Eawag, he worked for the Bern cantonal authority responsible for awarding hydropower concessions. In spring 2019, he joined the Federal Office of Energy, where he deals with applications for subsidies for the renovation and expansion of small-scale hydropower plants.

Andri Bryner, Eawag

Matteo Bonalumi completed his doctoral thesis at Eawag eight years ago. Since then, his professional interests have continuously expanded: as well as the impacts of hydropower on surface waters, he has focused on legal aspects and, most recently, economic considerations. His time at Eawag, he now says, strengthened his understanding of the connections between areas which are often dealt with separately.

Geologist Matteo Bonalumi initially opted for warm water: in his ETH diploma dissertation, he investigated hydrothermal systems in Iceland. But in his doctoral thesis – forgoing the pleasures of bathing in the Blue Lagoon near Reykjavik – he turned his attention to the cold reservoirs of the Swiss mountains. In an interdepartmental project at Eawag, he studied how pumped-storage operations at hydropower plants affect the upper and lower reservoirs – in particular, how the passage of water through turbines and subsequent upward pumping affects temperature and turbidity in the two lakes concerned. In the case of the planned – but not yet realised – hydropower plant in Poschiavo (canton of Graubünden), for example, Bonalumi showed how substantially the period of ice-cover on the upper lake (Lago Bianco) would be shortened and how frequently the clear blue waters of the lower lake (Lago di Poschiavo) would become turbid.

Stimulating – but also challenging – environment

Today, more than eight years after completing his thesis, Bonalumi still looks back with great satisfaction on his time at Eawag: "We had a super team, but in spite or precisely because of that, I learned during that period to work independently and to take the initiative if necessary." This is a tribute to his colleagues, but also in particular to his supervisors, who, he recalls, always provided critical but positive support and encouragement. He admits: "I was glad to be working on such a practical topic. The prospects of achieving results that are applicable in practice are not so good in every dissertation."

Particularly useful in his case was the knowledge he gained about hydropower plants, and the experience of dealing with plant operators. For, after leaving Eawag, he spent seven years working for the Bern cantonal authority responsible for awarding hydropower concessions. Sometimes, he reflects, what was needed most were social skills, in order to find a viable course between all the various perspectives of plant operators, environmentalists, policymakers and authorities.

Since spring 2019, Bonalumi has been responsible at the Federal Office of Energy for reviewing applications for subsidies for the renovation and expansion of small-scale hydropower plants. He remains attached to Eawag, subscribing to the newsletter and attending the annual Info Day. But what he appreciates most are direct contacts with ex-colleagues: "I still go out for an after-work drink with several of them."

Win-win for students and supervisors

Each year at Eawag, around 140 Master's students are supervised and often directly involved in research projects. Again and again, this integration – as well as Eawag's flat hierarchies and interdisciplinary culture – leads to outstanding Master's theses.

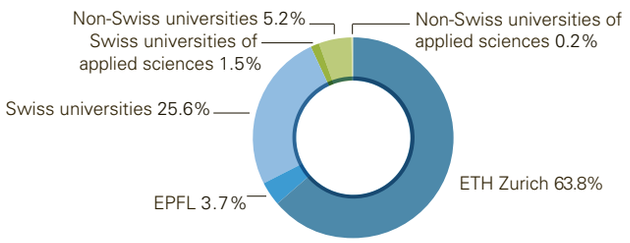
At Eawag, Master's theses are normally integrated into research projects, which gives students the advantage of working within a set framework but still having the flexibility to inject their own perspective. This was particularly valued by Dominik Boller, who received an ETH award for an excellent Master's thesis in Environmental Engineering: "I had a great deal of freedom to put my own ideas into practice. The openness of the researchers, and also the ultra-flat hierarchies, were very motivating. You were never afraid to ask critical questions." Fellow ETH award winners Livia Britschgi and Viviane Furrer found it invaluable to be able to go directly to group leaders and ask questions, and they welcomed the support they received with setting up their experiments in the workshop.

The supervisors also benefit from the collaboration with Master's students, who constantly bring fresh perspectives, and will sometimes introduce new approaches or methods. Samuel Renggli, a supervisor in Eawag's Sandec department, enjoys seeing how original ideas are developed and uncertainties overcome: "Master's students can already conduct real research, and at best this can be useful for the entire research project".

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.

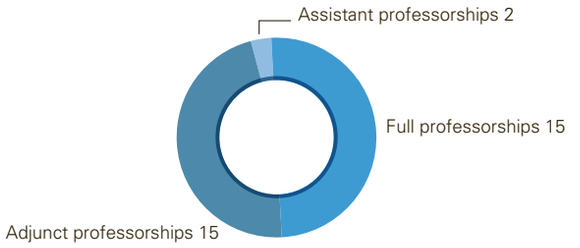
Tertiary-level teaching

4539 h



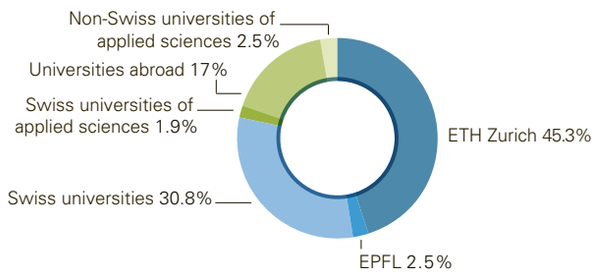
Professorships

32



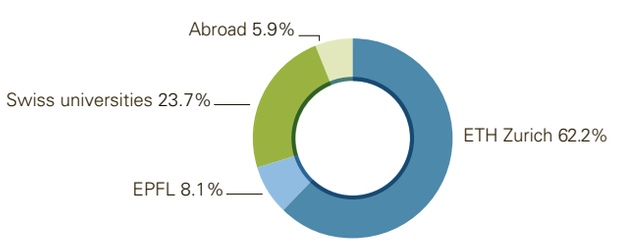
Bachelor's and Master's theses supervised

159



Doctoral theses supervised

135



Golden Owl for Lenny Winkel

Each year, the ETH Zurich Students Association (VSETH) awards the Golden Owl to lecturers showing outstanding dedication. Based on an online student survey, one lecturer per department is selected by the VSETH study associations. In the Department of Environmental Systems Science, the award went in 2019 to Lenny Winkel, head of the Environmental Inorganic Geochemistry group in the Water Resources & Drinking Water department at Eawag, who has been Associate Professor of Environmental Inorganic Geochemistry at ETH since 2018. In the Environmental Sciences Bachelor's degree programme, she organises the practical training in Biogeochemistry and lectures on Chemistry of Aquatic Systems. In the Environmental Sciences MSc programme, she lectures on Biogeochemistry of Trace Elements and runs two scientific training courses.

Lenny Winkel was delighted to receive this award: "It's a kind of audience prize – that's a gratifying recognition of my work." For Winkel, teaching is an ideal complement to research, helping her to engage in continuous self-reflection. She appreciates the contact with and direct feedback from students and is very interested in hearing their views: "Different perspectives give me new inputs for my research work." Her aim is to enable students to think critically: "They should realise that, in the environmental sciences, nothing can be viewed in isolation. That's why it's important for me to give them an understanding of complex relationships and interactions."

Peter Penicka, Eawag

Massive open online courses: a success story

Since 2014, Eawag in partnership with EPFL has offered free online courses on the topics of household water treatment, sanitation systems, municipal solid waste management and faecal sludge management. These four courses make up the MOOC series "Sanitation, Water and Solid Waste for Development".

Interest in the courses has grown steadily. In 2019, for the first time, the total number of people enrolled was over 100,000. Around 66,000 participated regularly, while 11,200 completed a course. The MOOCs are particularly popular among professionals and students in Africa, Asia and Latin America. The success of the programme is due, not only to the relevance of the topics, but also to the ease of access (via the online platform Coursera), attractive content presentation and straightforward progress checks. The short modules consist of videos and readings. Learners can test their knowledge by taking a quiz – and, if necessary, repeat the module. Those who have completed all four courses obtain a free Statement of Accomplishment.

In collaboration with the International Committee of the Red Cross (ICRC), Eawag has also developed the MOOC "Introduction to Public Health Engineering in Humanitarian Contexts". This explains how engineers and technical specialists in water, sanitation, energy and environment can help to improve living conditions in humanitarian emergencies.

For two years, the MOOCs have increasingly been adopted by partner universities in Africa, Asia and Latin America. They generally use the so-called blended learning approach, combining online materials with classroom teaching, field trips or project work. This approach is extremely popular with learners, as it makes it possible to combine the strengths of digital and traditional formats.
The online courses can be accessed at
www.eawag.ch/mooc


Aldo Tästaro, Eawag

Consulting

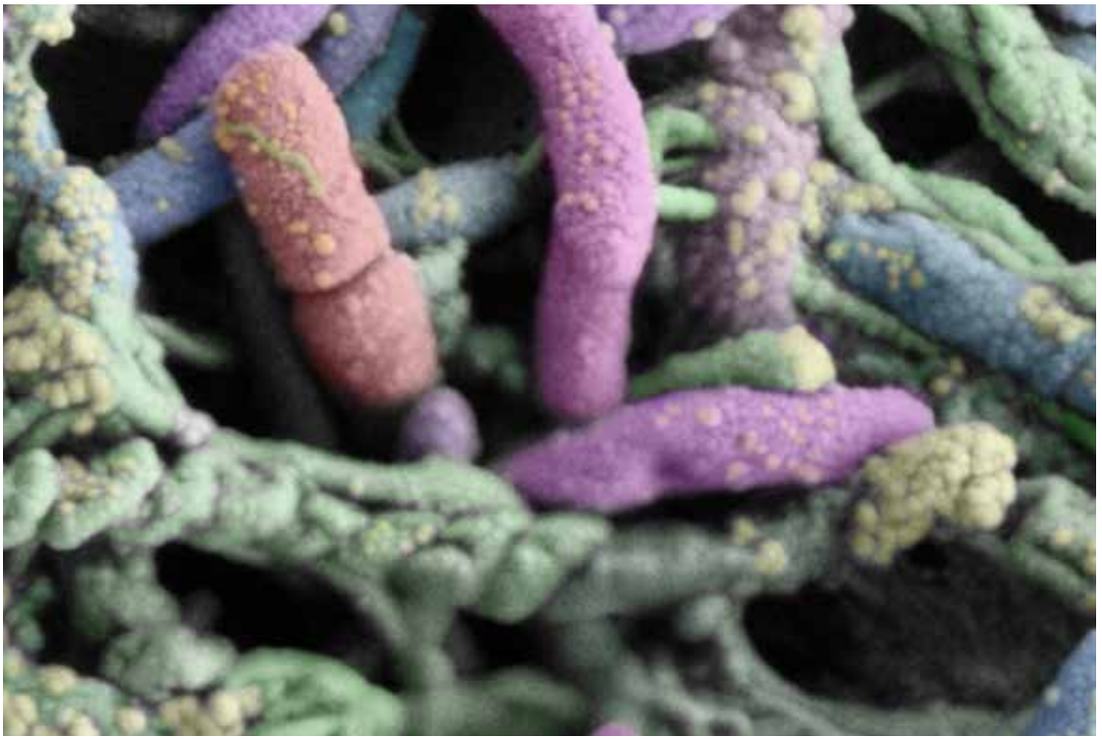
Eawag scientists collaborate with water professionals in numerous projects and provide technical input to a wide variety of national and international bodies. In addition, they serve on expert committees and take on consulting contracts. Eawag also operates various Competence Centres, further promoting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

Pictured opposite Franziska Rölli of Lucerne University of Applied Sciences and Frederik Hammes investigate how pathogenic Legionella bacteria develop in drinking water. This involves analysing water samples from various hot water pipes.

Legionella at Eawag: how researchers made a virtue of necessity

Inhalation of Legionella bacteria – which thrive in hot shower water – can cause illness. In a multidisciplinary project, Eawag scientists are studying how the risks associated with these bacteria can be controlled, using their own building as a test case.

Frederik Hammes und ZMB, UZH



Electron micrograph of bacterial communities in a shower hose.

Legionnaires' disease, a severe form of pneumonia, is becoming more common in Switzerland: 582 cases were recorded by the Federal Office of Public Health (FOPH) in 2019 – twice as many as in 2013. In 5–10% of cases, the disease is fatal, despite treatment with antibiotics.

The causative agent is Legionella pneumophila, a type of bacteria found in water. While contaminated water is safe to drink, problems may arise if water droplets are inhaled. This can occur wherever such droplets are formed – in car wash facilities, air-conditioning cooling systems or industrial cooling towers. Under certain conditions, however, Legionella can also develop in drinking water, making fountains, steam baths and showers potential sources of infection.

Eawag building just one among many

In 2017, scientists detected legionella in Eawag's research building at Dübendorf. Legionella counts in the hot-water supply system, including showers, exceeded the legally specified limit. The measurements were part of a case study carried out by research groups led by Frederik Hammes of the Environmental Microbiology department and Franziska Rölli of the Institute of Building Technology and Energy, Lucerne University of Applied Sciences. Hammes recalls: "We wanted to find out to what extent Legionella in drinking water is a problem." They had chosen the Eawag building because samples could be readily and straightforwardly collected. In addition, the building management was interested and ready to find a solution.

Further projects followed, and it became clear that Eawag was not an isolated case: "Many large and small buildings have similar problems with Legionella in drinking water," says Hammes.

Ideal temperature between 35 and 40 degrees

But how do these pathogens enter building plumbing systems? Most bacteria and nutrients are removed at the central treatment plants which provide municipal

water supplies. Concentrations also remain low in the distribution networks which convey drinking water to buildings. "But then things becomes more problematic," says Hammes: water is heated in buildings, and as legionella bacteria grow best at temperatures between 35 and 40°C, they can colonise hot-water systems.

Although Legionella can be killed by heating water to 60°C, this temperature is rarely attained in showerheads, for example. In addition, in order to save energy, boiler temperatures in many buildings are set below 60°C. This was also the case at Eawag, where the water temperature in the boiler was set at 45°C. In 2018, as a remedial measure, the temperature for the entire hot-water system was raised to 60°C. "The high Legionella concentrations disappeared immediately," says Hammes. Since February 2019, no more critical levels have been detected anywhere in the Eawag building.

Unanswered questions

The solution is not, however, always so simple. Many questions have yet to be resolved – for example, how precisely the occurrence of Legionella and human infection are related, or how Legionella can be most effectively detected in drinking water pipes. For this reason, the Federal Food Safety and Veterinary Office (FSVO), the Federal Office of Energy (SFOE) and the Federal Office of Public Health (FOPH) are now providing CHF 2.5 million in funding for a 4-year multidisciplinary Eawag project. Participating alongside the Eawag research groups led by Frederik Hammes (Drinking Water Microbiology) and Tim Julian (Pathogens & Human Health) are Lucerne University of Applied Sciences (HSLU), the Swiss Tropical and Public Health Institute (Swiss TPH) and Zurich Cantonal Laboratory (KLZH).

Julian, in collaboration with Swiss TPH, is studying the relationship between Legionella counts in shower water and the incidence of legionnaires' disease. More specifically, using mathematical modelling, they wish to determine the likelihood of infection at various Legionella concentrations.

The project will also be focusing on the improvement of sampling. For, in a federal ordinance which came into effect in 2017, a limit of 1000 colony forming units per litre is specified for Legionella in showers accessible to the public. But bacterial community composition in plumbing systems varies, which complicates sampling. Franziska Rölli of HSLU says: "To increase the reliability and comparability of samples, we need to optimise and standardise collection methods." She also emphasises the importance of awareness-raising and communication: architects, planners, plumbers and building operators are often not sufficiently familiar with the issue of legionella. Accordingly, in addition to research activities, the project consortium is committed to disseminating new findings – for example, via workshops or seminars.

3D model predicts lake water temperatures

Since 2019, it has been possible to find information on water temperatures in Lake Zurich – current values and estimates for the coming hours and days – by consulting www.meteolakes.ch. Here, a publicly accessible 3D model developed by Eawag and EPFL scientists estimates lake water temperatures, using current and forecast meteorological data from MeteoSwiss and hydrological data from the Federal Office for the Environment, as well as satellite data. Temperatures are calculated for various depths, with a temporal resolution of three hours, and looking five days ahead. Previously, the online platform only covered Lakes Geneva, Biel and Greifen; now, Lake Zurich has been added.

Underlying the Meteolakes platform is the CORESIM project, led by Damien Bouffard of the Surface Waters department. The researchers' aim is to provide added value for other scientists, since only monthly measurements are currently available for many lakes. Thanks to Meteolakes, scientists wishing to combine their own data – e.g. on nutrient distribution – with lake physics can now access high temporal resolution data.

Unravelling complex relationships between humans and nature

A new social-ecological approach allows complex relationships in ecosystem governance to be modelled as abstract but easily understandable networks.

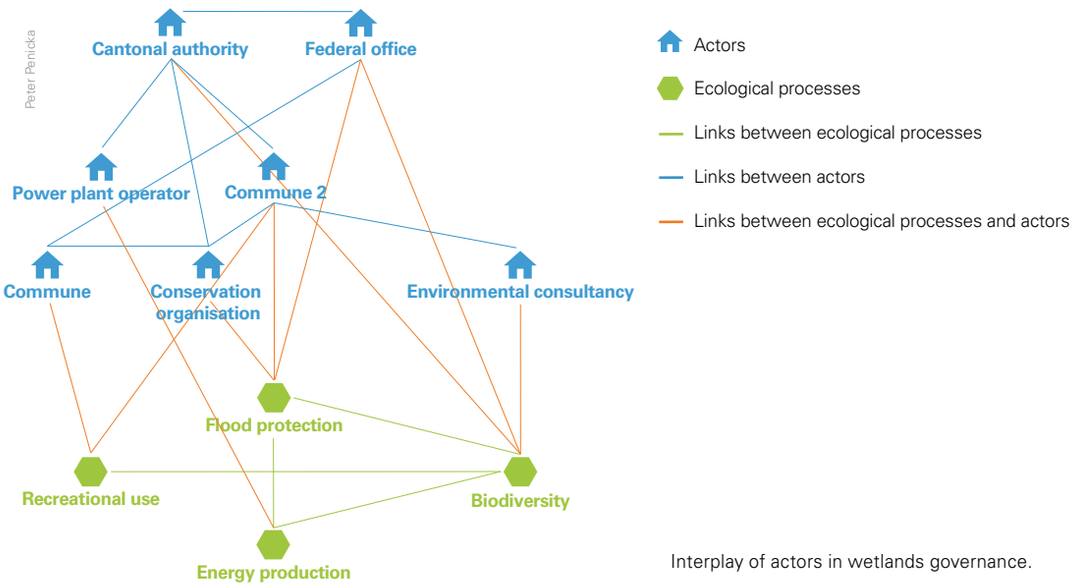
Environmental problems are generally complex, and the ecological processes and actors involved are often closely interlinked. Social-ecological networks make it possible to untangle such complex relationships. In these networks, social and ecological components and the interactions between them are represented as nodes and links.

This approach is being used to study ecosystem governance by political scientist Manuel Fischer and his research group in the Policy Analysis and Environmental Governance cluster of the Environmental Social Sciences department. Fischer explains: "Our aim is, firstly, to provide organisations with information to help them better coordinate their activities. Secondly, this approach enables us to compare various ecosystem governance situations and identify structural determinants of successful governance."

Social-ecological networks in Swiss wetlands governance

In the Wetlands project, the researchers are studying twelve alluvial plains in Switzerland. The new approach adopted involves analysing, not the spatial connectivity of wetlands, but the functional interactions between ecosystem governance topics such as flood protection, recreation, energy production and biodiversity. The multiplicity of actors gives rise to an intricate social-ecological network. Fischer says: "We're now investigating how such a network needs to be structured to permit good governance of wetlands." Is it beneficial for flood protection if the canton and tourism work together? Does the lack of contact between power plant operator and environmental consultancy prevent effective species conservation? And why do certain actors successfully coordinate their efforts while others do not, even though the areas concerned are interdependent. "We're eager to see the results," says Fischer. "We currently suspect that, apart from technical reasons, human factors often play a role, such as power struggles, conflicting interests or empathy."

The Eawag team is part of an international scientific group promoting further development of the network approach. In an article entitled "Improving network approaches to the study of complex social-ecological interdependencies", published in Nature Sustainability in summer 2019, the group presents some unifying research design considerations to facilitate comparison across case studies using a network approach. In addition, the authors propose a typology of causal assumptions, which should permit the development of generalisable theories.



Interplay of actors in wetlands governance.

Alternative to animal experiments: fish cell test internationally certified

For the first time, a toxicity test using a cultured fish gill cell line has received ISO certification. The test is designed to determine the acute toxicity of water samples and chemicals to fish. This marks a milestone, given the current lack of recognised alternatives to experiments with live fish.

Basil Stücheli/ETH-Rat

Researchers Melanie Fischer (left) and Kristin Schirmer. Displayed on the screen is a micrograph of the rainbow trout gill cell line.

In 2017, more than 7,500 ecotoxicity tests were carried out on fish in Switzerland alone. For some years, Eawag has been exploring alternative methods in order to reduce or even replace experiments in live animals. One such method, involving cultured rainbow trout cells, is the RTgill-W1 cell line assay. This can be used to determine the acute toxicity of water samples and many chemicals to fish.

In recent years, the method has been continuously refined by scientists in the Environmental Toxicology department, led by Kristin Schirmer. The robustness and transferability of the assay has now been examined in an international round robin study, focusing on six selected chemicals and involving six industrial and academic laboratories. The reliability of the method was confirmed by the assessment of repeatability (intra-) and reproducibility (interlaboratory variability). In 2019, the method was also published as an ISO standard. For this work, Kristin Schirmer and lab technician Melanie Fischer received the 2019 3Rs award from the Swiss 3R Competence Centre. 3RCC promotes efforts to replace, reduce and refine animal experimentation (the 3Rs principle).

The researchers now aim to make the test completely free of animal components – at present, fetal bovine serum is still required for cell growth. For this project, Kristin Schirmer has been awarded funding of around CHF 250,000 from 3RCC.

Thallium: highly toxic, but little studied

One of the heavy metals naturally present in soils is thallium. Since little is known about its environmental behaviour, a research group from the Water Resources & Drinking Water department has been studying this metal in detail..

Aldo Todaro, Eawag

Doctoral student Silvan Wick (right) and lab technician Numa Pfenninger analysing thallium in soil samples.

In Agatha Christie's novel The Pale Horse, the victims die of thallium poisoning. The author describes the action of the poison: the initial symptoms are similar to those of influenza; later signs include hair loss and stripes on the fingernails – at which point it is too late to administer an antidote. Precisely because thallium poisoning is difficult to diagnose, this odourless, tasteless substance was once a popular murder weapon.

But as well as being found in poisoned cocktails, this metal – toxic to humans in minute doses – enters the environment as a result of industrial processes such as cement production, metal mining and coal combustion. Thallium can also accumulate naturally in soils and is found at certain sites in Switzerland. In 2013, for example, the Office of Environmental Protection and Energy of Canton Basel-Landschaft discovered that soils at Erzmatt near Buus contain exceptionally high levels of naturally occurring thallium, with concentrations of up to several thousand milligrams per kilogram. Thallium concentrations in soil typically range from 0.01 to 1 milligram per kilogram.

Scientific studies almost non-existent

Geochemist Andreas Voegelin of the Water Resources & Drinking Water department learned by chance of the thallium rich soil at the Erzmatt site. Having reviewed the scientific literature, he concluded that very little was known about the environmental behaviour of thallium. Since then, his research group has been studying this metal.

The group's first project sought to establish in what chemical form thallium occurs in soils from Erzmatt. This information can help to determine the solubility of thallium in soil, and whether it could potentially be absorbed by plants or enter groundwater. It was found that, in deep soil layers, thallium is mainly bound in weathering products of ores. In topsoils, by contrast, a large fraction of the metal is fixed in the clay mineral illite, but it is also bound to manganese oxides. Four years ago, geologist Silvan Wick joined

Voegelin's group, as a doctoral student, to investigate the chemical reactions between thallium and illite and manganese oxides in laboratory experiments using pure minerals and Erzmatt soils. The doctoral thesis was a joint project involving Eawag, the Paul Scherrer Institute and ETH Zurich. To analyse the binding of thallium, Wick used methods such as X-ray absorption spectroscopy at synchrotron light sources. He explains: "The models resulting from this work make it possible to estimate the solubility of thallium in soils on the basis of soil composition." For the Erzmatt site, it was also shown that the relatively low solubility of thallium can be attributed to the fact that, in the course of soil formation, the metal was largely integrated into the structure of the clay mineral illite.

Geogenic thallium also present in other regions

Andreas Voegelin says: "Because no limits have been specified for thallium in Switzerland, this heavy metal is not normally determined in environmental samples." Following the discovery at the Erzmatt site, the question arose whether elevated concentrations of thallium could also occur elsewhere. Over the past two years, Voegelin and lab technician Numa Pfenninger have therefore analysed drinking and stream water in the Baselbieter Jura region and in neighbouring communes. Their findings corroborate the conclusions of a study carried out by the Federal Office of Public Health: in Northwestern Switzerland, elevated concentrations of geogenic thallium may occur in water. However, the levels measured are always well below the US drinking water limit of 2 micrograms per litre and thus do not pose any risk to human health.

Urine fertiliser: mobile unit on tour

Urine contains valuable nutrients, such as nitrogen, phosphorus and potassium. For this reason, a few years ago, Eawag developed a method for producing a fertiliser from urine. The Eawag spin-off Vuna is now working on a mobile treatment unit.

Urine-diverting toilets – already in use at open-air events, on building sites or in Alpine huts – provide an ideal basis for urine fertiliser production using the Vuna method: after the removal of pharmaceutical residues, hormones and microorganisms, a highly concentrated solution is produced, in which the nutrients are retained. The final product – the liquid fertiliser Aurin – has been approved by the Federal Office for Agriculture since 2018 for both ornamental and edible plants.

"In many places, urine volumes are too small to operate an on-site treatment plant," says Nadège de Chambrier of Vuna. With support from the Federal Office for the Environment and Eawag, the spin-off has therefore developed a compact mobile unit which can treat up to 150 litres of urine per day. At the same time, the engineers have optimised the process: new sensors monitor the nitrite content, which is crucial for process stability. De Chambrier explains: "Previously, a lot of things had to be measured and controlled by hand. For the mobile unit, we've now automated the process." As a next step, production costs are to be further reduced. The VUNA team is now taking the "UrinExpress" on tour. The aim is also to demonstrate the effectiveness of the process to potential clients for permanent installations. One of the first stops will be the new lawn tennis courts in Biel. The tour may then continue to Paris, where urine recycling is attracting a lot of interest as wastewater treatment capacity reaches its limits.

Nadège de Chambrier

The UrinExpress at the Martinimarkt fair in Zurich.

Improved health check for rivers

Benthic macroinvertebrates are closely watched, since they serve as indicators of the ecological status of rivers and streams. A Swiss-wide Eawag study shows which species are particularly significant and how monitoring and river management can be further improved.

Turn over a stone in a river or stream and you'll find a host of tiny creatures – caddisflies, water beetles, amphipods and snails. These streambed invertebrates visible to the naked eye – known as benthic macroinvertebrates – may seem unremarkable, but they are of major importance as indicators of water quality. For some of these species are sensitive to changes in the environment, responding for example to pollutant inputs or engineered bank structures. Macroinvertebrate diversity can thus provide important information on water quality and ecological status. In some cases, conclusions can even be drawn as to the causes of habitat degradation.

Peter Penicka, Eawag

Bogdan Caradima (left) and Nele Schuwirth analyse the benthic macroinvertebrate datasets.

Swiss-wide modelling analysis of macroinvertebrates

Now, for the first time, Eawag scientists Nele Schuwirth and Bogdan Caradima, together with colleagues from the Systems Analysis, Integrated Assessment and Modelling department, have performed a comprehensive analysis of cantonal and national data on benthic macroinvertebrates. For this purpose, they used the macroinvertebrate database MIDAT of the Swiss Centre for the Cartography of Fauna (CSCF/SZKF), which contains data from the Swiss Biodiversity Monitoring (BDM), National Surface Water Quality Monitoring (NAWA) and 14 cantonal monitoring programmes.

Using statistical models, the scientists analysed the datasets and identified key variables directly and indirectly influencing the occurrence of individual species. These included water temperature, insecticide use in the catchment, flow rate, settlement area and livestock units in the catchment.

Recommendations based on the results of the analysis

- Identification of causes via determination of species: since 2010, studies and assessments of benthic mac roinvertebrates in Swiss watercourses have been carried out using the Modular Stepwise Procedure. Under this procedure, organisms are to be recorded at the family level. The study points out that a higher taxonomic resolution (i.e. species-level identification) would provide valuable additional information.
- More data, greater reliability: The more data is available for the analysis, the more reliable are the results. For future analyses, it is therefore essential that data from as many monitoring programmes as possible, as well as additional information (e.g. substrate data), is submitted to the MIDAT database.
  Standardised monitoring plans: At present, in cantonal programmes, different groups of benthic macroinvertebrates are recorded down to species level. However, for a Swiss-wide analysis, it would be useful to consistently record the same groups at this high taxonomic resolution.
- Extension of monitoring: To improve the identification of key variables influencing aquatic ecology, it would be worth including additional sites in the monitoring programmes. Integrated watershed management: aquatic flora and fauna are usually sensitive to multiple stressors, such as poor water quality, consistently high flows and increased water temperatures. In order to improve water quality and ecological status, it is therefore advisable to adopt a variety of measures – for example, river restoration combined with upgrades to wastewater treatment plants.

Drinking water compendium to support collaborative planning

UN Sustainable Development Goal (SDG) 6.1 calls for universal access to safe drinking water – and 780 million people are still waiting for this goal to be achieved. A new compendium should help stakeholders to develop sustainable drinking water systems.

Sandra Gujer, www.illuhouse.ch

The illustration shows various possible drinking water systems and technologies for water treatment and distribution.

What sources of drinking water are available? Would household filters match local customs, or would a village be better served by a water kiosk? The answers are best known to the local population. For this reason, it is essential that NGOs involve the community in the planning of drinking water systems. Other stakeholders include the regional authorities who grant the necessary approvals and, ideally, also contribute funding. "In this process, experts often encounter people without a technical background," says Maryna Peter, who recently left Eawag to join the University of Applied Sciences and Arts Northwestern Switzerland (FHNW). To facilitate the decision-making process, she conceived a new compendium – "Drinking Water Systems and Technologies from Source to Consumer".

This publication describes possible drinking water systems for each type of source and explains the advantages and disadvantages of the various schemes and technologies. "With the aid of the Compendium, stakeholders can discuss the various options and put together a system appropriate to their particular situation," she says.

Maryna Peter had the idea for this manual while she was working at Eawag and developed it together with two colleagues – Lea Breitenmoser, a doctoral student at FHNW, and Sara Marks, a drinking water specialist at Sandec. Marks points out: "The Compendium is a product of collaboration between numerous international drinking water experts, most of whom contributed as volunteers." The World Health Organization undertook the peer review and put the finishing touches to the content.

The Compendium "Drinking Water Systems and Technologies from Source to Consumer", can be downloaded in English after publication at: eawag.ch/en/trinkwasserkompendium. It is relevant for drinking water projects in a rural, peri-urban or urban context.

Aldo Todaro, 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.

Pictured opposite November 2019: A 30 m^3 underground rainwater tank is lowered into place. This will supply flush water to the FLUX building currently under construction. The tank will be fed with rainwater from the green roof, which will also be equipped with solar panels.

Awards

Four Eawag researchers among the most highly cited worldwide

Four Eawag scientists – Juliane Hollender, Ole Seehausen, Bernhard Truffer and Urs von Gunten – were included in the Web of Science Group's list of Highly Cited Researchers 2019. This means that the four researchers are among the most influential in their field worldwide. The list recognises researchers who have produced multiple highly cited papers over the past decade (2008–2018). Overall, 155 researchers from Switzerland were included in the 2019 list.

Two awards for NEST living lab

The Eawag-Empa research and innovation building NEST received two awards in 2019. In January, it was one of the five winners of the Watt d'Or prize, which has been awarded annually since 2007 by the Swiss Federal Office of Energy. Here, the jury mentioned in particular the solar-powered fitness & wellness unit. In June, NEST was the winner in the Research & Development category of the Building Award, presented each year by "bilding" (the Swiss foundation for the promotion of the next generation of construction engineers) to recognise excellence and innovation in construction engineering.

Ineson Lecture given by Mario Schirmer

Mario Schirmer of the Water Resources & Drinking Water department was invited to deliver the 2019 Ineson Lecture in London. He discussed challenges in urban hydrogeology and explained the importance of groundwater resources for global drinking water supplies. Schirmer says: "I was very proud to be asked to give the Ineson Lecture – it was certainly the professional highlight of my year." The Ineson Lecture is one of the most important events for hydrogeologists in the UK.

International Association of Hydrogeologists

Mario Schirmer hält die Ineson Lecture in London.

Silver Medal of ETH Zurich for an outstanding doctoral thesis
Stefan Achermann (Environmental Chemistry), Meret Aeppli (Environmental Chemistry), Sven Eggimann (Environmental Social Sciences)

ETH Zurich Otto Jaag Water Protection Prize
Stefan Achermann (Environmental Chemistry)

University of Zurich Faculty of Science Prize for doctoral thesis
Chelsea Jean Little (Aquatic Ecology)

3RCC 3Rs Award
Kristin Schirmer & Melanie Fischer (Environmental Toxicology)

Society of Environmental Toxicology and Chemistry (SETAC) Young Scientist Award
Hannah Schug (Environmental Toxicology)

University of Florence Francesca Gherardi Memorial Prizet
Kate Mathers (Surface Waters)

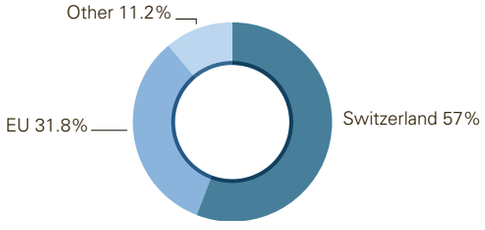
Headcount and personnel structure

As of 31 December 2019, Eawag's headcount (excluding interns, visiting academics and temporary staff) was 507 people (457.03 full-time equivalents/FTEs), distributed among the following functions: scientific, technical and administrative staff, and apprentices. Women account for 50.3% of the total (including apprentices). Eawag continues to provide training for 26 apprentices – chemical and biological laboratory technicians, business administrators and computer scientists.

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

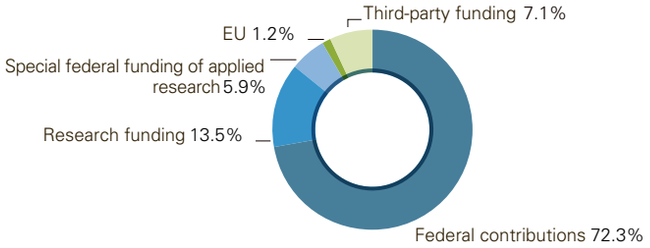
507



Financing for staff derives not only from federal contributions but also from research funding obtained on a competitive basis. As of 31 December 2019, the financing of the FTEs (excluding apprentices) breaks down as follows:

Sources of funding for personnel (CHF thousand)

16,259



Personnel policy and career development

Eawag is a responsible employer, offering flexible working time models, integrated health management and outstanding training opportunities. It focuses continuously on the recruitment, development and retention of first-class employees, both in research and in technical and administrative areas.

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

For its 89 doctoral students, Eawag provides an 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 take part in the sharing of knowledge at Eawag, engage in research, establish contacts, and – when they return to their home countries – pass on the expertise they have acquired. The Eawag Postdoctoral Fellowship for outstanding young scientists, awarded annually, is an established part of Eawag's efforts to foster talents and expand research networks.

Personnel news

Carsten Schubert Adjunct Professor at ETH Zurich
Geologist Carsten Schubert has been appointed by the ETH Board as Adjunct Professor at ETH Zurich. This appointment recognises his research on biogeochemical cycles, as well as his teaching and doctoral training activities. Carsten Schubert joined Surface Waters as a research scientist in 2001, becoming head of the department in 2012. Since 2004, he has also taught in the Department of Environmental System Sciences at ETH Zurich. His interests include organic geochemistry and isotope geochemistry in lakes and oceans.

Peter Penicka, Eawag

Carsten Schubert's research focuses on biogeochemical cycles.

Markus Holzner takes up Eawag-WSL position
Since June 2019, Markus Holzner has been working at Eawag and WSL, thus bringing the two institutes' research closer together. Holzner, a South Tyrolean, took his doctorate at ETH Zurich, and held a Marie Curie postdoctoral fellowship at the Max Planck Institute in Göttingen. In 2013, he was awarded an SNSF professorship at ETH Zurich. Holzner says: "I'm particularly interested in the interface between aquatic and terrestrial ecosystems – for example, how particles and organisms interact in watercourses. Or what happens to microplastics transported by rivers to seas, and how aquatic organisms react."

Peter Penicka, Eawag

Markus Holzner works at Eawag, WSL and ETH Zurich.

Benoît Ferrari appointed interim director of the Ecotox Centre
On 1 September 2019, biologist and biochemist Benoît Ferrari took over from Inge Werner as interim director of the Ecotox Centre. Since 2013, he has been leader of the Sediment and Soil Ecotoxicology group at the Ecotox Centre in Lausanne. Ferrari's research focuses on the ecotoxicity of sediments. Here, in recent years, he has helped to develop innovative systems for assessing sediment quality – for example, the E-board, a device for assessing the development of chironomid larvae in rivers. He has also promoted the use of eDNA approaches for sediment monitoring.

Kathrin Fenner head of new SCS section
Kathrin Fenner has been appointed head of the Swiss Chemical Society's new Section of Chemistry and the Environment (SCE). In this capacity, Fenner – a group leader in the Environmental Chemistry department – will be responsible for organising the committee and regular meetings. Various environmental chemistry events are planned, as well as joint projects and collaboration with industry. The SCE is hosted by the Division of Analytical Sciences, which is led by Marc Suter.

Peter Penicka, Eawag

Kathrin Fenner has been head of the SCE since 2019.

Christian Zurbrügg appointed Adjunct Professor at Swedish University of Agricultural Sciences

Environmental engineer Christian Zurbrügg of the Sanitation, Water and Solid Waste for Development department has been appointed Adjunct Professor at the Swedish University of Agricultural Sciences (SLU) in Uppsala. Here, he will teach in the Department of Energy and Technology and supervise doctoral students. Zurbrügg and his Solid Waste Management research group have partnered with SLU for many years, e.g. for black soldier fly biowaste processing projects. Zurbrügg looks forward to gaining access to Swedish and EU research funding and collaborating with SLU on projects in developing countries concerning plastic waste in rivers and seas.

Peter Penicka, Eawag

Christian Zurbrügg now also teaches in Sweden.

Broad dialogue

Info Day: hydropower and aquatic ecosystems

Switzerland's energy strategy calls for the expansion of hydropower, putting pressure on waterbodies and aquatic landscapes. At Eawag's 2019 Info Day, around 200 experts – water professionals, scientists and officials – discussed how competing interests can be sustainably addressed. The Eawag researchers showed that this involves not only technical solutions but also questions of social acceptance – for example, if measures to protect aquatic ecosystems lead to increases in electricity prices.

TED talk by Christoph Lüthi: Why shit matters

Three billion people live in cities without sewers or wastewater treatment plants. Their waste is dumped into open waters, contaminating the drinking water for others downstream. In a TED talk in Munich, Christoph Lüthi, head of the Sanitation, Water and Solid Waste for Development department, explained one approach to tackling this global problem: nutrients can be recovered from wastewater, rather than polluting the environment.

National Future Day

In autumn 2019, numerous children once again took the opportunity to accompany a relative to work at the Eawag sites in Dübendorf and Kastanienbaum. This gave some aspiring water researchers a chance to see how Eawag staff spend their working day.

Raoul Schaffner, Eawag

Marta Reyes (left) explains how plankton species can be identified under the microscope.

Science City

Without Water No Life: "blue gold" was the theme of the autumn 2019 Eawag-ETH Science City events. Eawag scientists presented various aspects of aquatic research at public talks, demonstrations and panel discussions. For example, Eawag Director Janet Hering gave a presentation entitled "Is the world running out of water?". Other experts spoke on clean drinking water, the wastewater-free house, aquatic biodiversity and water supplies in the Global South.

Simone Kral, Eawag

Janet Hering gives a presentation at Science City.

Illustration: Auf der Maur & Böschenstein

A visualisation of the new building, called Limnion, planned for the Kastanienbaum site.

Property

In March 2019, work began on the construction of the new FLUX building at Eawag's Dübendorf site. This research, office and teaching building will accommodate not only Eawag staff, but also the Ecotox Centre, which is headquartered at Eawag. In addition, it will provide working space for Master's and doctoral students and for visiting academics, who often spend several months at Eawag, thus helping to strengthen the institution's research, teaching and consulting networks.

The building will also house special joint laboratories for the departments of Process Engineering and of Sanitation, Water and Solid Waste for Development. The so-called Synthesis Centre will further enhance knowledge transfer within and beyond Eawag: here, scientists and visitors will work at the interface between research, policymaking and practice. Also to be established in FLUX is a photo and video studio, which will facilitate the production of e-learning videos such as MOOCs, project videos, social media clips or interviews.

In accordance with the Confederation's duty to set an example, the latest sustainable construction technologies are being used for FLUX. For example, an innovative laboratory ventilation system is being installed, and the building will be certified to the Minergie ECO standard.

New building planned for Kastanienbaum

A new building is also to be constructed at the Kastanienbaum site. This project was triggered by an unsafe conditions of at an older storage building. A feasibility study showed that renovation work would cost just as much as a new building. As there is also a shortage of working space at Kastanienbaum, the Directorate decided not only to replace the lost storage area but also to create space for office and research facilities. The project is to be planned in detail over the course of 2020 and submitted to the ETH Board for approval in spring 2021.

Equal opportunities

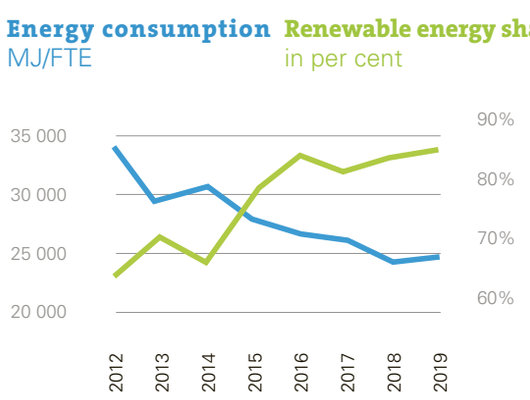
The Equal Opportunities Committee (EOC), which includes representatives from all staff groups, seeks to prevent discrimination of any kind at Eawag and within the ETH Domain. Its activities are supported by an Intranet site (in German and English), which was revised in 2019. In addition to the ETH Domain's well-established "Fix the leaky pipeline" programme, Eawag now also participates in the CONNECT programme (financially supported by swissuniversities), which aims to connect women's careers in academia and industry. In 2019, a "Respect" campaign was conducted in collaboration with the EOC: online and in a flyer, Eawag's values were highlighted, and contacts and responsibilities were specified for cases of harassment, stalking, bullying or discrimination. Under the motto "Respect – we're living it!", an in-house action day was held, which included a panel discussion on respectful communication and conduct in daily working life.

The compatibility of family and career remains an important topic. 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, and new fathers can temporarily reduce their working hours. The proportion of women in management positions at Eawag remains relatively high (30.55%). As well as supporting the Empa-Eawag childcare centre, Eawag contributes to the childcare costs of low-income parents.

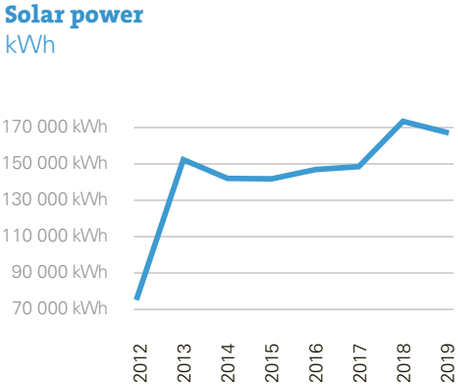
Environment

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 2019, under the "FlyAware" initiative, young scientists at Eawag, together with the Environment team and other staff, have been discussing ways of further reducing business flights. Around half of all employees took part in a "FlyAware" survey, with a clear majority calling for action.
One initial measure has already been taken: since autumn 2019, Eawag has had a new videoconferencing platform, making it much easier for researchers to conduct remote meetings. The adoption of further measures is currently being prepared in collaboration with the Directorate.

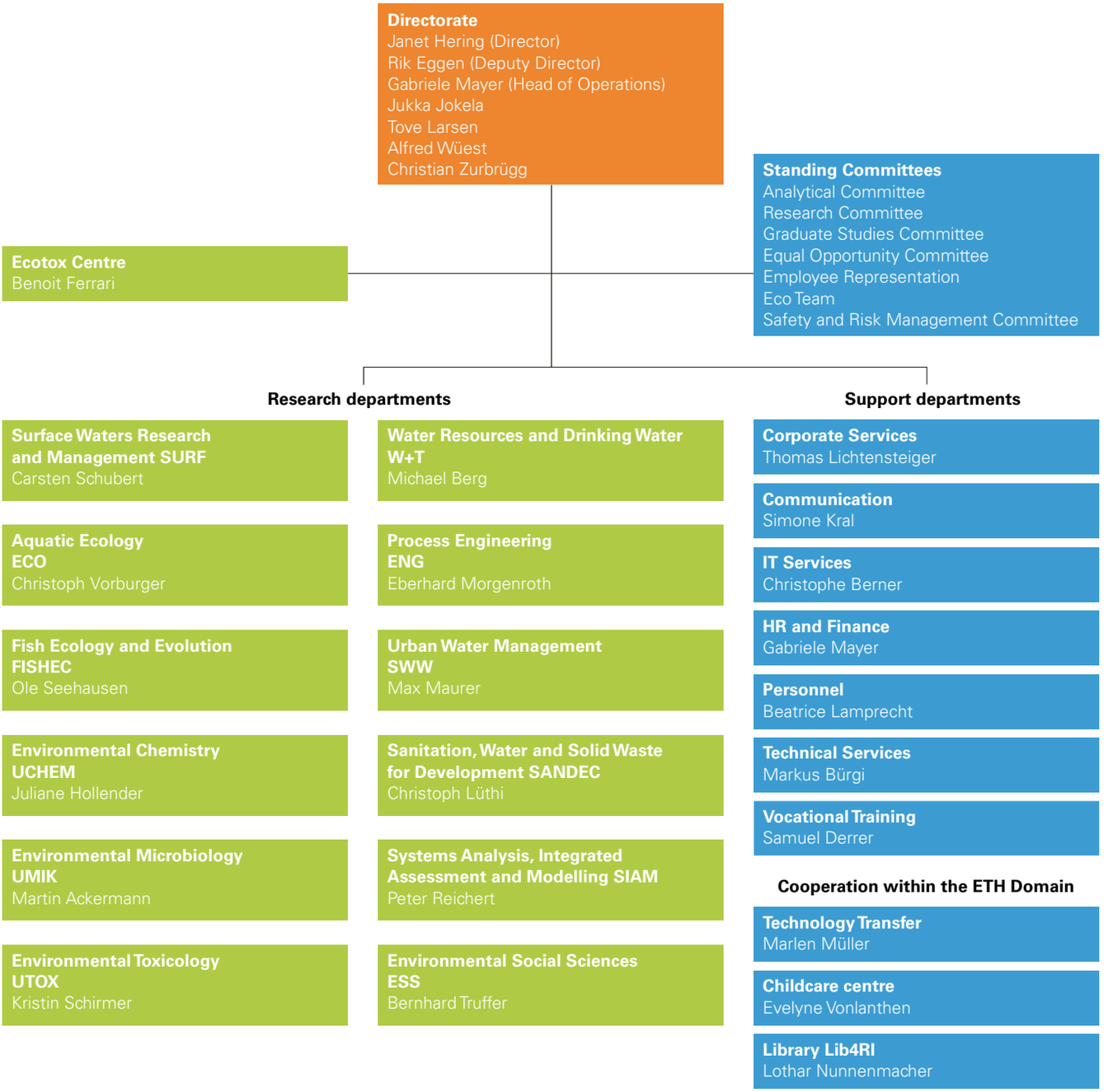
Energy consumption per capita



Photovoltaic electricity generation



Organisation



As of 31 December 2019

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 and is also a member of the Board of Directors of the Ecotox Centre.

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.

Alfred Wüest Group Leader SURF
Alfred Wüest, an environmental physicist, investigates and models mixing processes and biogeochemical fluxes in lakes. In addition, he studies how the aquatic environment is affected by pumped-storage hydropower operations and lake heat use. He is Professor of the Physics of Aquatic Systems (Margaretha Kamprad Chair) at EPFL, where he is also Director of the Limnology Centre.

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. He teaches at ETH Zurich, EPFL and various universities

Risk management at Eawag

Background

Requirements for the management of risks are specified in the ETH Board's directives of 4 July 2006 on risk management at ETH and its research institutes, issued in accordance with Art. 19a para. 2 of the Ordinance on the ETH Domain (SR 414.110.3). These directives regulate the essential aspects of risk management and define the goals of the risk policy pursued by the ETH Board. Based on a decree of the ETH President, the directives came into force on 15 February 2007. 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 circumspect and timely manner, to identify 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 process

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. Accordingly, the two Federal Institutes of Technology and the four research institutes have each introduced their own risk management process, based on the requirements specified by the ETH Board. This process comprises the identification and assessment of individual risks, risk minimisation strategies and risk controlling. Eawag has a risk manager, who coordinates risk management activities and controls the risk management process. The risk manager is supported by the other individuals responsible within Eawag's risk organisation. The implementation of risk management is monitored 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 loss or damage in each case, are described in detail in the risk catalogue and assessed in terms of the likelihood of occurrence and the financial impact (potential losses). In addition, particular attention is paid to the potential impact of risks on the institute'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 covers 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

Core risks are those with a potentially high financial impact and an above-average likelihood of occurrence which pose a direct threat to the fulfilment of the institute's legal duties.

Each spring, the risk organisation meets for its annual discussion of the risk situation at Eawag and, under the leadership of the risk manager, prepares a risk report. In addition to the minutes, this report includes the revised risk catalogue, as well as brief reports by all risk owners, comprising a review of the year and outlook. The risk report is submitted to the Eawag Directorate for consideration and approval. In its annual reporting, Eawag provides information on its core risks, in particular the extent and potential impacts of these risks. In addition, the ETH Board, as the supervisory body of the ETH Domain, is directly informed, in a timely manner, of any exceptional changes to the risk profile or exceptional loss events. Eawag's core risks are considered to lie 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.

Insurance situation

Despite prudent risk management, the risk cannot be excluded that an institution might be affected by an event resulting in loss or damage that jeopardises its ability to fulfil its duties as set out in federal legislation. In such a case, the ETH Board, under Art. 19a para. 4 of the Ordinance on the ETH Domain (SR 414.110.3), would submit an application to the Department, for the attention of the Federal Council, concerning an adjustment of the performance mandate or an increase in the federal financial contribution. For the evaluation of this subsidiary risk for the Confederation (i.e. the federal guarantee under Art. 19 para. 1 of the Government Liability Act, SR 170.32), the insurance policies taken out by the institutions within the ETH Domain are of particular importance. The institutions are, however, required to take their individual risk situation into account and to strive for an appropriate cost benefit ratio, as well as complying with the relevant provisions concerning federal public procurement. These insurance policies must meet the usual standards of the Swiss insurance market and must be issued by an insurance company licensed in Switzerland.

Each institution 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 be borne in mind that not all core risks can be insured, and that such insurance cannot always be financed. Eawag has taken out property and liability insurance policies covering losses or damage. Eawag also has smaller policies covering specific 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" (>50% 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.

Jonas Steiner, Eawag

Eawag
Überlandstrasse 133
8600 Dübendorf
Telefon +41 (0)58 765 55 11
info@eawag.ch
eawag.ch