Eawag
Swiss Federal Institute of Aquatic Science and Technology

Annual Report 2020

eawag
aquatic research

Contents

Cover photo and opposite page At the Zurich Werdhölzli plant, which treats wastewater from around 450,000 people, Eawag scientists collect samples which will be tested in the laboratory for SARS-CoV-2. Pictured here are Christoph Ort and Pravin Ganesanandamoorthy of the Urban Water Management department and Anina Kull of the Environmental Microbiology department. For more information see p. 32.

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 34 professors and over 300 scientists a unique environment for pursuing research to generate new scientific findings and develop solutions for fundamental societal challenges. Here, an important role is played by an interdisciplinary approach and knowledge transfer to authorities and stakeholders from business and society. The 5,200-plus teaching hours at Swiss higher education institutions and the supervision of over 160 Bachelor's and Master's theses and 156 doctoral theses per year make an important contribution to the education of young professionals for the Swiss water sector.

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

Eawag responds with flexibility to societal needs.

Eawag

In 2020, individuals, communities, institutions and governments all around the world were sorely tested by the COVID-19 pandemic. Travel and face-to-face meetings were cancelled, and much of life and work migrated to online platforms. Eawag colleagues, especially the members of our COVID-19 taskforce, responded quickly to protect the health and safety of our community, including not only those working at Eawag but also their families. Our excellent administrative staff, with support from IT, were able to keep all essential business processes running.

2020 delivered some hard lessons about the vulnerabilities of our interconnected world, the risks of human encroachment on nature, and our dependence on individuals who serve crucial, but often unappreciated, roles in our societies. At the same time, the benefits of science and scientific progress, as well as the importance of science communication, gained widespread recognition.

Eawag's portfolio of water research proved – perhaps surprisingly – relevant to the challenges posed by COVID-19. Despite the restrictions on our operations, Eawag researchers quickly engaged with colleagues at EPFL and with partners in practice to track SARS-CoV-2 by analysing wastewater (p. 32). Eawag's research on legionella bacteria in plumbing systems (p. 8) was highly relevant to the safe reopening of our buildings after lockdown. In addition, Eawag provided support so that ETH Zurich Professor Martin Ackermann, Head of Eawag's Environmental Microbiology department, could serve as Head of the Swiss National COVID-19 Science Task Force.

The origins of the COVID-19 pandemic highlight the impacts of food systems on habitats, ecosystem services and biodiversity. Eawag researchers have been studying these issues in Switzerland for many years – specifically, the impacts of plant protection products on aquatic ecosystems (p. 20). Novel methods to assess biodiversity (p. 12) have been developed. In 2020, Eawag and WSL launched a collaborative initiative on blue-green biodiversity, which will integrate across aquatic and terrestrial ecosystems to provide a basis for the mitigation of biodiversity loss (p. 8).

Through these and other projects, Eawag researchers in 2020 contributed to a sustainable future for Switzerland and the world, and they will continue to do so in the future.

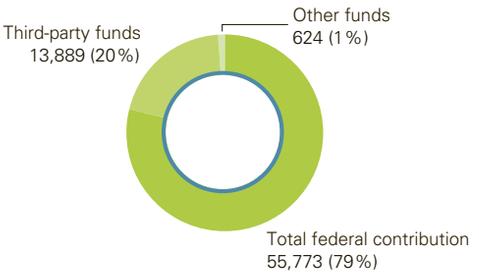
Janet Hering
Eawag Director

Eawag in figures

Finances

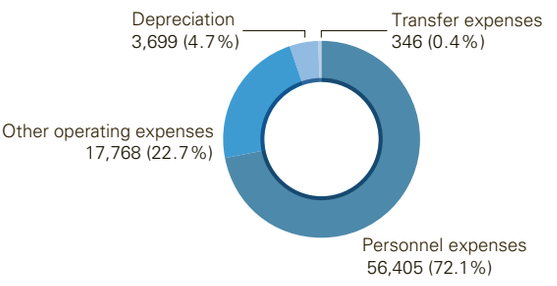
Operating revenue (CHF thousand)

70,286



Operating expenses (CHF thousand)

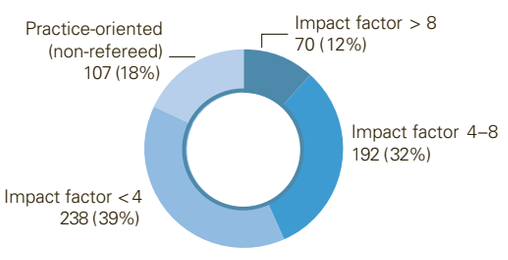
78,217



Research

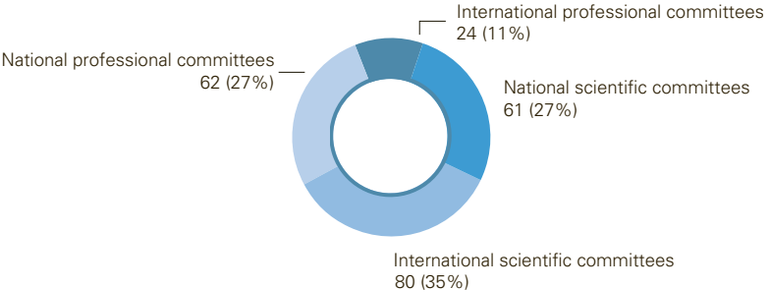
Publications

607



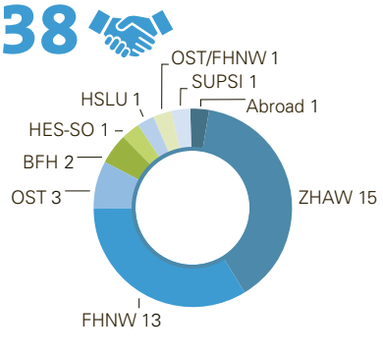
Committee memberships

227



Joint projects with universities of applied sciences

38

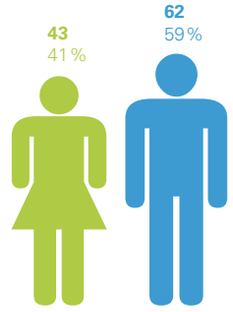


Due to rounding, individual figures may not sum to the totals shown.

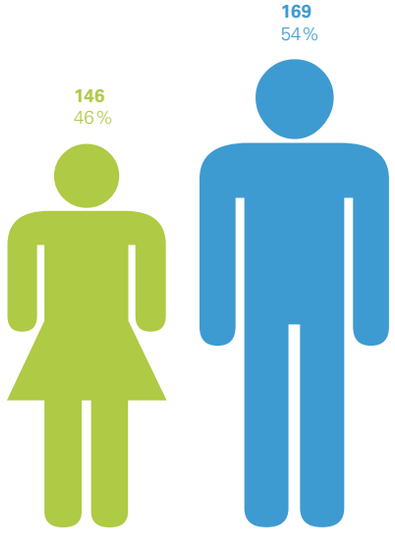
Personnel

Employees by function

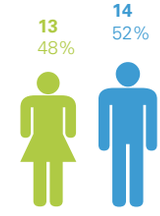
520 **50.2%** **49.8%**



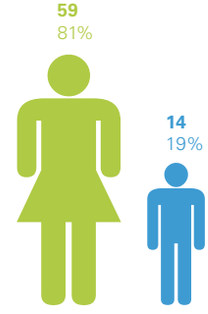
Technical 105



Science 315



Apprentices 27



Administration 73

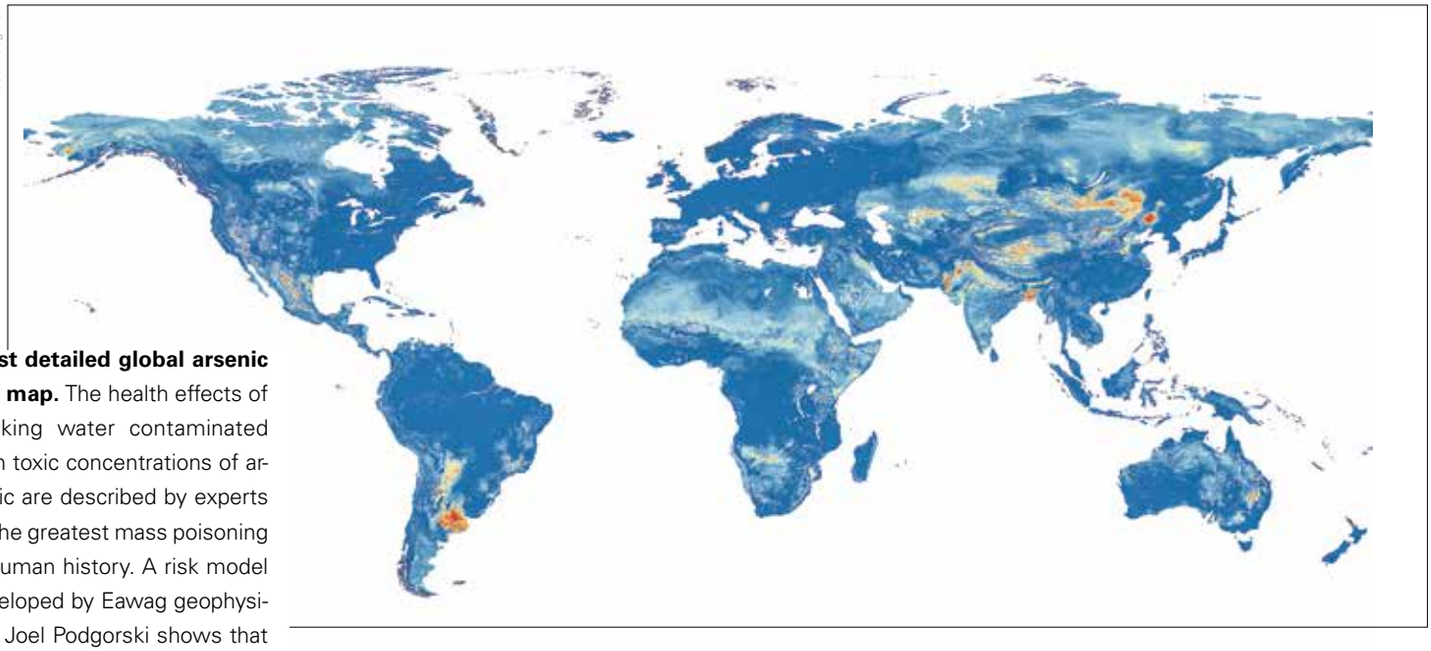
Annual financial statements: eawag.ch/annualreport

Highlights of 2020

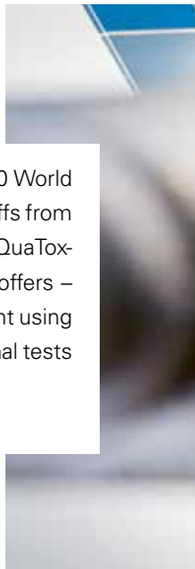
Peter Longatti, WSL

A new research initiative involving Eawag and WSL. The Blue-Green Biodiversity initiative is to strengthen these two institutes' environmental research, with the common goal of pursuing interdisciplinary research on biological diversity in water and on land. "Closer collaboration should enable us to make a substantial contribution towards mitigating the loss of biodiversity and ecosystem services," says Eawag Professor Florian Altermatt, co-leader of the initiative.

Joel Podgorski



Most detailed global arsenic risk map. The health effects of drinking water contaminated with toxic concentrations of arsenic are described by experts as the greatest mass poisoning in human history. A risk model developed by Eawag geophysicist Joel Podgorski shows that up to 220 million people worldwide could be affected. The study, published in *Science,* was co-financed by the Swiss Agency for Development and Cooperation.



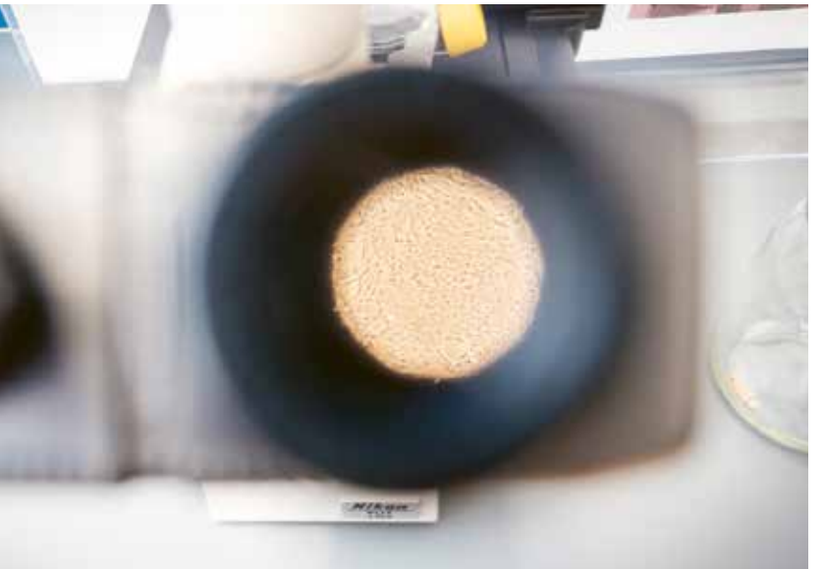
Eawag spin-off aQuaTox-Solutions at the WEF. The 2020 World Economic Forum showcased innovative start-ups and spin-offs from the ETH Domain. Representing Eawag was the spin-off aQuaTox-Solutions. CEO Stephan Fischer explained the services it offers – alternative, animal-free methods of chemical risk assessment using fish cell lines and embryos, which are superior to conventional tests in terms of precision, variability and efficiency.

Frederik Hammes und ZMB, UZH

Legionella control in buildings. Legionella bacteria can occur in drinking water and proliferate in hot water in buildings. Inhalation of these bacteria may lead to legionellosis. As the number of infections has risen sharply in recent years, the research project "LeCo" was launched, with funding of 2.5 million Swiss francs from the Federal Food Safety and Veterinary Office, and the Federal Offices of Public Health and Energy.

Esther Michel, Eawag

SARS-CoV-2 detected in wastewater. Using a method developed by Eawag scientists in collaboration with EPFL, the prevalence and dynamics of coronavirus infections can be monitored in wastewater. For more information see p. 32.



Mallaun Photography


Esther Michel, Eawag

Research

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

Photo opposite Luca Carraro (right) and Professor Florian Altermatt of the Aquatic Ecology department have developed a method which allows biodiversity hotspots to be identified in streams and rivers.

Predicting biodiversity in rivers

The biodiversity and thus the condition of freshwater ecosystems can be predicted by combining environmental DNA analysis with hydrological models. This approach, developed by scientists at Eawag and the University of Zurich, makes it possible to identify biodiversity hotspots.

Esther Michel, Eawag

Biodiversity can be assessed by extracting and sequencing eDNA from water samples.

Biodiversity is severely threatened both in Switzerland and worldwide, and numerous organisms are suffering massive declines – particularly in freshwater ecosystems. All the species living in rivers – including fish, bacteria and macroinvertebrates such as may-, stone-, or caddisflies – are crucial for the functioning of these ecosystems. The loss of biodiversity is attributable to habitat homogenisation, chemical pollution and the spread of invasive species. Biodiversity monitoring is essential if freshwater ecosystems are to be better understood and protected.

Combining environmental DNA and models

All organisms shed DNA into the environment. By extracting and sequencing environmental DNA (eDNA) from water samples, biodiversity can be assessed more rapidly, less invasively and more comprehensively than by collecting and identifying individual organisms. To predict spatial patterns of biodiversity in freshwater ecosystems, a novel approach was developed by a research team led by Florian Altermatt (Group Leader in Eawag's Aquatic Ecology department and Professor at the University of Zurich). Altermatt explains: "For the first time, we've combined the use of eDNA with hydrological models, so as to predict biodiversity at high spatial resolution across a catchment covering hundreds of square kilometres."

Highly accurate biodiversity prediction

As eDNA in rivers can be transported downstream for many kilometres, information is also obtained on the distribution of species in upstream reaches. Using models based on hydrological first principles, the scientists were able to reconstruct biodiversity patterns across the entire 740-square-kilometre basin of the Thur in north-eastern Switzerland at a resolution of 1-kilometre-long stream sections. According to first author Luca Carraro, "Our model matches direct observations of

aquatic insects' local occurrence with an unprecedented accuracy of 57 to 100 per cent."

Identifying overlooked biodiversity hotspots

The Thur catchment comprises a wide variety of land-use types, including forest, agriculture and settlements. The findings are thus generalizable to many freshwater ecosystems. In addition, the new method permits high-resolution biodiversity assessments on a large scale, even with minimal prior knowledge of the ecosystem. Altermatt adds: "In particular, this approach allows the identification of biodiversity hotspots that could otherwise be overlooked, enabling the implementation of targeted conservation strategies."

Elvira Mächler, Eawag

With conventional methods, the assessment of macroinvertebrates is a time-consuming process.

Rapid transfer to practice

Many countries currently introducing eDNA-based aquatic biomonitoring could benefit from the novel method. According to Florian Altermatt, Switzerland is playing a leading role in this field: "The translation from scientific findings to practical application has been very rapid. We recently finalised guidelines on the use of eDNA in standard biodiversity monitoring for the Federal Office for the Environment (FOEN)." This means that biodiversity can now be more effectively assessed and monitored for Switzerland's 65,000-kilometre network of rivers and streams.

> A video on this topic is available at:
eawag.ch/environmental-DNA

FOEN publication on environmental DNA applications

Even though eDNA studies can never wholly replace conventional species identification and enumeration, this new approach is more than just an additional tool. But what are its advantages and disadvantages, what methods are available, and what best practices and routine standards are to be recommended? Answers to these questions are provided by the new FOEN guidelines on "Environmental DNA applications in biomonitoring and bioassessment of aquatic ecosystems". The publication was prepared by Eawag in collaboration with the Universities of Zurich and Geneva.

> The publication is available in PDF format at: bafu.admin.ch/uw-2010-e

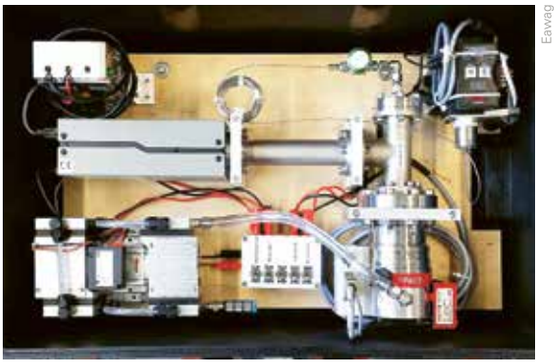
Observing how fracture systems are formed

In order to increase permeability for applications such as geothermal energy, rock is artificially fractured. Methods of observing this process in situ in real time have not previously been available, but a new technique has now been developed to make this possible.

Zairon, Wikimedia Commons

The rock laboratory where the hydraulic fracturing experiments took place is at the Grimsel Pass in the Bernese Alps.

Eawag



The portable mass spectrometer, mounted in a wheeled suitcase. Visible in the middle at the top is the coiled "trunk".

The rock laboratory at the Grimsel Pass in the Bernese Oberland lies around 400 metres below the surface. Here, geophysicists from ETH Zurich have established an experimental set-up in which rocks are fractured by high-pressure fluid injections. The aim is to determine how, for example, geothermal energy projects can be safely implemented in Switzerland in the future. Also participating in these experiments are two scientists from Eawag's Water Resources & Drinking Water department – geochemist Rolf Kipfer (Adjunct Professor at ETH Zurich) and environmental physicist Matthias Brennwald. In the controlled hydraulic fracturing experiments, mixtures of water and chemicals were injected through boreholes into existing shear zones to create new flow pathways in the Grimsel rock.

Transport monitored in real time

With the aid of a mobile gas analysis system (the "MiniRuedi"), the scientists demonstrated that fracturing led to the release of fluid-gas mixtures stored in the rock mass. These are transported along the new fractures and enter existing aquifers. The results were recently published in *Scientific Reports.* Rolf Kipfer says: "This has never previously been observed directly in situ, simply because the equipment required was not available." Such investigations are now possible thanks to the MiniRuedi, which he and Matthias Brennwald developed at Eawag some years ago.

System in a suitcase

Crucially, the compact system operates autonomously and provides continuous measurements – every few minutes – from the aquifer. Gases are sampled via a membrane immersed in the water and transferred to a coiled "trunk". They are then analysed in the mass spectrometer. Previously, such analyses would have required months of laboratory work. Kipfer concludes: "For numerous applications, our geochemical approach fills a gap which would be left open with conventional seismic methods."

MiniRuedi deployed all over the world

The MiniRuedi can quantify gases in environmental systems. As this mobile unit can analyse a wide variety of gases in less than a minute and can be deployed at remote locations, it is much in demand. It has been used by Eawag scientists in research projects around the world.
The MiniRuedi can be purchased from the Eawag spin-off Gasometrix.

> gasometrix.com

Global warming may make viruses more resistant

A recent Eawag-EPFL study showed that viruses adapting to warmer environments may become more resistant to disinfection. Global warming could thus make viruses more difficult to control.

Esther Michel, Eawag

The researchers created populations of a human enterovirus.

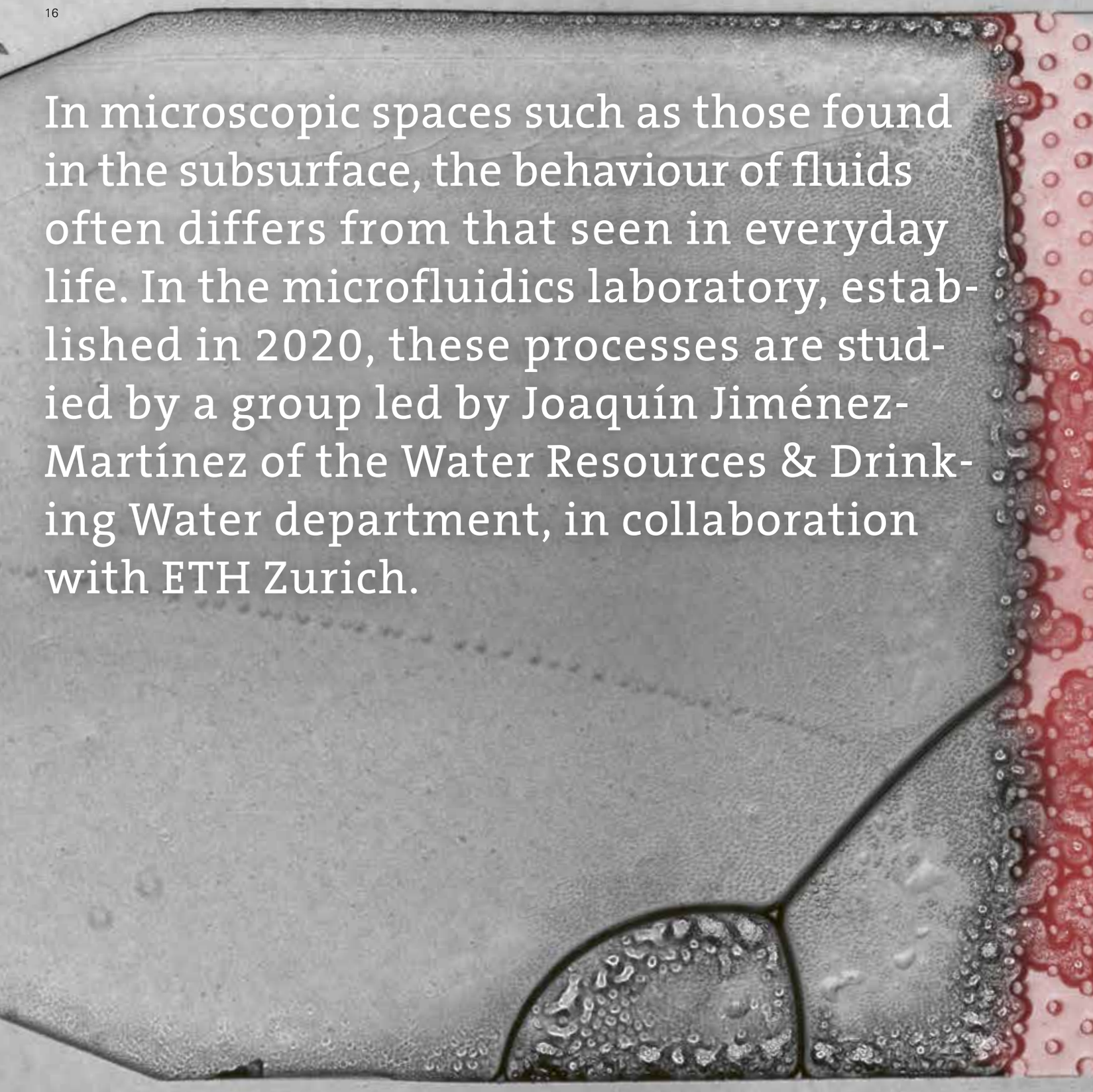
Certain pathogenic viruses which enter wastewater via faeces make their way into surface waters. Here, they can be inactivated by heat, sunlight and other microbes, thus losing their ability to spread disease. An EPFL research team – including Tim Julian of Eawag's Environmental Microbiology department – investigated how climate change could affect the resistance of viruses. They found that viruses could become more resistant, not only to environmental conditions but also to disinfectants such as chlorine.

More resistant to heat and chlorine

The team created four populations of a human enterovirus by incubating samples in lake water in flasks at ten or thirty degrees Celsius. The viruses were then exposed to heat, simulated sunlight and other microbes. Warm-water-adapted viruses were shown to be more resistant to heat than those adapted to cold water, while little or no difference was observed in resistance to sunlight or microbes among the four populations. Surprisingly, however, when transplanted to cool water, warm-water-adapted viruses not only remained active for longer than the cool-water strains, but also better withstood exposure to chlorine.

Tougher to eliminate

The scientists conclude that adaptation to warm conditions reduces viral susceptibility to inactivation. In the tropics or in regions affected by global warming, viruses could therefore become tougher to eliminate by chlorination or heating. This increased hardiness could also extend the length of time heat-adapted viruses would be sufficiently infectious to sicken someone coming into contact with contaminated water.



In microscopic spaces such as those found in the subsurface, the behaviour of fluids often differs from that seen in everyday life. In the microfluidics laboratory, established in 2020, these processes are studied by a group led by Joaquín Jiménez-Martínez of the Water Resources & Drinking Water department, in collaboration with ETH Zurich.

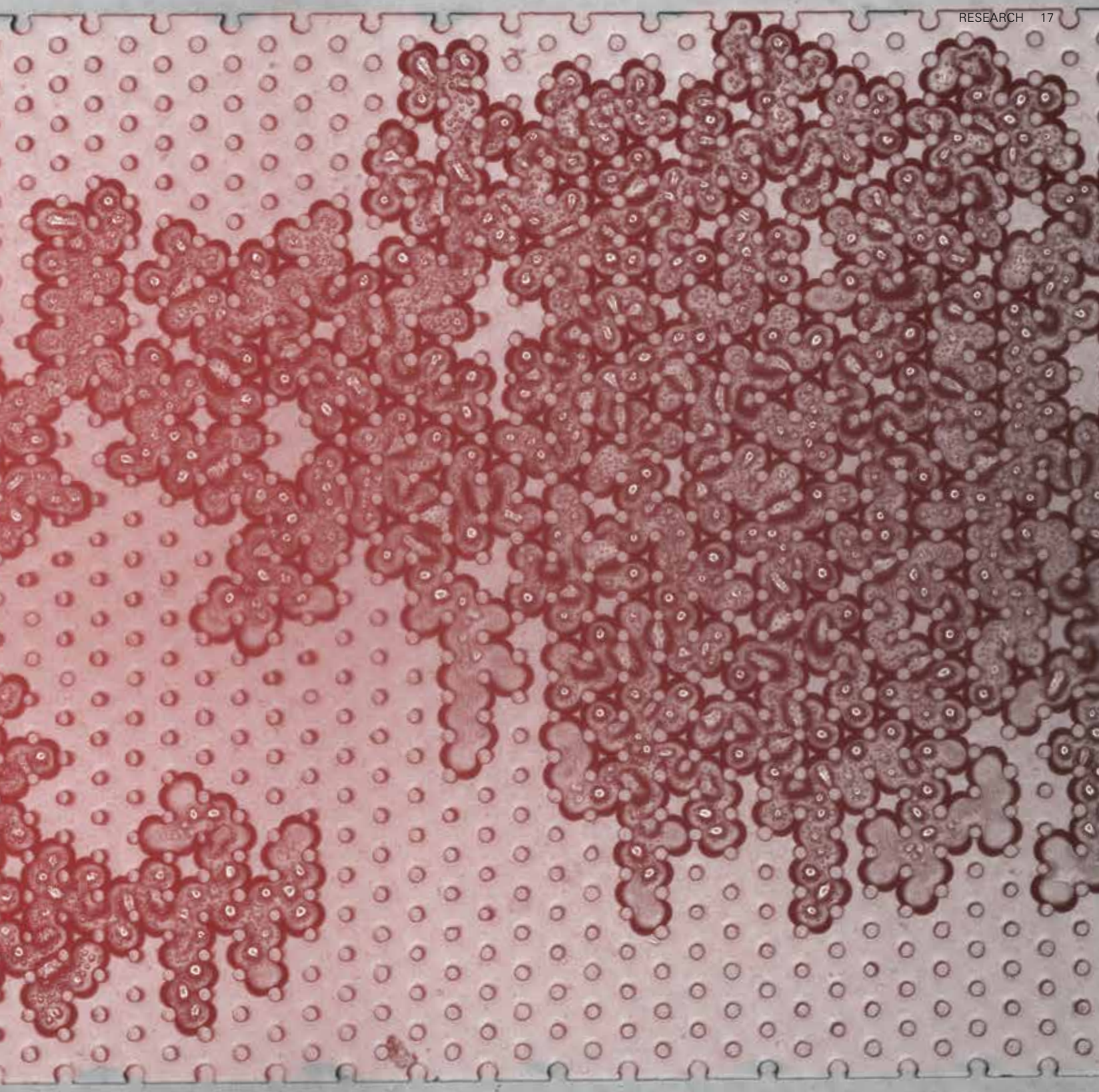


Photo In the new microfluidics lab, the scientists are investigating, for example, how subsurface physical and environmental conditions influence the transport of water and chemicals, as well as biological processes. In this micromodel, water is displaced by air entering the medium from the left. The artificial microenvironment consists of tiny columns which act as a barrier, causing the air to assume a dendritic form.

Dorothee Kurz, Julian Schoch, Romain Stocker, Joaquin Jimenez-Martinez

Two lakes, seven whitefish species

Scientists from Eawag and Bern University have described seven whitefish species endemic to the Bernese Oberland lakes – including four not previously described scientifically, two of which have only been identified as distinct species in the last few years.

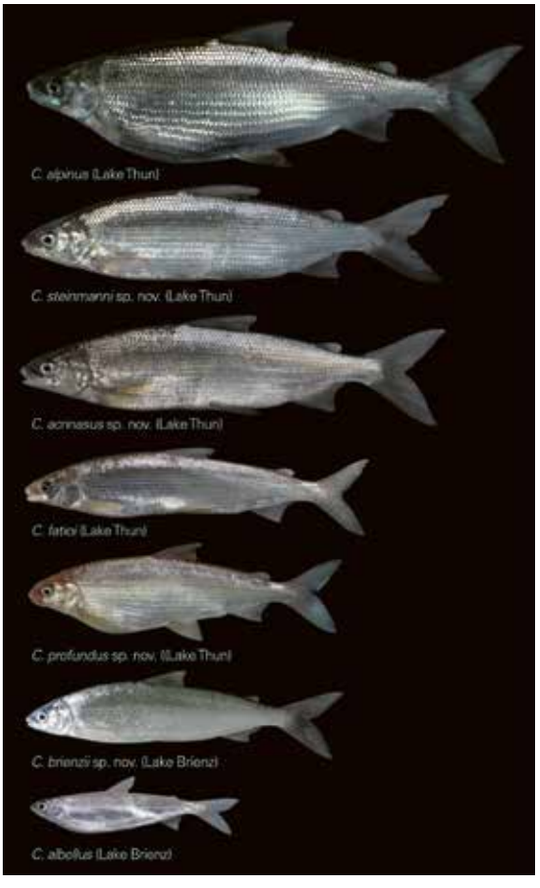
As a result of the pollution and eutrophication affecting Swiss lakes after the mid-20th century, a third of all historically known whitefish species became extinct or merged genetically with other whitefish species through hybridisation. The species concerned have been lost irrevocably, since all Switzerland's whitefish species are endemic – i.e. they only occur in the lakes where they arose.

Among the lakes which were originally particularly species-rich, those less affected were Lake Lucerne and the lakes of the Bernese Oberland. Harbouring seven known species, these are still among the lakes with the highest whitefish diversity worldwide. All seven species have now been scientifically described – four for the first time – by a team led by Oliver Selz and Professor Ole Seehausen of Eawag's Fish Ecology & Evolution department and the Bern University Institute of Ecology & Evolution.

Four newly described species

Scientific descriptions already existed for the "Brienzlig" *(Coregonus albellus),* the "Balchen" *(Coregonus alpinus)* and the "Felchen" *(Coregonus fatioi).* The "Kropfer" has been newly described and named *Coregonus profundus*. In 2018, the scientists discovered a species which, on account of its similarity to the "Balchen", was provisionally designated as "Balchen 2". This species has now been named *Coregonus steinmanni* – in honour of the whitefish researcher Paul Steinmann. Further investigations revealed that a Lake Brienz whitefish initially also designated as "Balchen 2" is in fact a separate species. As it is the only one of the seven species that is not found in Lake Thun, it has been named *Coregonus brienzii*.

Also scientifically described for the first time is the "Albock" *(Coregonus acrinasus).* It has a recent history of hybridisation: genetically, it is closely related both to whitefish introduced to the Oberland lakes from Lake Constance in the 20th century, and to the other Lake Thun whitefish. The biologists conclude that further surprises emerging from the depths of the Oberland lakes cannot be ruled out.



Eawag

The seven whitefish species from Lakes Brienz and Thun.

Legacy effects of persistent organic pollutants

Although use of the fungicide HCB has been banned since 2004, this compound is chemically stable – and accumulates in the polar regions where humpback whales replenish their fat reserves. Cell line studies have now shown that, while HCB does not have acute toxic effects, it can cause damage to DNA.

Hexachlorobenzene (HCB), formerly widely used as a fungicide, is one of the so-called dirty dozen – the first twelve toxic chemicals whose use was banned worldwide in 2004 under the Stockholm Convention on Persistent Organic Pollutants. However, due to its chemical structure, this compound is extremely stable and is only broken down very slowly in nature.

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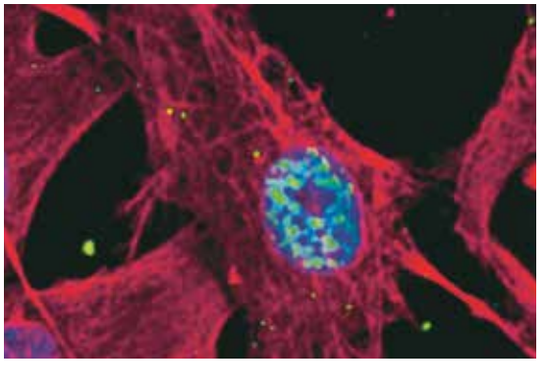


A humpback whale cell. Humpback cell lines were developed by Eawag scientists in collaboration with Griffith University (Queensland, Australia).

Global grasshopper effect

HCB is not only persistent but also, under certain conditions, volatile. It enters the atmosphere via evaporation over tropical and temperate zones and is subsequently deposited with rain or snow. Michael Burkard, a postdoctoral researcher in the Environmental Toxicology department, explains: "This is the grasshopper effect, whereby HCB is gradually transported to polar regions. But because it's cold at the poles, HCB remains and accumulates there."

This is precisely where the summer feeding grounds of humpback whales lie – in the seas of the Arctic and Antarctic. Here, for around three months, these marine mammals build up the fat reserves which they live off for the rest of the year. Burkard says: "When the fat reserves are mobilised, fat-soluble substances, including HCB, are released. Various pollutants accumulate in fasting whales – on average, concentrations are increased two- to threefold in these creatures before they return to their summer feeding grounds."

Damage to DNA is possible

It is not known whether – and if so, how – HCB is toxic to humpbacks. Some light has been shed on this question by experiments carried out on a humpback whale cell line by Burkard and colleagues. For toxicity tests, the group uses cells cultured in the laboratory, thus avoiding the need for experiments in live animals. For their study, the scientists developed a system which allows cells to be exposed to stable concentrations of HCB.

The results of the study show that, at environmentally relevant concentrations, HCB is not acutely toxic to humpback whale cells. These findings are in agreement with the available literature. Burkard was, however, surprised by the results of the genotoxicity tests: while the cell line experiments do not directly predict effects in animals, "We've certainly shown that damage to DNA is possible in whale cells." And because – with a half-life of several years to decades – HCB will only gradually disappear, humpback whales will have to contend with this substance for some time to come.

Research efforts to reduce pesticide contamination

With the latest analytical methods, potentially toxic substances can be detected even at very low concentrations. However, the aim of research is not merely to document such contamination but also to understand how it occurs in streams and groundwater, and to propose mitigation measures.

Markus Zeh

Small streams are exposed to risks of contamination, which may be substantially increased as a result of hydraulic shortcuts.

In agricultural areas, large volumes of water from fields, roads and paths enter streams via manholes or other artificial drainage systems. Because this water is not purified, either at a treatment plant or by passing through the soil, these pathways – which also allow pesticides to enter surface waters – are known as "hydraulic shortcuts". To assess their significance, scientists from the Environmental Chemistry department studied 20 catchments in the Central Plateau and the Jura region, using aerial (drone) images, drainage plans and field surveys.

Particularly problematic for small streams

In the catchments studied, the proportion of the agricultural area connected to surface waters via hydraulic shortcuts varied, depending on topography, the number of inlets and other factors. The average for all catchments was 55 per cent. The authors of the study conclude that these flow paths are responsible for considerable contamination of streams with pesticides – especially since concentrations in runoff from roads and paths may be much higher than was previously assumed. In water samples collected from storm drainage inlets, pesticide concentrations were found to be sharply increased during rainfall events. Water from these inlets would need to be diluted by a factor of up to 50 to prevent risks to aquatic organisms in streams.

Risk reduction options

The study was carried out in connection with the national Action Plan on risk reduction and sustainable use of plant protection products. The scientists now recommend that greater attention should be paid to hydraulic shortcuts in measures designed to reduce pesticide runoff to surface waters. For example, entire catchments should in future be taken into consideration, rather than merely agricultural areas alongside surface waters. Risks could also be reduced by measures restricting hydraulic shortcut structures or requiring the use of vegetated buffer strips.

Modelling essential for reliable conclusions

As well as field surveys, various model-based approaches, combined with geographical information systems, were employed in the study. This involved collaboration with scientists led by Peter Reichert, Adjunct Professor at ETH Zurich and, until the end of 2020, Head of Eawag's Systems Analysis, Integrated Assessment and Modelling department. For even with extensive fieldwork, reliable conclusions as to the situation at the national level are not possible without modelling. Thanks to collaboration between environmental chemists, soil hydrologists and modelling experts, the relevant transport processes were analysed in detail and then extrapolated on the basis of statistical data for the entire Central Plateau and Jura region.

Peak concentrations underestimated

Apart from hydraulic shortcuts, other factors may also lead to peak concentrations of pesticides in surface waters. This was demonstrated by another study – involving scientists from the Environmental Chemistry, Process Engineering and Urban Water Management departments – in which the mobile mass spectrometer MS²field was deployed on a stream for the first time. While water protection authorities usually make use of composite samples, collected over a period of several days, the MS²field system developed at Eawag can analyse samples automatically every 20 minutes. This provided a real-time picture of the highly dynamic processes of water pollution: concentrations of certain pesticides measured in individual samples were up to 170 times higher than in the 3.5-day composite samples.

Risks of acute toxicity

The peak concentrations recorded by the MS²field system were not only higher than those found in conventional composite samples but, in several cases, they also exceeded the limits specified in the Waters Protection Ordinance, which are designed to prevent acute toxicity to aquatic organisms – by a factor of up to 30 in the case of the insecticide thiacloprid. This is relevant for the assessment of water pollution since, in some cases, peaks lasting for less than an hour can have adverse effects on aquatic organisms. If peak concentrations recur, the impact of the second or third peak may be still greater – even if it is lower than the first – as the organisms have not been able to recover in the meantime.

Analytical chemistry – ecotoxicology – process engineering – social sciences

The example of pesticides demonstrates the value of interdisciplinary collaboration, both within Eawag and with external partners. Increasingly precise analytical methods (in the nanogram-per-litre range) are not in themselves sufficient: the risks posed by the concentrations detected need to be assessed by ecotoxicologists. Based on studies carried out by Eawag and the Ecotox Centre, substance-specific limits were introduced for twelve pesticides in the revised Waters Protection Ordinance which came into effect on 1 April 2020. In addition, analyses performed by Eawag revealed the presence not only of pesticide active substances but also of transformation products – in groundwater as well as in surface waters – which may likewise be problematic. For persistent metabolites of the fungicide chlorothalonil, elimination methods have already been tested in collaboration with water suppliers, in case the precautionary measures adopted are not sufficiently effective. Lastly, in the "Sustainable water-friendly agricultural production" project, carried out jointly with the Federal Office for Agriculture and Agroscope, measurable indicators were defined within an objective hierarchy so as to facilitate sound, transparent decision-making for policymakers and professionals. Methods of this kind have previously been used mainly in social scientific research.

Teaching

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

Photo opposite Sam Derrer, head of Vocational Training (right) with two apprentices in the Eawag/Empa training lab. Here, trainee laboratory technicians specialising in Chemistry or Biology attend courses each year to acquire the basic and more advanced skills they need for their chosen occupation.

Our apprentices: tomorrow's skilled workers

Eawag has been involved in vocational training for many years. In 2020, nine young people successfully completed their apprenticeship, and another nine began their training in August. In its programme for trainee laboratory technicians, Eawag collaborates with external partners such as Bachema, Biotronik, Coca-Cola and Labor Veritas.

Peter Penicka, Eawag

Nadine Locher, Laboratory technician EFZ specialising in Biology, third-year trainee

In her training, Nadine is involved in molecular biology – working with microscopic amounts of materials to prepare the products required. She appreciates the fact that, as a lab technician, she has contacts with numerous departments and participates in research projects. "There's also a good sense of community among the apprentices," she says. Her plans for the future? First of all, get through the final exams – apart from that, she's keeping her options open.

Peter Penicka, Eawag

Samuel Ehmann, Laboratory technician EFZ specialising in Chemistry, third-year trainee

"The aspect of research that particularly appealed to me was generating new knowledge and learning from it," says Samuel. That's what motivated him to apply to train as a chemistry lab technician. Now he's involved in research on compounds affecting taste. "Meeting people from all over the world here at Eawag is an enriching experience," he says. After completing his training, he wants to take the vocational baccalaureate so that he can then study Natural Sciences and continue working in research.

Peter Penicka, Eawag

Ifedayo Ogunsola, ICT specialist EFZ, fourth-year trainee

As a trainee ICT specialist focusing on systems engineering, Ifedayo deals with the many challenges systematically – analysing, evaluating and then solving the problem. He appreciates the excellent support he receives from his Eawag supervisor in preparing for the final exams. "And I particularly enjoy my contacts with colleagues here," he says. When he has qualified, he plans to train as a football coach and then return to the IT sector.

Peter Penicka, Eawag

Melanie Gonzalez, Business administrator EFZ, third-year trainee

"After the first taster day, I knew I wanted to do my commercial apprenticeship at Eawag," says Melanie. She's pleased that trainees here are offered revision time and intensive preparation for the final exams. She tries to tackle challenges herself, but if that doesn't work, she can always find trainers ready to help her solve any problem. Melanie could imagine taking the vocational baccalaureate and then pursuing a career in event management.

Best preparation for the career journey

Sam Derrer has been Head of Vocational Training at Eawag for ten years, so he knows just how varied the apprenticeships are, and how trainees here are both supported and stretched.

Eawag

Sam Derrer answering our questions.

What are the distinctive features of vocational training at Eawag?
With its vocational training, Eawag offers a professional learning environment, with motivated trainers who also supervise the trainees as line managers – during the time they spend in the various departments. One particularly distinctive feature is the large number of apprentices we train here. For these young people, that makes the transition to the "adult world" a bit easier, as it gives them an opportunity to compare notes and network amongst themselves.

What apprenticeships does Eawag offer?
At Eawag, we provide training particularly in the laboratory sector – for both chemistry and biology laboratory technicians. But we also offer apprenticeships in the administrative and IT areas – for business administrators (EFZ/Federal Certificate of Proficiency), system engineers (EFZ) and ICT specialists (EFZ).

What exactly does an apprenticeship involve?
Apprentices here spend three to twelve months working in the same position and then move to a different group or department. This breadth of training provides insights into a number of different areas. Theoretical input reinforces what the apprentices learn on the job and supplements their practical training.

Are there any highlights the apprentices particularly look forward to?
That's certainly true of our Apprentice Camps, which promote their social skills and personal development, and which the apprentices help to organise. In the first year, we have a forest project week, and our annual ski camp is also popular. Our collaboration with partners in industry gives trainees an opportunity to experience different corporate cultures and ways of working outside Eawag.

What requirements do candidates have to meet for an Eawag apprenticeship?
When we select our apprentices, we pay particular attention to their basic motivation and enthusiasm for the job. In today's working environment, team skills and the ability to communicate effectively are also key requirements.

What else is important in vocational training, apart from the actual qualifications?
We want to make sure our trainees are not just technically qualified, but also prepared for their overall career journey. That includes personal development and also an awareness of social questions which will be important later in life.

> More information on apprenticeships at Eawag can be found in our video profiles at: eawag.ch/VET

As a young scientist, you have to focus on innovative methods.

34-year-old Denise Mitrano investigates tiny particles, measuring only a few millionths to thousandths of a millimetre. She joined Eawag over three years ago, setting up her own team within the Particle Laboratory research group in the Process Engineering department. During this period, she has developed a method to track the fate of nanoplastics in the environment, which was not previously possible. Prior to her time at Eawag, Mitrano held a postdoctoral fellowship at Empa, having received her PhD in geochemistry from the Colorado School of Mines in the US.

Peter Penicka, Eaweg

This year, geochemist Denise Mitrano was awarded a Swiss National Science Foundation (SNSF) Eccellenza Professorial Fellowship. She was one of the 34 selected from 229 applicants. The fellowship enables her to establish her own research group as an Assistant Professor.

Why do you think grants like Eccellenza are needed?
They offer young scientists like myself a wonderful opportunity to gain experience on the way to a full professorship – learning, securing research funding, teaching, supervising doctoral theses or expanding one's own network. However, there is still the uncertainty associated with a fixed-term contract. After five years, with an Eccellenza fellowship, you do not have the possibility to be employed on a permanent basis, as is the case with a tenure track programme.

In other words, after the first five years, you need to find another job?
Exactly, Eccellenza is a start-up grant, as it were. So in these five years I'll certainly be putting myself under a lot of pressure to achieve the best possible results. But that's OK for me, I work well under pressure.

So your ultimate goal is a permanent position as a professor?
Absolutely! I've had this dream ever since I started my doctorate.

What is your advice for young researchers who also want to pursue an academic career?
Be courageous and think out of the box! As a young scientist, you have to focus on a new field and innovative methods that are not yet established. This may entail risks, but at best you'll become a pioneer in your own field.

Master's students closely involved in research

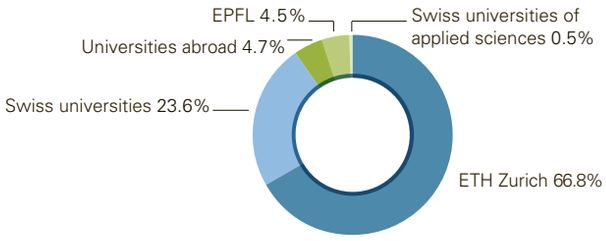
Each year at Eawag, around 160 Master's and Bachelor's students are supervised and often directly involved in research projects. Again and again, this collaboration – as well as Eawag's flat hierarchies and interdisciplinary culture – leads to outstanding Master's theses.

At Eawag, Master's theses are normally integrated into research projects, which gives students the advantage of working within a set framework but still having the flexibility to inject their own perspective. Gabriel Ulrich, who received an ETH award for an excellent Master's thesis in Biology, greatly appreciated the working atmosphere at Eawag: "I had a lot of useful input from my supervisors, which helped me to structure my experiments and analyses." More generally, there was a good deal of interaction between the students and the scientists: "That helps you to feel part of a research community, which I found motivating and exciting." His Master's thesis had been an instructive and valuable experience.

The supervisors also benefit from collaboration with the students, who always bring enthusiasm and fresh perspectives. For Christoph Vorburger, Head of the Aquatic Ecology department and Adjunct Professor at ETH Zurich, the supervision of Master's theses is one of the most satisfying aspects of his work: "Not infrequently, we can also persuade outstanding Master's students to do doctoral research at Eawag." Many of these students, he adds, end up in positions of responsibility in government, environmental consultancies or industry. "These contacts are crucial for Eawag in fulfilling its mission." To promote the transfer of knowledge to students, Eawag maintains a number of joint professorships with ETH Zurich and EPFL, as well as with other higher education institutions in Switzerland and abroad.

Tertiary-level teaching

5,267 h



Professorships

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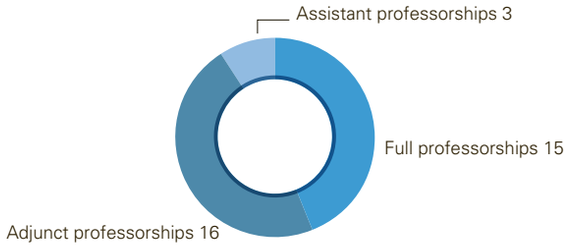

Bachelor's and Master's theses supervised

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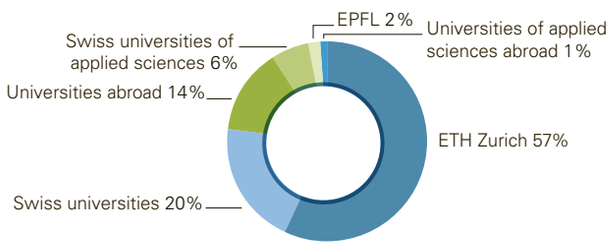

Doctoral theses supervised

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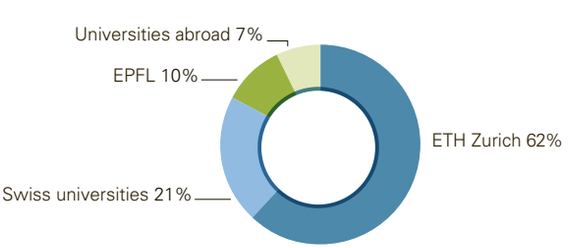


Practice-oriented courses in spite of the pandemic

Eawag's practice-oriented courses (known as PEAK) provide training for professionals. The courses – lasting one or more days – are organised in collaboration with professional associations and training partners, and are based on recent research findings and experience. Isabelle Schläppi of the PEAK Office looks back over a year marked by the COVID-19 pandemic.

Peter Penicka, Eawag

Isabelle Schläppi answering our questions.

What courses does the PEAK programme offer?
In 2020, nine training courses were planned, including three in French-speaking Switzerland. Our selection of topics is guided by new ordinances which need to be implemented – for example, in relation to the construction of fish migration structures or outcome evaluation for restoration projects. We also aim to communicate new research findings to practitioners. So surface water assessment and pollutant inflows and elimination were also important topics.

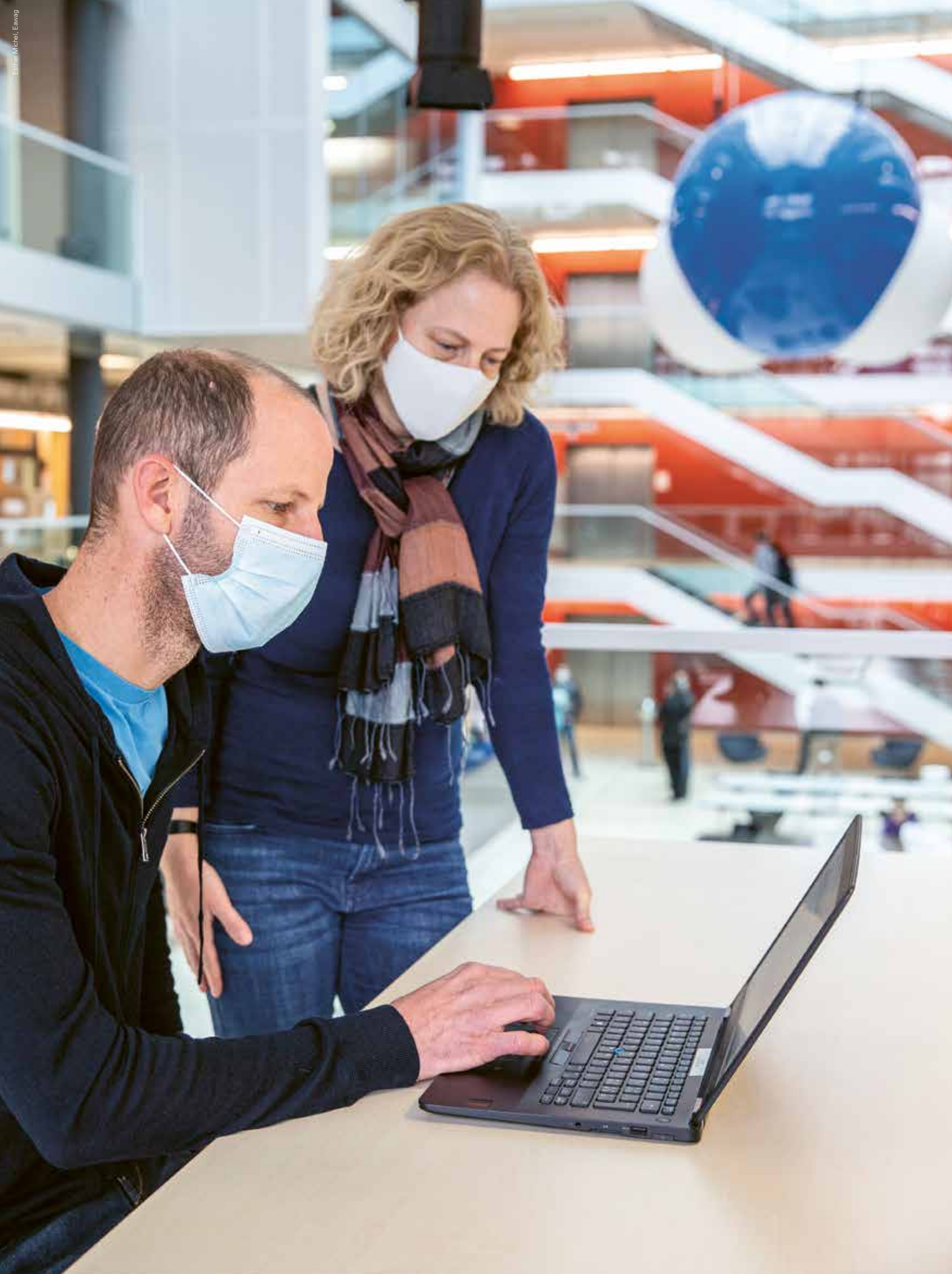
But everyone's plans were disrupted by the coronavirus – what did this mean for Eawag?
The need for specific training for professionals still existed in spite of the coronavirus. So it was important for us to ensure that knowledge transfer could still take place. A third of our courses were switched to online or hybrid formats. We managed to do this successfully thanks to the dedication and flexibility of all concerned. But practical training in the field had to be postponed to 2021.

How were the new course formats received by participants?
We didn't see any decline in applications, and we got a lot of positive feedback. The participants appreciated our thorough preparations and our professionalism. It's nice to have our efforts recognised like that! Of course, what was missing was the networking and interaction with other participants.

You also offered three courses in French-speaking Switzerland. How did they go?
Both Eawag and professionals in French-speaking Switzerland are keen to have PEAK courses there. Even if it involves more effort for us, we would like to meet this demand. But it's important to find experts with a good local network to run the courses. We managed to do that, and two courses were successfully held online. For this, we were supported by EPFL, the University of Lausanne and other local partners.

How has PEAK been changed by the events of 2020?
Our assessment is positive: the new online and hybrid formats have proved successful, and we'll continue to use them if possible. As a result of this experience, we're more flexible and can still offer most of our programme, which is appreciated by our professional audience. But it remains important for us to offer a wide variety of non-virtual courses, so that participants can interact and network in person.

> The current PEAK programme is available online at: eawag.ch/peak-en


Esther Michel, Eawag

Consulting

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

Photo opposite Christoph Ort, Group Leader in Eawag's Urban Water Management department, and Professor Tamar Kohn of EPFL are working together with other scientists to track the coronavirus pandemic in wastewater.

Hunting down the virus in wastewater

Concentrations of genetic material from the novel coronavirus in wastewater can be used to track the course of the pandemic, representing a valuable tool in addition to clinical test data. But detecting the virus in wastewater is a complex matter.

Esther Michel, Eawag

Part of a composite wastewater sample collected at the treatment plant is taken to the lab for analysis.

Esther Michel, Eawag

Coronavirus genetic material can only be quantified in wastewater after elaborate sample preparation.

When the first cases of COVID-19 were reported in the southern Swiss canton of Ticino – in February 2020 – scientists at Eawag, together with colleagues from EPFL, responded rapidly. Thanks to their close contacts with wastewater treatment plant (WWTP) operators, they obtained samples from WWTPs in Ticino, Zurich and Lausanne, and began laboratory experiments to determine how genetic material deriving from the novel coronavirus could be detected in wastewater.

Signal measured at an early stage

"Detection and quantification of SARS-CoV-2 in wastewater" – a project on this scale would usually take several years to complete. But by the end of April, the intense efforts of the group led by Tamar Kohn (Associate Professor at EPFL), Christoph Ort (Urban Water Management) and Tim Julian (Environmental Microbiology) of Eawag had already borne fruit: a signal was successfully measured in wastewater from Lugano, where only one case, and from Zurich, where only six cases of coronavirus infection had been officially reported.

PCR analysis hampered by substances in wastewater

The team had high hopes of being able to make wastewater tests available as early as summer 2020, thus providing a robust tool to complement clinical coronavirus tests, since epidemiologists were well aware that a second wave would arrive – the only question being when. However, wastewater-based epidemiology with regard to the coronavirus proved to more complex than initially thought. Firstly, viruses excreted in faeces are (fortunately) destroyed in wastewater. The viral envelope is attacked by soap and other substances in wastewater, and only fragments of the genetic information (RNA) contained in the virus can be identified. Secondly, detection involves an elaborate procedure, comprising a number of filtration and extraction steps, followed by PCR analysis (as in medical diagnostics). In addition, the results still showed wide variation: PCR analysis is hampered by substances present in wastewater. The small team continued working and compared notes with research groups in other countries, who were facing similar problems. To make matters worse, there were sometimes considerable delays in obtaining the reagents or pipette tips required.

Large number of unreported cases suspected

In July and August 2020, the number of reported new cases declined sharply. But the low levels of infection were still detectable almost every day, based on the RNA of SARS-CoV-2 in wastewater. The pandemic was not over. In the meantime, the detection method was further optimised. Then, in late September and early October, the number of new cases reported per day rose – from under 50 to 1000 in the canton of Zurich, and from several hundred to almost 10,000 nationwide by early November. This second wave could be tracked in wastewater samples from the cities of Lausanne and Zurich – including at weekends, when case numbers reported from clinical tests were lower. The decline in infections seen by the end of November was also reflected in wastewater. The figures then stagnated at a high level. Shortly before Christmas, they were once again almost as high as in early November, although laboratory-confirmed test

results indicated lower case numbers – particularly in the canton of Vaud. Was this evidence of a large number of unreported cases? That question is now being addressed by the research team, with the assistance of mathematicians from the ETH Zurich Department of Biosystems Science and Engineering. In addition, samples are now also being tested for new variants of the virus, and, from February 2021, four other WWTPs are being included in a pilot monitoring programme as well as those in Zurich and Lausanne.

Other projects concerned with the coronavirus
Apart from wastewater analysis, research groups at Eawag are tackling other questions relating to the pandemic: environmental social scientists – in collaboration with the Eawag spin-off Ranas – are investigating the factors which influence compliance with behavioural measures, such as mandatory face coverings. And Eawag environmental microbiologists – in partnership with Imperial College London and Tufts University (US) – are studying whether pressing traffic-light buttons or touching door handles poses a risk of infection.

> More details of the project and current data are available at: eawag.ch/covid

Esther Michel, Eawag

Environmental engineer Christoph Ort, Group Leader in the Urban Water Management department.

What are the advantages of looking for the virus in wastewater?
First of all, the results don't depend on whether or how many clinical tests are performed, since everyone goes to the toilet. Although wastewater doesn't lie, we need to develop sophisticated methods of measurement and data analysis to get the true story. And secondly, with this approach, a single wastewater sample, collected over a period of 24 hours from the inlet of a large treatment plant, will cover a large number of people – around 450,000 in the case of the Zurich Werdhölzli plant.

What can wastewater analysis not do?
Measurements of virus concentrations can track the curve of infections, but they only provide limited information on the actual number of cases. That's because we still don't know enough about who excretes how much identifiable viral genetic material, and when this occurs. Initially, we had also hoped that wastewater analysis would provide information much more rapidly than clinical tests. Researchers in Switzerland and abroad were talking about up to two weeks' early-warning time. Since a lot more testing can now be done, and the results are available sooner than they were at first, we're no longer so far ahead.

Several research groups around the world have been working on methods of detecting the coronavirus in wastewater. Why can't you simply agree on a single method?
That could be possible, at a later date. In the case of wastewater testing for drug consumption, we've now developed pan-European standards, and we use ring tests to make sure all the labs involved are measuring in the same way. But that took almost 15 years! However, when something new appears, it's precisely competition among scientists that means various techniques and scenarios are studied, thus helping to deal with the problem more rapidly than if everything was first standardised. There would then be a substantial risk of backing the wrong horse, and specific local conditions – for example, concerning the composition of wastewater – would not be taken into consideration.

Ensuring effective outcome evaluation

In many parts of Switzerland, rivers, streams and lakeshores are being restored. The new Eawag-FOEN practice documentation "Evaluating the outcome of restoration projects" provides a basis for collaborative learning across project boundaries.

Christine Weber, Eawag

Widening of the Ile de Falcon on the Rhône near Sierre (canton of Valais).

As a result of channelisation, waste disposal and hydropower operations, watercourses are among the most heavily impacted ecosystems worldwide. At the same time, watercourses are highly dynamic systems of exceptional biological diversity and social importance. As part of ongoing efforts to manage conflicts between resource use and protection, 4,000 kilometres of rivers, streams and lakeshores are to be restored in Switzerland by 2090.

Collaborative learning for the future

In restoration projects, everyone – from river engineers and anglers to ornithologists – can expand their knowledge of the dynamics of river ecosystems. The wide variety of projects in Switzerland provides opportunities to share experiences, learn from one another and thus continuously improve restoration projects.

In order to facilitate collaborative learning across projects, a team from the Surface Waters department was requested by the Federal Office for the Environment to develop practice documentation on evaluating the outcome of restoration projects. The needs of the cantonal agencies which carry out or commission such projects were ascertained in an iterative process and fed into the documentation.

Harmonised approach

Since January 2020, outcome evaluation in Switzerland has followed this harmonised approach, which comprises two elements. With the STANDARD outcome evaluation, before/after comparisons are used to assess the development of numerous restoration projects, covering as far as possible the entire spectrum of restoration measures and types of waterbody. With the EXTENDED outcome evaluation, specific practice-related questions can be rapidly addressed. For 2020 to 2024, the focus is on the restoration of small streams. The practice documentation "Evaluating the outcome of restoration projects" is available in English, French, German and Italian.

> Practice documentation available for download at: bafu.admin.ch/wirkungskontrolle-revit

Adequate space for surface waters is essential

The spatial requirements for surface waters specified in the Waters Protection Act represent the absolute minimum required to safeguard their ecological functions. This is shown by Eawag's work, which was cited by the Federal Supreme Court in a recent ruling.

A review published in *Umweltrecht in der Praxis* by Florian Altermatt, Group Leader at Eawag's Aquatic Ecology department and Professor at the University of Zurich, shows that, from an ecological perspective, the minimum width of the space to be provided under the relevant legislation is to be considered as the absolute minimum required to safeguard natural functions. Given the importance of this space, in particular, as a habitat, as a buffer against inputs of contaminants, and as a regulator of water temperature, substantially wider spaces would be needed in some cases.

Altermatt's work provided a sound scientific basis for a ruling of the Federal Supreme Court. In an appeal to this body, a farmer and the Farmers' Association of Basel-Stadt and Basel-Landschaft had called for the designation of a watercourse space for a small stream to be annulled. Citing the Eawag scientist in its considerations, the Court noted that very small streams are important connectivity and migration corridors for numerous species. The appeal was rejected.

Planning aid for granular activated carbon filtration

As well as ozonation, granular activated carbon (GAC) filtration is increasingly being used to remove micropollutants from municipal wastewater. In collaboration with authorities and water professionals, Eawag has prepared a planning aid on this topic.

Eawag

Pilot tests on GAC filtration at the Muri WWTP.

Since 2016, work has been underway to upgrade Swiss wastewater treatment plants (WWTPs) with an additional step to remove organic micropollutants, in accordance with the Micropoll Strategy of the Federal Office for the Environment (FOEN). In this connection, a "Micropollutants Process Engineering" platform is operated by the Swiss Water Association (VSA). The methods employed to date have been ozonation and GAC filtration. The latter is regarded by experts as an attractive option, but various uncertainties remain – for example, concerning the appropriate system dimensions. In December 2019, a workshop on GAC filtration for micropollutant removal was therefore held by Eawag and the VSA. This was attended not only by researchers but also by representatives of WWTPs and engineering consultancies, as well as FOEN and VSA experts.

As a result of this workshop, a broad-based consensus paper has now been published, providing greater certainty for the planning and design of GAC filters for micropollutant removal at Swiss WWTPs. As co-organiser Marc Böhler of Eawag emphasises, it also takes account of input from colleagues in Germany. The publication represents a significant contribution by Eawag and the VSA to efforts to support the implementation of micropollutant removal measures.

> The consensus paper (in German) is available for download at: micropoll.ch

Circular economy: wastewater holds great potential

At NEST – the Empa-Eawag modular research and innovation building – Eawag is conducting research on decentralised wastewater treatment, with the aim of using wastewater as a source of nutrients, energy and water.

Aldo Todaro, Eawag

Aurea Heusser of the Process Engineering department investigates urine treatment for fertiliser production.

The term "circular economy" is now mostly applied to the recycling of (raw) materials. However, the closing of cycles also holds enormous potential in other areas – where, in some cases, much more progress has been made than in conventional recycling. For 25 years, Eawag's wastewater research has been focusing on how wastewater streams can be separated at source, and treated and reused as efficiently as possible. The guiding principle is that wastewater is not waste, but a valuable resource.

From waste to resource

Today, mixed wastewater is transported to a treatment plant, where it is extensively treated before being discharged into receiving waters. This involves various challenges: for example, treatment at the wastewater treatment plant requires energy and space. In addition, wastewater contains valuable nutrients. If wastewater streams are separated at source, they can be separately treated and nutrients, for example, can be reused in accordance with the circular economy model.

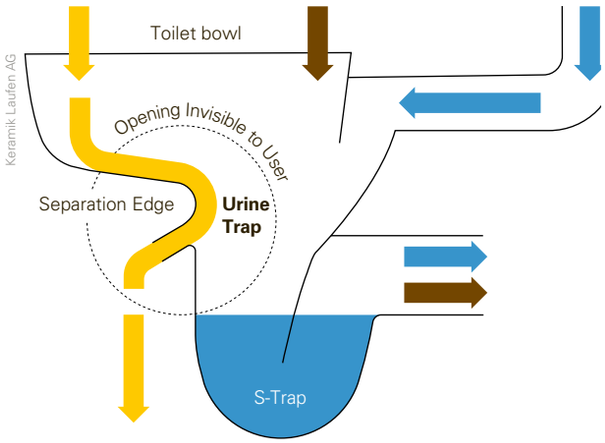
Carina Doll, project coordinator at Eawag, says: "Urine contains large quantities of nitrogen and phosphorus, which can be recycled as plant fertiliser. But wastewater can also serve as a source of energy and process water." Greywater – from showers or washbasins, for instance – can also be treated and, depending on local needs, reused for various purposes, such as irrigation, toilet flushing or, with appropriate treatment, even showering. Faeces from blackwater – wastewater from the toilet, from which urine has been separated – can be processed into pellets. When these are burned, energy is recovered in the form of heat.

Efficient circular economy at NEST

At the NEST Water Hub, Eawag and its spin-off Vuna are conducting research on resource-oriented, decentralised wastewater treatment. One key component

is a urine-diverting toilet, which separates the various streams – urine and other wastewater – at source. This is where the NEST partner Keramik Laufen (a long-established Swiss company) is involved: in 2020, following a pilot installation at the end of 2019, the company equipped the entire NEST building with its new "Save!" toilets. Rolf Schmidt, Head of Marketing at Keramik Laufen AG, says: "With the installation of our 'Save!' toilets at NEST, we can achieve a highly efficient circular economy for the building and further advance research in this area."

The innovative toilet separates urine from flushwater without any need for moving parts or sensors. It relies on the urine trap, which is based on the so-called teapot effect: urine is drained into a concealed opening, while faster-flowing flushwater overshoots the separation edge and removes faeces and toilet paper, as in conventional toilets. The special design that makes this possible was created by Harald Gründl and his team at the Austrian company EOOS Design.



Keramik Laufen AG

As a result of the shape of the "Save!" toilet, urine is drained into a separate outlet, while faster-flowing flushwater overshoots the separation edge and removes faeces and toilet paper. Urine can thus be collected and separately treated.

Closing the loop with a fertiliser

At NEST, wastewater streams are fed into the Water Hub via separate pipes. One of these streams is particularly important for the Eawag spin-off Vuna: a process within the Water Hub enables the valuable nutrients contained in urine to be recovered.

First, urine is stabilised by nitrification, a biological process which converts ammonium to nitrate, eliminating unpleasant odours. Next, drugs and hormones are removed by an activated carbon filter. Finally, the liquid is evaporated so as to eliminate pathogens and reduce the volume. The end products are water and Vuna's liquid fertiliser Aurin.

Aldo Todaro, Eawag

Wastewater streams separated at source can then be separately treated. Here, greywater, blackwater and urine are separated.

Bastian Etter, Director of Vuna, explains: "Separately collected urine is a very rich source of nutrients. Thanks to our treatment process, our fertiliser contains all the important nutrients that plants need to grow. Aurin is also the first urine fertiliser in the world to be authorised for use on edible plants." Thanks to cooperation on urine recycling between research and industry, the loop is thus now closed.

New strategy for assessing sediment quality

The Ecotox Centre has published a new strategy for assessing the quality of sediments, which are of great importance in the protection of natural waters.

Sediments are of crucial importance for the quality of surface waters as habitats. In the Waters Protection Ordinance, it is therefore stipulated that sediments must not contain any persistent synthetic substances or pollutants with harmful effects on living organisms. However, investigations by the Ecotox Centre and Eawag have found several pesticide active substances in stream sediments in potentially toxic concentrations.

New assessment strategy

To date, cantons lacked a consistent strategy for monitoring sediment quality. Over the past six years, a new strategy was developed by the Ecotox Centre on behalf of the Federal Office for the Environment, in collaboration with Eawag and the Swiss Water Association (VSA).

In the assessment strategy, the following questions are addressed: How should a monitoring campaign be planned? What procedure is recommended for sample collection and preparation? What substances should be analysed? And how precisely can sediment quality be assessed?

Uniform recommendations

The recommendations specify 20 substances or groups of substances which are particularly relevant for sediment monitoring. These include substances long known as sediment pollutants, such as polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and metals, but also pesticides, medicines and personal care products.

In each case, the Ecotox Centre has defined sediment quality criteria, i.e. threshold values for possible toxicity. Based on the concentrations determined by chemical analysis, sediment quality can thus be assigned to one of five classes for purposes of assessment.

> The document is available for download at: ecotoxcentre.ch

PlaNet tool: planning stakeholder participation

The new online tool PlaNet makes it easier for communes to identify important project partners – including critical voices – for complex environmental and infrastructure projects. It helps them to organise participatory processes in a professional manner.

Every year, Swiss communes undertake numerous environmental and infrastructure projects – for example, in the areas of wastewater management, flood control or river restoration. However, it is not always easy to identify and involve all important stakeholders at an early stage. Often, small and medium-sized communes, in particular, do not have the time or resources to plan a participatory process in a professional manner. But inadequately prepared processes may lead to objections or complaints, especially in the case of controversial projects.

Identifying critical voices in good time

To support communes in their work, the online tool PlaNet was developed by researchers at Eawag and the University of Bern, in collaboration with Water Excellence AG. PlaNet takes users through seven steps, in which questions are answered about the project and stakeholders. Based on the information provided, the tool identifies all important project partners, including critical voices, and enables a clear overview of their potential influence and role.

Finally, the network of stakeholders and their requirements are presented in a clear graphical form. The visualisation is designed to help communes systematise and simplify the participatory process, thus saving time and resources.

> The new tool is available at: planet.eawag.ch

Making organic waste management sustainable

Treatment of organic waste with black soldier fly larvae (BSFL) offers a sustainable and economic solution for organic waste management in Indonesia.

In Indonesia, organic waste accounts for 70 per cent of all waste, and it is generally landfilled or illegally disposed of. But with an economic incentive, organic waste is more often treated appropriately, rather than being allowed to pollute the environment. This was shown by a project carried out by Eawag in Surabaya (Indonesia) – Sustainability of Insect-Based Recycling Enterprises (SIBRE). By converting organic waste into marketable products, the costs of waste treatment can be covered at the same time.

Yosa Padu

SIBRE team member Mauliddiana Nurul Ilyas promoting BSFL products to Mas Sueb, a local retailer.

Market analysis shows good potential for dried BSFL products

Treating organic waste with BSFL creates two marketable products – compost and larvae. In contrast to compost, a large market exists for fresh larvae as animal feed. However, as the storage and transport of fresh larvae pose various problems, attention is increasingly focused on dried larvae: they are easy to store, package and transport, and can be sold at a higher price. In addition, they can be packaged in a way which is attractive for customers.

Sirajuddin Kurniawan

Pictured on the left is a crumble product made of dried, processed BSFL for ornamental fish; on the right, a pop larvae product for pet birds.

The SIBRE market analysis identified bird and ornamental fish markets as possible outlets for dried BSFL products in Indonesia. Potential customers at these markets, appreciating the natural qualities of the new products, reacted positively. They are used to insects as a source of animal feed and are aware that they are a valuable source of protein.

Subsequently, SIBRE collaborated with several entrepreneurs to found Pro BSF, one of the first companies selling dried BSFL products in Surabaya. There are now more and more brands selling similar products at pet markets.

Waste can be treated on-site

The advantages of BSFL are well-suited for waste systems in Indonesia, with its numerous urban regions. Waste is a particular problem in densely populated areas, and BSFL plants do not require a lot of space or expensive equipment. Small-scale decentralised waste treatment facilities can operate near restaurants and markets. Organic waste then no longer has to be transported to landfills, but can be readily treated, manually, on-site and made into marketable products, transforming organic waste management into a sustainable business.


Christian Dinkel, Eawag

Institution

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

Photo opposite People from over 40 different countries work at Eawag. This diversity – ethnic, cultural and linguistic – has been captured in photographs by Christian Dinkel, a technician at Kastanienbaum. Pictured here is Salome Mwaiko, a laboratory manager from Tanzania. Her contributions to Eawag have been valuable not only in the lab but also during fieldwork in East Africa, as she speaks Swahili and is familiar with the local customs.

Awards

Magdalena Mayr wins the Hydrobiology-Limnology Prize

In alternate years, the Swiss Foundation for Hydrobiology-Limnology awards a prize for an outstanding doctoral (even years) or Master's thesis (odd years). In her thesis, supervised by Helmut Bürgmann at the Surface Waters department in Kastanienbaum, Magdalena Mayr studied methane-oxidising bacteria in four Swiss lakes.

Microbial Ecology Group, Eawag

Magdalena Mayr on a fieldwork excursion.

Otto Jaag Water Protection Prize for Moy de Vitry

In November 2020, Matthew Moy de Vitry received the Otto Jaag Water Protection Prize. This ETH Zurich award recognises outstanding doctoral and Master's theses in the field of water protection and hydrology. In his doctoral thesis, Moy de Vitry showed that unconventional and potentially controversial approaches may be required to manage urban flash floods – an increasingly pressing problem due to climate change and urbanisation.

Giulia Marthaler, ETH Zürich

Moy de Vitry and Sarah M. Springman, Rector of ETH Zurich.

Golden Owl for David Johnson

In 2020, David Johnson, Group Leader in the Environmental Microbiology department, received the Golden Owl of the ETH Zurich student association (VSETH). This award is presented to lecturers for excellent teaching. It recognises Johnson's commitment to teaching in the Department of Environmental Systems Science.

Four Eawag researchers among the most highly cited worldwide

Four Eawag scientists – Professors Juliane Hollender, Ole Seehausen, Bernhard Truffer and Urs von Gunten – were included in the Clarivate list of Highly Cited Researchers 2020. 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 (2009–2019). Overall, 154 researchers from Switzerland were included in the 2020 list.

SSE Presidents' Award for Outstanding Dissertation Paper in Evolution (formerly the R. A. Fisher Prize)
Dorota Paczesniak (Aquatic Ecology)

SETAC Rifcon Early Career Scientist Award
Michael Burkard (Environmental Toxicology)

Silver Medal of ETH Zurich for an outstanding doctoral thesis
Alma Dal Co (Environmental Microbiology), Magdalena Mayr (Surface Waters), Jonas Mechelke (Environmental Chemistry), Lena Mutzner (Urban Water Management)

Silver Medal of ETH Zurich for an outstanding Master's thesis
Gabriel Ulrich (Aquatic Ecology)

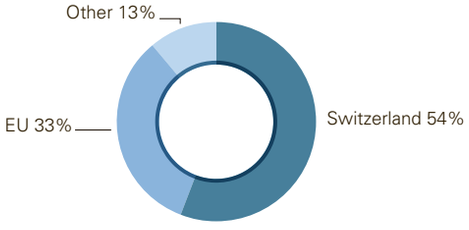
Headcount and personnel structure

As of 31 December 2020, Eawag's headcount (excluding interns, visiting academics and temporary staff) was 520 people (469.8 full-time equivalents/FTEs), distributed among the following functions: scientific, technical and administrative staff, and apprentices. Women account for 50.2% of the total (including apprentices). Eawag continues to provide training for 27 apprentices – chemical and biological laboratory technicians, business administrators and ICT specialists.

Eawag's international character as a world-leading aquatic research institute is reflected by the diverse origins of its employees, who come from 48 different countries.

Origin of employees

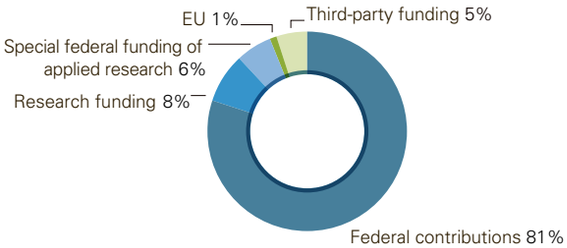
520



Financing for staff derives not only from federal contributions but also from research funding obtained on a competitive basis. As of 31 December 2020, the financing of the FTEs (excluding apprentices) breaks down as follows:

Sources of funding for personnel (CHF thousand)

56,405



Personnel policy and career development

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

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

For its 83 doctoral students, Eawag provides excellent infrastructure, training options and information platforms. For scientists with fixed-term project appointments, Eawag organises career planning workshops and offers academic transition grants to develop their qualifications for the labour market.

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

Eawag and COVID-19

Throughout the year, Eawag's COVID-19 Task Force monitored the situation, developing forward-looking strategies and adopting appropriate measures. The goal of avoiding infections within the institute was achieved. Around three quarters of planned internal training events took place, either in person or online. In addition, courses were held on hygiene and safety measures, and aids were made available.

Personnel news

Janet Hering becomes Co-Chair of SDSN

In February, Janet Hering, Eawag Director and a Professor at ETH Zurich and EPFL, was elected to co-chair the Sustainable Development Solutions Network (SDSN) Switzerland, together with Océane Dayer (WWF Switzerland). SDSN Switzerland seeks to mobilise universities, research centres, civil society organisations, business and other knowledge centres to create and implement solutions to achieve the goals of Agenda 2030 and the Paris Agreement.

Alessandro Della Bella, Eawag

Janet Hering

Martin Ackermann becomes Chair of the COVID-19 Science Task Force

The Swiss National COVID-19 Science Task Force was mandated by various federal agencies to act as a national scientific advisory body in relation to the COVID-19 pandemic. In August 2020, Martin Ackermann, Head of Eawag's Environmental Microbiology department and Professor of Molecular Microbial Ecology at ETH Zurich, was appointed as the new Chair of the Task Force.

Ethan Oelman

Martin Ackermann

Kristin Schirmer becomes Adjunct Professor at ETH Zurich

In December 2020, biologist Kristin Schirmer was appointed as Adjunct Professor at ETH Zurich. In 2006, she had obtained her habilitation at ETH Zurich, where she subsequently taught ecotoxicology. In 2008, she joined Eawag as the new Head of the Environmental Toxicology department. In 2011, she began teaching as an Adjunct Professor at EPFL.

Peter Penicka, Eawag

Kristin Schirmer

Piet Spaak representing research in the Lake Greifen Protection Association

In June 2020, the Lake Greifen Protection Association elected a new Council of Delegates. Represented on this body, as well as all the communes located around the lake, are cantonal agencies, farmers, fishermen, sailors and – for the first time – research. Representing the latter is Piet Spaak of Eawag's Aquatic Ecology department, who is also a privatdozent at ETH Zurich. In his new role, he can represent Eawag's interests in the lake, while Eawag will benefit from even closer links with the stakeholders associated with the lake.

Peter Penicka, Eawag

Piet Spaak

Research abroad thanks to SNSF mobility grant

Four young scientists from the Urban Water Management department – Mariane Schneider, Lena Mutzner, Omar Wani and Matthew Moy de Vitry – received an Early Postdoc.Mobility fellowship from the Swiss National Science Foundation to enhance their research profile abroad. The scientists previously worked together as a team during their doctoral research, publishing, for example, a review of data-driven urban water management.

Peter Penicka, Eawag

The research team led by Head of department and ETH Professor Max Maurer (fourth from right): Wani (left), Mutzner (fourth from left), Schneider (third from right) and Moy de Vitry (right).

Manuel Fischer: Adjunct Professor at University of Bern and Board member of eco.ch

In December 2020, political scientist Manuel Fischer of the Environmental Social Sciences department was appointed as Adjunct Professor at the University of Bern. Fischer joined Eawag as a postdoctoral researcher in 2012. Since 2014, he has co-headed the Policy Analysis and Environmental Governance research group with Professor Karin Ingold of the University of Bern. For the past seven years, Fischer has served as a lecturer and privatdozent at the Bern University Institute of Political Science. In November 2020, Fischer was also elected to the Board of eco.ch – the Swiss forum for sustainable development, which brings together key players in politics, society, academia and industry.

Peter Penicka, Eawag

Manuel Fischer

Spin-offs

Entracers GmbH

What changes in gas composition occur in a bentonite-based engineered barrier system at temperatures of up to 200 degrees Celsius? This is one of the questions being investigated by Nagra in connection with radioactive waste disposal. Participating in this research is the new Eawag spin-off Entracers GmbH, headed by Yama Tomonaga of the Water Resources & Drinking Water department. Since July 2020, the company has been advising associations, companies and research institutes on the development and implementation of gas monitoring/screening strategies. The company also performs gas sampling in the field and carries out measurements in accordance with its own analytical capabilities.

> entracers.com

Ranas Ltd.

Changing people's behaviour is no easy matter, as the coronavirus pandemic has demonstrated once again. However, the Ranas behaviour change model, developed at Eawag, can increase the effectiveness of interventions by analysing factors that may influence target groups' behaviour. This model is being applied worldwide – in consulting, courses and projects – by the new spin-off Ranas Ltd. The founders (Miriam Harter, Silvie Palacios, Elisa Mosler, Andrea Tamas and Max Friedrich) have collaborated for some years with Hans-Joachim Mosler of RanasMosler, another Eawag spin-off. The Ranas model, based on the results of research by a working group in the Environmental Social Sciences department, was published by Mosler in 2012.

> ranas.ch

Broad dialogue

UrinExpress on tour in Switzerland

The Eawag spin-off Vuna took its mobile fertiliser production unit (UrinExpress) on a tour around Switzerland. This treatment unit – a converted trailer – gives people a chance to see for themselves how fertiliser can be produced from urine. The first stop (in February) was the public grass tennis courts at the Gurzelen stadium in Biel. Project manager Nadège de Chambrier explains: "We were able to persuade the tennis club to maintain their lawn in future using the fertiliser produced on-site. This was also a good opportunity to present our technology to a lot of people." The tour had to be cut short because of the pandemic, but it was at least possible to visit the Dübendorf and Lucerne locations. The tour will continue in 2021. The UrinExpress is a joint Eawag-

Vuna project, supported by the Federal Office for the Environment's programme for environmental technology promotion.

Aquatic Biodiversity session at the World Biodiversity Forum

The first World Biodiversity Forum was held in Davos in February 2020. At the session on "Aquatic Biodiversity", organised by Eawag scientists, the new ABCD conference format was tested. Speakers were selected not only on the basis of scientific excellence and relevance, but also according to the ABCD criteria – from All continents, with gender Balance and attendance by low Carbon transport, and representing Diverse backgrounds. The scientists hope that this format will also be adopted for working group meetings or research projects.

> More information on the ABCD format is available at: eawag.ch/abcd-conferences

Interview on World Water Day

The theme of UNESCO World Water Day on 22 March 2020 was "Water and Climate Change". How does climate change affect Switzerland's lakes? Will the country still have a surplus of water in the future? These and other questions were answered by environmental scientist Martin Schmid of the Surface Waters department.

> The interview is available online at: eawag.ch/worldwaterday

Beat Kienholz, Eawag

Martin Schmid

Abishek Narayan reaches the final of FameLab Switzerland

FameLab, established by the British Council, is one of the world's biggest science communication competitions. Participants have just three minutes to win over the judges and audience with a scientific talk that excels for its content, clarity and charisma. In September 2020, Abishek Narayan – a doctoral researcher in the Sanitation, Water and Solid Waste for Development department – qualified for the Swiss national final with his talk on alternative wastewater treatment methods. The international final is held at the Cheltenham Science Festival in the UK.

FameLab Switzerland

Abishek Narayan

Videos to mark World Toilet Day

To mark World Toilet Day on 19 November 2020, seven Eawag scientists explained in short videos what makes toilets such a fascinating topic and what their current research involves. Today, over two billion people still lack access to sanitation. Eawag is conducting research on new planning methods and concepts to address this challenge sustainably and equitably. Modern toilets also open up new possibilities for the recovery of nutrients, water and energy from wastewater. Eawag is developing toilet systems and technologies to enable valuable resources to be recycled.

> The seven videos are available at: eawag.ch/worldtoiletday

Equal opportunities

The Equal Opportunities Committee (EOC), which includes representatives from all staff groups at Eawag, seeks to prevent discrimination of any kind at the institute and within the ETH Domain. In 2020, Eawag participated not only in the ETH Domain's long-running "Fix the leaky pipeline" programme (designed to foster women's scientific careers), but also in the swissuniversities CONNECT programme, which aims to connect women's careers in academia and industry, providing financial support for projects in this area. The second round of the programme, which involved a total of 35 participants from all the institutions of the ETH Domain (including 4 from Eawag) plus the University of Zurich, took place in spite of the pandemic, with some meetings switching to a virtual format.

In 2020, the first training event on unconscious bias was held for management. This event explored the significance of implicit prejudices and how these can be addressed and reduced both by leaders and within teams. There was a special focus on the topics of recruitment, doctoral research and promotion, and daily work in the team.

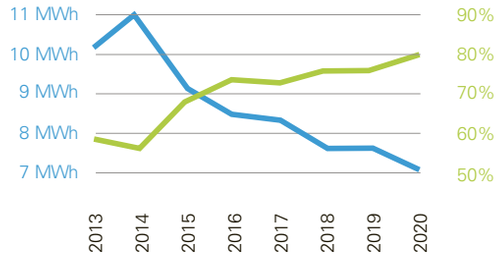
The compatibility of family and career remains an important topic. Under the Tailwind programme, grants are available to support mothers returning to work. The term of employment for tenure-track female scientists is automatically extended if they start a family, and new fathers can temporarily reduce their working hours. The proportion of women in management positions at Eawag remains relatively high (34%). As well as supporting the Empa-Eawag nursery, Eawag contributes to the childcare costs of low-income parents.

Environment

It's a well-known dilemma: international research activities are of vital importance for scientists, but aircraft emissions contribute to climate change. As an environmental research institute, Eawag therefore wishes to reduce business air travel. Over the last two years, 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.
Since 2020, under an internal directive, staff have been required to travel by rail rather than air for journeys of up to 1,000 kilometres. And since 2019, Eawag has had its own videoconferencing facility, making it much easier for researchers to conduct remote meetings.

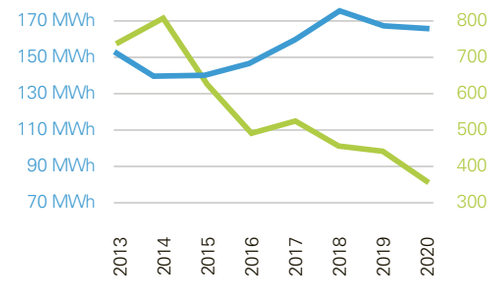
Energy consumption per capita

Energy consumption MWh/FTE **Renewable energy share** in per cent

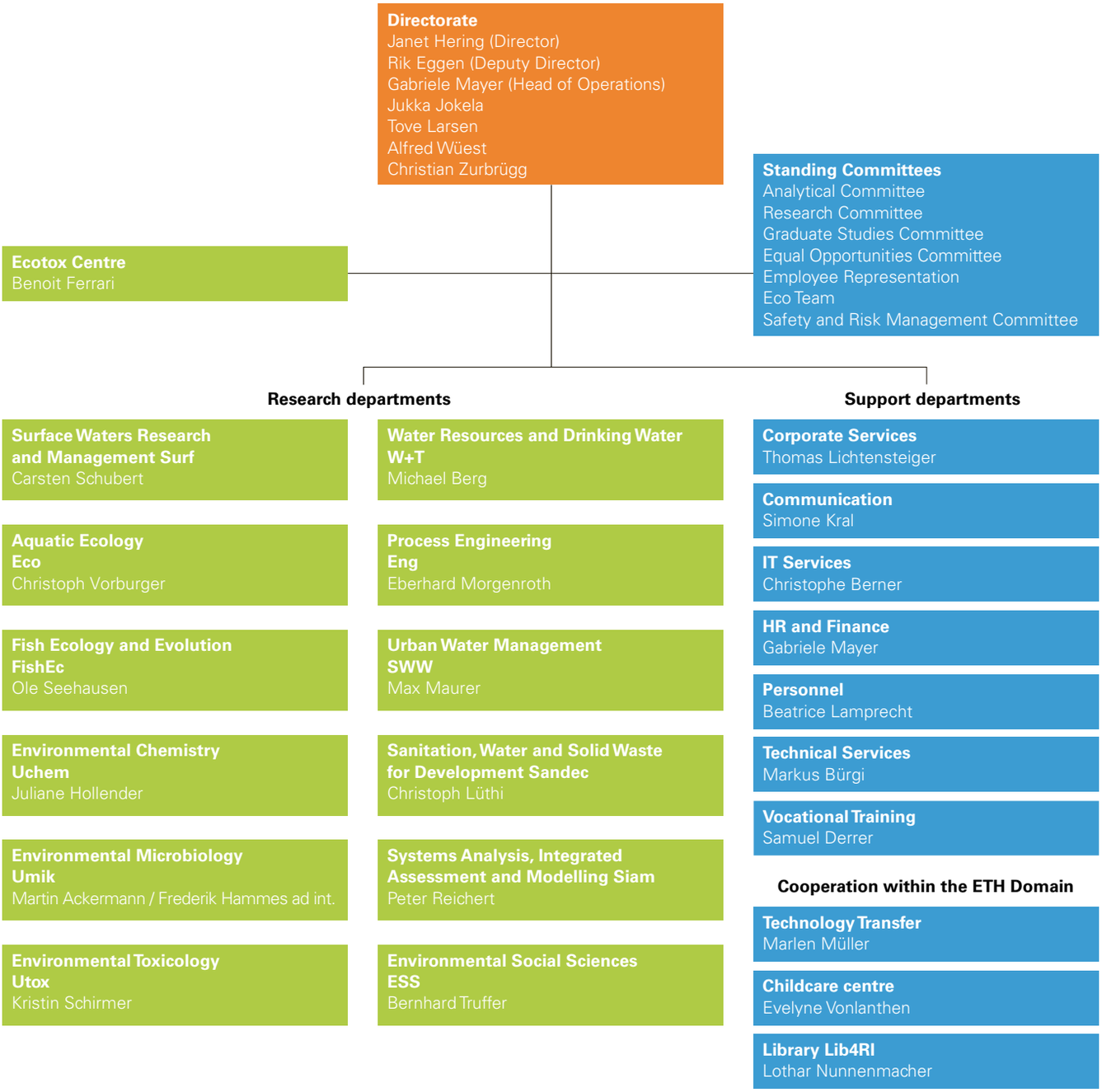


Electricity generation and greenhouse gas emissions

Solar power MWh **Greenhouse gas emissions** in t CO_2-eq



Organisation



As of 31 December 2020

Directorate

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

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

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

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

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

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 (revised version: 16 May 2018) on risk management at ETH and its research institutes. These directives regulate the essential aspects of risk management and define the goals of the risk policy pursued by the ETH Board. 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. In 2020, on account of the pandemic, these exchanges took place via electronic channels. As in previous years, the risk report was submitted to the Eawag Directorate for consideration and approval. In its annual reporting, Eawag informs those responsible within the ETH Board as to its core risks, and 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, in accordance with the ETH Board's directives of 4 July 2006 (revised version: 16 May 2018) on risk management at ETH and its research institutes, 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.

Annual financial statements: eawag.ch/annualreport

Editor: Eawag Communication

Contributors: Johann Dossenbach, Bastian Etter, Sibylle Hunziker (freelance author), Beatrice Lamprecht, Thomas Lichtensteiger, Julian Matheson, Gabriele Mayer, Ori Schipper (freelance author)

Graphics and layout: Peter Penicka

Translations: Jeff Acheson, Laurence Frauenlob
Proofreading: INTERSERV AG, Jeff Acheson, Marianne Leuzinger

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Eawag
Überlandstrasse 133
8600 Dübendorf
Switzerland
+41 (0)58 765 55 11

Eawag
Seestrasse 79
6047 Kastanienbaum
Switzerland
+41 (0)58 765 21 11

info@eawag.ch
eawag.ch

Esther Michel, Eawag

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