Eawag:
Swiss Federal Institute of Aquatic
Science and Technology

Annual Report 2017

Esther Michel, Eawag

The National Surface Water Quality (NAWA) programme is a monitoring network operated by federal and cantonal authorities to assess changes in the state of waterbodies across Switzerland. As part of this programme, Eawag scientists, together with the VSA Water Quality Platform and other institutes, have studied pesticide levels in small streams (cf. p. 12). Pictured here: investigations in the Eschelisbach near Güttingen (canton of Thurgau).

Contents


Aldo Todaro, Eawag

Eawag, the Swiss Federal Institute of Aquatic Science and Technology, is part of the ETH Domain. This comprises the Swiss Federal Institutes of Technology in Zurich (ETHZ) and Lausanne (EPFL), Eawag and three other independent, application-oriented research institutes – the Paul Scherrer Institute (PSI), the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) and the Swiss Federal Laboratories for Materials Science and Technology (Empa). Nationally rooted and internationally networked, Eawag is concerned with concepts and technologies for the sustainable management of water resources and aquatic ecosystems. In cooperation with universities, other research centres, public authorities, the private sector and NGOs, Eawag strives to harmonise ecological, economic and social interests in water, providing a link between science and practical applications. Just under 500 staff are employed in research, teaching and consulting at the Dübendorf (Zurich) and Kastanienbaum (Lucerne) sites.

Honouring the contract between science and society

On Earth Day (22 April) in 2017, marches and rallies for science were held in over 600 cities around the world. Why? After all, science, technology, engineering and mathematics (STEM) have profoundly shaped modern life. In industrialised, high-income countries, access to basic infrastructure and services – water, electricity, mobility and communication – can be taken for granted. Advances in medical science and technology have contributed to a worldwide increase in life expectancy. Access to infrastructure is increasing even in low- and middle-income countries, which supports their participation in global markets.

Against the politicisation of science

The marches for science were meant to highlight the importance of STEM activities to society, to promote the incorporation of STEM knowledge in policymaking, and to protest against the politicisation of science and political attacks on the integrity of science. That so many scientists felt the need to march calls the unwritten contract between science and society into question.

A substantial proportion of STEM research is supported by public funds. This investment is based on the proposition that scientific progress is essential to national and international interests – specifically, health, prosperity and security. Government investment in basic research and education has been seen as a necessary complement to market-oriented support of research by industry. Since environmental research deals with public goods, public investment is needed not only for basic research and education but also for applied research.

For evidence-based policymaking

Eawag makes substantial efforts to ensure that its research can serve as a reliable basis for decision-making in environmental policy, management and practice. Our researchers conduct applied projects and present results in trade magazines and at events attended by regulators and practitioners, including our PEAK courses and our annual Info Day. Our staff in Communications and Corporate Services play a vital role in making our research results accessible outside the scientific community. Yet we must also appreciate and communicate that our basic research is the wellspring of new knowledge that may only be applied far in the future and in ways that cannot be predicted today.

Janet Hering
Director Eawag

Highlights of 2017

WBF

In July, Federal Councillor Johann Schneider-Ammann (centre) visited Indonesia with a high-level delegation of Swiss business and science representatives – including Eawag Director Janet Hering (right in red). Among other events, the scientific delegation took part in a seminar on innovation and science parks, also attended by Muhammad Nasir, Indonesia's Minister of Research, Technology and Higher Education. Discussions focusing on closer cooperation in the areas of research and education provided opportunities to establish or strengthen contacts.

"I was honoured to accompany Johann Schneider-Ammann to Indonesia with the scientific delegation. I was impressed by the great interest shown in the local Eawag project using black soldier fly larvae for biowaste treatment." **Janet Hering**

Peter Penicka, Eawag

As part of the Water Hub project in the Eawag-Empa experimental building NEST, light and heavy grey water is to be treated on-site so that it can be used not only for flushing toilets but also for showering. The grey water is collected and first passed through a membrane which filters out contaminants and pathogens. The treated water then flows through an activated carbon filter, which eliminates any remaining pollutants.

eco.ch

Gravit'eau, a joint Eawag–FHNW School of Life Sciences project, received the 2017 Swiss Sustainability Prize (prix eco.ch). The project was developed by Regula Meierhofer (right) of Sandec and her former Eawag colleague Maryna Peter (left), who is now a research scientist at the FHNW School of Life Sciences. Gravit'eau off-grid water kiosks – used in schools, villages and health centres in Uganda – supply drinking water purified by gravity-driven membrane filtration. The systems are robust, low-maintenance, low-cost and easy to operate.

Stefan Kubli, Eawag

The completion of Projet Lac marks a milestone in the systematic assessment of fish biodiversity in Switzerland's prealpine lakes. The researchers' final report has now been published. In Lake Lucerne – the last lake to be surveyed – the species composition determined using standardised methods differed markedly from commercial catches. Particularly gratifying was the rediscovery of the historically described deep-water char in the Urnersee.

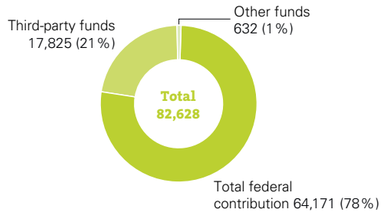
Matthias Brennwald, Eawag

If a research project leads to a business idea, Eawag supports the establishment of a spin-off, providing professional, unbureaucratic assistance for young entrepreneurs during the start-up phase. Another two promising spin-offs were launched in 2017: Oncyt offers an automated system for the assessment of microbiological water quality, based on flow cytometry measurements with high temporal resolution. Gasometrix is developing and commercialising a portable mass spectrometer (pictured left) used for on-site gas analysis (cf. p. 40). An overview of Eawag spin-offs can be found on the website: www.eawag.ch/spinoffs

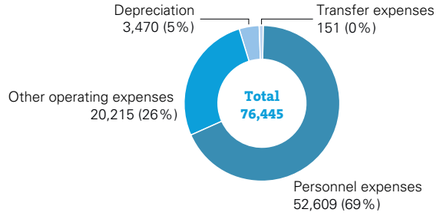
Eawag in figures

Finances

Operating revenue (in thousand CHF)



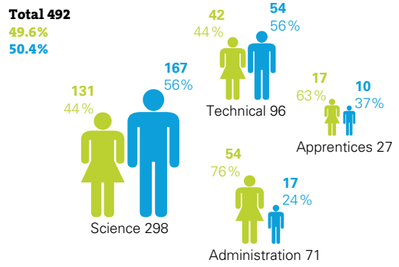
Operating expenses (in thousand CHF)



Due to rounding, individual figures may not sum to the totals shown (see Annual Financial Statements, p. 47).

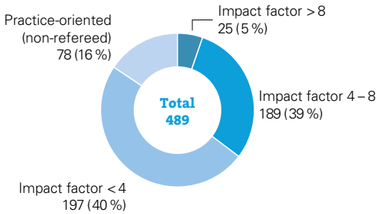
Personnel

Employees by function

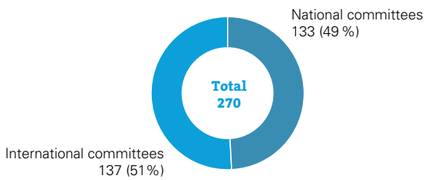


Research

Publications

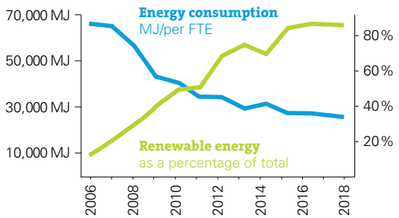


Committee memberships



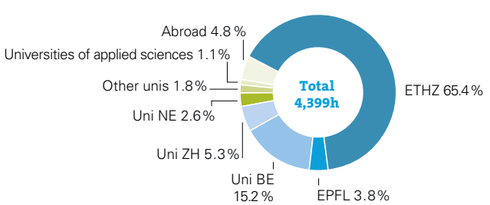
Environment

Energy consumption per capita

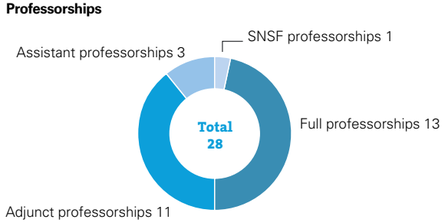


Teaching

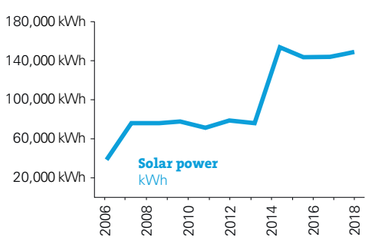
Tertiary-level teaching



Professorships



Photovoltaic electricity generation



Awards

European Association of Geochemistry Distinguished Lecturer 2017
Lenny Winkel (Water Resources and Drinking Water)

Swiss Sustainability Prize (prix eco.ch) for the Gravit'eau project
Regula Meierhofer, Maryna Peter (Department of Sanitation, Water and Solid Waste for Development)

IHE Delft Honorary Fellowship Award
Janet Hering (Director)

RIFCON and SETAC Europe Best Publication Award
Yang Yue (Environmental Toxicology)

Venture start-up competition, third prize for Business Plan
Kristin Schirmer, Vivan Lu Tan (Environmental Toxicology)

Mid-term Career Achievement Award, International Conference on Urban Drainage
Jörg Rieckermann (Urban Water Management)

Alberto Rozzi Award for the best paper on biological treatment
Christian Zurbrügg, Bram Dortmans, Audinisa Fadhila, Bart Verstappen, Stefan Diener (Department of Sanitation, Water and Solid Waste for Development)

Otto Jaag Water Protection Prize
Michael Besmer (Environmental Microbiology)

2017 Highly Cited Researchers in the Environment/ Ecology category (Clarivate Analytics)
Adriano Joss (Process Engineering), Christa McArdell (Environmental Chemistry), Hansruedi Siegrist (Process Engineering)

Silver Medal of ETH Zurich for an outstanding doctoral thesis
Anja Felmy (Aquatic Ecology)

University of Bern faculty award 2017 for the best dissertation in biology
Joana Meier (Fish Ecology and Evolution)

Eawag

In flume system experiments, Eawag scientists investigate the effects of wastewater constituents on aquatic organisms. In the Ecoimpact project, they are also analysing the impacts of micropollutants in natural waters (cf. p. 17).

Research

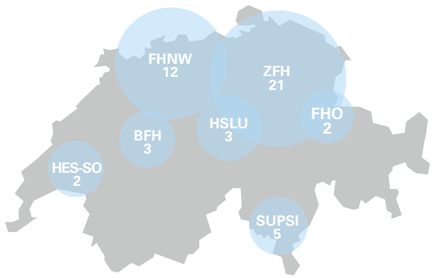
Eawag's research is concerned with practical issues and societal challenges, focusing on water for human welfare and ecosystem function, as well as strategies for resolving resource-use conflicts. For example, at the new outdoor facility comprising 36 experimental ponds, Eawag scientists are investigating the resilience of aquatic ecosystems to disturbances.

National concerns are also a key element of Eawag's work. The institute conducts numerous research projects in collaboration with universities and universities of applied sciences (UAS). In connection with the Swiss Energy Strategy 2050, Eawag scientists in 2017 continued to collaborate with partners from the Swiss Competence Centres for Energy Research (SCCER), focusing in particular on ecological aspects of hydropower production.

Participation in global research networks is vital for Eawag: international and interdisciplinary partnerships create valuable synergies and enhance the impact of research projects. Eawag is currently represented on over 100 international bodies.

Sustainable solutions require not only scientific and engineering approaches, but also the integration of a social science perspective. Accordingly, Eawag has its own Environmental Social Sciences department, focusing in particular on water governance and innovation.

Collaboration with UAS



Eawag promotes collaboration with Switzerland's universities of applied sciences (UAS). In 2017, Eawag scientists were involved in 48 joint projects.

Petra Nobs, Eawag

For their investigations, doctoral student Philip Dermond's group caught trout in mountain streams.

Interactions between fish and their habitats

How do trout adapt to ecological conditions? How do invasive sticklebacks and their habitats influence each other? These questions have been studied by Eawag research groups.

Individual diets in trout

Little is known about how trout adapt to different habitats. Jakob Brodersen of the Fish Ecology and Evolution department and doctoral student Philip Dermond investigated how trout diets in groundwater-fed streams with a stable food supply differ from those in mountain streams, where water levels vary widely and prey is frequently washed away during flooding. The results were clear: trout in mountain streams exploit the entire food supply – they have to eat whatever is available. Under more stable conditions, the fish are more selective and individual diets are strongly specialised. "These results support the assumption that the development of generalists and specialists involves adaptation to ecological conditions", says Brodersen. To confirm their findings, the researchers are now investigating 150 streams across Switzerland.

The scientists are also studying how brown trout react to engineered banks and other anthropogenic stress factors – and thus also how conservation measures can be optimised for trout populations.

"These results support the assumption that the development of generalists and specialists involves adaptation to ecological conditions."

Jakob Brodersen, Fish Ecology and Evolution department

Adaptable hybrid sticklebacks

Rebecca Best and her team studied how sticklebacks and their habitats influence each other. The researchers wished to find out how changes in ecosystem conditions promote or inhibit the proliferation of this invasive species in Switzerland. For their controlled experiment, they used 50 identical outdoor tanks (mesocosms), each filled with 1,000 litres of water, to which sand, mussels, insect larvae, etc., were added. The mesocosms were populated with adult sticklebacks from Lake Constance or Lake Geneva; five weeks later, these fish were removed, changes in the algae and invertebrates were documented, and juveniles from the two lakes and of mixed origin were then placed in the mesocosms.

The experiments showed that adult sticklebacks from Lakes Constance and Geneva alter their habitats in a way that influences the survival and fitness of juveniles. The latter's ability to cope with these alterations varies, with hybrids faring best. Their advantage over non-hybrid sticklebacks is particularly marked when food is in short supply. They benefit from their genetic inheritance, with a broad spectrum of genes providing many potentially useful traits.

Freshwater snails can cope with heatwaves

Like many other organisms, pond snails are affected by climate change. Their response to heatwaves was studied in laboratory experiments carried out by the Aquatic Ecology department. In snails exposed to temperature stress, egg production increased by 60 per cent on average. At the same time, the activity of phenoloxidase – an enzyme offering protection against parasites – was reduced. Stress responses were also investigated in snails additionally exposed to micropollutants – and the effects were often found to be antagonistic; for example, the increased investment in egg production was reversed. The scientists concluded that pond snails are highly resilient to environmental changes, but this finding is not automatically applicable to other aquatic organisms.

Marko Koenig, Imagebroker, Okapia

Pond snails are resilient to environmental changes such as a warmer climate.

Pesticides in watercourses and soils

Plant protection products (PPPs) used in agriculture can contaminate surface waters and persist in soils. In a study conducted by Eawag and the Ecotox Centre in partnership with five cantons (Thurgau, Basel-Landschaft, Bern, Valais and Ticino) and the Swiss Water Association (VSA), water quality was monitored in five small watercourses over a 6-month period.

Limits chronically exceeded

A total of 61 herbicides, 45 fungicides and 22 insecticides were detected in the water samples collected. On average, 20 to 40 substances were found in each sample. In 80% of samples, the limit specified in the Waters Protection Ordinance was exceeded by at least one substance – for almost the entire study period in two of the five streams studied. Bioassays provided evidence of chronic ecotoxicity in all cases; gammarids released in one of the streams showed increased mortality and lethargy. As organisms in the streams are exposed to a constantly changing cocktail of PPPs, they often have no time to recover.

Urgent need for improvement

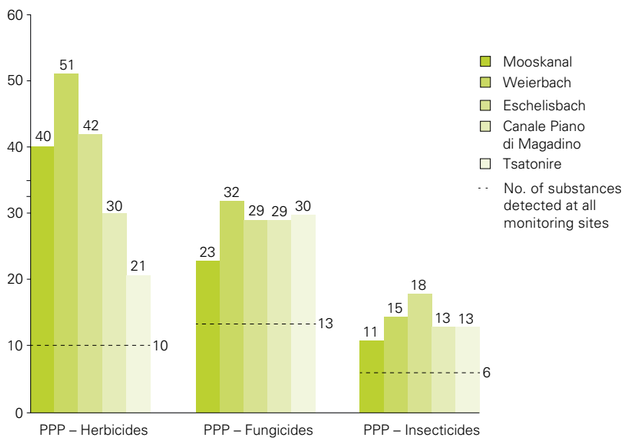
Stephan Müller, Head of the Water Division at the Federal Office for the Environment (FOEN), concludes that agricultural PPPs – alongside micropollutants in wastewater – are currently the most important source of contaminants in Swiss surface waters. This is particularly true of small streams, which serve as a refuge and nursery for aquatic organisms. To improve the situation, the Federal Office for Agriculture has developed an "Action Plan on risk reduction and sustainable use of PPPs", which was approved by the Federal Council in 2017.

Persistent residues in soils

Another study funded by the FOEN showed that pesticides can persist in soils for a decade or more. In the study, Eawag and Agroscope scientists analysed topsoil samples collected from 14 agricultural sites in Switzerland between 1995 and 2008. As well as pesticides whose application had been reported at the time, substances were detected which were assumed to be residues of pesticides applied prior to 1995.

Esther Michel, Eawag

For the first time, water quality was monitored in small Swiss streams over an extended period. Pictured here: sampling on the Eschelisbach in Güttingen (canton of Thurgau).



A wide variety of plant protection products (PPPs) were detected in all the streams studied.

Selenium deficiency exacerbated by climate change

Selenium is an essential micronutrient – required for the synthesis of numerous proteins – obtained from dietary sources. The selenium content of foodstuffs depends on concentrations in the soil. Studies have shown that low selenium concentrations are associated with high pH and oxygen availability and low clay and soil organic carbon content. Higher selenium concentrations are thus most likely to occur in areas with low to moderate precipitation and high clay content, while lower concentrations are found in arid areas with alkaline soils. In Europe, for example, selenium-poor soils are found in Germany, Scotland and certain Balkan countries.

Shifts in distribution expected by end of century

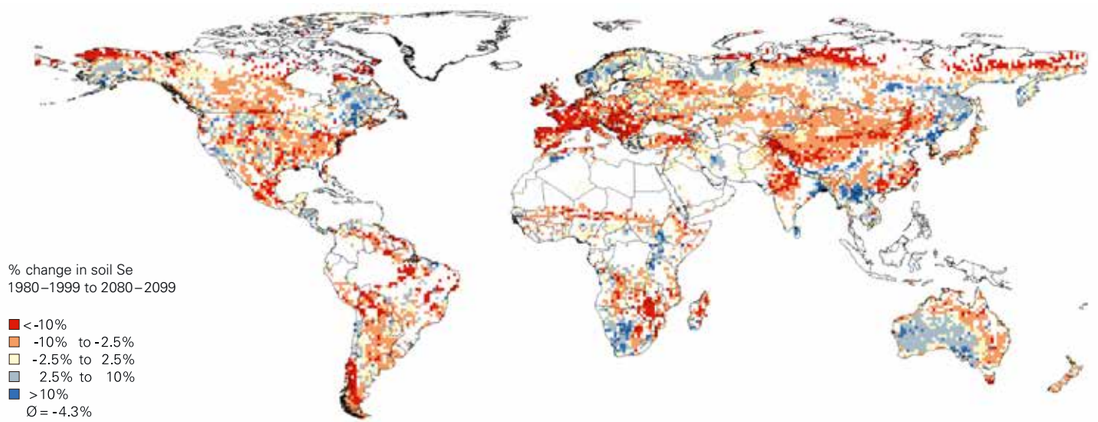
Eawag scientists, together with partners from ETH Zurich, the Potsdam Institute for Climate Impact Research, Rothamsted Research and Aberdeen University, used 33,241 soil data points to model mean soil selenium concentrations for the periods 1980–1999 and 2080–2099. As a result of climate change, selenium levels are predicted to decrease by an average of 9 per cent in two thirds of croplands by the end of this century, with agricultural areas of Europe and India, China, southern South America, southern Africa and the south-western United States being particularly affected. Selenium levels are predicted to increase in parts of Australia, China, India and Africa.

Consequences for health?

The losses could have implications for human health – at present, around a billion people are already affected by inadequate dietary selenium intake, which can weaken the immune system. According to the authors, this study should serve as an early warning for humanitarian organisations and agro-industry. Fertilisers containing selenium, or selenium additives in animal feed, could be used to combat selenium deficiency.

Agroscope (G. Brändle, U. Zihlmann), LANAT (A. Chervet)

The trace element selenium is taken up from the soil by crops and thus enters the food chain.



Changes in soil selenium concentration due to climate change: Areas where soil selenium concentrations are predicted to decrease by more than 10 per cent by the end of this century are marked in red. Areas with increased soil selenium concentrations are marked in blue.

Aldo Todaro, Eawag

In the Athene project, numerous degradation processes were analysed in multiple wastewater treatment experiments.

New degradation processes discovered

In terms of costs and environmental impact, a biological treatment method for the removal of micropollutants from wastewater would offer advantages, since the existing ozonation method is energy-intensive, while activated carbon filtration leads to CO_2 emissions.

With the goal of improving our understanding of biochemical processes and thus enabling a biological method to be used for micropollutant removal at wastewater treatment plants (WWTPs), the international research project Athene was launched in 2010. The partners involved in this project (financed by the European Research Council) were Eawag, the German Federal Institute of Hydrology and Goethe University Frankfurt.

Individual degradation processes identified

After a total of 15 years' reactor operation time, Athene was completed in 2016. Eawag co-investigator Adriano Joss says: "Unfortunately, we did not find a biological method which could adequately remove all organic micropollutants from wastewater. However, many micropollutants can be degraded by biological treatments." For example, biological degradation processes were found for diclofenac (the active ingredient of Voltaren) and for acesulfame (an artificial sweetener used in carbonated drinks). According to Joss, "acesulfame was previously thought to be so stable that concentrations of the substance could be used to determine the amount of municipal wastewater". Thanks to Athene, it is now known to be susceptible to biological degradation.

"We won't find a bacterium that can degrade all micropollutants."

Adriano Joss, Process Engineering department

New analytical methods

The lengthy operation time and large numbers of experiments conducted in the course of Athene yielded a much better understanding of numerous degradation processes. For diclofenac, five or six degradation reactions involving different sequences are now known. As Joss explains, "this leads to the formation of around 20 transformation products, which were analysed in detail during the project". The analytical methods themselves were also further developed in the course of this work. Joss adds: "Even if we didn't find a super bacterium that could degrade all micropollutants, we still accumulated a lot of new knowledge about processes at WWTPs."

Targeted support for innovation

The development and diffusion of innovative technologies is driven by knowledge, financial investment, market formation and social legitimation. Also required are cooperation and interaction between all the actors concerned. However, according to Christian Binz and Bernhard Truffer of the Environmental Social Sciences department, the processes differ from one industrial sector to another.

Differences between sectors

Industrial sectors differ in the type of knowledge they require to generate innovations: some rely on science-based, others on experience-based knowledge. Biotech firms, for example, have close links with universities and conduct their own research, whereas wastewater treatment experts rely on practical experience. Industries also differ in the degree of standardisation of their products or services: while smartphones are similar and consumers' preferences are undifferentiated throughout the world, legal advice is tailored to the needs of specific user groups and is regionally oriented.

Targeted investments

On this basis, Binz and Truffer have developed a conceptual framework for describing the relevant innovation drivers. This should also make it possible to identify and eliminate innovation system failures, such as that seen in Germany in the early 2000s: here, the domestic solar industry was to be boosted by a photovoltaic support programme, but because international photovoltaic production is highly standardised, manufacturing rapidly shifted to China, Korea and Taiwan. To ensure that this error is not repeated under Switzerland's Energy Strategy 2050, Binz and Truffer argue that the country should invest in research and development and final assembly rather than in solar panel production.

Solar Impulse

Solar Impulse's round-the-world flight demonstrated the potential of innovative technologies. For countries like Switzerland, investment in photovoltaic R&D is more promising economically than the production of solar panels.

Granular activated carbon: an attractive option

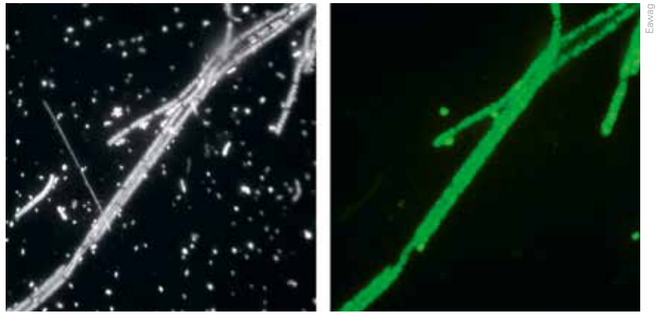
In a study commissioned by the Federal Office for the Environment, Eawag assessed the suitability of treatment with granular activated carbon (GAC) for removing micropollutants from wastewater. To date it has been assumed that GAC methods cannot compete in economic terms with powdered activated carbon (PAC) or ozone treatment. To evaluate this, Eawag scientists together with twenty external partners conducted pilot-scale experiments at the Bülach wastewater treatment plant (WWTP).

It was found that the investment and operating costs of GAC methods are similar to – or possibly even lower than – those associated with PAC, and the technical effort required for operation and maintenance is also lower. At the same time, GAC methods offer greater reliability and are thus particularly attractive for smaller plants with limited personnel resources.

The infrastructure established at the Bülach WWTP will now be used to study additional questions concerning GAC filtration, the combination of ozonation and GAC, and performance monitoring with UV probes.

New methane-consuming bacteria discovered

Methane is produced when dead organic matter is broken down in a lake or ocean. Some of the methane is released into the atmosphere – where it acts as a potent greenhouse gas – while some is broken down by microorganisms in the water column. Until recently, small, round bacteria were assumed to be the main methane consumers. Now, scientists from Eawag and the Max Planck Institute have discovered that filamentous bacteria of the genus Crenothrix play a major role in the methane removal process.



Eawag

In the Rotsee and Lake Zug, filamentous Crenothrix bacteria play an important role in methane removal.

Chance discovery

The researchers were seeking to quantify methane removal in the Rotsee and Lake Zug using methane molecules labelled with heavy carbon-13 atoms. When ^{13}C-labelled methane is assimilated by bacteria, the individual cells can be visualised. Much to their surprise, the scientists found that the bacteria enriched with ^{13}C were not only single round cells (as expected) but also long, filamentous Crenothrix: these bacteria had not previously been detected in lake water. Carsten Schubert of the Surface Waters department – an expert on microbial degradation of methane – admits: "We seem to have completely underestimated the importance of Crenothrix bacteria in the carbon cycle." Previously, these bacteria have only been known as a contaminant in drinking water systems, where their proliferation can cause clogging of pipes, sand filters and screens. In the light of these findings in the two Swiss lakes, the scientists have now begun to investigate more closely the role played by Crenothrix bacteria in natural methane removal.

"We'd completely underestimated the importance of Crenothrix bacteria in the carbon cycle."

Carsten Schubert, Surface Waters department

Helmut Burgmann, Eawag

In Lake Cadagno, bioconvection was demonstrated for the first time under natural conditions.

Mixing of water layers caused by bacteria

Can microorganisms cause lake water to be mixed? All previous studies said no, since the movement of small, slow-swimming bacteria is too weak to create eddies. However, a recent Eawag-led study shows that bacteria can indeed cause the mixing of water masses: if large numbers of microorganisms that are denser than water accumulate locally, the density of the water is increased and the heavier water sinks, carrying the organisms with it. This indirect mixing process was demonstrated by the scientists in Lake Cadagno (canton of Ticino). At a depth of 11–13 metres, they observed over 10,000 bacteria of the species Chromatium okenii per millilitre – more than ten billion per cubic metre – being carried downwards and then actively swimming upwards towards the light. This is required to maintain the mixing process, which is known as bioconvection, creating a homogeneous layer. The phenomenon is presumed to be relevant to lake ecology. According to Tobias Sommer, first author of the study, the role of bioconvection has previously been overlooked.

Ecosystem stress caused by micropollutants

Eawag

In reaches upstream and downstream of 24 WWTPs, Eawag scientists are investigating the impacts of micropollutants on aquatic ecosystems.

Micropollutants are organic or inorganic chemical contaminants occurring in very low concentrations. Deriving from cosmetics, construction materials, pharmaceuticals or biocides, they can enter waterbodies via wastewater or runoff from agricultural land and road surfaces. The effects of micropollutants on specific organisms have already been widely studied. To investigate their impacts on entire aquatic ecosystems, the interdisciplinary Ecoimpact project was launched in 2013. It is being conducted by an Eawag team in collaboration with the Eawag-EPFL Ecotox Centre and partners from Canada, Germany, the UK and the Netherlands.

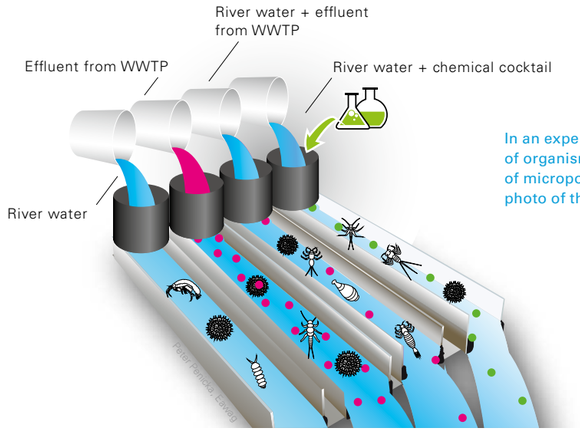
Impacts upstream and downstream of treatment plants

Numerous Swiss wastewater treatment plants (WWTPs) are being upgraded with an additional treatment step to remove micropollutants. The upgrade programme provides a unique opportunity to study how aquatic ecosystems respond to a reduction in micropollutants. Molecular, physiological and ecological endpoints are being assessed in reaches upstream and downstream of 24 WWTPs in the Central Plateau and Jura. At the same time, the effects of different constituents of wastewater are being investigated in controlled experiments using a flume system.

The Ecoimpact project should make it possible to identify the impacts of micropollutants and to determine whether different groups of micropollutants have different effects. The goal is to draw general conclusions, rather than merely making statements about individual sites.

Influence on aquatic ecosystems

Initial results show that increased micropollutant concentrations have an impact on stream ecosystems. For example, they can inhibit photosynthesis or induce the expression of detoxification genes in brown trout. Micropollutants thus exert stress on aquatic organisms, resulting in biological responses. The study also demonstrates that the first WWTP upgrades are already having an effect: for example, the induced expression of detoxification genes was lost in brown trout living downstream.



In an experimental flume system, groups of organisms are exposed to mixtures of micropollutants in wastewater (cf. the photo of the flume system on p. 8).

Aldo Todaro, Eawag

Fabian Suter and Philippe Reymond recording a video lecture for a massive open online course (MOOC). Eawag, in partnership with EPFL, offers a total of four MOOCs on sanitation, water and solid waste for development; over 50,000 people worldwide have taken one of these courses (cf. p. 21).

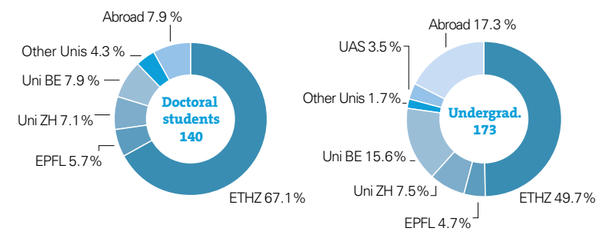
Teaching

Eawag scientists make a substantial contribution to training in environmental systems science and environmental engineering. In 2017, their teaching commitments at ETH Zurich and EPF Lausanne amounted to more than 3,000 hours. Another 1,300 hours were taught at other higher education establishments (mainly cantonal universities). As well as at ETH Zurich and EPFL, Eawag scientists hold professorships at the Universities of Bern (Aquatic Ecology and Social Sciences), Neuchâtel (Hydrogeology) and Zurich (Biodiversity, Environmental Chemistry and Environmental Psychology).

In partnership with EPFL, Eawag offers open-access online courses on sanitation, water and solid waste for development. Over the last three years, more than 50,000 people from 176 countries have participated in these courses. Eawag Summer Schools, with an international focus, are another well-established activity: in 2017, the ninth Summer School in Environmental Systems Analysis was held at Dübendorf. In addition, Eawag contributed to the ETHZ-EPFL Summer School on Catchment Transport Processes.

Through its practice-oriented training programme, Eawag maintains a close dialogue with water professionals. In 2017, 13 courses were held – some jointly organised with professional associations or universities of applied sciences – on topics such as resource-use conflicts involving groundwater and agriculture; heating and cooling with lake and river water; synergies between hydraulic engineering and ecology; and lakeshore restoration planning.

Doctoral students and undergraduates



In 2017, Eawag staff supervised 140 doctoral students and a total of 173 Bachelor's and Master's students from various universities.

Peter Penicka, Eawag

In her presentation, Eva Reinhard (Deputy Director of the Federal Office for Agriculture) outlined the aims of the new agricultural policy for 2022 and beyond.

Eawag Info Day on agriculture and surface waters

Eawag's Info Day, held on 5 September 2017, was entitled "Agriculture and surface waters – Possible solutions to current challenges". Ecosystem services, such as preserving water quality, depend on near-natural aquatic environments. But many ponds have been drained and streams are frequently culverted or contaminated with fertilisers and pesticides. For decades, watercourses have been engineered and channelised, and pools and ponds have largely disappeared from Switzerland's countryside. According to Beat Oertli of the University of Applied Sciences of Western Switzerland, "this represents a huge loss of biodiversity, so protection for ponds needs to be improved".

Challenge for everyone

As a result of climate change and population growth, conflicts between water protection and agriculture are intensifying. At the Info Day, 300 academics, officials and policymakers showed that these conflicts can be addressed through dialogue, clearly defined goals and a variety of measures.

Eawag environmental chemist Christian Stamm emphasised that water protection concerns the whole population. Although it is possible, for example, to use robots to apply pesticides only where they are really necessary, "such innovations cannot resolve all conflicts, so consumers' expectations regarding foods will probably also have to be adjusted".

Increasing resource efficiency

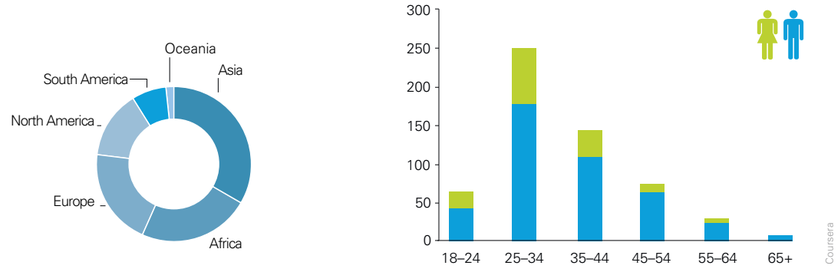
The "Action Plan on risk reduction and sustainable use of plant protection products" should also help to improve water quality. This plan aims to reduce inputs of chemicals to waterbodies while still ensuring that crops are protected. Christian Leu, Head of the Water Quality Section at the Federal Office for the Environment, has high hopes for the plan. He stressed, however, that successful implementation will require concerted efforts by all stakeholders and close monitoring.

Eva Reinhard, Deputy Director of the Federal Office for Agriculture, underlined the need to increase resource efficiency through strong innovation, entrepreneurial thinking and knowledge of ecosystem services. It should also be promoted by adopting new incentive systems and technologies, and exploiting the potential of digitalisation in agriculture.

New MOOC on faecal sludge management

In partnership with EPFL, Eawag has launched a massive open online course (MOOC) entitled "Introduction to Faecal Sludge Management (FSM)". The five-week course explains how to apply the concepts of FSM on a city-wide scale. The online course materials (video lectures and tests) provide a comprehensive overview of the topic. Participants are introduced to the engineering fundamentals and learn how to design and select suitable technologies, as sanitation solutions are prone to failure without an integrated planning approach, including the development of appropriate institutional, management and financial arrangements. The MOOC concludes with a review of the most recent options, based on current research and technological innovations.

This is the fourth in a series of MOOCs on "Sanitation, Water and Solid Waste for Development". Since 2014, over 50,000 people from more than 170 countries have participated in these courses. Videos, supplementary texts, quizzes and exams are available free of charge. An optional course certificate can be obtained for a fee of just under USD 50.



Coursera

Participants in the MOOC "Introduction to Faecal Sludge Management" by continent, and by age and sex. The course has been particularly popular in Africa and Asia, and among younger people.

Zurich University

Eawag experts are lecturing in a new online course. Pictured here: Lake Oeschinen in the Bernese Oberland.

Online course on water in Switzerland

Anyone interested in how water shapes the life, society, landscape and economy of Switzerland can find out more in a new online course on "Water in Switzerland". The course, which is addressed to the public, runs for seven weeks, with each weekly module taking one to three hours. It was created by the Hydrology and Climate group at the Geography Department of Zurich University. The online videos and lectures include contributions from two Eawag experts – Christian Stamm and Alfred Johny Wüest.

Data-driven urban water management

How will urban water management develop in the future? How could it be changed by the ability to collect and utilise large amounts of data? To explore these questions, seven Eawag PhD students held a retreat in a Swiss mountain hut. In their discussions, the group benefited from the various members' individual scientific background. The result of this pooling of the young scientists' knowledge was a publication in the journal *Environmental Science & Technology*.

Efficient control instead of new pipes

The scientists highlight the benefits of data analysis for various aspects of urban water management. Much of what they describe is already possible today or soon will be, thanks to modern sensing technologies, data transmission and data processing. The challenges of wastewater management are increasing in parallel with the growth of urban areas. With modern methods of data analysis, processes in sewer networks can be studied in detail. It becomes apparent, for example, that existing capacity is not being used efficiently: during heavy rainfall, some pipes remain empty while others overflow. If existing networks could be more efficiently managed and controlled, it might not be necessary to expand or replace the entire system. In cases where new pipes are required, precise data will enable a more detailed situation analysis and more economic solutions. On this basis, wastewater systems can be planned to meet actual needs.

The same is true of water supply systems: in water-scarce regions, for example, a lot of money can be saved by rainwater harvesting and reuse; this requires a knowledge of how much water arises where and when. If water quality is also monitored at various sites, it may even be possible to prevent epidemics.

Who owns the data?

The PhD students are also conscious of the risks involved in data collection. For example, if a single household's wastewater is treated on-site, the data collected at this facility could provide a wide variety of personal information about the users – for example, who is at home when, the occupants' activities, what medicines they take, and so on. Accordingly, the issues of data access and ownership need to be carefully addressed.

Eawag

On a retreat in the mountains, the PhD students prepare their joint paper on urban water management.

"An intense and rather crazy time"

Michael Besmer, Eawag alumnus

For his doctoral thesis, Michael Besmer developed an online flow cytometer to enable automatic monitoring of microbiological water quality. The Eawag alumnus is now an entrepreneur, running the spin-off Oncyt.

It was chance that brought Michael Besmer to Eawag: "Frederik Hammes, the group leader of Drinking Water Microbiology, supervised a literature review assignment when I was an undergraduate", he recalls. He was so enthusiastic about working with Hammes that he decided to write his Master's thesis under his direction too. After Besmer had won an award for this thesis, Hammes recommended that he should be responsible – as a research assistant – for the microbiology part of the "Basel-Landschaft Regional Water Supply 21" project. What had originally been planned as a postdoc position was promptly turned into a doctorate.

"Apart from all my work, I've just been lucky to keep on meeting the right people."

Besmer's task was to measure short-term changes in the concentrations of bacteria in water. In the karstic region of the canton of Basel-Landschaft, stormwater infiltrates the ground within a matter of hours and is not adequately filtered; as a result, springwater is susceptible to contamination. Short-term variations of this kind cannot be detected by conventional methods.

Together with an engineer friend, the team led by Hammes and Besmer sought to design a robotic flow cytometry system that would enable automatic monitoring, with high temporal resolution. Their efforts were successful: "The method delivers very precise results, rapidly and simply. After six months, we had two datasets and the proof of principle." A publication duly appeared in 2014. Besmer subsequently collected data in spring- and groundwater and at water treatment plants, discovering, in many cases, dynamics which were not previously measurable. He remains fascinated today: "We found something intriguing wherever we looked and were able to produce a series of international publications and reports. When you start out on a PhD thesis, you wouldn't dream of achieving that kind of success. It was a very exciting, intense and rather crazy time, as it coincided with the birth of my second daughter."

Besmer appreciated the fact that he spent so much time in the field for his research: "In my work, I need a connection to practice." Besmer was thus confronted with two realities: the local well managers were initially sceptical, while the scientific community was beating a path to the group's door. Despite all the excitement, spending time with his family was always very important for Besmer. "I was able to write my Master's and my doctoral thesis with flexible working times", he says. "With my passion for the subject, I was able to persuade Frederik, my supervisor, to accept this solution." He has nothing but praise for Eawag: "It's a good place to carry out research and get good results." Apart from the excellent infrastructure, he emphasises the working atmosphere: "You can approach anybody if you have a question."

Otto Jaag Water Protection Prize

For his doctoral thesis, Michael Besmer was awarded the 2017 Otto Jaag Water Protection Prize, which recognises outstanding doctoral and Master's theses at ETH Zurich in the field of water protection and hydrology. In spite of his successes, he remains modest: "Of course I'm very happy to receive the award. But this is all a bit crazy, too. Apart from all my work, I've just been lucky over the years to keep on meeting the right people."

The environmental scientist is now also an entrepreneur: with the Eawag spin-off Oncyt, he is commercialising the innovation which came out of his doctoral research. Here, too, he has been able to rely on support from Eawag.

Peter Penicka, Eawag

Simon Dicht, Eawag

A flooding experiment conducted at a Swiss military training facility by the Urban Water Management department. The data collected is being used to develop algorithms allowing water levels and flow rates to be estimated from videos and photographs. Such data is required to improve the modelling of flash floods in urban areas (cf. p. 29).

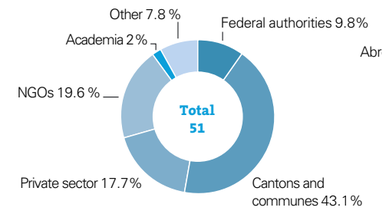
Consulting

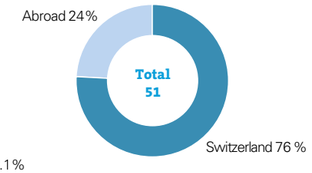
Eawag operates a number of Competence Centres which promote exchanges between various scientific disciplines and practice, and initiate joint research projects. Key partners include the Swiss Gas and Water Industry Association (SVGW) and the Swiss Water Association (VSA). The “Micropollutants Process Engineering” and “Water Quality” platforms are operated by Eawag in collaboration with the VSA and the Federal Office for the Environment (FOEN). These platforms maintain databases with background information and provide advice for communes, cantons and the private sector.

In the “Swiss Rivers” programme, Eawag and the FOEN, in partnership with water professionals and researchers, develop guidelines for assessing the effectiveness of river restoration projects and remediation measures in the hydropower sector. There is also broad national collaboration on biodiversity and – under the National Surface Water Quality (NAWA) programme – on the monitoring and assessment of pesticide inputs to waterbodies. On behalf of the Federal Office of Public Health, Eawag continuously monitors radioactivity in aquatic systems, using gamma-ray spectrometry.

In 2017, the Eawag-EPFL Ecotox Centre completed work on the specification of risk-based limits for biocides, plant protection products and other micropollutants in natural waters. After the consultation procedure, these numerical values are to be included as requirements in the Swiss Waters Protection Ordinance.

Consulting mandates





Collaboration with cantonal and communal authorities accounts for a large proportion of Eawag’s consulting mandates.

Tracking the deadly fish disease PKD

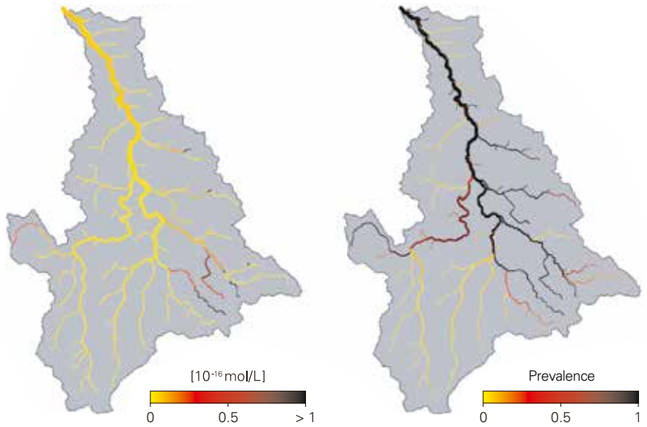
Freshwater fish in Switzerland, as well as in the rest of Europe and the US, are susceptible to a parasite that causes proliferative kidney disease (PKD) – which is highly contagious and can wipe out entire fish populations. The species particularly affected in this country are trout and char. PKD is considered to be one of the main causes of the decline in fish stocks seen in recent decades.

Model to predict outbreaks

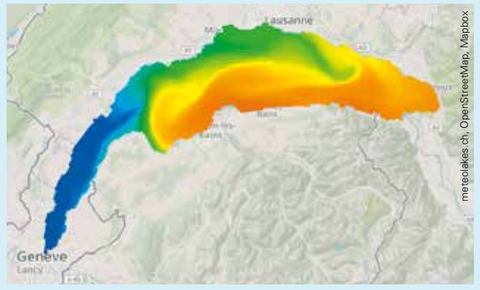
Scientists from Eawag, ETH Zurich, EPFL and the University of Bern's Centre for Fish and Wildlife Health (FIWI) spent three years studying PKD in the River Wigger (cantons of Lucerne and Aargau). Using data collected in the field, they developed a mathematical model for predicting the spread of the parasite and disease outbreaks. The project, addressing a practical problem, also yielded relevant theoretical findings, and the results were published in the journal PNAS.

Complex life cycle

For the epidemiological model, the parasite's complex life cycle had to be taken into account. Its primary hosts are bryozoans – moss animals encrusting stones on the riverbed. Parasite spores released into the water enter fish via the gills and skin, before multiplying in the kidney. Spores excreted in fish urine can then again infect colonies of bryozoans. Symptoms only become apparent when water temperatures exceed 15 °C for several weeks. Infected fish which survive may continue to excrete spores for several summers, making it more complicated to model the disease.



Results of modelling for the Wigger catchment. Left: predicted density of bryozoans; right: predicted PKD prevalence in young-of-the-year fish at the end of summer 2016.



Surface temperatures across Lake Geneva on 1 July 2017: while temperatures below 10 °C were recorded off Geneva and along the southwest shore towards Nyon, swimmers at Évian were enjoying temperatures of 22–23 °C.

Lake Geneva: sudden drop in water temperature

At the end of June 2017, the surface temperature of Lower Lake Geneva plummeted in just 48 hours from 23 °C to 8 °C. This drop was due to a phenomenon known as upwelling: warm surface water driven northeastwards by persistent southwesterly winds was replaced by cold water rising from the depths of the lake. This cooling had been predicted by a 3D model developed by the Eawag-EPFL Physics of Aquatic Systems Laboratory in Lausanne. The model uses current and forecast meteorological data, hydrological and satellite data to estimate lake water temperatures for the next three to five days. Accessible online, it currently covers Lakes Biel and Greifen as well as Geneva: www.meteolakes.ch

Ecological benefits of sediment bypass tunnels

Sediment accumulation can dramatically reduce the storage capacity of reservoirs. For this reason, sediment bypass tunnels (SBTs) are operated at a number of Swiss reservoirs, conveying sediment-laden waters into downstream reaches during high flows. In a study carried out on the Solis reservoir (canton of Graubünden), biologists from Eawag and the Zurich University of Applied Sciences (ZHAW) showed that SBTs also have beneficial effects on ecological conditions in downstream receiving waters.

Importance of sediment regimes

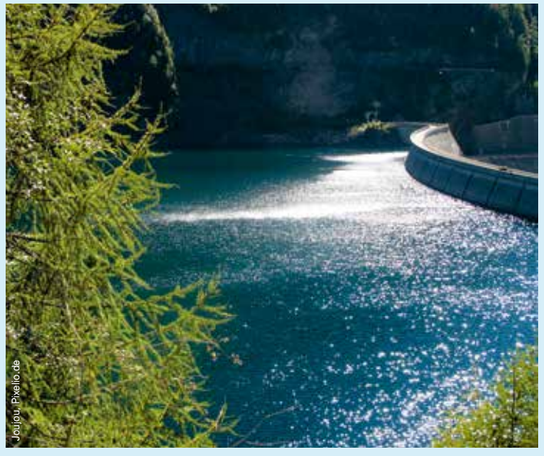
According to the researchers, SBTs enable more natural flow and sediment regimes than would otherwise be possible in dam-regulated rivers. Disturbances associated with periodic high-flow pulses are essential for the functioning of river ecosystems, as they drive biotic and abiotic interactions and play a key role in aquatic organisms' life histories.

While SBTs can facilitate the balancing of technical and ecological demands, the authors of the study stress the need to define appropriate maximum discharge levels so as to prevent permanent adverse impacts on river ecosystems.

Disturbances associated with periodic high-flow pulses are essential for river ecosystem functioning.

evz+Medienarchiv, Matthias Kuntermann

At Tiefencastel (canton of Graubünden), a bypass tunnel built in 2012 ensures that, rather than accumulating in the Solis reservoir, sediments are transported downstream during high flows.



Jodigo, Pixelio.de

The Lago di Luzzone dam.

Swiss would pay more to expand hydropower

The Swiss public supports the federal government's Energy Strategy 2050. A representative survey conducted by Eawag environmental economists found that 78 per cent approve of the phase-out of nuclear power and, on average, households would be prepared to pay at least an extra CHF 160 a year for electricity as a result – around a fifth more than at present. On top of these transition-related costs, they would pay another CHF 180 for an increase in hydropower generation; the expansion of existing plants would be preferred to the construction of new ones, as the environmental impacts would be lower. The researchers conclude that hydropower will continue to have an economic potential, even though it is currently struggling in Switzerland's partly liberalised electricity market.

The ideal site for drinking water abstraction

In the future, where should water be abstracted from Lake Biel to provide supplies for Biel and Nidau? In a study commissioned by Energy Service Biel, this question was addressed by Eawag scientists in collaboration with EPFL and Bern University.

Turbidity mystery solved

As well as assessing how water temperatures will be affected by climate change, the scientists investigated the causes of the mysterious clouding of lake water which occurred in December 2009, leading to the interruption of supplies for several days. They found that the turbidity had been caused by an underwater landslide. They therefore also studied slope stability in Lake Biel and the influence of the Aare and Schüss tributaries on the particle content of the water. Taking all the relevant factors into account, they concluded that the current site of the water intake would continue to meet water quality requirements in the future. They recommended only that the intake should be located somewhat deeper than at present.

Warming offset by shutdown of Mühleberg plant

While water temperatures will rise in the years ahead as a result of global warming, the shutdown of the Mühleberg nuclear plant in 2019 will have the opposite effect: the researchers' modelling indicates that winter water temperatures will decrease by more than 3 °C in parts of Lake Biel. This should offset the projected rise in temperatures due to climate change: year-round water temperatures will be, on average, 0.3 °C lower than in the past.

ESB, Oliver Oetiti

Energy Service Biel plans to replace the Ipsach waterworks (pictured here), which has been in operation for over 40 years.

Limnonet, CC-BY-SA 4.0

Antifouling coatings control unwanted growths on submerged surfaces.

Chillies for clean hulls

Antifouling coatings are used to control the growth of algae, mussels and barnacles on ships' hulls and other underwater surfaces. However, these biocides often leach into the aquatic environment and may be harmful to non-target organisms. Efforts are therefore being made by industry to develop less toxic products. Scientists from the Environmental Toxicology department investigated the toxicity of three new substances – tralopyril, triphenylborane pyridine and capsaicin – to algae, daphnia (water fleas) and zebrafish. While the first two biocides produced toxic effects, no toxicity was observed with capsaicin. An ecological risk assessment performed for a hypothetical freshwater marina confirmed that capsaicin – derived from chilli peppers – is an environmentally friendly compound. As tralopyril degrades rapidly in water, this substance is also suitable for aquatic applications despite of its toxical effects.

Improving urban flood prediction

We are all familiar with the chaotic scenes caused by torrential rain in towns – roads turned into raging rivers and sewers overflowing, unable to cope with the volume of water running off streets, squares and rooftops. In July 2017, for example, the historic old town of Zofingen (canton of Aargau) was completely inundated. Although modelling can be used to simulate flooding, the flood event data that are needed to calibrate, validate and improve computer models has been lacking to date. Generating such data is the goal of the Calico project, which is supported by the Swiss National Science Foundation. Ultimately, data could be extracted from surveillance camera videos, or images posted on social media (Facebook, Instagram, etc.).

"We're developing algorithms to estimate water levels and flood discharges from images." **João Leitão,** Urban Water Management department

Experiments at a military training facility

To generate a reference data set for the development of new methods, flooding experiments were conducted by a team of researchers led by João Leitão and PhD student Matthew Moy de Vitry of the Urban Water Management department. A military facility used by army and firefighting personnel for flood response training provided an ideal infrastructure for the experiments. As well as installing a variety of sensors, still-image and video cameras, the researchers parked a bicycle in the floodable area. João Leitão explains: "We can use objects such as bicycles in a photo or video to estimate water levels. Now we're training computers to do this too."

Extracting quantitative data from images

The team carried out almost 30 flooding experiments, collecting vast amounts of data in the process. They are now developing algorithms to allow flood discharges to be estimated from video data or to determine whether water levels are rising, falling or unchanged.
With data of this kind, it should be possible in future to develop more reliable flash flood models for urban areas. This would enable authorities to identify areas at risk and issue early warnings.

Andreas Scheidegger, Eawag

Experimental flooding: Eawag researchers collected data to improve the modelling of flash floods in urban areas.

Three million francs' worth of gold and silver going to waste

Trace elements are increasingly being used in the high-tech and medical sectors, but their ultimate fate has been little studied to date. As a large proportion is known to enter wastewater, a research team led by Eawag environmental chemists Bas Vriens and Michael Berg carried out a systematic, quantitative assessment of elements discharged in effluents or disposed of in sewage sludge. The study – involving 64 wastewater treatment plants across Switzerland – was commissioned by the Federal Office for the Environment.

Substantial amounts per year

Expressed in kilograms per year, the element fluxes calculated for the Swiss population are quite substantial – 3,000 kg silver, 43 kg gold, 1,070 kg gadolinium, 1,500 kg neodymium and 150 kg ytterbium. This means that gold and silver each amounting to around CHF 1.5 million a year are lost via effluents and sewage sludge. The researchers conclude, however, that it would not currently be worthwhile to recover metals from wastewater or sludge, either economically or in terms of the amounts that could be extracted. Recovery would only be an option at certain sites where concentrations are increased as a result of local industry – in Ticino, for example, where relatively high concentrations of gold are found in sewage sludge.

Elke Suess, Eawag

Eawag environmental chemists collect samples at the Werdhölzli treatment plant in Zurich to determine concentrations of trace elements in wastewater.

Varying contributions to total fluxes

The researchers also investigated the extent to which treatment plants contribute to total fluxes in receiving waters. While, in the case of gadolinium, effluent inputs account for 83 per cent of river fluxes, the proportion is just 24 per cent for zinc, 7 for lithium and only 1 for arsenic. The concentrations do not pose risks to the environment.

Strong case for thermal use of surface waters

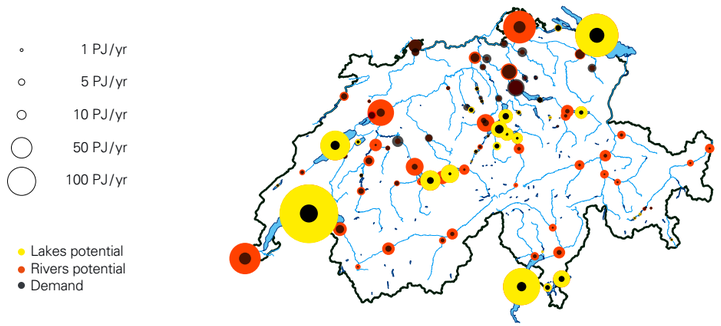
Switzerland's lakes and rivers contain vast amounts of thermal energy which could be used for heating or cooling. Eawag scientists have estimated the ecological impacts of thermal use on the basis of various studies.

Sustainable thermal use possible

The researchers conclude that, in general, ecosystems are not adversely affected by a slight decrease in water temperature due to use of lake water for heating in the winter. An increase in temperature due to discharges of cooling water in the summer may, however, be problematic: in some cases, trout and other temperature-sensitive species are already under stress due to climate warming, and additional warming could further reduce their ability to compete. However, according to the researchers, as long as ecological requirements are taken into account in the planning process, sustainable thermal use is possible and reasonable in the case of deep lakes and large rivers.

Potentials at a glance

In a project funded by the Federal Office for the Environment, Eawag scientists estimated the potential for thermal use of 36 lakes, 57 river sites and 9 lake outlets. The results, together with other useful information, are available online: by clicking on an interactive map, planners, agencies and other interested parties can find out for each waterbody not only the potential for heat extraction and disposal, but also basic data on flow rates and temperature regimes, and estimates of regional demand for heating and cooling. In addition, using a thermal discharge model, experts can simulate the spread of a discharge of warm or cold water. https://thermdis.eawag.ch/en



Potential for thermal use of Swiss lakes and rivers versus regional demand for heat.

Helmut Bürgmann, Eawag

Resistant bacteria can grow in an antibiotic-treated culture medium.

Low levels of antibiotic resistance in water

Switzerland's drinking water shows low levels of contamination with antibiotic resistant bacteria or resistance genes. This was demonstrated in a study of eight drinking water systems carried out by Eawag researchers on behalf of the Swiss Gas and Water Industry Association (SVGW) and water suppliers. Bacteria resistant to all the antibiotics tested were found in raw water samples; in treated drinking water, however, they were markedly reduced or no longer detectable. The resistance genes investigated were also frequently below the limit of detection. While the researchers cannot entirely rule out the possibility of antibiotic resistance developing and spreading in Switzerland's drinking water, they conclude that the transfer of resistance genes to pathogenic or human gut bacteria via this pathway is limited.

Peter Penicka, Eawag

Stefan Diener, who was responsible for preparation of the guide, with a "love cage", where adult flies mate and females lay the eggs from which larvae are reared.

Black soldier fly biowaste processing: a new guide

Larvae of the black soldier fly (Hermetia illucens) can reduce organic waste material by 50–80 per cent within about 14 days. The grown larvae make an excellent source of protein for animal feed, offering a sustainable alternative to fishmeal or soya. Scientists at Sandec (Department of Sanitation, Water and Solid Waste for Development) have been studying this type of biowaste processing for ten years. They have now published a step-by-step guide explaining how a processing facility can be designed and operated. The Sandec research team is developing the technology at a pilot treatment facility established in Indonesia. Adapted to local conditions, this treatment option is applicable worldwide; it is particularly suitable for villages and towns with local waste collection facilities processing at least five tons of biowaste per day.

Kellenberger Kaminski Photographie, ETH-Rat

In Fehraltorf, digitalisation has reached the sewers: Eawag researchers have installed sensors throughout the town's sewer network, which transmit data wirelessly every five minutes. This enables researchers to monitor precisely and gain a comprehensive understanding of urban drainage processes. The five-year project is also designed for student training.

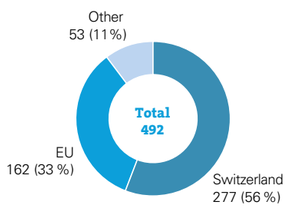
Institution

At the Dübendorf and Kastanienbaum sites, Eawag provides an excellent infrastructure for its researchers. Around 200 visiting academics from Switzerland and abroad have also benefited from these facilities, finding an ideal environment for scientific interaction. Eawag's international character is reflected in the origin of its employees, with about 44 per cent coming from abroad.

The support departments create an environment which facilitates the scientists' activities, ensures smooth operations and thus helps to maintain and enhance the high quality of research, teaching and consulting. Particular emphasis is placed on sustainability, with regard to buildings and research or other infrastructure. The Vocational Training department is responsible for apprentices in the non-scientific sector – currently 27 in all.

To permit synergies, various support functions – such as the library (Lib4RI) – are organised on a cross-institutional basis. High priority is accorded to the efficient use of financial resources, which is supported by an internal control system (ICS) and the application of International Public Sector Accounting Standards (IPSASs). As well as enhancing (international) comparability, these ensure that Eawag's stakeholders and the public are fully and transparently informed about the institute's financial position and the use of public funds.

Origin of employees

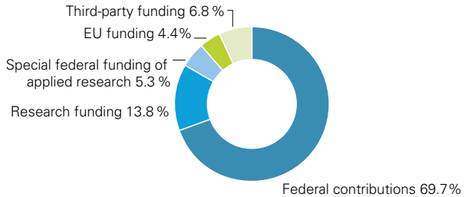


In 2017, a total of 492 people from 41 different countries worked at Eawag.

Headcount and personnel structure

As of 31 December 2017, Eawag's headcount (excluding interns, visiting academics and temporary staff) was 492 people (445.6 full-time equivalents/FTEs), distributed among the following functions: scientific, technical and administrative staff, and apprentices. Women account for 49.6 per cent of the total. Eawag's international character as a world-leading aquatic research institute is reflected by the diverse origins of its employees. In 2017 – including visiting academics – women and men from over 50 different countries were involved in the institute's research. Eawag continues to provide training for 27 apprentices – chemical and biological laboratory technicians, business administrators and computer scientists.

Financing for staff derives not only from federal contributions but also from research funding obtained on a competitive basis. As of 31 December 2017, the financing of the FTEs (excluding apprentices) breaks down as follows:



Sources of funding for personnel.

Personnel policy and career development

Eawag is a responsible employer, offering flexible working models, integrated health management and excellent training opportunities. It recruits first-class employees, both in research and in technical and administrative areas, and invests in continuous support and career development so as to retain staff over the long term.

Internal training focuses in particular on leadership skills and management development. For many years, Eawag has also supported language courses, reflecting the institute's international ethos. In addition, financial support is provided for numerous individual training courses, so that employees' qualifications are maintained at a high level. For its early-career scientists (98 doctoral students), Eawag provides an excellent infrastructure, specific training options and tailored information platforms.

Support for academic careers

Each year, Eawag invites young scientists to apply for a postdoctoral fellowship. This position enables outstanding individuals to conduct research at Eawag for two years, laying the foundations for their future career. Eawag supports scientists with fixed-term project contracts in planning their subsequent career. For example, Academic Transition Grants make it possible to enter new research fields or obtain additional qualifications. The Eawag Partnership Programme for Developing Countries promotes the transfer of expertise to these countries.

Equal opportunities

Thanks to consistent support and compliance with internal guidelines, Eawag maintains a high proportion of women (31 per cent) in leadership and upper management positions.

Tailwinds for mothers

The Equal Opportunities Committee (EOC) initiates mentoring programmes to support young female scientists within the ETH Domain. A particular concern of the EOC is work/life balance. So-called Tailwind Grants make it easier for researchers to resume their scientific work in the first months after maternity leave, relieving them of the burden of routine tasks which can be delegated. The term of employment for tenure-track female scientists is extended if they start a family. Fathers can temporarily reduce their employment level. As well as supporting the Empa-Eawag childcare centre, Eawag contributes to the childcare costs of low-income parents. As far as possible, employees with illnesses or disabilities are integrated into the work process.

People

Associate Professor at University of Zurich

Kathrin Fenner, a group leader in the Environmental Chemistry department, has been appointed as Associate Professor of Environmental Chemistry at the University of Zurich. Fenner studied Chemistry at Zurich University and obtained her PhD in Environmental Chemistry at ETH Zurich. She also has a postgraduate degree in Industrial Management and received her habilitation at ETH in 2010. She has held research positions in the US at the Lawrence Berkeley National Laboratory and at the University of Minnesota (SNSF Fellowship for advanced researchers). From 2004 to 2010, she served as a senior research associate at the ETH Institute of Biogeochemistry and Pollutant Dynamics.

Peter Penicka, Eawag

With funding from a European Research Council grant, Kathrin Fenner is conducting research on predicting environment-specific biotransformation of chemical contaminants.

Co-director of Fisheries Advisory Service

In August 2017, biologist Sébastien Nusslé joined Corinne Schmid as co-director of the Swiss Fisheries Advisory Service (FIBER). FIBER is financed by Eawag and the Federal Office for the Environment. The Governing Board includes representatives of these two institutions, as well as the Swiss Anglers Association, the Swiss Association of Fisheries Wardens, and the Conference of Hunting and Fishery Managers. FIBER brings together professionals, authorities and researchers with the aim of promoting sustainable fishing and protection of natural waters.

Eawag

Sébastien Nusslé studied reduced growth in whitefish for his doctoral thesis at Lausanne University. As a postdoc at the Universities of Bern and Berkeley, California, he carried out research on conservation biology and fishery management.

Adjunct Professor at the Technical University of Denmark

Tove Larsen, a group leader in the Urban Water Management department and member of the Eawag Directorate, has been appointed as Adjunct Professor at the Technical University of Denmark (DTU). Larsen's association with DTU dates back to the start of her career, when she studied Chemical Engineering and obtained her PhD there. After working as a postdoc at ETH Zurich, she joined Eawag, where she initiated und led several transdisciplinary projects on innovative technologies in urban water management. In 2008, her Novaquatis project received the Swiss Academies award for transdisciplinary research, and in 2014 her Blue Diversion project won two International Water Association innovation awards.

Michael Sieber, ETH-Rat

Tove Larsen is particularly interested in sustainable wastewater management and transdisciplinary research.

Adjunct Professor at ETH Zurich

Kai Udert, who has led the Source Separation and Decentralisation research group since 2012, has been appointed by the ETH Board as Adjunct Professor at ETH Zurich. Udert joined the Process Engineering department in 2006. His research focuses on the development of new technologies for resource recovery from wastewater. He obtained his PhD at ETH Zurich and worked as a postdoc at Eawag and the Massachusetts Institute of Technology (MIT).

Aldo Todaro, Eawag

Kai Udert's innovative research on wastewater separation, decentralised technologies, nutrient and urine source separation, and resource recovery enjoys the highest international recognition.

New member of Eawag Directorate

Gabriele Mayer, who has been Head of HR and Finance for ten years, has been appointed by the ETH Board as a member of the Eawag Directorate. In her new role, she will be responsible for the support departments and for helping Eawag to meet the increasingly stringent requirements in the areas of compliance and corporate governance.

Peter Penicka, Eawag

At Eawag, Gabriele Mayer has successfully led projects such as the introduction of SAP business process management software or the International Public Sector Accounting Standards (IPSASs). She has also served on various committees within Eawag and the ETH Domain.

Vice-President of Biodiversity Forum

Biologist Florian Altermatt of the Aquatic Ecology department has been appointed Vice-President of the Swiss Academy of Sciences' Biodiversity Forum. Altermatt, who holds an SNSF professorship at the University of Zurich, is head of the Spatial Dynamics research group at Eawag. He studies how animal and plant species occur in space and time, and how they interact. Altermatt has been on the Scientific Advisory Board of the Biodiversity Forum since 2010, and a member of its decision-making body since 2013. The Forum is Switzerland's scientific competence centre for biodiversity and ecosystem services. It supports research in this area and promotes dialogue between scientists and policymakers in the administration, industry and society.

Aldo Todaro, Eawag

Florian Altermatt is particularly interested in how natural communities are affected by dispersal and the spread of invasive species. He is also studying a new approach to biodiversity monitoring, in which the occurrence of aquatic organisms can be determined using environmental DNA extracted from water samples.

Remote sensing: joint assistant professorship with Zurich University

Alexander Damm has been appointed by the University of Zurich as Assistant Professor in Remote Sensing of Water Systems. The joint assistant professorship between Eawag and Zurich University will enable both institutions to expand their knowledge and expertise in remote sensing. Damm has worked at the Geography Department of Zurich University since 2008, most recently as senior research associate and group leader. His research is concerned with the development of spectroscopic approaches for ecosystem and environmental analysis. He is involved, for example, in a European Space Agency project developing the future Fluorescence Explorer (FLEX) satellite mission, which is designed to study plant photosynthesis at a global scale. FLEX measurements should allow substantial progress in ecosystem research and improve our understanding of matter and energy exchanges between the soil, vegetation and the atmosphere.

Zurich University

Alexander Damm has helped to develop remote sensing approaches which can be used to assess the role of vegetation in the water cycle or provide new options for measuring surface water quality.

Awards

Honorary Fellowship for Eawag Director
The IHE Delft Institute for Water Education has awarded Eawag Director Janet Hering an Honorary Fellowship. The Dutch institute carries out aquatic research in developing countries, promotes knowledge transfer and contributes to the training of local water professionals. The Honorary Fellowship is awarded to individuals who excel in their contributions to this field. Janet Hering's research interests include biogeochemical cycling of trace elements in natural waters, treatment technologies for removing contaminants from drinking water and knowledge exchange at the interface of science with policy and practice.

ETH Zurich

Janet Hering was awarded an Honorary Fellowship of the IHE Delft Institute for Water Education.

Doctoral thesis on adaptive radiation in stickleback
For his doctoral thesis, David Marques of the Fish Ecology and Evolution department received the second prize from the European Federation for Freshwater Sciences (EFFS). In his study, using genetic data and behavioural experiments, he investigated incipient species formation in threespine stickleback in Lakes Constance, Geneva and Biel. He showed that the exchange of genetic diversity from different catchments and particular genomic properties contributed to the rapid development of ecotypes adapted to different habitats, breeding in sympatry after only 150 years of divergence.

European Association of Geochemistry Distinguished Lecturer
Lenny Winkel, group leader of Environmental Inorganic Geochemistry in the Water Resources and Drinking Water department, was selected as the European Association of Geochemistry (EAG) Distinguished Lecturer 2017. The EAG lecture programme aims to introduce and motivate scientists and students in Central and Eastern Europe to emerging research areas in geochemistry. In her research, Winkel focuses on molecular to global-scale biogeochemical processes that control the mobility and cycling of health-impacting elements in the environment. In addition, she studies the effects of environmental stresses (e.g. climate change) on trace element cycles. She also holds a professorship at the ETH Zurich Institute of Biogeochemistry and Pollutant Dynamics.

Aldo Todaro, Eawag

Lenny Winkel's lecture tour took her to Hungary, Romania and the Czech Republic.

Outstanding achievements in urban water management
Jörg Rieckermann, a group leader in the Urban Water Management department, received the Mid-term Career Achievement Award at the International Conference on Urban Drainage (ICUD) in Prague. This award recognises outstanding contributions in the field of urban drainage. Rieckermann was honoured for his influential research on sewer epidemiology and on the monitoring and modelling of urban drainage. The Joint Committee also cited his efforts to bridge the gap between the international and the German-speaking urban drainage community, as well as science and policy integration.

ETH Medal for Anja Felmy
Anja Felmy of the Aquatic Ecology department received an ETH Zurich Silver Medal for her outstanding doctoral thesis. In her research, she studied variation in the reproductive strategies of the freshwater snail Radix balthica. This hermaphroditic species is capable of both self- and cross-fertilisation. She found that the study population had been almost exclusively outcrossing for at least several generations. Multiple paternity was present in half of all clutches, which suggests that sexual selection may be a strong evolutionary force in this population.

Peter Penicka, Eawag

Anja Felmy received an ETH Medal for her doctoral thesis on reproduction in freshwater snails.

Cell-based biosensor
At the Venture start-up competition, Eawag scientists won third prize in the business plan category for their Rainbow Biosystem – a fish-cell-based biosensor developed in partnership with the University of Applied Sciences HES-SO Valais-Wallis. The biosensing system offers a simple solution for water quality monitoring, with measurements based on changes in electrical impedance in rainbow trout cells. The test results can be accessed and processed using a mobile phone app. The easy-to-use system can be deployed in waterbodies or off-site and provides readily interpretable results. The Swiss-wide Venture initiative supports young entrepreneurs in founding a company and promotes the realisation of innovative business ideas.

Alessandro Della Bella

The Venture prize is awarded to the Rainbow Biosystem team, with Federal Councillor Johann Schneider-Ammann looking on.

Spin-offs

Automated online microbiological water monitoring
The assessment of microbiological water quality has been revolutionised by flow cytometry. With this method, rather than waiting days for bacteria to grow – as in conventional plate counts – bacterial cells stained with fluorescent dyes can be precisely counted by laser scanning in just a few minutes. But even with this method, monitoring of temporal microbial dynamics requires considerable effort. Microbiologists at Eawag have now developed an automated system enabling measurements to be made at high temporal resolution. Rather than having to load samples individually by hand, a unit coupled to the flow cytometer handles each step autonomously – from sample collection and preparation (DNA staining) to cleaning of the instrument. The monitoring system can be installed in situ – e.g. at a water treatment plant – to provide time series for cell concentrations over a period of months. The substantial interest shown in the technology by academia and industry prompted the researchers to set up the Eawag spin-off Oncyt Microbiology AG.

Jürg Sigrist, Eawag

Fully automated online flow cytometry system, comprising a conventional flow cytometer (red and white) and the automation module developed by Eawag (blue).

Portable mass spectrometer for on-site gas analysis
Eawag scientists have developed a portable mass spectrometer enabling analyses of environmental gases to be carried out rapidly in the field, rather than requiring months of laboratory work. For example, the team needed only two weeks to complete a groundwater analysis project in Australia, which – using conventional methods – would have taken around six years in the lab. Measurement precision is nonetheless assured, with an analytical uncertainty of one to three per cent. In addition, the system, weighing 13 kilograms, offers low power consumption and maintenance-free operation. It can currently quantify helium, argon, krypton, nitrogen, oxygen, carbon dioxide and methane, with other gases being continually added to the list. A spin-off (Gasometrix) has been established to commercialise the new system; among the company's first clients is the University of Oxford.

Broad dialogue

Life in a drop of water
At the well-attended Lucerne Water and Forest Day, scientists from Eawag's Kastanienbaum site gave members of the public an insight into lake research. They explained how to analyse water samples collected from the Rotsee by the visitors themselves. Using a special camera adapter, visitors were able to transfer to a laptop microscopic images of aquatic organisms, which could then be printed and taken home as a souvenir.

Hands-on research
On National Future Day, youngsters had an opportunity to visit their parents' (godfather's, aunt's...) workplace. At Dübendorf, for example, budding researchers peered through microscopes at amphipods, caddisfly larvae or zooplankton which they had just fished out of the restored Chriesbach stream. At Kastanienbaum, the young visitors were so busy measuring fish and analysing plankton samples that they had to be reminded to take a break for pizza.

Ilse Hildbrand, Eawag

On Future Day, these girls learned how to collect a wide variety of organisms from the Chriesbach.

On-site wastewater treatment: an option for Switzerland?
The Eco-Naturkongress held in Basel on the topic of "Switzerland, the Water Tower in danger" included contributions from a number of Eawag scientists. In her presentation, Director Janet Hering emphasised the importance of knowledge and science in attaining the UN sustainable development goals. Eawag social scientists led a workshop on the potential of water sector forums for policy coordination in Switzerland. In another workshop, Eawag researchers addressed the question to what extent on-site wastewater treatment is a realistic option for Switzerland.

International dialogue at World Water Week in Stockholm
Eawag scientists gave presentations and led workshops on water and sanitation at World Water Week in Stockholm. This event brings together international experts from academia, practice, industry and government. The Eawag delegates presented, for example, open-access e-learning formats which enable people around the world to participate in education programmes. Another session was concerned with improving emergency wastewater management.

Eawag

Eawag delegates attending World Water Week in Stockholm.

Environment

Cost and energy savings with mid-temperature network
Eawag and Empa are further increasing the sustainability of their site's energy supplies. Heating supply flow temperatures are being reduced, better use is being made of on-site waste heat, and internal power generation is being maximised. To optimise waste-heat use, the two research institutes are constructing an underground thermal energy store. Work on the mid-temperature network was carried out in 2017. Energy efficiency refurbishment should allow lower temperatures to be used for heating. The new on-site district heating network operates with supply and return flow temperatures of 38 °C and 28 °C respectively. Buildings which have already been refurbished can be connected to the network without delay, and others can be connected when refurbishment is completed. The phase out of the existing high-temperature network (65 °C/40 °C) will reduce emissions and costs.

Eawag

Peter Penicka, Eawag

On the Eawag/Empa site, construction workers laid new pipes for the mid-temperature network.

Eco Team

Eawag attaches great importance to environmental management. The Eco Team, whose members represent various departments, functions and sites, seeks to ensure that energy, consumables and other resources are used sustainably. It provides leadership and motivation at all levels, so that environmentally sound behaviour remains a way of life at Eawag.

Organisation

Directorate
Janet Hering (Director)
Rik Eggen (Deputy Director)
Gabriele Mayer (Head of Operations)

Jukka Jokela
Tove Larsen
Alfred Wüest
Christian Zurbrügg

Standing Committees
Analytical Committee
Research Committee
Graduate Studies Committee
Equal Opportunity Committee
Employee Representation
Eco Team
Safety and Risk Management Committee

Eawag-EPFL Ecotox Centre
Inge Werner

Research departments

Surface Waters Research and Management SURF
Carsten Schubert

Water Resources and Drinking Water W+T
Michael Berg

Aquatic Ecology ECO
Piet Spaak

Process Engineering ENG
Eberhard Morgenroth

Fish Ecology and Evolution FISHEC
Ole Seehausen

Urban Water Management SWW
Max Maurer

Environmental Chemistry UCHEM
Juliane Hollender

Sanitation, Water and Solid Waste for Development SANDEC
Christoph Lüthi

Environmental Microbiology UMIK
Martin Ackermann

Systems Analysis, Integrated Assessment and Modelling SIAM
Peter Reichert

Environmental Toxicology UTOX
Kristin Schirmer

Environmental Social Sciences ESS
Bernhard Truffer

Support departments

Corporate Services
Thomas Lichtensteiger

Communication
Simone Kral (since Feb. 2018)

IT Services
Gabriel Piepke

HR and Finance
Gabriele Mayer

Technical Services
Markus Bürgi

Vocational Training
Samuel Derrer

Cooperation within the ETH Domain

Technology Transfer
Marlen Müller

Childcare centre
Evelyne Vonlanthen

Library Lib4RI
Lothar Nunnenmacher

Advisory Board

Peter Hunziker (Chair), Director, Hunziker Betatech, VSA representative / **Anna Bozzi,** biotechnology and nutrition research expert, scienceindustries / **Heinz Habegger,** Water Excellence AG / **Catherine Martinson,** Head of Regional Work, Executive Board member, WWF Switzerland / **Stephan Müller,** Head of Water Division, Federal Office for the Environment / **Martin Sager,** Director, Swiss Gas and Water Industry Association / **Thomas Weibel,** National Councillor, Green Liberal Party, Canton Zurich

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 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 molecular mechanisms, and the development of mitigation strategies. He is Adjunct Professor of Environmental Toxicology at ETH Zurich and is also a member of the Board of Directors of the Eawag-EPFL Ecotox Centre.

Gabriele Mayer Head of Operations

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

Jukka Jokela Aquatic Ecology department

Jukka Jokela is an internationally recognised 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, Urban Water Management department

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, Surface Waters Research and Management department

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, Sanitation, Water and Solid Waste for Development department

Christian Zurbrügg, an expert in water supplies, sanitation and waste management, studies concepts and technologies for upgrading infrastructure and services in urban areas of low- and middle-income countries. He has led several international programmes and projects in this field. He teaches at ETH Zurich, EPFL and various universities

Risk management at Eawag

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

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

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

Responsibility and risk management process
In accordance with the autonomy granted to ETH's six institutions under the Federal Act on the Federal Institutes of Technology, which is fundamental to their work in the fields of teaching, research and knowledge/technology transfer, each institution is responsible for managing the risks existing in its own sphere of operations. The Presidents of the Federal Institutes of Technology and the Directors of the research institutes thus have overall responsibility for risk management within their respective institutions. Accordingly, the two Federal Institutes of Technology and the four research institutes have each introduced their own risk management process, based on the requirements specified by the ETH Board. This process comprises the identification and assessment of individual risks, risk minimisation strategies and risk controlling. Eawag has a risk manager who coordinates risk management activities and controls the risk management process. The risk manager is supported by the other individuals responsible within Eawag's risk organisation. The implementation of risk management is monitored by the Directorate and by the ETH Board's internal audit, which reports to the ETH Board's Audit Committee.

Risk situation

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

The risks identified, and the potential loss or damage in each case, are described in detail in the risk catalogue and assessed in terms of the likelihood of occurrence and the financial impact (potential losses). In addition, particular attention is paid to the potential impact of risks on the institute's reputation. Eawag updates its risk catalogue at least once a year, taking account of new developments and changes in the risk situation. The catalogue covers the following risk categories:

– financial and economic risks
– legal risks
– property, infrastructure and natural hazard risks
– personnel and organisational risks
– technological and scientific risks
– social and political risks
– environmental and ecological risks

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

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

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

Risk management instruments and measures
As a fundamental element of risk management, subsidiary to other measures, Eawag is required to obtain insurance covering possible losses.

Insurance situation

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

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

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

It is to 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 thus 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

Rounding differences: The figures presented in this document may not add up precisely to the total amounts presented in the tables. Changes are calculated on unrounded amounts and may differ from a figure that is based on the rounded amounts presented in the tables.

Statement of financial performance

CHF 1,000	2017	2016	Note
Operating result			
Federal financial contribution	59,758	57,337	
Federal contribution to accommodation	4,413	4,162	
Total federal contribution	64,171	61,499	5
Tuition fees and other utilisation fees	169	205	6
Swiss National Science Foundation (SNSF)	6,105	5,025	
Commission for Technology and Innovation (CTI)	294	503	
Special federal funding of applied research	4,917	4,867	
EU Framework Programmes for Research and Innovation (FP)	2,471	2,692	
Industry-oriented research (private sector)	643	2,018	
Other project-oriented third-party funding (incl. cantons, municipalities, international organisations)	3,395	2,522	
Research contributions, mandates and scientific services	17,825	17,627	7
Other revenue	463	159	8
Operating revenue	**82,628**	**79,489**	
Personnel expenses	52,609	48,984	9, 21
Other operating expenses	20,215	19,185	10
Depreciation	3,470	3,323	16
Transfer expenses	151	535	11
Operating expenses	**76,445**	**72,028**	
Operating result	**6,184**	**7,462**	
Net finance income/expense	**45**	**–33**	**12**
Surplus (+) or deficit (–)	**6,229**	**7,429**	

Balance sheet

CHF 1,000	31.12.2017	31.12.2016	Note
Current assets			
Cash and cash equivalents	56,780	46,551	13
Current receivables from non-exchange transactions	10,567	13,895	14
Current receivables from exchange transactions	661	1,511	14
Current financial assets and loans	25,228	25,228	17
Prepaid expenses and accrued income	3,530	2,821	15
Total current assets	**96,767**	**90,005**	
Non-current assets			
Property, plant and equipment	23,790	23,361	16
Intangible assets	–	–	16
Non-current receivables from non-exchange transactions	7,264	6,573	14
Total non-current assets	**31,054**	**29,934**	
Total assets	**127,821**	**119,939**	
Liabilities			
Current liabilities	3,199	3,368	18
Accrued expenses and deferred income	1,202	850	19
Short-term provisions	2,668	2,598	20
Short-term liabilities	7,069	6,816	
Dedicated third-party funds	23,338	24,429	22
Net defined benefit liabilities	44,684	59,623	21
Long-term provisions	1,782	1,797	20
Long-term liabilities	69,804	85,849	
Total liabilities	**76,873**	**92,665**	
Equity			
Valuation reserves	–25,954	–39,339	
Dedicated reserves	15,495	12,122	
Free reserves	70,446	67,524	
Accumulated surplus (+)/deficit (–)	–9,040	–13,033	
Total equity	**50,947**	**27,274**	
Total liabilities and equity	**127,821**	**119,939**	

Statement of changes in equity

CHF 1,000	Cum. actuarial gains/losses (IPSAS 39)	**Valuation reserves**	Teaching and research reserves	Infrastructure and administration reserves	**Dedicated reserves**	**Free reserves**	**Accumulated surplus (+)/deficit (–)**	**Total equity**
2016								
As of 01.01.2016	**–28,012**	**–28,012**	**11,341**	**–**	**11,341**	**61,323**	**–13,481**	**31,171**
Surplus (+) or deficit (–)							7,429	**7,429**
Items directly recognised in equity: Change from defined benefit liability	–11,327	–11,327						**–11,327**
Reclassifications in equity		–	781		781	6,201	-6,982	–
Total changes	*–11,327*	*–11,327*	*781*	*–*	*781*	*6,201*	*447*	***–3,898***
As of 31.12.2016	**–39,339**	**–39,339**	**12,122**	**–**	**12,122**	**67,524**	**–13,033**	**27,274**
2017								
Changes from restatement as of 01.01.2017		–					4,060	**4,060**
As of 01.01.2017	**–39,339**	**–39,339**	**12,122**	**–**	**12,122**	**67,524**	**–8,973**	**31,334**
Surplus (+) or deficit (–)							6,229	**6,229**
Items directly recognised in equity: Change from defined benefit liability	13,385	13,385						**13,385**
Reclassifications in equity		–	3,373		3,373	2,922	–6,295	–
Total changes	*13,385*	*13,385*	*3,373*	*–*	*3,373*	*2,922*	*–66*	***19,614***
As of 31.12.2017	**–25,954**	**–25,954**	**15,495**	**–**	**15,495**	**70,446**	**–9,040**	**50,947**

As hedge accounting is not applied at Eawag, no items are recognised under the reserves from hedging transactions.

Cash flow statement

CHF 1,000	**2017**	**2016**	**Notes**
Cash flows from operating activities			
Surplus (+) or deficit (–)	**6,229**	**7,429**	
Depreciation	3,470	3,323	16
Net finance income/expense (non-cash)	–	–	12
Increase/decrease in net working capital	3,650	2,091	
Increase/decrease in net defined benefit liabilities	2,506	–1,733	21
Increase/decrease in provisions	55	267	20
Increase/decrease in non-current receivables	–691	–695	
Increase/decrease in dedicated third-party funds	–1,091	–2,972	22
Reclassification and other (non-cash) income	–	–	
Cash flows from operating activities	**14,128**	**7,711**	
Cash flows from investing activities			
Investments			
Purchase of property, plant and equipment	–3,938	–2,490	16
Increase in current and non-current financial assets	–	–	17
Total investments	*–3,938*	*–2,490*	
Divestments			
Disposal of property, plant and equipment	39	29	16
Total divestments	*39*	*29*	
Cash flows from investing activities	**–3,899**	**–2,461**	
Cash flows from financing activities			
Cash flows from financing activities	–	–	
Total cash flow	**10,229**	**5,250**	
Cash and cash equivalents at the beginning of the period	**46,551**	**41,301**	13
Total cash flow	10,229	5,250	
Cash and cash equivalents at the end of the period	**56,780**	**46,551**	13

Notes to the financial statements

1 Business Activity

Eawag is a global leader in aquatic research. The combination of natural, engineering and social sciences allows water to be investigated across the continuum from relatively pristine natural waters to fully engineered wastewater management systems. Eawag offers its professors, scientific staff and doctoral students a unique research environment, promoting active engagement with stakeholders from industry and society.

Eawag is an independent institute within the ETH Domain.

2 Basis of accounting

These financial statements cover the reporting period from 1 January 2017 to 31 December 2017. The reporting date is 31 December 2017.

Legal Principles
The accounting system for Eawag is based on the following legal foundations (including directives and regulations):

– Federal Act on the Federal Institutes of Technology of 4 October 1991 (ETH Act; SR 414.110)
– Ordinance concerning the Domain of the Swiss Federal Institutes of Technology of 19 November 2003 (Ordinance on the ETH Domain; SR 414.110.3)
– Ordinance on Finance and Accounting of the ETH Domain of 5 December 2014 (SR 414.123)
– Accounting Manual for the ETH Domain (version 6.2)

Accounting standards
The financial statements of Eawag have been prepared in accordance with the International Public Sector Accounting Standards (IPSASs). The underlying accounting provisions are set out in the Directive Accounting Manual for the ETH Domain (Art. 34 of the Directives, Ordinance on Finance and Accounting of the ETH Domain, SR 414.123).

IPSAS standards that have been published but not yet applied
The following IPSAS had been published up to the reporting date. This is only to become effective later and has not been early applied in the present financial statements

– IPSAS 40 Public Sector Combinations

The standard listed previously comes into effect on 1 January 2019. The impact on the financial statements will be analysed systematically. There are no further changes or interpretations which would not have to be applied and which would have a significant impact on Eawag.

Restatement of the financial statements of Eawag as of 1 January 2017
In 2015, Eawag transitioned to IPSAS, apart from the two items below, which were applied on 1 January 2017:

1. The provisions on disclosure of financial instruments (IPSAS 30) were not fully implemented.

2. The provisions of IPSAS 23.76 et seq. on transfers of services in-kind and goods in-kind were not applied.

IPSAS 39 Employee Benefits, which comes into effect on 1 January 2018, superseding IPSAS 25, was early adopted as per 1 January 2017.

As Eawag is preparing complete IPSAS financial statements for the first time for the period to 31.12.2017 (First IPSAS Financial Statements), the simplified procedure may be applied for the restatement in accordance with IPSAS 33 (First-time Adoption of Accrual Basis IPSASs).

The previous year's figures are presented pursuant to the annual financial statements 2016, wherein the effective date for the restatement is 1.1.2017.

The full implementation of the disclosure of financial instruments had no impact on the balance sheet as the recognition of and accounting policies for financial instruments have already been applied since 2015, when converting to IPSAS (transitional provision 1).

The provisions of IPSAS 23.76 et seq. regarding the transfer of services in-kind and goods in-kind were applied in full, but had no financial consequences (transitional provision 2).

The effects of the adoption of IPSAS 39 are shown in the restatement as of 1 January 2017.

Restatement as of 1.1.2017

			Revaluation				
CHF 1,000	**Balance sheet 31.12.2016 (before restatement)**	**Reclassifications**	Net defined benefit liabilities (IPSAS 39)	In-kind services received	Other	**Total changes**	**Opening balance sheet as of 01.01.2017**
Total current assets	90,005						90,005
Total non-current assets	29,934						29,934
Total assets	**119,939**	**–**	**–**	**–**	**–**	**–**	**119,939**
Short-term liabilities	6,816						6,816
Long-term liabilities	85,849		–4,060			–4,060	81,789
Total liabilities	**92,665**	**–**	**–4,060**	**–**	**–**	**–4,060**	**88,605**
Valuation reserves	–39,339					–	–39,339
Dedicated reserves	12,122					–	12,122
Free reserves	67,524					–	67,524
Other equity	–13,033		4,060			4,060	–8,973
Total equity	**27,274**	**–**	**4,060**	**–**	**–**	**4,060**	**31,334**
Total liabilities and equity	**119,939**	**–**	**–**	**–**	**–**	**–**	**119,939**

The first-time adoption of IPSAS 39 (Employee Benefits) has reduced net defined benefit liabilities by CHF 4,060,000. This is primarily attributable to the inclusion of employee contributions as a negative benefit. In addition, the net interest approach and extended disclosures in the notes are implemented (see Note 21 Net defined benefit liabilities).

3 Accounting policies

The accounting policies are derived from the basis of accounting. The financial statements present a true and fair view of Eawag's financial position, financial performance and cash flows, presenting revenue and expenses in the period in which they occur (accrual accounting).

The financial statements are based on historical cost. Exceptions to this rule are described in the following presentation of the accounting principles.

The annual financial statements of Eawag are included in the consolidated financial statements of the ETH Domain.

Currency translation
The reporting is prepared in Swiss francs (CHF). All figures are shown in thousands of Swiss francs (CHF 1,000) unless otherwise indicated.

Transactions in foreign currencies are translated using the exchange rate valid at the time of the transaction. The date on which the transaction is first recognised is to be used for the transaction date.
For each reporting date, monetary items in foreign currencies are translated using the closing rate. Resulting currency translation differences are recognised under finance income or finance expense. Non-monetary items are translated using the exchange rate on the day of the transaction.

The main currencies and their exchange rates are:

		Closing rate as of			Average rate	
Currency	**Entity**	**31.12.2017**	**31.12.2016**	**Currency**	**Entity**	**2017**
EUR	1	1.1701	1.0717	EUR	1	1.1116
USD	1	0.9743	1.0160	USD	1	0.9846
GBP	1	1.3168	1.2582	GBP	1	1.2681
JPY	1,000	8.6460	8.7080	JPY	1,000	8.7780

Revenue recognition
Each inflow of funds into an entity is to be examined to see whether it is revenue from exchange transactions (IPSAS 9) or revenue from non-exchange transactions (IPSAS 23). If there is a revenue from exchange transactions (IPSAS 9), the revenue will always be recognised at the time the goods and services are delivered. In the case of project contracts, the performance obligation which has not yet been provided is allocated to liabilities. The revenue is billed and itemised to reflect the progress of the project, based on the costs incurred in the reporting period.

For revenue from non-exchange transactions (IPSAS 23), a distinction is to be made between whether or not there is an obligation to pay/repay. Should any such obligation apply, the relevant amount will be recognised as borrowed capital when the contract is concluded and will be released to income in step with the progress of the project.

If there is neither a corresponding exchange nor an obligation to pay or repay as stipulated in IPSAS 23, as is frequently the case with donations, a revenue that affects net income is to be booked in the reporting year which increases the net assets/equity of the entity accordingly.

The revenue is structured as follows:

– Total federal contribution
  The grants by the Federal Government or Parliament to the ETH Domain include the federal financial contribution (in the narrower sense) and the federal contribution to accommodation. Both these types of revenue are classed as revenue from non-exchange transactions (IPSAS 23).

  The contributions by the Federal Government are recognised in the year in which they are paid. Unused funds from federal financial contributions result in reserves under equity.

  The contribution towards accommodation corresponds to the accommodation expenses, equating to a rent calculated for the state-owned buildings used by Eawag. The accommodation expenditure is recognised as part of the other operating expense.

– Tuition fees and others utilisation fees
  Revenue from tuition fees and other utilisation fees are to be classed as revenue from exchange transactions (IPSAS 9). In principle, the revenue is recognised at the time the goods or services are delivered. If significant services are provided beyond the reporting date, an accrued income is recognised.

– Research contributions, mandates and scientific services
  Project-related contributions are given to Eawag by various donors, with the aim of promoting teaching and research. Project financing largely involves multi-year projects. Depending on the characteristics of the contributions, they are classed as revenue from exchange transactions or revenue from non-exchange transactions. The type of revenue recognised depends on whether there is a performance or repayment obligation. Revenue from non-exchange transactions (IPSAS 23) is recognised if there is a receivable that is legally binding, the inflow of funds is probable, and there is no further performance obligation. Usually, a performance obligation exists and revenue is recognised as the project progresses in the accounting period based on the resources consumed.

– Donations and bequests
  Revenue from donations and bequests is to be classed as a revenue from non-exchange transactions (IPSAS 23). Donations without any conditional risk of repayment are generally recognised in full as revenue when the contract is signed.

  The donations also include the in-kind contributions, which are differentiated between as follows:

  – Goods in-kind are entered at the time the contract is signed. Assets are posted in accordance with prevailing regulations (capitalisation and depreciation).

  – Donated rights within the meaning of operational leasing are posted as expenses and revenue; those within the meaning of finance leasing are assessed at their fair value at the time the contract is concluded, if known, and they are depreciated over the period of useful life. If a performance obligation exists, a liability is recorded, and the revenue will be realised annually in accordance with the services provided. If there is no performance obligation, the revenue will be implemented upon capitalisation of the capital good as a whole.

  – Material services in-kind which are received will not be recorded but are disclosed and commented upon in the notes.
    Due to the high number and the difficulty in elicitation, separability and measurement of rights of use and services in-kind within research agreements, these are not recognised. There is only a general description of the research activity in the notes section.

– Other revenue
  Other service revenue and revenue from real estate, inter alia, is counted as other revenue. This revenue is classed as revenue from exchange transactions (IPSAS 9). In principle, the revenue is recognised at the time the goods or services are delivered. If the service is provided beyond the reporting date, an accrued income is recognised.

Cash and cash equivalents
Cash and cash equivalents include cash on hand, demand and term deposits with financial institutions, as well as funds that are invested with the Federal Government, with a maximum term of 90 days. Cash and cash equivalents are valued at nominal value.

Receivables
Receivables from exchange transactions (from goods and services) and from non-exchange transactions are presented separately in the balance sheet.

For receivables from non-exchange transactions (IPSAS 23), such as from SNSF and EU projects and from other donors, an inflow of funds in relation to the total contractual project volume is probable. Therefore, the total project amount is usually recognised as a receivable at inception of the agreement if the fair value can be measured reliably. If the recognition criteria cannot be met, information is disclosed under contingent assets.

Non-current receivables of over CHF 10 million are stated at amortised cost using the effective interest method. Current receivables from non-exchange transactions are stated at cost when the revenue is realised.

Value adjustments are made to receivables on the basis of experience and on a case-by-case assessment.

Property, plant and equipment
Property, plant and equipment items are recognised in the balance sheet at cost less accumulated depreciation. Depreciation is applied linearly, according to the estimated period of useful life. The estimated periods of useful life are:

Asset category	Useful life research institutes
Immovable assets	
Property	unrestricted
Leasehold improvements ≤ CHF 1 million	10 years
Leasehold improvements > CHF 1 million	according to components[1]
Buildings and structures	according to components[2]
Biotopes and geotopes	unrestricted
Movable assets	
Machinery, equipment, tools, devices	5–10 years
Passenger vehicles, delivery vehicles, trucks, aircraft, ships, etc.	4–7 years
Furnishings	5–10 years
IT and communication	3–7 years
Large-scale research plants and equipment	10–40 years

[1] In the case of items of property, plant and equipment with a value of CHF 1 million or above, it is checked whether components (with a value that is significant in relation to the total value) need to be recognised and depreciated separately because they have a different useful life (components approach).

[2] Useful life depends on the type of building, its purpose and the fabric of the building (20–100 years). Assets under construction are not yet depreciated.

Capitalised leasehold improvements and installations in rented premises are depreciated over the estimated useful life or the shorter period of the lease.

For incoming property, plant and equipment, it is checked whether components that represent a significant portion of the total value should be capitalised and depreciated separately because of their different periods of useful life (component approach).

Major renovations and value-enhancing investments that increase the economic benefit of a property, plant and equipment item or extend its useful life are to be capitalised and depreciated over the estimated useful life. Costs merely for repairs and maintenance are recognised as an expense. Borrowing costs for assets under construction are capitalised.

The residual value of property, plant and equipment that is decommissioned or sold is derecognised at the time of the asset's physical disposal. The gains or losses resulting from the derecognition of an item of property, plant and equipment are recognised as operating revenue or operating expenses.

Movable cultural items and works of art (e.g. teaching collections, art or historical collections, libraries) are not recognised as assets. An inventory of these items is kept.

Intangible assets
Intangible assets are recognised at cost. For standard software, the depreciation is applied linearly over three years, with an effect on surplus or deficit. Other intangible assets are depreciated linearly over the estimated period of useful life, with a period of depreciation that is to be determined for each individual case.

Impairments (property, plant and equipment and intangible assets)
Each year, property, plant and equipment as well as intangible assets are reviewed for any indications of impairment. If any such indications are found, an impairment test is to be carried out. If the carrying amount continually exceeds the value in use or the net realisable value, an impairment is recognised, with an effect on the surplus or deficit.

Financial assets and loans
Financial assets are recognised at fair value if they are purchased with the intention of generating short-term profits from market price fluctuations, or if they are designated as financial assets at fair value (for instance, investments held that do not entitle the holder to exert a significant influence). Changes in value are recognised in surplus or deficit.

The other non-current financial investments which are held for an indefinite period and may be sold at any time for reasons of liquidation or as a response to changes in market conditions are classified as "available for sale" and recognised in the balance sheet at their fair value or at their purchase value if the fair value cannot be determined reliably. Gains and losses that are not realised are recognised in equity, and only transferred to surplus or deficit when the financial assets are sold or decrease in value (impairment).

Loans granted and fixed deposits are to be recognised in the balance sheet either at amortised costs (nominal value under CHF 10 million, as well as current loans and fixed deposits over CHF 10 million) or at amortised costs using the effective interest method (non-current loans and fixed deposits over CHF 10 million). The effective interest method allocates the difference between the acquisition cost and the repayment amount (premium/discount) over the period of the investment, using the net present value method. Impairments are made on the basis of a case-by-case assessment.

Derivative financial instruments are primarily to be used for the purpose of hedging an investment or as a strategic position. They are valued solely at fair values. Any value adjustments are usually recognised in surplus or deficit.

Investment property
Eawag does not own any investment property.

Current liabilities
Current liabilities are usually recognised in the balance sheet on receipt of the invoice. Current accounts with third parties (including social insurance institutions) are also recognised in the balance sheet under this item. They are valued at the nominal value.

Provisions
Provisions are recognised when a past event leads to a present obligation, an outflow of funds is likely, and the amount can be estimated reliably.

Net defined benefit liabilities
All employees and pensioners of Eawag are insured under the pension scheme of the ETH Domain in the collective institution "Swiss Federal Pension Fund" (PUBLICA). The net defined benefit liabilities correspond to the present value of defined benefit obligations (DBO), measured according to the methodology in IPSAS 39, less the fair value of plan assets.

The defined benefit obligations are calculated by external actuarial experts annually using the Projected Unit Credit method ("PUC method"). The calculation is made based on information on the beneficiaries (salary, vested benefits, etc.) and relevant assumptions. The assumptions include both demographic (retirement rates, disability rates, mortality rates, etc.) and financial ones (salary development, pension development, discount rate, etc.). The amounts calculated are discounted to the valuation date by applying the discount rate. Changes in estimates of economic conditions can affect significantly defined benefit obligations.

Under the PUC method, benefit entitlements are added evenly over the number of years of service to be rendered, rather than reflecting the actual distribution of retirement credits under the ETH Domain's pension scheme, where they are graduated and increase with age. The defined benefit obligations were valued based on the current membership data of the ETH Domain's pension scheme as of 31 October 2017, using actuarial assumptions as of 31 December 2017 (e.g. BVG 2015 actuarial tables), and on the plan provisions of the ETH Domain's pension scheme. The results were then adjusted using pro rata estimated cash flows as of 31 December 2017. The fair value of plan assets is used with reference to the estimated performance as of 31 December 2017.

The statement of financial performance includes the current service cost, the past service cost arising from plan amendments and curtailments, gains and losses from plan settlements, administrative costs as well as the interest expense from defined benefit obligations in personnel expenses.

The effects of plan amendments and curtailments (past service cost) that are deemed fully vested are recognised immediately in surplus or deficit in the period in which they occur. Actuarial and investment gains and losses on defined benefit plans are recognised directly in equity in the reporting period in which they occur.

Significant other long-term employee benefits (e.g. future long-service award) are also measured using the PUC method.

Dedicated third-party funds
The liabilities from dedicated projects whose revenue has been classed as a revenue from non-exchange transactions (IPSAS 23) are recognised in the balance sheet as dedicated third-party funds in long-term liabilities.

Long-term because the projects usually last for several years and the short-term component of the liability cannot be determined.

The valuation is done by considering the outstanding performance obligation on the reporting date. The figure is calculated from the contractually agreed project total minus services performed until the reporting date.

Equity
Net assets/equity is the residual interest in the assets of an entity after deducting all its liabilities. The equity is structured as follows:

– Valuation reserves
  The following entries which do not affect surplus or deficit are made in the valuation reserves:

  1) Revaluation reserves for financial assets that are categorised as "available for sale" and which are recognised in the balance sheet at the fair value. Changes to the fair value are recognised in equity, until the financial assets are sold.

  2) Valuation reserves from defined benefit obligations. Actuarial and investment gains and losses from defined benefit obligations or plan assets are recognised in equity, without affecting the surplus or deficit.

  3) Valuation reserves from hedging transactions. If hedge accounting is used, positive and negative replacement values from hedging transactions are recognised in equity, and released to surplus or deficit as soon as the underlying hedged transaction has an effect on the surplus or deficit.

– Dedicated reserves
  The dedicated reserves under equity include:

  1) Reserves for teaching and research (teaching and research projects)
  2) Reserves for infrastructure and administration (value fluctuations, construction projects)

Dedicated reserves must have been generated. Recognition and release take place within the equity.

Reserve for teaching and research
This item indicates that different commitments exist, and that corresponding reserves have had to be created to cover them. Commitments are subject to a resolution, generally by the Directorate/Executive Board, and must be able to be verified at any time.

Reserves for infrastructure and administration
They include reserves for construction projects.

The reserve for construction projects relates to Federal Government funds which were granted and paid out for real estate projects, and which have not yet been used due to delays.

Free reserves
Free reserves include:
– Free reserves that are at the disposal of the Directorate. There are no external or internal conditions imposed which would restrict their freedom of disposal.

– Free research reserves of the departments. They derive primarily from the remaining balance of completed third-party-funded projects. They serve teaching and research purposes, as well as to cover losses (e.g. short-term losses of earnings, foreign currency losses). They are not specifically earmarked in terms of time or purpose, however.

Accumulated surplus/deficit
The item "Accumulated surplus/deficit" shows the status of the accumulated results as at the reporting date. It consists of: the surplus or deficit carried forward, the surplus or deficit for the period and reclassifications in equity.

The surplus or deficit carried forward is accumulated annually as part of the appropriation of surplus or deficit. The portion of the surplus or deficit that has not yet been distributed is included in the surplus or deficit of the period.

Contingent liabilities and contingent assets
A contingent liability is either a possible obligation that arises from past events and whose existence will be confirmed only by the occurrence or non-occurrence of an uncertain future event not wholly within the control of the entity or a present obligation that arises from past events, but is not recognised because of its low probability of occurrence (less than 50%) or because the obligation cannot be measured reliably, as a result of which the criteria for recognising a provision are not met.

A contingent asset is defined as a possible asset from a past event whose existence first has to be confirmed by a future event. The occurrence of this event cannot be controlled. This only includes contingent assets from third parties.

Financial commitments
Financial commitments are presented in the Notes if they are based on events prior to the reporting date, and will definitely lead to obligations towards third parties after the reporting date, and their amount can be reliably determined.

Cash flow statement
The cash flow statement shows the cash flows from operating activities and from investment and financing activities. The figures are shown according to the indirect method. This means operational cash flow based on the surplus or deficit for the period, adjusted to reflect value flows which do not trigger any direct flow of funds. The "total cash flow" corresponds to the change in the "Cash and cash equivalents" item on the balance sheet.

4 Estimation uncertainty and management judgements

Estimation uncertainty in the application of accounting policies
When preparing the financial statements in accordance with generally accepted accounting principles, it is necessary to use estimates and assumptions. The estimates and assumptions are based on past experience as well as other appropriate, substantiated factors, such as expectations about the occurrence of future events. Additionally, when applying the accounting policies, decisions have to be made that may have a significant effect on the figures shown in the financial statements. Although these estimates are based on management's best knowledge, the actual results may deviate from those estimates.

This applies especially to the following items:

– Useful life and impairment of plant, property and equipment
  The useful life of plant, property and equipment is defined in due regard for current technical circumstances and past experiences and is reviewed periodically. A change in the estimate can impact upon the future level of the depreciations and of the carrying amount.

  Within the scope of the regular impairment test, estimates are also made which may result in a reduction of the carrying amount (impairment).

– Provisions
  Provisions have a higher reliance on estimates than other balance sheet items. This may lead to a higher or lower outflow of funds depending on the outcome of the respective situation.

– Net defined benefit liabilities
  The net defined benefit liabilities are calculated based on long-term actuarial assumptions for the defined benefit obligations and for the expected return on plan assets. These assumptions may deviate from the actual future development. The determination of the discount rate and the future salary developments form an important part of the actuarial valuation.

– Discounting rates
  Uniform discount rates are defined for the discounting of non-current receivables, liabilities and provisions. These are based on a risk-free interest rate and a credit risk premium. However, because of the current interest rate situation these discounting rates are subject to some uncertainties.

Management judgements in the application of accounting policies
Neither in the reporting year nor in the previous year were there any management judgments in this regard having a material effect on the annual financial statements.

5 Total federal contribution

Federal financial contribution		
CHF 1,000	**2017**	**2016**
Basic federal financial contribution	59,075	55,674
Performance-based allocation of funds	1,800	1,000
Credit reallocation from federal investment credit	–300	1,133
Credit reallocation within ETH Domain	–817	–470
Federal financial contribution	**59,758**	**57,337**

The federal financial contribution was used to achieve the goals specified in the ETH Act (SR 414.110) and the performance mandate 2017–2020. The funds from the financial contribution were used not only to cover current operating expenses but also to finance investments.

Federal contribution to accommodation		
CHF 1,000	**2017**	**2016**
Federal contribution to accommodation	**4,413**	**4,162**

The federal contribution to accommodation is used to cover rental expenses for federally owned properties.

6 Tuition fees and other utilisation fees

CHF 1,000	2017	2016
Tuition fees and other utilisation fees	**169**	**205**

Tuition fees and other utilisation fees mainly comprise income from Peak and other courses, and from the Info Day.

7 Research contributions, mandates and scientific services

CHF 1,000	2017	of which revenues (IPSAS 23)	of which revenues (IPSAS 9)	2016	of which revenues (IPSAS 23)	of which revenues (IPSAS 9)
Swiss National Science Foundation (SNSF)	6,105	6,095	10	5,025	4,606	418
Commission for Technology and Innovation (CTI)	294	294	–	503	503	–
Special federal funding of applied research	4,917	2,448	2,469	4,867	3,572	1,295
EU Framework Programmes for Research and Innovation (FP)	2,471	2,471	–	2,692	2,692	–
Industry-oriented research (private sector)	643	–	643		1,279	740
Other project-oriented third-party funding (incl. cantons, municipalities, international organisations)	3,395	2,205	1,190	2,522	1,779	743
Total research contributions, mandates and scientific services	**17,825**	**13,513**	**4,312**	**17,627**	**14,431**	**3,196**

Teaching and research projects are generally multi-year activities (approx. 3–5 years).

In the previous year, industry-oriented research included a large-scale project funded by a private foundation (CHF 934,000). Overall, revenues are similar to the previous year's, with shifts depending on the stage of completion of projects. In the reporting year, the EU Framework Programmes for Research and Innovation include CHF 909,000 (previous year: CHF 305,000) of direct federal (SERI) funding for Horizon 2020 bridging measures.

8 Other revenue

CHF 1,000	2017	2016
Sales	6	5
Other services	1	1
Real estate revenue	257	188
Profit from disposals (property, plant and equipment)	–	–
Own work capitalised	–	–
Other miscellaneous revenue	200	–35
Total other revenue	**463**	**159**

Real estate revenue includes, in particular, income from rental of guest house apartments; this is dependent on occupancy.

9 Personnel expenses

CHF 1,000	2017	2016
Professors	–	–
Scientific personnel	26,360	26,904
Technical and administrative personnel, apprentices, trainees	15,632	15,465
IC, Suva and other refunds	–328	–331
Total salaries and wages	**41,664**	**42,037**
Social insurances OASI/DI/IC/MB	2,501	2,508
Net pension costs	7,328	3,069
Accident and sickness insurance Suva (BU/NBU/KTG)	171	181
Employer's contribution to Family Compensation Fund (FAK/FamZG)	476	478
Total social insurance schemes and pension expenses	**10,475**	**6,236**
Other employer contributions	–226	–142
Temporary personnel	–	–
Change in provisions for untaken leave and overtime	71	149
Change in provisions for contributions to long-service awards	–15	112
Other personnel expenses	639	592
Total personnel expenses	**52,609**	**48,984**

With the exception of net pension costs, personnel expenses are similar to the previous year's. The increase results from the changeover to IPSAS 39 with effect from 01.01.2017. (No restatement of the previous year's figures.)

10 Other operating expenses

CHF 1,000	2017	2016
Expenses for goods and materials	3,254	2,759
Premises costs	6,169	5,954
Other operating costs	10,793	10,473
Total other operating expenses	**20,215**	**19,185**

Other operating expenses increased, in accordance with internal planning, in the areas of materials and other operating costs. This includes asset acquisition costs below the capitalisation threshold.

11 Transfer expenses

CHF 1,000	2017	2016
Scholarships and grants to students and doctoral students	–	–
Contributions to research projects	151	535
Expenses for the participation in projects of national significance	–	–
Special initiatives	–	–
Other	151	535
Other transfer expenses	–	–
Total transfer expenses	**151**	**535**

In the previous year, a contribution of CHF 500,000 to the Federal Laboratories for Materials Testing and Research (Empa) project Nest was included.

12 Net finance income/expense

CHF 1,000	2017	2016
Finance income		
Interest income	–	–
Foreign currency gains	75	19
Other finance income	–	–
Total finance income	**75**	**19**
Finance expense		
Interest expense	1	–
Foreign currency losses	21	44
Other finance expense	7	8
Total finance expense	**30**	**52**
Total net finance income/expense	**45**	**–33**

13 Cash and cash equivalents

CHF 1,000	31.12.2017	31.12.2016
Cash	41	41
Swiss Post	4,092	4,828
Bank	947	982
Short-term deposits (<90 days)	51,700	40,700
Total cash and cash equivalents	**56,780**	**46,551**

Short-term deposits are wholly invested in federal financial instruments. The higher volume is partly due to the higher level of internal commitments and also to the increase in reserves from the federal contribution (included in free reserves), which in accordance with the Treasury Agreement are invested without interest at the Federal Treasury.

Cash and cash equivalents are not subject to any disposal restrictions.

14 Receivables

CHF 1,000	31.12.2017	31.12.2016
Receivables from project contracts and donations	17,392	20,019
Other receivables	439	449
Value adjustments	–	–
Total receivables from non-exchange transactions	**17,831**	**20,467**
of which current	10,567	13,895
of which non-current	7,264	6,573
Trade accounts receivable	578	1,476
Other receivables	83	35
Value adjustments	–	–
Total receivables from exchange transactions	**661**	**1,511**
of which current	661	1,511
of which non-current	–	–

Since the receivables do not include any at-risk items, no value adjustments have been made.

In the reporting year, losses on receivables totalled approx. CHF 1,000 (previous year: CHF 0).

15 Prepaid expenses and accrued income

CHF 1,000	31.12.2017	31.12.2016
Interest	–	–
Prepaid expenses	2,815	2,580
Other prepaid expenses and accrued income	715	241
Total prepaid expenses and accrued income	**3,530**	**2,821**

From 2017, prepaid expenses are recorded separately. The values for the previous year have been adjusted accordingly.

Prepaid expenses essentially comprise the fees payable in advance for the library databases. Other prepaid expenses and accrued income derive from current IPSAS 9 (exchange transaction) projects.

16 Property, plant and equipment and intangible assets

CHF 1,000	Large-scale research plants and equipment, machinery	IT hardware	Advance payments, movable assets under construction	**Total movable assets**	User-specific installations	Assets under construction	**Total immovable assets**	**Total property, plant and equipment**	**Total intangible assets**
Purchase value as of 01.01.2017	**28,563**	**1,176**	**172**	**29,911**	**20,366**	**166**	**20,532**	**50,443**	**109**
Additions	3,410	50	162	3,622	135	180	316	3,938	–
Reclassifications	308	–	–308	0	347	–347	–	–	–
Disposals	–482	–	–	–482	–	–	–	–482	–
as of 31.12.2017	**31,800**	**1,226**	**26**	**33,051**	**20,848**	**–**	**20,848**	**53,899**	**109**
Accumulated depreciation as of 01.01.2017	**20,033**	**1,126**	**–**	**21,160**	**5,923**	**–**	**5,923**	**27,082**	**109**
Depreciation	1,776	26	–	1,802	1,668	–	1,668	3,470	–
Impairments	–	–	–	–	–	–	–	–	–
Reversed impairments	–	–	–	–	–	–	–	–	–
Reclassifications	–	–	–	–	–	–	–	–	–
Disposals value adjustments	–443	–	–	–443	–	–	–	–443	–
as of 31.12.2017	**21,366**	**1,152**	**–**	**22,519**	**7,590**	**–**	**7,590**	**30,109**	**109**
Balance sheet value as of 31.12.2017	**10,433**	**73**	**26**	**10,532**	**13,258**	**–**	**13,258**	**23,790**	**–**
thereof leased assets				–			–	–	–

CHF 1,000	Large-scale research plants and equipment, machinery	IT hardware	Advance payments, movable assets under construction	**Total movable assets**	User-specific installations	Assets under construction	**Total immovable assets**	**Total property, plant and equipment**	**Total intangible assets**
Purchase value as of 01.01.2016	**28,244**	**1,369**	**84**	**29,697**	**17,694**	**1,632**	**19,326**	**49,022**	**109**
Additions	1,063	48	172	1,283	1,041	166	1,207	2,490	–
Reclassifications	379	–	–84	296	1,632	–1,632	–	296	–
Disposals	–1,123	–242	–	–1,365	–	–	–	–1,365	–
as of 31.12.2016	**28,563**	**1,176**	**172**	**29,911**	**20,366**	**166**	**20,532**	**50,443**	**109**
Accumulated depreciation as of 01.01.2016	**19,054**	**1,354**	**–**	**20,408**	**4,391**	**–**	**4,391**	**24,799**	**109**
Depreciation	1,777	15	–	1,791	1,532	–	1,532	3,323	–
Impairments	–	–	–	–	–	–	–	–	–
Reversed impairments	–	–	–	–	–	–	–	–	–
Reclassifications	296	–	–	296	–	–	–	296	–
Disposals value adjustments	–1,094	–242	–	–1,336	–	–	–	–1,336	–
as of 31.12.2016	**20,033**	**1,126**	**–**	**21,160**	**5,923**	**–**	**5,923**	**27,082**	**109**
Balance sheet value as of 31.12.2016	**8,530**	**49**	**172**	**8,751**	**14,444**	**166**	**14,610**	**23,361**	**–**
thereof leased assets				–			–	–	–

Eawag does not have any leased property, plant and equipment or leased intangible assets. There are no disposal restrictions or pledged tangible or intangible assets.

User-specific installations are located in or on federally owned buildings and property.

Additions in the reporting year include, in particular, several items of scientific equipment.

17 Financial assets and loans

CHF 1,000	31.12.2017	31.12.2016
Current financial assets and loans		
Other financial assets	25,228	25,228
Loans	–	–
Total current financial assets and loans	**25,228**	**25,228**

Current financial assets consist exclusively of financial assets placed in accordance with the agreement between the Federal Finance Administration and the ETH Board concerning Treasury relations between the Federal Finance Administration and the ETH Board (19 November 2007). The assets in question are third-party funds already received and temporarily deposited with the Federal Treasury before being used in teaching and research.

18 Current liabilities

CHF 1,000	31.12.2017	31.12.2016
Trade payables	1,791	2,027
Liabilities to social insurance institutions	647	789
Other current liabilities	761	552
Total current liabilities	**3,199**	**3,368**

19 Accrued expenses and deferred income

CHF 1,000	31.12.2017	31.12.2016
Interest	–	–
Deferred income	908	430
Other accrued expenses and deferred income	293	420
Total accrued expenses and deferred income	**1,202**	**850**

From 2017, deferred income is recorded separately. The values for the previous year have been adjusted accordingly.

Deferred income comprises income from IPSAS 9 (exchange transaction) projects which is only to be recognised as revenue in the new accounting period.

20 Provisions

Overview

CHF 1,000	31.12.2017	31.12.2016
Provisions for untaken leave and overtime	2,628	2,557
Other long-term employee benefits (IPSAS 39)	1,782	1,797
Other provisions	40	41
Total provisions	**4,450**	**4,395**

Derivation 2017

CHF 1,000	Provisions for untaken leave and overtime	Other long-term employee benefits (IPSAS 39)	Other provisions	**Total provisions**
as of 01.01.2017	**2,557**	**1,797**	**41**	**4,395**
Creation (incl. increase)	71	222	40	333
Reversal	–	–	–	–
Appropriation	–	–237	–41	–278
Increase in present value	–	–	–	–
as of 31.12.2017	**2,628**	**1,782**	**40**	**4,450**
of which current	2,628		40	2,668
of which non-current		1,782	–	1,782

Derivation 2016

CHF 1,000	Provisions for untaken leave and overtime	Other long-term employee benefits (IPSAS 39)	Other provisions	**Total provisions**
as of 01.01.2016	**2,408**	**1,685**	**35**	**4,128**
Creation (incl. increase)	149	112	41	302
Reversal	–	–	–	–
Appropriation	–	–	–35	–35
Increase in present value	–	–	–	–
as of 31.12.2016	**2,557**	**1,797**	**41**	**4,395**
of which current	2,557		41	2,598
of which non-current	1,797	–		1,797

Other long-term employee benefits (IPSAS 39) are future long-service awards. These are calculated pro rata, taking account of staff turnover.

21 Net defined benefit liabilities

All employees and pensioners of Eawag are insured under the pension plan of the ETH Domain under the collective institution "Swiss Federal Pension Fund" (PUBLICA).

The standard IPSAS 39 (Employee Benefits) was adopted on 1 January 2017. The effects are explained in detail in Note 2. The previous year's figures are based on IPSAS 25 and have only been reclassified into the tables adjusted in line with IPSAS 39 (not restated).

Legal framework and responsibilities
Regulatory environment
Swiss plans need to be funded through a legally separate trustee-administered pension fund. The law prescribes minimum benefits.

Organisation of the pension plan
PUBLICA is an independent, state-run institution under public law.
The Board of Directors (Kassenkommission) is the uppermost executive body within PUBLICA. In addition to the executive management, it is also responsible for supervising and exercising control over the management of PUBLICA. The parity commission has 16 members (eight representing the people insured and eight representing the employers from among all the affiliated pension plans). This means that the

uppermost executive body of PUBLICA is made up in equal parts of representatives of employees and employers.

Each pension scheme has a separate parity commission. Among other things, it is involved in the conclusion of the affiliation contract and decides on the appropriation of any surpluses. Each parity commission is made up of nine people representing employers and nine representing employees, as well as representatives of the entities.

Insurance plan
According to IPSAS 39, the insurance plan is classified as "defined benefit" plan.
The pension plan is defined in the pension policies for employees and professors of the ETH Domain's pension fund, which form part of the affiliation contract with PUBLICA. The pension plan provides in excess of the minimum benefits required by the law in the event of invalidity, death, old age and departure; i.e. it is what is known as an enveloping plan (obligatory and extraordinary benefits).

The savings contributions by the employer and by the employees are defined as a percentage of the insured wage. A risk premium is collected for the risks of death and invalidity. The administrative costs are paid by the employer.
The old-age pension is calculated from the credit balance in the retirement fund multiplied by the conversion rate specified in the policy. The employee has the option of drawing the retirement benefits as capital.
There are pension plans for different groups of insured persons. In addition, the employee has the option of making additional savings contributions.
The risk benefits are determined depending on the projected savings capital, which attracts interest, and on the conversion rate.

Investment
Investments are made by PUBLICA collectively for all the pension plans (with the same investment profile). As the uppermost executive body within PUBLICA, the Board of Directors bears overall responsibility for the management of the assets. It is responsible for issuing and amending the investment policy and determines the investment strategy. The Investment Committee advises the Board of Directors on investment-related issues and oversees compliance with the investment policy and strategy.
Responsibility for the implementation of investment strategy rests with the Asset Management of PUBLICA. Asset Management also makes tactical decisions to deviate temporarily from the weighting of the investment strategy in order to generate added value compared to the existing strategy. Where individual investment classes are built up or reduced over a number of years, a pro rata strategy is calculated so as to enable transactions to be diversified over the time axis.

Risks for the employer
The parity commission of the ETH Domain's pension plan can change the financing system (contributions and future benefits) at any time. The parity commission may, if other measures prove ineffective, collect restructuring contributions from the employer during a period of undercoverage within the meaning of pension law (Article 44 BVV 2 (Ordinance on Occupational Retirement, Survivors' and Disability Pension Plans)). If this is to be used to finance extraordinary benefits, the employer must indicate that it is in agreement with this.

The definitive coverage ratio in accordance with the Occupational Pensions Act (BVG) was not available at the time the financial statements were approved. The provisional regulatory coverage ratio for the ETH Domain's pension scheme at PUBLICA, in accordance with BVV 2, amounted to 108.0% at the end of the year (2016: 103.2%, definitive). The provisional economic coverage ratio for the ETH Domain's pension plan at PUBLICA at the end of the year was 89.5% (2016: 84.9%, definitive).

Special events
There were no plan amendments, curtailments or settlements in the current reporting period.

Net defined benefit liabilities		
CHF 1,000	**31.12.2017**	**31.12.2016**
Present value of defined benefit obligations	–209,082	–212,327
Fair value of plan assets	164,398	152,704
Recognised net defined benefit liabilities	**–44,684**	**–59,623**

The decrease in net defined benefit liabilities is attributable, on the one hand, to the restatement dated 1 January 2017 (CHF 4,060,000) and to the change in actuarial assumptions, in particular the increase in the discount rate and the reduction in salary development and interest on the retirement savings.

Net pension costs		
CHF 1,000	**2017**	**2016**
Current service cost (employer)	7,298	6,365
Interest expense from defined benefit obligations	419	784
Interest income from plan assets	–306	–3,996
Administrative costs (excl. asset management costs)	120	–
Total net pension costs incl. interest expense recognised in statement of financial performance	**7,531**	**3,153**

The increase in net pension costs is due in particular to the change from IPSAS 25 to IPSAS 39. Since IPSAS 39 introduces the net interest approach, the expected return on plan assets is now calculated applying the discount rate. This results in lower interest income on plan assets amounting to CHF 306,000 (2016: CHF 3,996,000) in the income statement and a correspondingly higher actuarial gain in equity. Interest expense from defined benefit obligations decreased due to the lower discount rate of 0.2% (2016: 0.4%).

The current service cost amounting to CHF 7,298,000 (2016: CHF 6,365,000) rose due to a slight increase in the number of pension scheme members.

In the reporting year, deposits amounting to CHF 8.5 million were transferred by the ETH Board to the ETH Domain's pension plan. This sum was recognised pro rata for Eawag (CHF 203,000) as an employer contribution in the actuarial report and leads to a difference from the net pension costs actually entered since an internal transfer cannot be recorded.

For the coming financial year, the estimated employer contributions are CHF 4.9 million and employee contributions CHF 2.6 million.

Amounts to be immediately recognised in equity		
CHF 1,000	**31.12.2017**	**31.12.2016**
Actuarial gains (–) and losses (+)		
from change in financial assumptions	–7,466	3,415
from change in demographic assumptions	–	9,124
from experience adjustments	5,086	1,771
Return on plan assets excl. interest income	–11,005	-2'983
Other	–	–
Amount recognised in equity	**–13,385**	**11,327**
Cumulative amount of gains (–) / losses (+) recognised in equity	**25,954**	**39,339**

The actuarial gains recognised in equity in 2017 are CHF 13.4 million (2016: actuarial loss of CHF 11.3 million). This results in a cumulative accrued loss of CHF 26.0 million as of 31 December 2017 (2016: CHF 39.3 million).

Change in present value of defined benefit obligations during year		
CHF 1,000	**2017**	**2016**
Changes from restatement as of 01.01.2017	–4,060	
Present value of defined benefit obligations as of 01.01.	**208,267**	**194,901**
Current service cost (employer)	7,298	6,365
Interest expense from defined benefit obligations	419	784
Employee contributions	2,731	2,699
Benefits paid in (+) and paid out (–)	–7,253	–6,732
Past service cost	–	–
Gains (–) / losses (+) from plan settlements	–	–
Actuarial gains (–) / losses (+)	–2,380	14,310
Other	–	–
Present value of defined benefit obligations as of 31.12.	**209,082**	**212,327**

The weighted average term arising from defined benefit obligations is 15.4 years as of 31 December 2017 (2016: 15.9 years).

Change in fair value of plan assets during year		
CHF 1,000	**2017**	**2016**
Fair value of plan assets as of 01.01.	152,704	144,872
Interest income from plan assets	306	3,996
Employer contributions	5,025	4,886
Employee contributions	2,731	2,699
Benefits paid in (+) and paid out (–)	–7,253	–6,732
Gains (+) / losses (–) from plan settlements	–	–
Administrative costs (excl. asset management costs)	–120	–
Return on plan assets excl. interest income	11,005	2,983
Other	–	–
Fair value of plan assets as of 31.12	**164,398**	**152,704**

Transition of net defined benefit liabilities		
CHF 1,000	**2017**	**2016**
Changes from restatement as of 01.01.2017	4,060	
Net defined benefit liabilities as of 01.01.	**–55,563**	**–50,029**
Net pension costs incl. interest expense recognised in statement of financial performance	–7,531	–3,153
Amounts directly recognised in equity	13,385	–11,327
Employer contributions	5,025	4,886
Obligations paid directly by the entity	–	–
Other	–	–
Net defined benefit liabilities as of 31.12.	**–44,684**	**–59,623**

Major categories of plan assets	**Listed**	**Unlisted**	**31.12.2017**	**Listed**	**Unlisted**	**31.12.2016**
PERCENTAGE						
Liquidity	4	–	3	2	–	2
Bonds (in CHF) Confederation	6	–	6	6	–	6
Bonds (in CHF) ex. Confederation	12	–	11	12	–	11
Government bonds (in foreign currencies)	28	–	26	30	–	28
Corporate bonds (in foreign currencies)	15	–	14	16	–	15
Mortgages	–	–	–	–	–	–
Shares	33	–	31	32	–	30
Real estate	–	71	5	–	86	5
Commodities	2	–	2	2	–	2
Other	–	29	2	–	14	1
Total plan assets	**100**	**100**	**100**	**100**	**100**	**100**

PUBLICA will bear the insurance and investment risks itself. The investment strategy is defined in such a way that benefits under the policy can be provided upon maturity.
There is no known pension fund real estate used by the employer.

Principal actuarial assumptions used as at the reporting date		
PERCENTAGE	**2017**	**2016**
Discount rate as of 01.01.	0.20	0.40
Discount rate as of 31.12.	0.30	0.20
Expected salary development	0.50	0.90
Expected pension development	0.00	0.00
Interest on retirement savings	0.50	1.00
Life expectancy at age 65 – women (no. of years)	24.43	24.32
Life expectancy at age 65 – men (no. of years)	22.38	22.26

The discount rate is based upon the cash interest rates for federal bonds published by the Swiss National Bank and from the expected capital flows of the ETH Domain's pension plan at PUBLICA in accordance with existing data from the previous year. The expected future rate of salary development is based on reference economic variables. The pension development corresponds to the pension development expected for the average remaining term based upon the financial circumstances of the pension plan. The generation tables in BVG 2015 are applied for the assumptions made about life expectancy.

Sensitivity analysis (change in present value of defined benefit obligations)

		2017	2016	
CHF 1,000	**Increase in assumption**	**Decrease in assumption**	**Increase in assumption**	**Decrease in assumption**
Discount rate (change +/–0.25%)	–7,759	8,303	–8,167	8,729
Expected salary development (change +/–0.25%)	832	–815	1,243	–1,198
Expected pension development (change +/–0.25%)	6,452	–6,124	6,496	–6,169
Interest on retirement savings (change +/–0.25%)	1,269	–1,246	1,356	–1,334
Life expectancy (change +/–1 year)	6,718	–6,793	6,927	–7,009

Sensitivity analyses were performed for the principal assumptions used for the calculation of obligations. The change in defined benefit obligations upon adjustment of the actuarial assumptions is determined in the sensitivity analysis. Only one of the assumptions is adapted at once, while the other parameters remain unchanged. The discount factor, the interest on retirement savings and the assumptions made on salary and pension development have been increased or lowered by fixed percentage points. The sensitivity to mortality has been calculated by lowering or increasing mortality by a flat-rate factor, as a result of which the life expectancy of most age categories has been increased or reduced by about one year.

22 Dedicated third-party funds

CHF 1,000	**31.12.2017**	**31.12.2016**
Swiss National Science Foundation (SNSF)	13,699	12,781
Commission for Technology and Innovation (CTI)	810	563
EU Framework Programmes for Research and Innovation (FP)	4,066	5,481
Special federal funding of applied research	1,717	3,284
Industry-oriented research (private sector)	–	–
Other project-oriented third-party funding	3,047	2,320
Donations and bequests	–	–
Total dedicated third-party funds	**23,338**	**24,429**

Funding for major new projects was obtained from the Swiss National Science Foundation and the CTI. Projects for which EU and federal research funding was previously obtained are well underway. Other project-oriented third-party funding increased, in particular, due to a major project for which an agreement was signed in the reporting year.

23 Financial risk management and additional information about the financial instruments

General

Financial risk management is embedded in the general risk management of Eawag, in respect of which annual reports are made to the ETH Board (see Annual Report, chapter on Risk Situation and Risk Management, p. 44).

Financial risk management particularly involves:
– credit risk (default risk),
– liquidity risk
– as well as market risk (interest, trading price and foreign currency risk).

The focus of risk management remains unchanged in credit risk. There are guidelines which control the investment of financial resources in order to reduce default and market risk. A large proportion of the receivables and claims arising from financial assets is against parties with a high credit rating and solvency. Cluster risks only exist in respect of those counterparties, which is why the credit risk is assessed as low.
Furthermore, there are receivables and financial assets in foreign currencies which are hedged according to prevailing factors in order to minimise the risk.
The compliance with and effectiveness of the guidelines are insured by the internal control system (ICS).

Maximum exposure to credit risk, composition of counterparties 2017	**Total**	**Federation**	**European Commission FP***	**SNSF, CTI, OASI social service, Suva**	**SNB and banks with government guarantee**	**Postfinance and other banks**	**Other counterparties**
CHF 1,000							
31.12.2017							
Cash and cash equivalents	**56,780**	51,741	–	–	947	4,092	–
Receivables from non-exchange transactions	**17,831**	1,569	3,110	9,606	–	–	3,546
Receivables from exchange transactions	**661**	159	–	–	–	–	502
Financial assets and loans	**25,228**	25,228	–	–	–	–	–
Prepaid expenses and accrued income	**715**	715	–	–	–	–	–
Total	**101,216**	**79,412**	**3,110**	**9,606**	**947**	**4,092**	**4,048**

* The remaining receivables due from the state (State Secretariat for Education, Research and Innovation, SERI) under the bridging programme for Horizon 2020 and the receivables from European universities arising from EU research framework programmes are shown in the column headed European Commission.

The maximum default risk corresponds to the book values on the balance sheet. The actual risk is very low based on the fact that a large proportion of the financial assets are held with the state and with other public sector institutions.

Liquidity risk
Eawag has processes and principles which guarantee adequate liquidity for the settlement of ongoing and future obligations. This includes maintaining an adequate reserve of liquidity.

Contractual maturities of financial liabilities 2017

CHF 1,000	**Total carrying amount**	**Total contract value**	**Up to 1 year**	**More than 1 year**
31.12.2017				
Non-derivative financial liabilities				
Current liabilities	**3,199**	3,199	3,199	–
Accrued expenses and deferred income	**293**	293	293	–
Derivative financial liabilities	–	–	–	–
Total	**3,492**	**3,492**	**3,492**	**–**

Financial liabilities arise, most notably, from current liabilities and leasing liabilities. Under normal circumstances, expenses and investments are financed with funds generated internally. All financial liabilities are covered by liquidity and by short-term deposits with the state. The liquidity risk is low.

Market risk
Interest and trading price risk
The interest risk is not hedged. Any increase or decrease in the interest rate of 1% would raise or lower income by around CHF 303,000.

Foreign currency risk
Most of the receivables in foreign currencies are in euros and US dollars; they are hedged with derivatives according to prevailing circumstances. Any fluctuation in the exchange rate of these two currencies of +/– 10 %, allowing for hedging transactions, would impact upon the income statement as follows:

CHF 1,000	**Total**	**CHF**	**EUR**	**USD**	**Other**
31.12.2017					
Net currency balance	**80,691**	**81,047**	**–570**	**226**	**–11**
Sensitivity affecting financial performance +/–10%			57	23	
Closing rate			1.17	0.97	

Capital management
Managed capital refers to equity without valuation reserves. Eawag is seeking to create a solid equity base. This base will enable the implementation of the performance mandate to be guaranteed. Statutory criteria prohibit Eawag from raising funds in the capital market.

Estimate of fair values
Based on short-term maturity, the book value of cash and cash equivalents, as well as the book values of current loans, fixed deposits and receivables, as well as current liabilities reflect a reasonable assessment of the fair value.

The fair value of non-current receivables from non-exchange transactions and of non-current loans is calculated on the basis of future payments which are due and which are discounted at market interest rates.

Classes and categories of financial instruments 2017	**Loans and receivables**	**At fair value through surplus or deficit**	**Available for sale**	**Financial liabilities measured at amortised cost**	**Total carrying amount**	**Total fair value**
CHF 1,000						
31.12.2017						
Cash and cash equivalents	56,780				**56,780**	**56,780**
Receivables from non-exchange transactions	17,831				**17,831**	**17,831**
Receivables from exchange transactions	661				**661**	**661**
Financial assets and loans	25,228	–	–		**25,228**	**25,228**
Prepaid expenses and accrued income	715				**715**	**715**
Current liabilities				3,199	**3,199**	**3,199**
Accrued expenses and deferred income				293	**293**	**293**

Eawag does not have any held-to-maturity investments.

	31.12.2017			
Presentation of net surplus or deficit by valuation category	**Loans and receivables**	**At fair value through surplus or deficit**	**Available for sale**	**Financial liabilities**
CHF 1,000				
Interest income (+) / interest expense (–)	–	–		–1
Income from investments		–	–	–
Change in fair value		–	–	–
Currency translation differences, net	54	–	–	–
Impairments	–	–	–	
Reversal of impairment	–	–		
Gains and losses reclassified from equity to the statement of financial performance			–	
Net surplus or deficit recorded in the statement of financial performance	**54**	**–**	**–**	**–1**
Net surplus or deficit recognised in equity	**–**	**–**	**–**	**–**
Total net surplus or deficit by category	**54**	**–**	**–**	**–1**

24 Contingent liabilities and contingent assets

Contingent liabilities
There are no contingent liabilities.

Contingent assets
There are no contingent assets.

25 Financial commitments

CHF 1,000	31.12.2017	31.12.2016
Financial commitments ≤ 1 year	876	1,360
Financial commitments from 1 to 5 years	93	–
Total financial commitments	**969**	**1,360**

The financial commitments relate to equipment, software or services that have been firmly ordered but not yet supplied.

In addition, Empa and Eawag operate a communal guest house, with Empa acting as the primary tenant. This is recorded in Empa's accounts.

Each year, any expenses not covered by guest house rental income are settled internally between Eawag and Empa.

26 Operating leases

There are no fixed-term lease agreements.

27 Remuneration of key management personnel

Remuneration of key management personnel

CHF 1,000	2017	2016
Directorate	**1,486**	**1,455**

Key positions

Full-time equivalents	2017	2016
Directorate	**4.7**	**4.6**

Since October 2017, Eawag's Directorate has consisted of seven, rather than six, people: the Director, the Deputy Director, a Head of Operations and four other members, two of whom hold professorships – one at ETH Zurich, one at EPFL. These institutions are responsible for these two members' employment and salary costs, with EPFL charging 80% of the personnel costs to Eawag. The amount charged is included in the remuneration, and this member of the Directorate accounts for 0.8 FTE. The full-time equivalent and remuneration for the new member of the Directorate was calculated pro rata for this period.

28 Events after the reporting date

Eawag's annual financial statements were approved by the Director and the Deputy Director on 26 February 2018. No significant events have occurred to date which would necessitate a disclosure in or an adjustment to Eawag's annual financial statements as at 31 December 2017.

EIDGENÖSSISCHE FINANZKONTROLLE
CONTRÔLE FÉDÉRAL DES FINANCES
CONTROLLO FEDERALE DELLE FINANZE
SWISS FEDERAL AUDIT OFFICE

Reg. Nr. 1.18035.937.00123.002

Report of the statutory auditor

to the Director of the Swiss Federal Institute of Aquatic Science and Technology, Dübendorf

Report on the audit of the financial statements

Opinion

We have audited the financial statements of the Swiss Federal Institute of Aquatic Science and Technology (Eawag), which comprise the statement of financial performance 2017, the balance sheet as of 31 December 2017, the statement of changes in equity and the cash flow statement for the year then ended, and notes to the financial statements, including a summary of significant accounting policies.

In our opinion the financial statements (pages 47 to 79) present fairly, in all material respects, the financial position of the Eawag as of December 31, 2017, and its financial performance and its cash flows for the year then ended in accordance with the International Public Sector Accounting Standards (IPSAS) and legal requirements and the Accounting Manual for the ETH Domain.

Basis for Opinion

We conducted our audit in accordance with Swiss Law, International Standards on Auditing (ISAs), Swiss Auditing Standards and article 35ater of the Federal Act on the Federal Institutes of Technology (SR 414.110). Our responsibilities under those standards are further described in the Auditor's responsibilities for the audit of the financial statements section of our report. We are independent based on the Federal Auditing Act (SR 614.0), and we have fulfilled our other ethical responsibilities in accordance with these requirements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

Other information in the Annual Report

The Executive Board of the Eawag is responsible for the other information in the annual report. The other information comprises all information included in the annual report, but does not include the financial statements and our auditor's report thereon.

Our opinion on the financial statements does not cover the other information in the annual report and we do not express any form of assurance conclusion thereon.

In connection with our audit of the financial statements, our responsibility is to read the other information in the annual report and, in doing so, consider whether the other information is materially inconsistent with the financial statements or our knowledge obtained in the audit, or otherwise appears to be materially misstated. If, based on the work we have performed, we conclude that there is a material misstatement of this other information, we are required to report that fact. In this context, please refer to the section Report on other legal and regulatory requirements at the end of this report.

Responsibilities of the Executive Board of the Eawag for the financial statements

The Executive Board of the Eawag is responsible for the preparation and fair presentation of the financial statements in accordance with the International Public Sector Accounting Standards (IPSAS) and the legal requirements (Ordinance on the ETH Domain, SR 414.110.3; Ordinance on the Finance and Accounting of the ETH Domain, SR 414.123; Accounting Manual for the ETH Domain), and for such internal control as the Executive Board determines is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, the Executive Board of the Eawag is responsible for assessing the Eawag's ability to continue as a going concern, disclosing, as applicable, matters related to going concern.

Auditor's responsibilities for the audit of the financial statements

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with Swiss law, ISAs and Swiss Auditing Standards will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

As part of an audit in accordance with Swiss law, ISA's and Swiss Auditing Standards, we exercise professional judgment and maintain professional scepticism throughout the audit. We also:

- Identify and assess the risks of material misstatement of the financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.
- Obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the Eawag's internal control.
- Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made.

- Conclude on the appropriateness of the Executive Board of the Eawag's use of the going concern basis of accounting and, based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the Eawag's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor's report to the related disclosures in the notes to the financial statements or, if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report. However, future events or conditions may cause the Eawag to cease to continue as a going concern.
- Evaluate the overall presentation, structure and content of the financial statements, including the disclosures, and whether the financial statements represent the underlying transactions and events in a manner that achieves fair presentation.
- Obtain sufficient appropriate audit evidence regarding the financial information of the entities or business activities within the Eawag to express an opinion on the financial statements. We are responsible for the direction, supervision and performance of the audit of the financial statements. We remain solely responsible for our audit opinion.

We communicate with the Executive Board of the Eawag and the Audit Committee of the ETH Board regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during our audit.

Report on other legal and regulatory requirements

In accordance with the Federal Auditing Act and Swiss Auditing Standard 890, we confirm that an internal control system exists, which has been designed for the preparation of the financial statements according to the instructions of the ETH Board.

In accordance with Art. 21 par. 2 of the Ordinance on the Finance and Accounting of the ETH Domain, we confirm that no contradictions exist between the personnel reporting in the annual report (management report) and the financial statements. Likewise, we confirm that no contradictions exist between the financial figures in the annual report (management report) and the financial statements.

Furthermore, in accordance with Art. 21 par. 2 of the Ordinance on the Finance and Accounting of the ETH Domain, we confirm that risk management has been appropriately conducted according to the instructions of the ETH Board.

We recommend that the financial statements submitted to you be approved.

Berne, 26 February 2018 SWISS FEDERAL AUDIT OFFICE

Regula Durrer
Licensed audit expert

David Ingen Housz
Licensed audit expert

Editor: Communications Eawag and Irene Bättig (Sprachwerk)

Contributors: Anne Dietzel, Christine Arnold (Sprachwerk), Johann Dossenbach, Thomas Lichtensteiger, Gabriele Mayer

Design: Sandra Schwab, s-at.ch
Graphics and layout: Peter Penicka and Liz Ammann

Translations: Jeff Acheson, Laurence Frauenlob

The Annual Report is published in German (the authentic version) and also in English and French.

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

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

www.eawag.ch
info@eawag.ch

Eawag
Überlandstrasse 133
8600 Dübendorf
Phone +41 (0)58 765 55 11
Fax +41 (0)58 765 50 28
www.eawag.ch
info@eawag.ch

Esther Michel, Eawag