Eawag:
Swiss Federal Institute of Aquatic Science and Technology

Annual Report 2016

Aldo Todaro, Eawag

Alois Zwyssig and Nemiah Ladd retrieve a sediment core from Lake Lucerne. Lake sediments are valuable natural archives: depending on local conditions, different substances are deposited on the lake bottom over time. By analysing the various layers, sedimentologists can reconstruct the impacts of historical environmental influences and human activities – for example, tsunami waves in Lake Lucerne or the industrialisation of the Joux Valley (see page 16).

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.


Aldo Todaro, Eawag

Promoting a broader dialogue with society

For Eawag, 2016 was a roller-coaster year. Early in the year, we had a very successful evaluation by an external Peer Review Committee, composed of one national and six international experts from academia and practice. After meetings with researchers at all levels, the Committee commended Eawag for its "pioneering work in research, outreach, and fostering interdisciplinary collaboration across the fundamental-to-applied research continuum". In the middle of the year, we held a series of events, together with the Lucerne Society for Natural Sciences, to celebrate 100 years of lake research in Kastanienbaum. At the end of the year, we were very pleased that Switzerland regained full association with the EU Horizon 2020 programme, expanding opportunities for international collaboration.

Science is an international enterprise
This last point highlights not only the internationality of science but also its vulnerability to political trends. Fundamentally, science knows no national boundaries. Science is a shared cultural heritage of humanity, benefiting from advances made throughout history in societies around the world. Key scientific advances have been made by individuals who were marginalised or even persecuted in their homelands.

At Eawag, staff members from 40 nations work together to fulfil our mandate in research, education and expert consulting. We are dedicated to the highest standards of excellence in research. Our research advances the fundamental understanding of aquatic systems as the basis for technological development and societal decision-making. Our educational activities transmit the cultural heritage of aquatic science and technology to the next generation, as well as supporting practice through continuing education. Our expert consulting contributes to improving human welfare and to balancing the competing demands on aquatic systems that serve direct human needs and provide invaluable – often irreplaceable – ecosystem services.

Science is not just for experts
Another global trend in 2016 was the backlash against experts and expertise. Eawag researchers are justifiably proud of our hard-earned expertise, but we respect the fundamental Enlightenment principle that truth is not to be found by appealing to authority – even our own. Broader dialogue and participation are needed so that science is understood as a societal enterprise and scientific knowledge can be taken up as one (of many) valid inputs to societal decision-making.

Janet Hering
Director Eawag

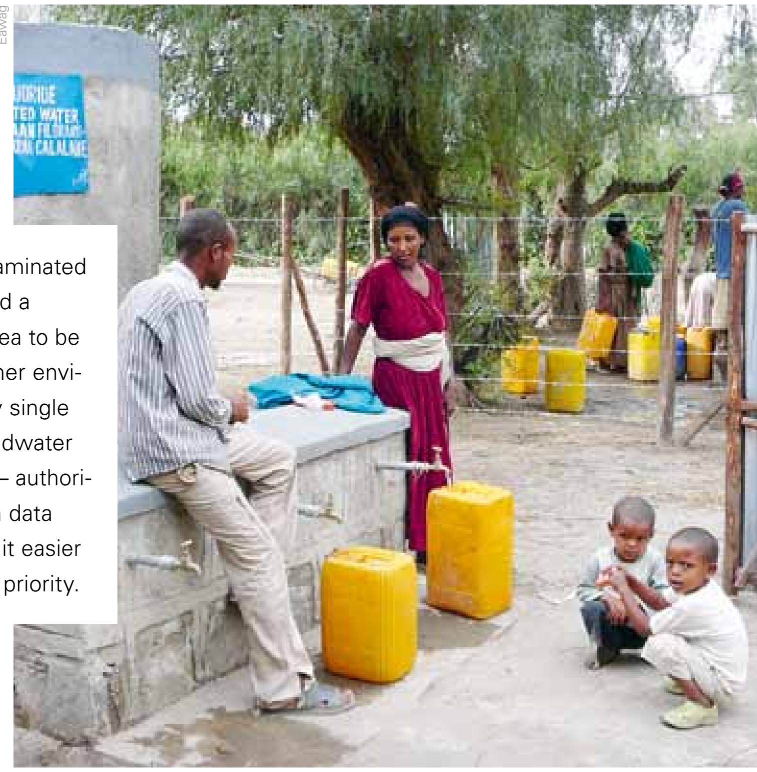
Highlights of 2016

Empa

On 23 May, the modular research building Nest was officially opened on the Empa/Eawag campus at Dübendorf. The ceremony was attended by Federal Councillor Johann Schneider-Ammann (fourth from left). The building is being used by Eawag and Empa – together with industrial and scientific partners – to investigate new forms of living and working, innovative construction methods and energy-efficient technologies. In the Water Hub project, for example, researchers are studying how urine-separating toilets can be used to save water and recover valuable nutrients.

"Switzerland's education, research and innovation sector is strong when all the key public and private players come together to focus on pressing questions – and Nest is a shining example."

Johann Schneider-Ammann, Federal Councillor



Eawag

Over 300 million people worldwide use groundwater contaminated with arsenic or fluoride. Eawag researchers have developed a method which allows the risk of contamination in a given area to be estimated on the basis of geological, topographical and other environmental data, without having to test samples from every single groundwater resource. Using the group's interactive Groundwater Assessment Platform (GAP) – now available free of charge – authorities or NGOs and other professionals can upload their own data and generate hazard maps for areas of interest. This makes it easier to identify wells that should be investigated as a matter of priority.

Andres Jordi, Eawag

On 9 June, at an event attended by 120 guests including policymakers, administration officials, scientists and practitioners, Eawag and the Lucerne Society for Natural Sciences celebrated the centenary of the Kastanienbaum Hydrobiology Laboratory. At Open Days held at the site on 18 and 19 June, well over 1,000 visitors were offered insights into the world of aquatic research. Scientific and technical experts were on hand to explain how sediment cores are retrieved and what can be learned from sediment layers deposited on the lake bottom, what genetic analysis can reveal about the development of new fish species, or how electronic tags can be used to track the migration of fish.

Aldo Todaro, Eawag

Eawag's efforts to promote the career development of female scientists are bearing fruit: in May, Nathalie Dubois of the Surface Waters Research and Management Department was appointed by the ETH Board as Assistant Professor of Paleolimnology at ETH Zurich. Here, the internationally recognised expert on lake sediments will focus on the impact of early human activity on the ecosystems of previously uninhabited eastern Pacific islands. As leader of the Sedimentology Group, Nathalie Dubois has been conducting research at Eawag since 2013.

Andri Bryner, Eawag

Over the past five years, under National Research Programme 64, 23 Swiss research groups from a variety of disciplines have investigated the health and environmental risks associated with nanomaterials. Eawag scientists were responsible for four NRP 64 projects, studying the behaviour of silver nanoparticles during wastewater treatment and their effects on microorganisms, interactions with aquatic organisms (algae and fish cells) and the biodegradation of carbon-based nanomaterials. Communication of the results is an important part of the programme – Eawag researchers are pictured here being interviewed on camera.

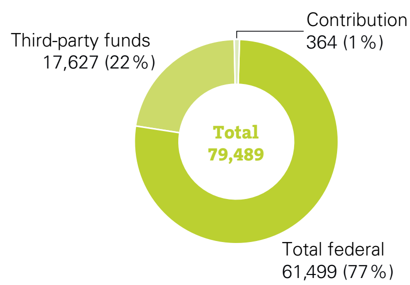
Andreas Hofstetter, ZHAW

As part of the "Sustainable floodplain management and hydropower" project (NRP 70), researchers carried out experimental flooding downstream of the Lake of Gruyère reservoir. The aim is to determine whether controlled floods can help to make hydropower generation on the Sarine river more sustainable. In the initial experiment, water was released from the dam at a rate of 250 cubic metres per second. The large amounts of data collected, as well as photographs and drone footage, are currently being analysed.

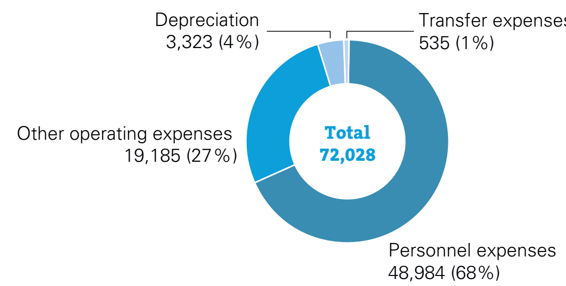
Eawag in figures

Finances

Operating revenue (in thousand CHF)



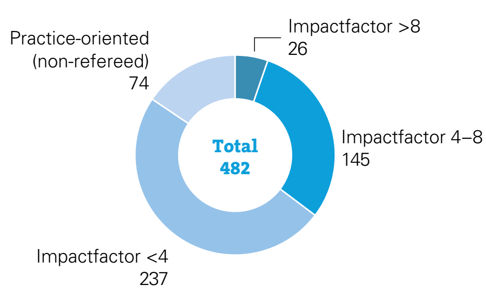
Operating expenses (in thousand CHF)



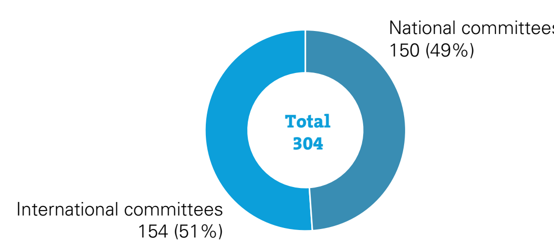
Due to rounding, individual figures may not sum to the totals shown (see Annual Financial Statements, p. 50).

Research

Publications

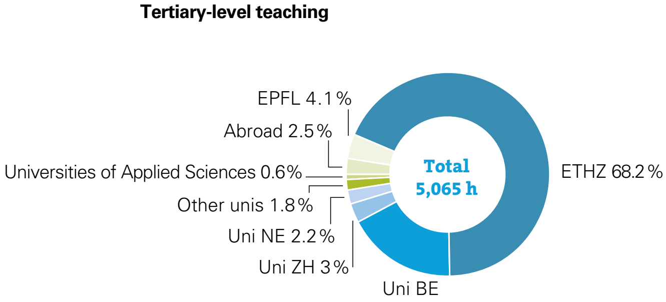


Committee memberships

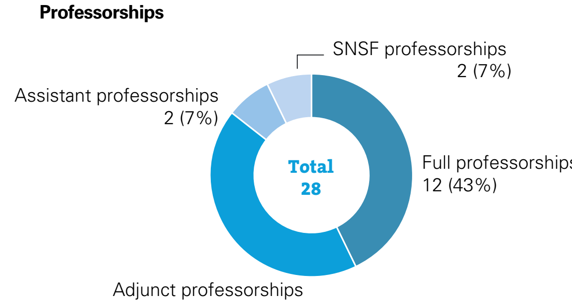


Teaching

Tertiary-level teaching

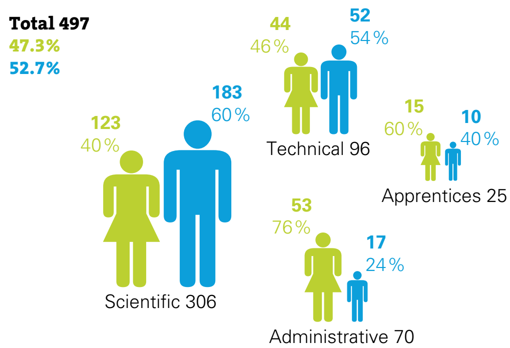


Professorships



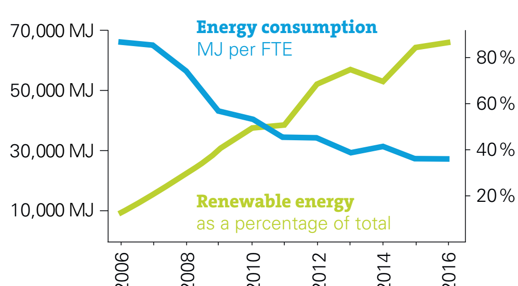
Personnel

Employees by function

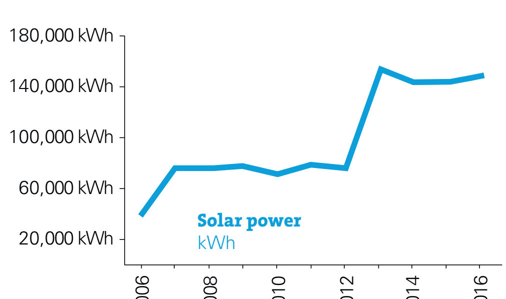


Environment

Energy consumption per capita



Photovoltaic electricity generation



Awards

Highly Cited Researchers 2016 in the Environment/ Ecology category (Clarivate Analytics)
Adriano Joss (Process Engineering), Christa McArdell (Environmental Chemistry), Hansruedi Siegrist (Process Engineering), Ole Seehausen (Fish Ecology and Evolution)

Volz Award for the best PhD thesis in Ecology and Evolution, University of Bern
David Marques (Fish Ecology and Evolution)

Silver Medal of ETH Zurich for an outstanding doctoral thesis
Sarah Pati (Fish Ecology and Evolution)

Silver Medal of ETH Zurich for an outstanding doctoral thesis
Kirsten Oswald (Surface Waters Research and Management)

Silver Medal of ETH Zurich for an outstanding doctoral thesis
Bastianus Vriens (Water Resources and Drinking Water)

Otto Jaag Water Protection Prize, ETH Zurich
Hanspeter Zöllig (Process Engineering)

IWA Fellow 2016–2020, International Water Association
Kris Villez (Process Engineering)

Prize for Young Researchers, Bettencourt Schueller Foundation
Clément Vulin (Environmental Microbiology)

Peter Kilham Memorial Award, International Society of Limnology
Ole Seehausen (Fish Ecology and Evolution)

National Energy Globe Award, Morocco
Bouziane Outiti (IT Services)

Aldo Todaro, Eawag

Environmental management depends on a detailed knowledge of the occurrence and distribution of species. But taxonomists are in short supply, and some species can be difficult to identify, even for experts. A new approach to species identification – analysis of environmental DNA isolated from water samples – is being pursued by Elvira Mächler and Florian Altermatt (see page 13).

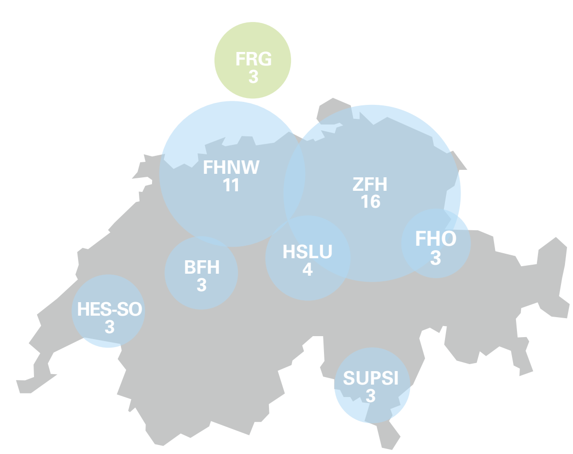
Research

Eawag's research has a strong practical orientation, focusing on water for human welfare and for ecosystem function, as well as strategies for resolving competing demands on water resources. National concerns are also addressed: in 2016, for example, Eawag collaborated on the Pesticide Action Plan, carried out pilot projects on wastewater treatment and participated in surface water projects.

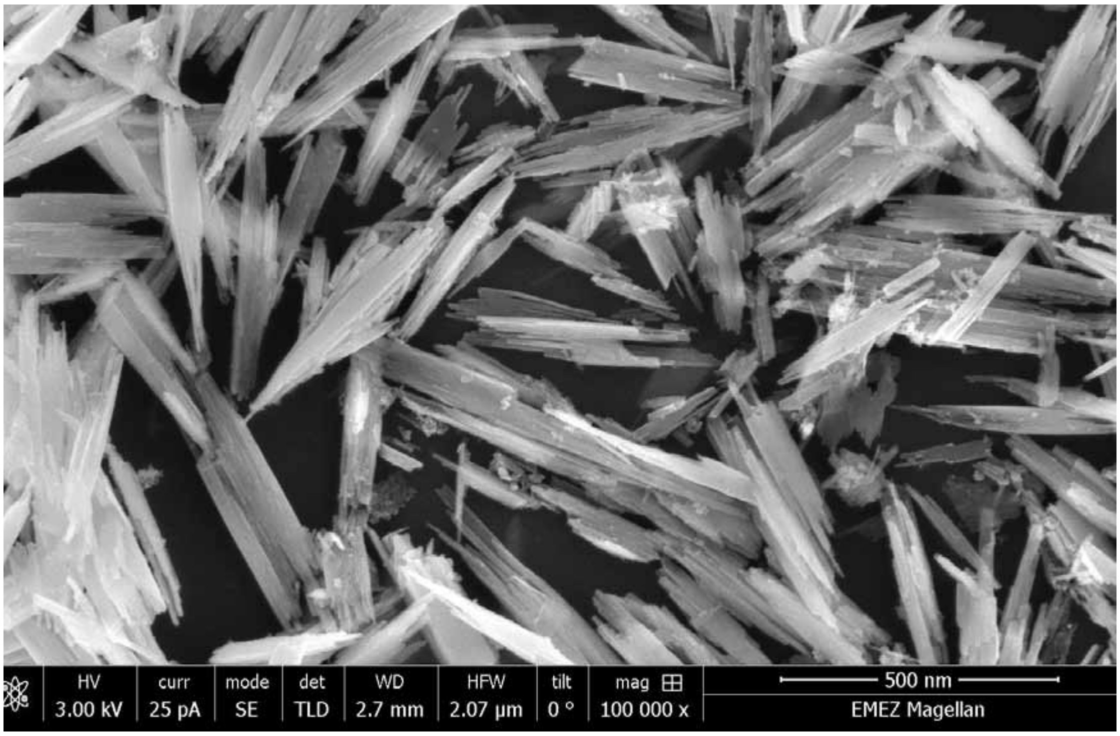
In view of Switzerland's energy transition, Eawag scientists have investigated ecological aspects of hydropower production, collaborating with partners from the Swiss Competence Centres for Energy Research (SCCER). They have also analysed the factors determining social acceptance of the expansion of hydropower production. In partnership with the Paul Scherrer Institute and the University of Applied Sciences and Arts Northwestern Switzerland (FHNW), Eawag continues to work on the Autarky sanitation project, which aims to develop self-sustaining, grid-free toilet systems in which urine, faeces and wastewater are separated at source for on-site treatment.

To facilitate research and enhance its impact, Eawag scientists participate in global networks; the institute is currently represented on over 70 international bodies. Eawag's interdisciplinary research on the impacts of micropollutants on aquatic ecosystems has benefited from involvement in the EU Solutions project, which is studying emerging pollutants in transboundary river basins such as the Rhine (in Switzerland, Germany and the Netherlands).

Collaboration with UAS



In 2016, Eawag scientists participated in 46 projects involving partners from universities of applied sciences (UAS). At selected sites, this collaboration is to be further expanded.



Ralf Kägi, Eawag

Silver nanoparticles (shown here magnified by a factor of 100,000) are used in a wide variety of products and enter wastewater treatment plants via the sewer system. Their behaviour and associated environmental risks were studied in four Eawag projects.

NRP 64 – Opportunities and Risks of Nanomaterials

Over the past five years, 23 Swiss research groups have been investigating the behaviour of synthetic nanomaterials. One of the main aims of National Research Programme 64 was to assess the risks they pose for human health and the environment.

Eawag's contributions to NRP 64

Three Eawag projects were concerned with silver nanoparticles, which are widely used because of their antimicrobial effects. Ralf Kägi's research indicates that silver nanoparticles in wastewater streams are relatively unproblematic, as they become attached to other particles in the sewer system and are converted to (less toxic) silver sulphide. In addition, at treatment plants, nanoparticles are largely eliminated from wastewater and end up in sewage sludge, which is incinerated in Switzerland. In contrast, Renata Behra's project showed that silver nanoparticles can disrupt the biodiversity of aquatic microorganisms, such as bacteria, algae and fungi, and the reproduction of invertebrates, thus adversely affecting various ecosystem processes. Kristin Schirmer's group found that certain algae have a protective membrane which prevents the cellular uptake of silver nanoparticles. They are, however, actively taken up by the more permeable cell membranes in fish, leading to the death of these cells.

In the fourth Eawag project, which was concerned with the fate of nanomaterials in the environment, Hans Peter Kohler studied the rate at which functionalised carbon nanotubes are degraded by enzymes. The half-life for biotransformation was found to be, at best, 80 years – not a few days, as previously reported. Non-functionalised nanomaterials were not enzymatically degraded.

Risks outweighed by opportunities

In general, the results of NRP 64 indicate that the opportunities outweigh the risks of nanomaterials. The risk assessments which are still required for each new nanomaterial or application will be facilitated by the results of this research. NRP 64 thus also paves the way for promising innovations. Knowledge gaps were identified primarily in the area of long-term studies.

Using environmental DNA for biomonitoring

Natural habitats are being altered by climate change, human activities and invasive species. Effective protection of ecosystems requires a detailed knowledge of the organisms they harbour. In the past, specimens have been collected and individually identified – a time-consuming and costly method. Now, scientists from Eawag and Zurich University have successfully identified resident species by analysing DNA extracted from river water samples.

Remarkable variety

All organisms release genetic material into the environment, e.g. in faeces or dead skin cells. This provides the basis for the new approach developed by Florian Altermatt and his team for the assessment of biodiversity in river ecosystems. The researchers collected water samples at several sites on the Glatt river. DNA extracted from these samples was then analysed in the laboratory and checked against a DNA database. The biologists were themselves surprised by the wide variety of species detected by this method – not only aquatic macroinvertebrates (mainly arthropods), but also animals not detected by conventional methods, including some terrestrial species. Even the beaver, living several kilometres upstream, was identified by its genetic fingerprint. According to the research team, this is attributable to the fact that DNA in soil can be washed out and transported long distances by complex networks of small and large rivers.

Automated monitoring

The success of the environmental DNA experiment opens up new possibilities: it is now conceivable, for example, that at water-quality monitoring stations where samples are collected every hour and screened for chemicals, biodiversity could also be monitored in future by means of environmental DNA analysis. This method of biodiversity monitoring is likely to become simpler and less expensive than traditional methods, as well as covering a wider range of organisms – not only at the sampling site but across the entire catchment.

Florian Altermatt, Eawag

Analysis of environmental DNA from river water samples permits reliable detection of species occurring in the surrounding area. In the laboratory, clean handling prevents samples from being contaminated with extraneous genetic material.

Collective memory and individualism

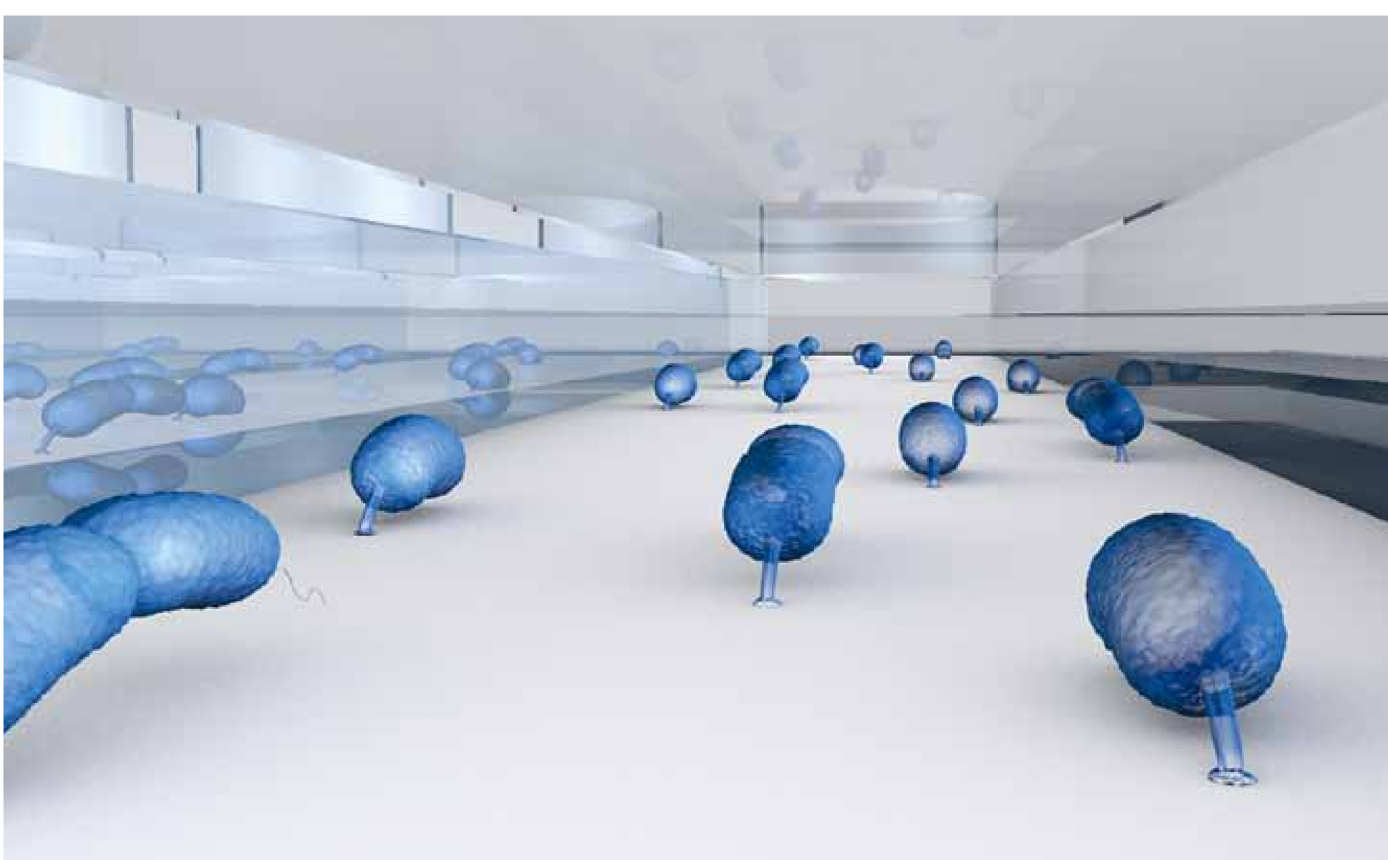
Bacteria exposed to a moderate concentration of salt survive subsequent exposure to a higher concentration better than if there is no warning event. But individual cells have short memories: after just 30 minutes, the survival rate no longer depends on the exposure history. However, when an entire population is observed, rather than individual cells, the bacteria appear to develop a kind of collective memory. This was shown by the microbiologist Martin Ackermann and his team in a study published in PNAS. In populations of *Caulobacter crescentus* exposed to a warning event, survival rates upon renewed exposure, even two hours after the warning, are higher than in populations not previously exposed.

Understanding the mechanisms

Firstly, salt stress causes a delay in cell division, leading to synchronisation of cell cycles; secondly, survival probability depends on the individual bacterial cell's position in the cell cycle at the time of the second exposure. As a result of regulation of the cell cycle, the sensitivity of the population changes over time. According to the scientists, an understanding of such collective effects could improve our ability to control bacterial populations. This is relevant, for example, to questions such as how pathogens can resist antibiotics, or how the performance of bacterial cultures in industrial processes or wastewater treatment plants can be maintained under dynamic conditions.

Individualists ensure survival

As well as collective phenomena, individualistic behaviour can also be observed in bacterial populations – even if the individual cells in a colony are genetically identical. Researchers from Eawag, ETH Zurich, EPFL and the Max Planck Institute for Marine Microbiology found that, in populations of *Klebsiella oxytoca,* nutrient limitation leads to increased heterogeneity. If the availability of a preferred nutrient is reduced, some cells switch to other nutrients. Then, if the original food source is depleted, this subpopulation ensures the survival of the colony. This strategy enables bacteria to cope with changing environmental conditions.



Eawag

Each chip comprises several channels, with a bacterial population growing in each channel. The bacteria are attached to the glass surface by an adhesive stalk. When the bacterial cells divide, one of the two daughter cells remains in the channel, while the other is washed out. Cell division cycles and survival probabilities can thus be reconstructed.

Watching new species develop in real time

The innumerable three-spined stickleback which end up in fishermen's nets on Lake Constance are an unwanted by-catch. This hardy species – of no commercial value – has been spreading rapidly throughout the Swiss Central Plateau for 150 years. Scientists are now beginning to understand the secret of its success: the stickleback evidently adapts rapidly to new habitats. In Lake Constance, according to a sophisticated genetic study by Eawag and Bern University, the fish appears to be diverging into two species.

"It was completely unexpected for the species to diverge over such a short period, given that the stickleback breed at the same time and at the same sites." **David Marques,** Department Fish Ecology and Evolution

Two distinct forms

Rather than just one "Lake Constance stickleback", Ole Seehausen and his colleagues found two different forms – one typical of the lake and one of inflowing streams. The scientists identified almost 40 genomic regions, spread across 11 chromosomes, where the "lake stickleback" differ from the "stream stickleback". These genetic differences are reflected in morphological features of the two ecotypes: for example, lake stickleback have wider lateral plates and longer spines, providing better protection against the predatory fish and birds mainly found in and on the lake. According to first author David Marques (the study is part of his doctoral research), "It was completely unexpected for the species to diverge over such a short period, given that the stickleback breed at the same time and at the same sites." But it remains uncertain whether the stickleback in Lake Constance will ever develop into fully isolated species.

Female mate choice promotes speciation

The development of new species can be promoted by mating behaviour, as in the case of African cichlids: evolutionary biologists at Eawag, Bern University and the Smithsonian Tropical Research Institute in Panama discovered that female cichlids of the species *Pundamilia nyererei* show a preference for males from their own population, picking out the "right" males by their nuptial coloration. Intrapopulation sexual selection restricts gene flow between populations; as a result, populations increasingly diverge over time and can ultimately develop into separate species.

Eawag

The lake (left) and stream (right) ecotypes of the three-spined stickleback *(Gasterosteus aculeatus)* from the Lake Constance catchment differ not only genetically but also morphologically. Pictured here are females (top), males with typical breeding coloration (middle) and alcohol-preserved males with bones stained red (bottom).

History in the sediments of Lake Joux

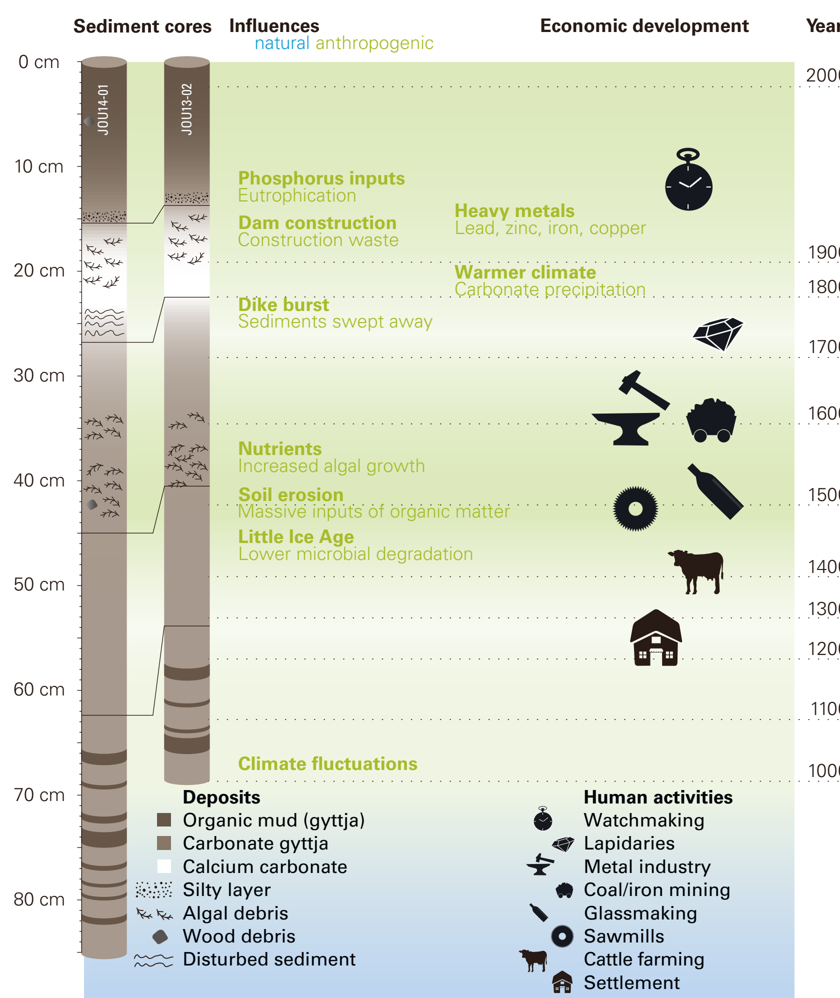
A wide variety of substances washed into lakes from surrounding areas are deposited on the bottom over time. By analysing sediment cores retrieved from the bottom of Lake Joux in the Jura Mountains of Canton Vaud, a team led by sedimentologist Nathalie Dubois managed to retrace 1,200 years of the Joux Valley's history. The bottom layers of the cores (almost a metre in length) reveal no traces of human activities. Alternating layers of dark brown mud and lighter carbonate deposits indicate climatic fluctuations. The effects of human activities are first discernible in the overlying layers: from around 1300, numerous settlers arrived in the valley and began to clear the forests. Large amounts of organic matter from the bare soil were thus washed into Lake Joux; this is reflected by a different pattern of long-chain hydrocarbons in the sediment. Nutrients entering the lake promoted algal growth – as indicated by algal debris.

Evidence of human activities

As economic development progressed and farmland was abandoned, erosion started to decline from around 1600. When a dike burst shortly after its construction in 1777, large quantities of sediments were disturbed or swept away. In the 19th century, the lower lake water level and warmer climate led to increased precipitation of calcium carbonate; this is reflected by lighter carbonate layers in the sediments. In 1942, a more robust dam was built. The carbon isotope composition of the sediment layers indicates eutrophication, promoted by inputs of phosphorus from detergents. Around 1950, lead, zinc, iron and copper suddenly appear: these metals are believed to be of anthropogenic origin, possibly deriving from the local watchmaking industry and from leaded petrol. According to Dubois, analysis of the sedimentary archive is a promising approach, as it reveals the impacts of historical human activity on a region and can also indicate how the environment is affected by current activities.

Günter Fischer/Chromorange

Sediments from Lake Joux (Canton Vaud) provide evidence of changing climatic conditions and human activities over the past 1,200 years.



The sediment cores, roughly a metre long, also contain traces of economic development in the Joux Valley.

Politicians' distorted perceptions

Political actors tend to have distorted perceptions of their opponents' positions and influence. Political scientists Karin Ingold and Manuel Fischer, together with researchers from Geneva University, found that this "devil shift" phenomenon can be observed even in a consensus-based democracy like Switzerland. In a project sponsored by the Swiss National Science Foundation, they analysed nine of the most important policy processes in Switzerland from the period 2001–2006.

"Parties, interest groups and more powerful actors in general are more affected by the devil shift than state actors and scientists."
Manuel Fischer, Department Environmental Social Sciences

Less divergent positions

Political actors often overestimated the dissimilarity between their opponents' positions and their own values and beliefs – particularly in policy processes relating to socioeconomic issues, where the devil shift is driven by traditional Right-Left opposition. According to Manuel Fischer, "Parties, interest groups and more powerful actors in general are more affected by the devil shift than state actors and scientists." In Swiss politics, evidence for the second dimension of the devil shift – a tendency to overestimate one's opponents' influence – was found to be less conclusive.

Bridging the divides

How can political divides be bridged? According to the authors of the study, there is a need for actors to cross the well-defined boundaries between competing coalitions of parties and interest groups so as to seek solutions with political opponents. As Fischer points out, "In a consensus-based system like Switzerland's, state actors can often serve as neutral mediators." He adds that platforms can help to avoid conflicts, citing a positive example in the environmental sector: "Water Agenda 21 enables actors from different areas to engage with one another on a regular basis."

SRF

The Swiss current-affairs programme "Arena" is well-known for lively debates across the political spectrum.

Standard identifiers for mass spectra

Mass spectrometry is a key method in analytical chemistry for detecting known compounds and characterising unknown substances. Every day, gigabytes of mass spectral data are collected by scientists around the world, and millions of gigabytes' worth are currently held in around 20 major databases. Because this information is stored in database-specific formats, it is difficult to determine whether and where compounds have already been described – particularly in the case of unknown and unnamed substances. An international research consortium (including Eawag environmental chemists) has therefore developed a program to generate standard identifiers, making it easier to search for mass spectra online. All the existing mass-spectral data stored in different databases can thus be combined and compared. For unknown compounds, the unique identifier provides an initial name, which also facilitates communication.

Raoul Schaffner, Eawag

With mass spectrometry, even minute traces of substances can be detected.

Norman network

Chemical substances such as pharmaceutical residues or pesticides which enter the environment can be identified with the aid of high-resolution mass spectrometry – as long as the relevant mass spectra are known and available. The international Norman network brings together reference laboratories, research centres and related organisations involved in the monitoring of emerging environmental pollutants. The network promotes synergies and exchanges between research groups so as to validate and harmonise measurement methods and monitoring tools, thus improving risk assessment. Eawag is one of the Swiss members of the Norman network: its world-leading mass spectrometry experts have supplied much of the data for the Norman MassBank – a database of mass spectra which can help researchers worldwide to identify environmental pollutants.

Effectiveness of biological post-treatment

Ozonation is a suitable method for the removal of contaminants at wastewater treatment plants (WWTPs): ozone attacks and largely eliminates organic micropollutants. However, this process gives rise to unstable and possibly toxic transformation products. In biological post-treatment, these products are therefore to be degraded and reduced at least to pre-ozonation levels.

Comparison of various methods

In a study sponsored by the Federal Office for the Environment, process engineers and environmental chemists, together with the Eawag-EPFL Ecotox Centre, assessed the effectiveness of various post-treatment methods. At the Neugut WWTP in Dübendorf, with support from industrial partners, they compared sand filtration, granular activated carbon filtration, and moving and fixed bed processes. According to Marc Böhler: "They all reduced the AOC (assimilable organic carbon) content and readily degradable transformation products. But the moving and fixed bed processes are much less efficient."

In bioassays to evaluate wastewater quality, none of the purely biological methods (sand filtration, moving or fixed bed) showed any effect. Böhler explains: "Because the wastewater exhibited very low toxicity even before post-treatment, a measurable reduction was scarcely possible. This confirms the suitability of ozonation at the Neugut WWTP." The carcinogenic nitrosamine NDMA was markedly reduced with all biological post-treatment methods. As expected, stable transformation products and micropollutant residues could only be eliminated by activated carbon, which has additional adsorptive properties.

Activated carbon and sand filtration: highly effective methods

In general, the performance of all the methods met the requirements. However, problems were observed with the fixed bed process, where the biologically active layer (biofilm) was reduced as a result of snail infestation; for this reason, the researchers recommend that it should not be used. Böhler concludes: "The sand filter showed good biological performance, easily meeting post-treatment requirements. In contrast to the moving bed process, it also retains solids containing heavy metals, organic micropollutants and phosphorus – an additional positive effect." While activated carbon filtration performed best, it is the most expensive method and exceeds the goals of biological post-treatment.

Aldo Todaro, Eawag

Moving bed bioreactor: plastic biofilm carriers enhance the degradation of organic compounds in treated wastewater.

Aldo Todaro, Eawag

The geologist Lenny Winkel is Professor of Inorganic Environmental Geochemistry at ETH Zurich. Women account for around 40 per cent of all professorships held by Eawag scientists.

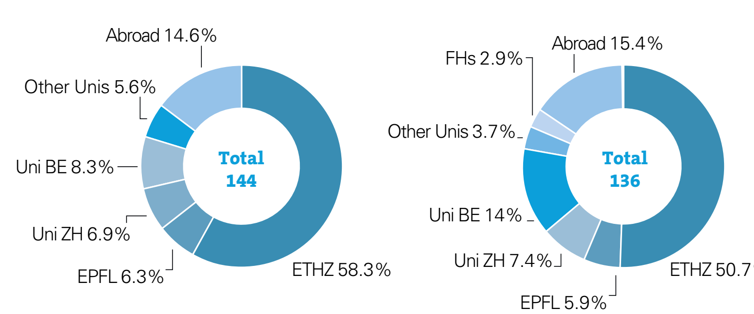
Teaching

Eawag's teaching activities extend beyond the ETH Domain and are based on the institute's own research. They cover specialised fields, considering the effects of various types of water use on ecosystems. In 2016, Eawag scientists' teaching commitments at ETH Zurich and EPF Lausanne amounted to more than 3,600 hours. Another 1,300 hours were taught at other higher education establishments, mainly at cantonal universities. Eawag scientists hold professorships at ETHZ and EPFL, and at the Universities of Bern (Aquatic Ecology and Political Science), Neuchâtel (Hydrogeology) and Zurich (Biodiversity and Environmental Psychology).

In 2016, Eawag launched a fourth massive open online course (Mooc), in partnership with EPFL, on "Municipal Solid Waste Management in Developing Countries". Eawag Summer Schools, with an international focus, are another well-established activity: in 2016, the eighth Summer School in Environmental Systems Analysis was held at Dübendorf.

Through its training programme, Eawag maintains a dialogue with water professionals. Two practice-oriented (Peak) courses proved particularly popular – "Conservation of indigenous crayfish" and "Genetics and fishery management". At a three-day Swiss Water Association (VSA) event on micropollutants and the implementation of the revised water protection legislation, the latest findings were presented from the VSA "Micropollutants Process Engineering" and "Water Quality" platform projects.

Doctoral students and undergraduates



In 2016, Eawag supervised 144 doctoral students and a total of 136 Bachelor's and Master's students from various universities.

Peter Penicka, Eawag

Around 250 experts attended Eawag's Info Day on "Lakes: reconciling resource use and conservation demands".

Info Day in Lucerne

Switzerland's lakes are diverse ecosystems, recreation sites, habitats and energy sources. Eawag's 2016 Info Day explored the tensions between resource use and conservation interests. To mark the centenary of the Kastanienbaum hydrobiology laboratory, the event was held at a lakeside venue in Lucerne on 6 September. Around 250 scientists, water professionals, administration officials and policymakers met to discuss new insights and trends in lake research, and their implications for practice.

Sound data thanks to modern methods

If complex lake ecosystems are to be effectively protected, systematic data collection is essential. For this reason, Eawag – in collaboration with the Federal Office for the Environment (FOEN) and Bern University – launched "Projet Lac" in 2010. Initial results indicate that human activities have had a major impact on pre-alpine lakes, with changes in nutrient and oxygen levels, and increasing homogenisation of ecosystems. In most cases, deep-water species have disappeared, but Projet Lac revealed one exception: the biologists discovered several specimens of the deep-water char, endemic to Lake Constance, which had previously been declared extinct.

Recent decades have seen quantum leaps in data collection and assessment methods. Today, high-resolution measurements are possible, and modelling enables detailed prediction of lakes' responses to disturbances. The passage of contaminants through food webs can be tracked, and the evolution of species can be followed. Satellite remote sensing systems, with high spectral resolution, can provide information on water quality and on concentrations of suspended particles, chlorophyll or coloured dissolved organic matter in water.

Importance of knowledge transfer

Research findings are also transferred to practice: for example, the Swiss authorities' planning instruments for lake revitalisation are partly based on collaboration with Eawag. At the Info Day, the FOEN presented the new method for ecomorphological assessment of lakeshores and the enforcement aid being developed for the cantons, which are required to submit strategic plans for revitalisation measures by 2022. Werner Göggel, head of the Waters Department at Canton Lucerne's Environment and Energy Office, commented: "Without the scientific support provided by Eawag, it would not be possible for cantonal agencies to carry out their enforcement tasks with this standard of quality."

ETH Week devoted to water

The aim of ETH Week is to generate creative solutions for global societal challenges. Working in groups, students formulate a problem within a thematic area and develop a sustainable solution. The projects are presented to a jury at a plenary session, with awards for the best projects. ETH Week is part of the “Critical Thinking Initiative”, which is designed to promote independent work in interdisciplinary teams.

Focus on water issues

The topic of the second ETH Week, held in September 2016, was "Challenging Water". More than 180 students from 20 countries – and all 16 ETH Departments – participated. Scientists from Eawag, together with other national and international water experts, helped the participants to understand the complexity of water resource issues. Various excursions provided opportunities for group members to increase their knowledge of the challenges involved and explore possible solutions. At Eawag’s Forum Chriesbach and the experimental building Nest of Empa and Eawag, they saw how sustainable approaches to construction, energy and water can be put into practice.

Award-winning projects

At the end of the week, 3 of the 18 projects received awards. The prize for the “Most Inspiring Story” went to the “Save-o-Pillar” project – a positive feedback device which motivates consumers to reduce their water footprint. The “Most Fascinating Science” award was won by the “Make grey water great again” project, a shower-to-toilet recycling system with the potential to reduce water consumption in private homes by 20 per cent. The “Peer-to-Peer” (students’) award went to the “Smart Fish” project – a concept whereby fish fitted with sensors would be used to collect geo- and ecological data in Swiss waters.

Alessandro Della Bella, ETH Zurich

The “Smart Fish” team presenting the project which won the students’ award.

Wastewater recycling for the Zollhaus development

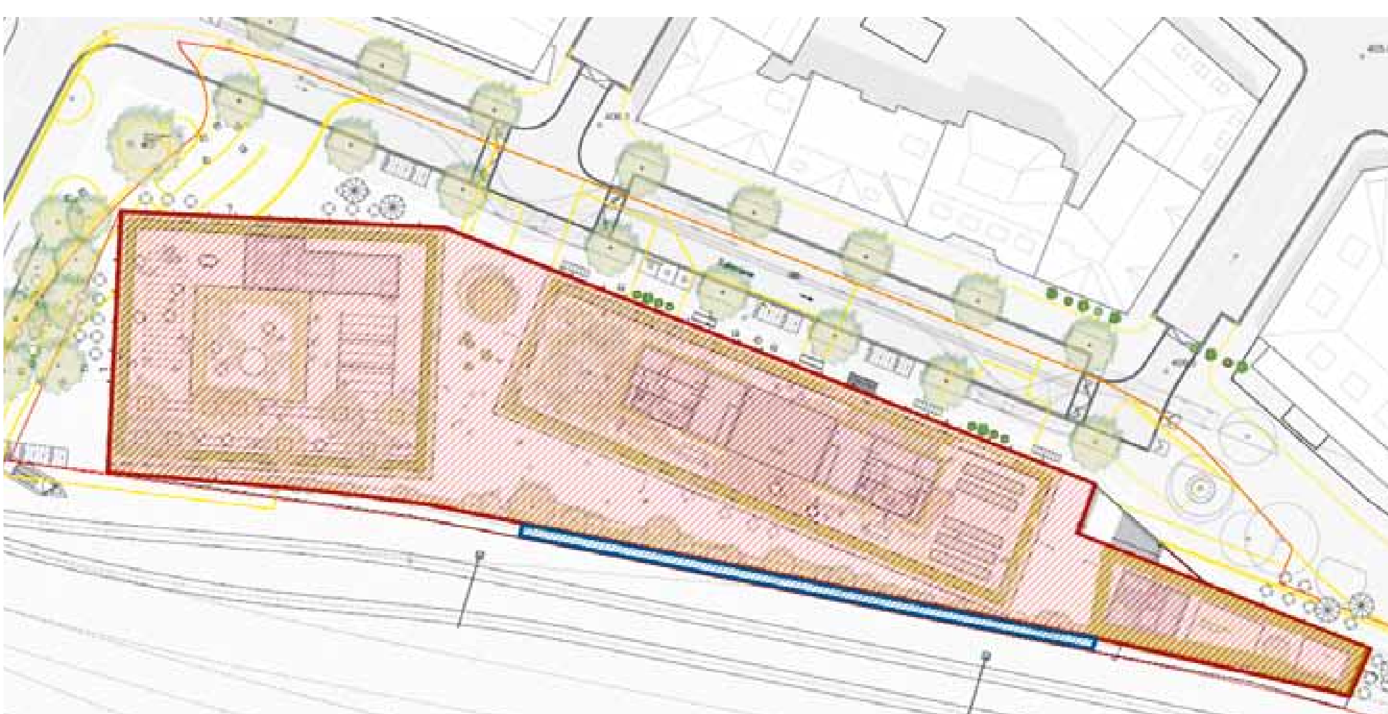
Does decentralised wastewater treatment represent an alternative to conventional sewer connections? This was the topic of a Master's thesis prepared at Eawag's Process Engineering department by Benjamin Schegg, an Environmental Engineering student at ETH Zurich.

In 2020, a new residential and commercial development is to be opened by the Kalkbreite Cooperative on Zollstrasse, close to Zurich's main railway station. As well as providing affordable apartments and business space, the Cooperative aims to promote sustainability, meeting the requirements of the 2,000-watt society. In this context, Benjamin Schegg investigated whether an on-site wastewater recycling system, including recovery of nutrients from urine and faeces, would be sustainable not only environmentally but also financially.

Legal obstacles and conflicting goals

Schegg's feasibility study assessed four decentralised wastewater treatment options, even though, as he points out, "It's difficult to install this kind of system in a city." Connection to a sewer system, if available, is actually a legal requirement. "In addition, space-saving processes are highly energy-intensive, which leads to conflicts with the energy consumption goals for the development." But one of the four options studied will now be pursued: "This involves nutrient recovery by means of a compost filter and infiltration of treated wastewater."

Having completed his degree, Schegg is now working for an engineering firm. The experience he gained during his Master's thesis proved to be extremely valuable: "It was a very practice-oriented study. I was able to collaborate with lots of different actors, get to know the process and benefit from the excellent support provided by my supervisors at Eawag."



Enzmann Fischer Partner AG, Koepli Partner GmbH

The residential and commercial Zollhaus development is being built on Zollstrasse, close to Zurich's main railway station. Marked in red is the area from which retained rainwater is to be allowed to infiltrate; shown in blue is the planned infiltration trench for rainwater and treated blackwater.

Groundwater made easy

What is groundwater? What factors influence groundwater levels? For his Master's thesis in Design at the Zurich University of the Arts (ZHdK), David Gärtner developed an app visualising the answers to these questions – with expert support provided by Eawag.

The interactive app is clearly and attractively designed. The three parts of the Knowledge module explain how groundwater is formed, how it is used and how it interacts with rivers. In the Groundwater Lab, users can find out for themselves how groundwater levels are affected by river morphology, climatic conditions or land use. Explanations are given in English, French, German or Italian. The free app is available for iPad or Android tablets. iPads with the app preinstalled can be hired by members of the Swiss Gas and Water Industry Association (SVGW), which was also involved in the project.

Barbara Fischer

New approach to education: an app for iPads or Android tablets makes learning about groundwater a fun and interactive experience.

"My work is relevant for everyone's daily life."

Eawag alumna Marianne Erbs, currently head of the Liquid Chromatography (LC) lab at the Basel-Stadt Cantonal Laboratory

A box containing nail varnish, children's toys and part of a desk pad – items you might not expect to find in Marianne Erbs' office at the Basel-Stadt Cantonal Laboratory (KL). She explains: "The KL looks for unwanted substances and residues, mainly in foods, but also on and in other articles of daily use." She has now been working at the KL for eight years. As head of the Liquid Chromatography (LC) lab, she is responsible for tests on foodstuffs, ensuring that legal limits for additives such as dyes and preservatives are complied with, excluding any risks from contaminants or natural toxins, and taking any action which may be required.

Having studied Environmental Chemistry in Denmark, Erbs did not think she would end up working mainly with foods. She came to Switzerland to write her doctoral thesis on the biogeochemical degradation of organic pollutants. She recalls: "I had an international scholarship, and Eawag – with its high-level research – was the best place for the project." She only specialised in organic trace analytics during her time as a postdoc at Agroscope in Reckenholz. After spending a couple of years in industry, she joined the KL. Here, she built up the newly established LC group, focusing on work which is not done at other cantonal laboratories. She explains: "Switzerland's KLs are increasingly specialising, as it doesn't make sense for them all to use exactly the same methods. So we also conduct analyses for other cantons." For Erbs, switching to the food sector has brought one major advantage: "My work is relevant for everyone's daily life."

Often, for substances appearing on the market, specified limits or analytical methods – sometimes both – do not yet exist. "My first case at the KL was in 2009, when powdered baby milk adulterated with melamine found its way onto the market." As melamine can cause severe kidney damage in infants, Marianne Erbs had to rapidly develop and implement a detection method. The KL seeks to anticipate cases of this kind: "We monitor the national and international market, and consider what steps can be taken to minimise the public's exposure to harmful substances."

Marianne Erbs is now rarely to be found in the lab – usually only when problems arise. Her tasks include planning analyses and developing new methods. Here, she is still benefiting from her time at Eawag – "And, of course, from everything that's involved in completing a doctoral thesis."

Christian Grund, 13photo.ch

Eawag scientists Tony Merle (left) and Urs von Gunten (right) discussing a new method of drinking water treatment with Adrian Auckenthaler of the Basel-Landschaft Cantonal Office for Environmental Protection and Energy (see page 28).

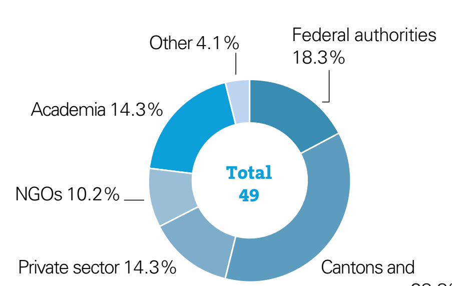
Consulting

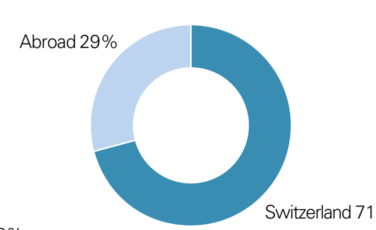
Eawag operates a number of Competence Centres which promote exchanges between various scientific disciplines and practice, and initiate joint research projects. For example, in the "Basel-Landschaft Regional Water Supply 21" project, the Competence Centre for Drinking Water collaborated with the cantonal authorities to study ground and drinking water contamination in various parts of the canton. Together with the Swiss Water Association (VSA) and the Federal Office for the Environment (FOEN), Eawag operates two VSA platforms – "Micropollutants Process Engineering" and "Water Quality". These compile a body of specialist knowledge and advise cantonal agencies – in 2016, for example, on the planning of a programme to evaluate the effectiveness of measures for the reduction of pesticides in surface waters.

The Fisheries Advisory Service (Fiber) – jointly run by Eawag, the FOEN and the Swiss Anglers Association (SFV) – provides information on scientific findings and advice on aquatic ecology and fishery management. The Eawag-EPFL Ecotox Centre studies and assesses the effects of chemicals on the aquatic environment. Eawag also participates in the "Water Agenda 21" network, which provides a platform for dialogue among key actors in Switzerland's water sector.

The "Swiss Rivers" programme, initiated by Eawag and the FOEN, promotes the sharing of experience and the learning process in relation to revitalisation projects and remediation measures in the hydropower sector. Research projects are undertaken to address unresolved questions from practice.

Consulting mandates





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

Basel-Landschaft Regional Water Supply 21

In a three-year project, the Basel-Landschaft Cantonal Offices for Environmental Protection and Energy (AUE) and Food Safety and Veterinary Affairs (ALV) studied the region's groundwater and water supply systems. They were supported by Eawag scientists led by Urs von Gunten and experts from other institutions. Thanks to the results of this project, the canton's high level of drinking water safety can be further increased.

New measures and methods

Microbiological water quality varies according to weather conditions, particularly in the case of karstic springs. Previously, the risks associated with rainfall were not adequately indicated. Now, communes can access this data online, which facilitates monitoring of drinking water quality. It was also found that river-water quality is of central importance for safe water supplies, since groundwater wells close to rivers show increased levels of microorganisms during high-water events.

The Hardwald aquifer (Birsfelden) is artificially recharged with infiltrated Rhine river water. About half of the micropollutants in the river water are removed by natural processes, and the remaining substances are eliminated by activated carbon filtration. The optimum filter lifetime was determined by laboratory studies, and a pilot plant was used to assess the effects of an additional oxidation step (with ozone, ultraviolet light and hydrogen peroxide), which could extend the operating life of the activated carbon filter and provide additional safety. In another sub-project, it was shown that the interruption of Rhine water infiltration for more than four days could lead to inflows of possibly contaminated groundwater from adjacent areas.

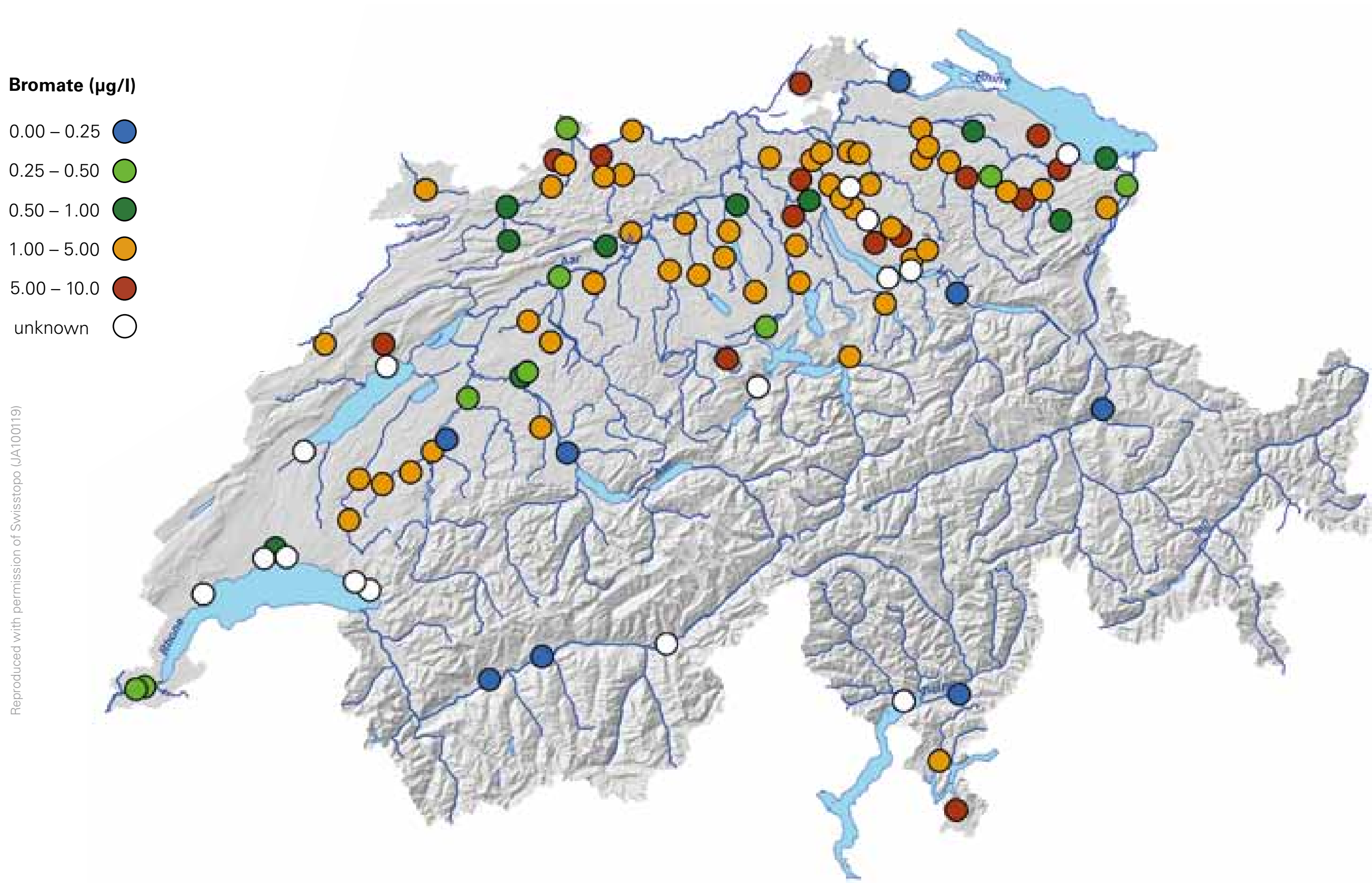
To meet the challenges associated with groundwater protection and water supply safety, smaller operators could envisage regional cooperation, provided that they continue to have a say in decision-making. The project also identified potential for optimisation in the coordination of groundwater protection with spatial planning.

Christian Grund, 13.photo.ch

The Hardwald aquifer (near Muttenz) supplies drinking water for 130,000 residents. The groundwater is artificially recharged with river water from the Rhine.

Bromate: a problem for wastewater ozonation?

In the coming years, around a hundred wastewater treatment plants (WWTPs) across Switzerland are to be upgraded with an additional treatment step in order to eliminate micropollutants. One possible method is ozonation. But if wastewater is contaminated with bromide, the ozonation process leads to the formation of bromate – a potentially carcinogenic substance – which enters rivers and lakes with the treated wastewater. Particularly affected are WWTPs with chemical plants and waste incinerators in their catchment areas. In a modelling study, Eawag scientists showed that – even in the worst case – bromate concentrations in major Swiss rivers will not be substantially increased following WWTP upgrades. In the case of smaller rivers, however, increased bromate levels could pose problems for drinking water use. The researchers conclude that bromate formation must always be carefully assessed; if necessary, the activated carbon process can be used as an alternative to ozonation.



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Estimated increase in bromate concentrations in Swiss rivers following WWTP upgrades adding an ozonation step. The tolerance value specified for drinking water in the Food Impurities and Ingredients Ordinance (FIV) is 10 micrograms per litre.

Eawag

Rheinsfelden monitoring station on the Glatt river.

Monitoring water quality

On behalf of the Radiation Protection Division of the Federal Office of Public Health, Eawag continuously monitors radioactivity in aquatic systems, using gamma-ray spectrometry. Together with the WSL and the FOEN, it participates in the National River Monitoring and Survey Programme (Naduf), which tracks the concentrations of substances occurring in selected Swiss watercourses.

Controlling bacterial growth in shower plumbing

Bacterial growth varies from one shower hose to another, depending on the type of plastic material used for the inner lining. This influences the amount of organic carbon leached and thus the formation of biomass in the pipe. Bacterial community composition also depends on the material and on the length of time for which the hose has been in use. In addition, early contamination can be prevented by careful system installation and commissioning. These were the findings of a study carried out by Frederik Hammes's group in the Environmental Microbiology department and research by Eawag and the Lucerne University of Applied Sciences.

Long-term experiment

The scientists studied shower hoses made of six different flexible plastic materials approved for household use. The hoses were compared in a shower simulator over an eight-month period, at relatively high temperatures and with regular but not constant use – ideal conditions for the growth of bacteria and other pathogens.

After eight months, concentrations on the various materials ranged from 2 million to 200 million bacterial cells per square centimetre. Only 44 per cent of the genera identified were found on all materials, and community composition changed over time. Interestingly, genera containing opportunistic pathogens were more common in pipes with lower biomass.

Simple solutions

Based on these findings, plastic materials could be developed which not only support less microbial growth but also promote the presence of non-pathogenic bacteria. Early contamination of newly installed water supply systems can be prevented by a number of straightforward measures. Firstly, an inert gas should be used for integrity testing. To avoid prolonged stagnation – which promotes bacterial growth – the system should be regularly flushed once it has been connected to the mains.

Jürg Sigrist, Eawag

Various types of hose were tested under realistic conditions in a shower simulator for eight months.

Chemical pollution in low- and middle-income countries

A report prepared by an interdisciplinary team of Eawag scientists concludes that chemical pollution has reached alarming levels in low- and middle-income countries – and that the situation is worsening.

Inadequate controls

Many of the world's most severely polluted areas are in the low- and middle-income countries of Central and Latin America, Africa and the Asia-Pacific region. Here, the mining, construction and textile sectors are often associated with releases of extremely hazardous and bioactive substances. These include heavy metals, pharmaceuticals, pesticides, detergents, solvents and persistent organic pollutants. While the management of toxic chemicals requires the utmost care, production technologies are often obsolete and emissions and discharges are inadequately regulated and controlled. According to the World Health Organization, inappropriate management of toxic chemicals is associated with high levels of deaths from unintentional poisoning, with up to 450 cases per million inhabitants per year in countries such as Belarus, Kazakhstan and Ukraine and in parts of South Asia and West Africa.

Urgent need to reduce pollution

The report is addressed to all stakeholders interested in public health, industrial development or environmental protection in the regions concerned. The authors call on governments, NGOs and industry to take joint action to reduce impacts on human health and the environment, especially in low- and middle-income countries. At the same time, the report provides a valuable overview of existing data, identifies significant knowledge gaps, and recommends questions for future research at the global, national and local level.

Jörg Böthling, visualindia.de

Levels of chemical pollution are particularly alarming in Central and Latin America, Africa and the Asia-Pacific region. Pictured here: Indian farm workers spraying pesticide on a cotton field.

Andri Bryner, Eawag

A restored reach of the Töss: compared to unrestored reaches, the overall ecological state shows a marked improvement.

How do restoration measures benefit ecosystems?

When a monotonous, linear concrete channel is transformed into a near-natural river meandering through floodplains, a restoration project appears – to the human eye – to have been successful. But is it also beneficial for nature? Because restoration outcomes have not been systematically evaluated to date, this question was investigated by Amael Paillex. Working with colleagues from the Systems Analysis, Integrated Assessment and Modelling department and the University of Duisburg-Essen, he developed a method that allows the ecological effects of restoration measures to be assessed systematically. It addresses all the relevant states of a watercourse – physical (morphology and hydrology), chemical (water quality) and biological (animals and plants). Existing assessment methods for fish and macroinvertebrates were combined with new methods for the evaluation of ground beetles, riparian vegetation and aquatic plants.

Increased habitat diversity on the Thur and Töss

To test how the method works in practice, Paillex and his co-workers compared restored and degraded reaches of the Thur and Töss rivers. He reports: "Our analyses show an improvement in the overall ecological state of the restored reaches, both on the Thur and on the Töss." While the unrestored reaches of both rivers were rated as poor, the restored reaches were assessed as moderate in the case of the Thur and (barely) good in that of the Töss. Paillex concludes: "Systematic evaluation would not only make the ecological benefits of restoration measures more visible, but also help to improve future projects."

Guidance on mitigation of hydropeaking

Rapid fluctuations in discharge below storage hydropower plants (so-called hydropeaking) can have adverse ecological effects; for example, fish and macroinvertebrates can be flushed downstream or stranded. In the coming decades, appropriate measures are to be taken to mitigate the effects of hydropeaking. With the aid of case studies, scientists at Eawag developed a conceptual framework for the planning and evaluation of mitigation measures. It is based on indicators (e.g. flow velocity, riverbed clogging or redd dewatering) covering key processes in the various phases of hydropeaking; modelling is used to make quantitative predictions of the effects of mitigation measures. This work helped to shape the new guidance issued by the Federal Office for the Environment.

Markus Zeh

In 2016, the hydropower company Kraftwerke Oberhasli AG opened a retention basin at Innerkirchen to mitigate hydropeaking in the Hasliaare.

Christine Bärlocher, Ex-Press

Cattle farming can create conflicts with water protection – except in the case of extensive grazing.

Resolving conflicts between agriculture and water protection

Conflicts between the societal goals of agricultural production and protection of water resources arise in particular with regard to river restoration, sustainable nutrient management and ecological compensation areas. These were the conclusions of AProWa ("Water-friendly agriculture for the future"), a project conducted by scientists from Eawag, the Federal Office for Agriculture and the Agroscope research centre.

Opportunities – and need for action

The aim of the project was to investigate options for addressing such conflicts. While direct drilling ("no till") appeared to be a promising method, the results of the complex evaluation were difficult to interpret. Most of the options for water-friendly agriculture rated as "conflict-free" came under the heading of sustainable pasture management.

Research gaps were identified in relation to pesticide use, soil management, erosion control and hydrological connectivity. Although the methods applied in this study need to be simplified, the results provide a sound basis for future projects and policymaking.

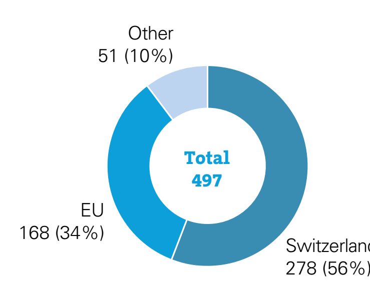
Institution

Eawag provides an excellent research infrastructure at the Dübendorf and Kastanienbaum sites. Academic visitors from Switzerland and abroad also benefit from these facilities and find an ideal environment for interactions reflecting Eawag's international character. This is also demonstrated by the origin of Eawag's employees, with 44 per cent coming from outside Switzerland.

The support departments, including the library (Lib4RI), Technical Services, IT, HR, Finance, Communication and Corporate Services, provide staff with an environment that facilitates their activities and ensures smooth operations, so as to maintain and increase the high quality of research, teaching and consulting. Particular emphasis is placed on sustainability, with regard to buildings and research or other infrastructure. The new Vocational Training department is responsible for apprentices in the non-scientific sector – currently 25 in all.

To permit synergies, various support functions are organised on a cross-institutional basis. Efficient use of financial resources is assured 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 society and Eawag's stakeholders are fully and transparently informed about the institute's financial position and the use of public funds.

Origin of employees

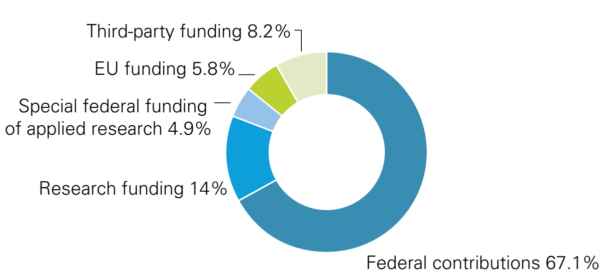


In 2016, a total of 497 people from 40 different countries worked at Eawag.

Headcount and personnel structure

As of 31 December 2016, Eawag's headcount (excluding interns, visiting academics and temporary staff) was 497 people (447 full-time equivalents/FTEs), distributed among the main functions – scientific, technical and administrative staff and apprentices. Women account for 47.3 per cent of the total. Eawag's international character as a leading aquatic research institute is reflected by the diverse origins of its employees. Eawag continues to provide training for 25 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 2016, the financing of the FTEs (excluding apprentices) breaks down as follows:



FTEs by source of funding (%).

Personnel policy and career development

Eawag's personnel policy focuses on the recruitment, retention and career development of first-class employees, both in research and in technical and administrative areas.

In our internal training, the focus is on leadership skills and development for managerial staff. For many years, Eawag has also invested in language courses at all sites, 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 consistently high level.

Eawag has long been committed to fostering the next generation of young scientists, providing an excellent infrastructure, targeted training and information events for its 95 doctoral students. The Doctoral Studies Committee addresses the concerns of doctoral students and their supervisors. In 2016, it launched a structured exchange on future and career planning at this early stage of the scientists' career development. Workshops are also offered for young scientists with fixed-term project contracts, dealing with their career development and designed to motivate them to engage proactively in thought about their future.

The long-established Postdoc Fellowship – a competitive award – aims to foster talented young scientists by providing funding for a year's research at Eawag. At the same time, the award enables Eawag to expand its network, raise its profile and identify young talent.

The Eawag Partnership Programme for Developing Countries continues to offer students from these countries the opportunity to take part in the sharing of knowledge at Eawag, engage in research, establish contacts, and – when they return to their home countries – pass on the expertise they have acquired.

Aldo Todaro, Eawag

At an EOC workshop, Eawag scientists explored issues relating to part-time work and research careers. Interest in flexible working models is very high among Eawag staff – especially women.

Equal opportunities

The Equal Opportunities Committee (EOC), which includes representatives from all areas, is concerned with all aspects of equality at Eawag. In partnership with the PSI, a new position was created for an Equal Opportunity & Diversity coordinator, who is also to represent Eawag in external bodies and support strategic activities. These include initiatives such as the ETH Domain's "Fix the leaky pipeline", which is to be continued in the coming years. Work/life balance remains one of the most important topics dealt with by the EOC. Accordingly, EOC members held a workshop for scientific staff on "Part-time work and success in research". The large number of participants – especially women – underlined once again the growing importance of flexible working models. Gratifyingly, there has been a further increase in the already high proportion of female managerial staff (Functional Level 9 or above) – from 29 to 31 per cent.

ETH Domain

Successful peer review

In mid-January, an external evaluation was conducted at Eawag. In its final report, the Peer Review Committee recognises the important role of Eawag as a national and international leader in aquatic research. It also notes that, thanks to the institute's strong interdisciplinary focus, it complements Switzerland's universities and the two Federal Institutes of Technology in the provision of academic training. The Committee, consisting of national and international experts, commends Eawag for its "pioneering work in research, outreach, and fostering interdisciplinary collaboration across the fundamental-to-applied research continuum".

Peter Penicka, Eawag

Eawag scientists discussing their work with members of the Peer Review Committee.

Evaluation of the Eawag-EPFL Ecotox Centre

A report on the previous year's evaluation of the Eawag-EPFL Ecotox Centre was published in May 2016. The Centre's development and services were highly rated both by the national and international experts and by the cantonal water protection authorities: over the past few years, the Ecotox Centre has established itself as an internationally recognised competence centre. It provides important services to the private and public sector, and thanks to its professional development programme it makes a significant contribution to the development of expertise in ecotoxicology among specialists in the public sector and in industry.

Lib4RI: fifth-anniversary celebrations

In 2016, Lib4RI – the library serving the four research institutes within the ETH Domain (Eawag, Empa, PSI and WSL) – celebrated its fifth anniversary. In the first five years of the merged library's existence, numerous new offerings were developed. In particular, its holdings of e-books and e-journals doubled, and new courses were introduced for users of its diverse services. The latest offering is a new institutional repository, providing easier access to publications by members of the four research institutes. Lib4RI is staffed by an 18-strong team. In a reorganisation in spring 2016, staff were allocated to three new sections in line with the library's new strategy.

Peter Penicka, Eawag

Various events were held to mark the fifth anniversary of Lib4RI. In October, author and gardening expert Sabine Reber gave a reading at Eawag's main building.

People

New Vocational Training department

Vocational training has been an integral part of Eawag's performance mandate since 1997, and the institute is committed to fulfilling its educational responsibilities under Switzerland's apprenticeship system. In 2016, Eawag's small existing unit became the Vocational Training department, led by Samuel Derrer. This department also includes an analytical and training laboratory, where professionals and trainees carry out analyses for Eawag scientists. As well as training chemistry and biology laboratory technicians, Eawag offers apprenticeships in administration and IT. Apprentices are recruited from the Zurich region and neighbouring cantons.

Aldo Todaro, Eawag

Apprentice lab technicians acquire practical skills in Eawag's analytical and training laboratory. Apprentices spend three to twelve months in the same position before being transferred internally.

New members of the Advisory Board

Catherine Martinson, a WWF Switzerland Executive Board member, and Anna Bozzi, a scienceindustries biotechnology and nutrition research expert, have joined Eawag's Advisory Board, replacing Gabi Hildesheimer and Michael Matthes. Members of the Advisory Board represent stakeholders from practice, policymaking, federal and cantonal authorities and the public vis-à-vis the Eawag Directorate. They highlight topics and concerns in their own spheres which could be relevant for Eawag. This helps to strengthen networks and makes it easier for Eawag to meet the needs of practitioners, policymakers and the public.

zVg

zVg

New members of the Advisory Board: Catherine Martinson (WWF Switzerland) and Anna Bozzi (scienceindustries business association).

Awards

Eawag scientists are nationally and internationally recognised for their work and once again received numerous awards in 2016. Some of these are listed below; others can be found on page 9.

ETH Medals for doctoral theses

In 2016, three Eawag researchers received the Silver Medal of ETH Zurich for outstanding doctoral theses: Kirsten Oswald (Surface Waters department) for her work on methane oxidation in lakes; Bastianus Vriens (Water Resources & Drinking Water department) for his research on methylation in the biogeochemical selenium cycle; and Sarah Pati (Environmental Chemistry department) for her work on the biodegradation of organic pollutants.

Otto Jaag Water Protection Prize awarded to Eawag doctoral student

Hanspeter Zöllig (Process Engineering department) received the 2016 Otto Jaag Water Protection Prize for his doctoral thesis entitled "Electrolysis for the treatment of stored source-separated urine". This award recognises outstanding doctoral and Master's theses at ETH Zurich in the field of water protection and hydrology. Hanspeter Zöllig investigated how electrolysis can be employed to recover nitrogen from urine.

ETH Zurich

The Otto Jaag Water Protection Prize recognises research in the field of water protection and hydrology. At ETH Day 2016, the award was presented to Hanspeter Zöllig by ETH Rector Sarah Springman.

Eawag doctoral student wins Bern University Volz Award

David Marques wrote his doctoral thesis on speciation in stickleback at the Fish Ecology and Evolution department. He received the University of Bern's Volz Award for the best thesis in Ecology and Evolution, a prize established by the Bern zoologist Dr Walter Volz.

HKIS Young Scientist Award

Feng Ju (Surface Waters department), who studies antimicrobial resistance genes in wastewater treatment, received the 2016 Young Scientist Award from the Hong Kong Institution of Science.

Energy Globe Award for project in Morocco

In June 2016, Eawag employee Bouziane Outiti received an Energy Globe Award for his wastewater treatment project in Morocco. The Energy Globe Awards, presented annually, honour innovative environmental sustainability projects around the world. In Outiti's six-year project, a new wastewater treatment facility – not requiring external energy supplies – was constructed for two villages in the mountains south of Marrakech.

Eawag

The new wastewater treatment facility serving a community of around 1,200 people south of Marrakech. Previously, wastewater flowed directly into the agricultural zone and the nearby river.

Kilham Memorial Lecture given by Ole Seehausen

As the recipient of the Kilham Memorial Award, Ole Seehausen – head of the Fish Ecology and Evolution department at Eawag's Kastanienbaum site and Professor of Aquatic Ecology at Bern University – gave the Kilham Memorial Lecture at the 33rd Congress of the International Society of Limnology (SIL) in Turin.

Eawag

Ole Seehausen giving his Kilham Memorial Lecture at the SIL congress on 4 August 2016 in Turin.

Spin-offs

Three Eawag spin-offs successfully launched

In 2016, three spin-offs were established by Eawag staff. Hans-Joachim Mosler (Environmental Social Sciences department) set up the "Ranas/Mosler" company, offering advice, applications and developments for the environmental and healthcare sector, based on a behaviour change method developed at Eawag.

Peter Penicka, Eawag

Hans-Joachim Mosler's new company "Ranas/Mosler" offers advice and training.

Stephan Fischer, Kristin Schirmer and Melanie Knöbel (Environmental Toxicology department) established "aQuaTox-Solutions GmbH", a company offering services in the field of environmental toxicology and monitoring, using alternative test methods (not involving animal testing). The third spin-off, Vuna GmbH, is concerned with the production of a liquid fertiliser using nutrients recovered from wastewater. In the recently completed Vuna project – led by Kai Udert and Bastian Etter (Processing Engineering department) – an innovative method was developed for recovering nutrients from source-separated urine. In 2016, the recycled nutrient product was officially approved by the Federal Office for Agriculture – initially as a fertiliser for flowers, ornamental plants and lawns. It is now available under the trade name Aurin.

Peter Penicka, Eawag

The fertiliser Aurin is derived from urine using a method developed at Eawag. It has been commercially available since 2016.

Peter Penicka, Eawag

The Vuna recycling process is explained in Eawag's hands-on exhibit at the Umwelt Arena Spreitenbach.

Broad dialogue

Eawag is committed to maintaining close contacts with water professionals and a dialogue with the wider public. In 2016, alongside more regular forms of collaboration and communication, various events were held to mark the centenary of the Kastanienbaum Hydrobiology Laboratory. In addition, there were a number of smaller scale events for the public, two of which are described below.

Exhibition in the Umwelt Arena Spreitenbach

Since 2016, the Vuna recycling process has been exhibited at the Umwelt Arena Spreitenbach. The exhibit shows how source-separated urine can be used to produce a fertiliser. It is designed to raise visitors' awareness of the fact that valuable substances can be recovered from wastewater.

Future Day: introduction to lake research

On last year's National Future Day, 20 fifth- to seventh-graders took the opportunity to visit the Eawag sites at Dübendorf and Kastanienbaum. In both cases, the youngsters spent the morning afloat, on a lake research expedition. In the afternoon, the budding scientists analysed the samples they had collected in the laboratory.

Ilse Hildbrand, Eawag

Young scientists on Lake Greifen: on Future Day at Eawag, children were introduced to the art of collecting samples for scientific research.

Environment

Forum Chriesbach ten years on: raising the bar for sustainable construction

Forum Chriesbach, Eawag's new headquarters at Dübendorf, was opened in 2006. Ten years later, it is still among the 100 most sustainable buildings worldwide. Setting new standards for green and energy-efficient construction, it continues to arouse great interest among architects, as well as students and professionals in the energy and facility management sectors. As the building does not require conventional heating or cooling in the office spaces, thermal energy consumption is very low. Sustainable energy production and procurement are assured by a rooftop photovoltaic system and renewable energy purchases. Forum Chriesbach still attracts visitors from Switzerland and abroad – more than 1,200 in 2016 alone.

Minergie P-Eco certificate for research building Eawag's more recent construction projects meet the same high standards: in 2016, the renovated and extended "Aquatikum" became the first laboratory building to receive the Minergie P-Eco energy efficiency certificate. In addition to conventional energy-saving measures, the choice of construction methods ensures that environmental burdens are kept to a minimum throughout the lifetime of the building and beyond. For example, the use of insulation foam was avoided, and no materials were used which could release formaldehyde into indoor air.

Andri Bryner, Eawag

Eawag's Deputy Director Rik Eggen (left) is delighted that the "Aquatikum" is the first laboratory building to have received the Minergie P-Eco energy efficiency certificate.

Stefan Kubli, Eawag

Forum Chriesbach set new standards and is still among the world's top 100 sustainable buildings.

Directorate
Janet Hering (Director)
Rik Eggen (Deputy Director)
Jukka Jokela
Tove Larsen
Alfred Wüest
Christian Zurbrügg

Eawag-EPFL Ecotox Centre
Inge Werner

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

Research departments

Surface Waters Research and Management SURF
Carsten Schubert

Aquatic Ecology ECO
Piet Spaak

Fish Ecology and Evolution FISHEC
Ole Seehausen

Environmental Chemistry UCHEM
Juliane Hollender

Environmental Microbiology UMIK
Martin Ackermann

Environmental Toxicology UTOX
Kristin Schirmer

Water Resources and Drinking Water W+T
Michael Berg

Process Engineering ENG
Eberhard Morgenroth

Urban Water Management SWW
Max Maurer

Sanitation, Water & Solid Waste for Development SANDEC
Christoph Lüthi

Systems Analysis, Integrated Assessment and Modelling SIAM
Peter Reichert

Environmental Social Sciences ESS
Bernhard Truffer

Support departments

Corporate Services
Thomas Lichtensteiger

Communication
Anke Poiger

IT Services
Gabriel Piepke

HR and Finance
Gabriele Mayer

Technical Services
Max Mauz

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 / **Reto Schneider,** Head of Emerging Risk Management, Swiss Re / **Felix von Sury,** Von Sury Consulting / **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 Bio-geochemistry 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.

Jukka Jokela
Group Leader, 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 concepts. Her research focuses on decentralised wastewater treatment technologies and source separation for wastewater management. She led the award-winning Blue Diversion project (development of a grid-free urine-diverting toilet). She is a member of the Advisory Boards of the FHNW School of Life Sciences and of the ZHAW School of Life Sciences and Facility Management.

Alfred Wüest
Group Leader, Surface Waters Research & Management department

Alfred Wüest, an environmental physicist, investigates mixing processes and geochemical fluxes in lakes. In his applied research, he studied the ecological impacts of pumped-storage hydropower operations and lake heat use. Alfred Wüest is Adjunct Professor of Aquatic Physics at ETH Zurich and 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 & 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.

Income statement

CHF thousand	2016	2015	Notes
Operating result			
Federal financial contribution	57,337	57,048	
Federal contribution to accommodation	4,162	4,171	
Total federal contribution	61,499	61,219	5
Tuition fees and other utilisation fees	205	175	6
Swiss National Science Foundation (SNSF)	5,025	5,880	
Commission for Technology and Innovation (CTI)	503	501	
Special federal funding of applied research	4,867	3,977	
EU Framework Programmes for Research and Innovation (FP)	2,692	2,762	
Industry-oriented research (private sector)	2,018	2,188	
Other project-oriented third-party funding (incl. cantons, municipalities, international organisations)	2,522	2,164	
Research contributions, mandates and scientific services	17,627	17,471	7
Other revenue	159	493	8
Operating revenue	**79,489**	**79,358**	
Personnel expenses	48,984	49,223	9, 21
Other operating expenses	19,185	21,672	10
Depreciation	3,323	3,286	16
Transfer expenses	535	500	11
Operating expenses	**72,028**	**74,681**	
Operating result	**7,462**	**4,677**	
Finance result			
Finance income	19	73	12
Finance expense	52	102	12
Finance result	**–33**	**–29**	
Surplus (+) or deficit (–)	**7,429**	**4,648**	

From 2016, income from courses (primarily Peak courses) is recorded under “Tuition fees and other utilisation fees”. In the previous year (2015), this was included in “Other revenue”. The values for the previous year have been adjusted accordingly for presentation in this income statement.

Balance sheet

CHF thousand	31.12.2016	31.12.2015	Notes
Current assets			
Cash and cash equivalents	46,551	41,301	13
Current receivables from non-exchange transactions	13,895	17,802	14
Current receivables from exchange transactions	1,511	383	14
Current financial assets	25,228	25,228	17
Prepaid expenses and accrued income	2,821	2,487	15
Total current assets	**90,005**	**87,200**	
Non-current assets			
Property, plant and equipment	23,361	24,223	16
Intangible assets	–	–	16
Non-current receivables from non-exchange transactions	6,573	5,878	14
Total non-current assets	**29,934**	**30,101**	
Total assets	**119,939**	**117,301**	
Liabilities			
Current liabilities	3,368	4,311	18
Accrued expenses and deferred income	850	261	19
Short-term provisions	2,598	2,443	20
Short-term liabilities	6,816	7,015	
Dedicated third-party funds	24,429	27,401	22
Net defined benefit liabilities	59,623	50,029	21
Long-term provisions	1,797	1,685	20
Long-term liabilities	85,849	79,115	
Total liabilities	**92,665**	**86,130**	
Equity			
Valuation reserves	–39,339	–28,012	
Dedicated reserves	12,122	11,341	
Free reserves	67,524	61,323	
Accumulated surplus (+)/deficit (–)	–13,033	–13,481	
Total equity	**27,274**	**31,171**	
Total liabilities and equity	**119,939**	**117,301**	

From 2016, current receivables from non-exchange transactions and current receivables from exchange transactions are recorded separately in the balance sheet. Previously, they were only shown separately in the notes. The values for the previous year (2015) have been adjusted accordingly for presentation in this balance sheet.

Statement of changes in equity

CHF thousand	Accumulated actuarial gains (+) /losses (–) from defined benefit pension plans	**Valuation reserves**	Teaching and research reserves	Infrastructure and administration reserves	**Dedicated reserves**	**Free reserves**	**Accumulated surplus (+)/deficit (–)**	**Total equity**
2015								
As of 01.01.2015	**–10,658**	**–10,658**	**10,405**	**997**	**11,402**	**55,831**	**–12,697**	**43,878**
Surplus (+) or deficit (–)							4,648	**4,648**
Items directly recognised in equity:								
Change in defined benefit liability	–17,354	–17,354						**–17,354**
Total items directly recognised in equity	–17,354	–17,354						**–17,354**
Reclassifications in equity		–	935	–997	–61	5,492	–5,431	–
Total changes in equity	*–17,354*	*–17,354*	*935*	*–997*	*–61*	*5,492*	*–783*	***–12,706***
As of 31.12.2015	**–28,012**	**–28,012**	**11,341**	**–**	**11,341**	**61,323**	**–13,481**	**31,171**
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 in defined benefit liability	–11,327	–11,327						**–11,327**
Total items directly recognised in equity	–11,327	–11,327						**–11,327**
Reclassifications in equity		–	781		781	6,201	–6,982	–
Total changes in equity	*–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**

Eawag does not use hedge accounting.

Cash flow statement

CHF thousand	2016	2015	Notes
Cash flows from operating activities			
Surplus (+) or deficit (–)	**7,429**	**4,648**	
Depreciation	3,323	3,286	16
Finance result (non-cash)	–	–	12
Increase/decrease in net working capital	2,091	–7,206	
Increase/decrease in net defined benefit liabilities	–1,733	–1,879	21
Increase/decrease in provisions	267	-339	20
Increase/decrease in non-current receivables	–695	1,394	
Increase/decrease in dedicated third-party funds	–2,972	2,036	22
Reclassification and other (non-cash) income	–	–	
Cash flows from operating activities	**7,711**	**1,940**	
Cash flows from investing activities			
Investments			
Purchase of property, plant and equipment	–2,490	–4,600	16
Increase in current and non-current financial assets	–	–3,002	17
Total investments	*–2,490*	*–7,602*	
Divestments			
Disposal of property, plant and equipment	29	283	16
Total divestments	*29*	*283*	
Cash flows from investing activities	**–2,461**	**–7,319**	
Cash flows from financing activities			
Cash flows from financing activities	–	–	
Total cash flow	**5,250**	**–5,379**	
Cash and cash equivalents at the beginning of the period	**41,301**	**46,680**	13
Total cash flow	5,250	–5,379	
Cash and cash equivalents at the end of the period	**46,551**	**41,301**	13

Notes to the annual 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

The present statements are separate financial statements for the reporting period from 1 January 2016 to 31 December 2016. The reporting date is 31 December 2016.

Legal basis
Eawag's accounting has the following legal basis (including directives and regulations):

- Federal Act of 4 October 1991 on the Federal Institutes of Technology (ETH Act; SR 414.110)
- Ordinance of 19 November 2003 on the Domain of the Federal Institutes of Technology (ETH Domain Ordinance; SR 414.110.3)
- Ordinance of 5 December 2014 on the Finance and Accounting of the ETH Domain (SR 414.123)
- Accounting Manual for the ETH Domain (Version 5.2)

Accounting standards
Since 1 January 2015, the annual financial statements of Eawag have been prepared in accordance with the International Public Sector Accounting Standards (IPSASs). The underlying accounting requirements are specified in the Accounting Manual for the ETH Domain (Art. 34 Directives, Ordinance on the Finance and Accounting of the ETH Domain, SR 414.123).

Application of transitional provisions for new IPSASs
For the 2015 and 2016 accounting periods, there are transitional periods for the adoption of IPSASs in the following areas, leading to deviations from IPSASs:

- Deviation 1: The provisions on "Financial Instruments: Disclosures" (IPSAS 30) are not fully complied with. Reason: The adoption of IPSAS 30 requires extensive changes to processes and procedures. Ensuring compliance and retroactively obtaining the relevant data is time-consuming and labour-intensive.

- Deviation 2: The provisions of IPSAS 23 paragraphs 76 ff. on transfers of goods and services in-kind are not applied. Reason: The complex issue must be assessed in detail and requires changes to procedures, among other things. This assessment and the changes to procedures are time-consuming and labour-intensive.

Standards issued but not yet applied

The following IPSASs were issued in the period before the annual financial statements were approved. They are not yet effective and have not been applied, or applied early, in the present annual financial statements.

- IPSAS 33 First-time Adoption of Accrual Basis IPSASs
- IPSAS 34 Separate Financial Statements
- IPSAS 35 Consolidated Financial Statements
- IPSAS 36 Investments in Associates and Joint Ventures
- IPSAS 37 Joint Arrangements
- IPSAS 38 Disclosure of Interests in Other Entities
- IPSAS 39 Employee Benefits (replacing IPSAS 25)

The above standards become effective on 1 January 2017, with the exception of IPSAS 39, which becomes effective on 1 January 2018. Their implications for the annual financial statements are being systematically analysed, and the standards are scheduled to be adopted on 1 January 2017.

There are no further changes or interpretations the application of which is not yet mandatory and which would have material implications for Eawag.

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 net assets, financial position and financial performance, recording revenues 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

Reporting is in Swiss francs. Unless otherwise indicated, all figures are given in thousands of Swiss francs (CHF thousand).

Foreign currency transactions are translated using the exchange rate at the transaction date, which is the date on which the transaction is initially recognised. At each reporting date, monetary items in foreign currencies are translated using the closing rate. The resulting currency translation differences are recognised as other finance income or finance costs. Non-monetary items are translated using the exchange rate at the transaction date.

The most important foreign currency exchange rates are as follows:

		Closing rate on	
Currency	**Unit**	**31.12.2015**	**31.12.2016**
EUR	1	1.0875	1.0717
USD	1	1.0014	1.0160
GBP	1	1.4722	1.2582
JPY	1,000	8.3370	8.7080

Revenue recognition

Each inflow of funds is assessed to determine whether it is an exchange transaction (IPSAS 9) or a non-exchange transaction (IPSAS 23). In the case of an exchange transaction (IPSAS 9), the revenue is generally recognised when the goods are delivered or the services rendered. For project agreements, the performance obligation not yet satisfied is recognised as a liability. The revenue is billed and reported by reference to the stage of completion of the project, based on the costs incurred in the reporting period.

In the case of a non-exchange transaction (IPSAS 23), a distinction is made based on whether or not a performance or return obligation exists. If there is such an obligation, the corresponding amount is recognised as a liability at the inception of the agreement, released according to the stage of completion of the project and concurrently recorded as revenue.

If there is neither an exchange nor a performance or return obligation as stipulated in IPSAS 23, as is generally the case with donations, revenue is recognised in surplus or deficit in the reporting period, with net assets/equity being increased accordingly.

Revenue is structured as follows:

– Federal contribution

  The contribution by the federal government to the ETH Domain comprises the financial contribution and the accommodation contribution. Both types of revenue are classified as arising from non-exchange transactions (IPSAS 23). Federal contributions are recognised in the year in which they are paid. Unused funds result in reserves under equity.

  The accommodation contribution corresponds to accommodation expenses, i.e. an imputed rent for federally owned buildings used by Eawag. Accommodation expenses are recorded under other operating expenses.

– Tuition fees and other utilisation fees

  Revenue from tuition fees and other utilisation fees is classified as arising from an exchange transaction (IPSAS 9). As a rule, revenue is recognised when goods are delivered or services rendered. If material services are performed beyond the reporting date, they are accounted for on an accrual basis.

– 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 primarily relates to multi-year projects. Depending on the nature of the contributions, they are classified as revenue either from an exchange or from a non-exchange transaction. How revenue is recognised depends on whether there is a performance or return obligation. Revenue from non-exchange transactions (IPSAS 23) is recognised when a receivable is legally binding, an inflow of resources is probable and there is no further performance obligation. Usually, a performance obligation exists and revenue is reported according to the stage of completion of the project in the accounting period based on the resources consumed.

– Other revenue

  Among other items, other revenue includes other service revenue and real estate revenue. This revenue is classified as arising from an exchange transaction (IPSAS 9). As a rule, revenue is recognised when goods are delivered or services rendered. If services are performed beyond the reporting date, they are accounted for on an accrual basis.

Cash and cash equivalents
Cash and cash equivalents comprise cash-in-hand, demand and term deposits with financial institutions and funds invested with the federal government with a term of up to 90 days. Cash and cash equivalents are valued at their nominal value.

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

In the case of receivables from non-exchange transactions (IPSAS 23), such as from SNSF and EU projects and from other donors, it is probable that there will be an inflow of funds in relation to the total contractual project volume. Therefore, the total amount of the project is usually recognised as a receivable at the inception of the agreement if the actual amount 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 exchange transactions are stated at cost when the revenue is realised.

No global valuation allowances are recognised on receivables. Specific valuation allowances are recognised if there are concrete indications that a default will occur.

Property, plant and equipment (tangible assets)
Items of property, plant and equipment are stated at cost less accumulated depreciation. They are depreciated over their estimated useful life using the straight-line method. The estimated useful lives are as follows:

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 facilities 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 capitalised 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 leased premises are depreciated over the estimated useful life or over the term of the lease, if shorter.

In the event of additions to property, plant and equipment, it is checked whether components with a value that is significant in relation to the total value need to be capitalised and depreciated separately because they have a different useful life (components approach).

Major renovations and value-enhancing investments that increase the economic utility of an item of property, plant and equipment or extend its useful life are capitalised and depreciated over the estimated useful life. Costs merely for repairs and maintenance are recognised as expenses. 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. However, an inventory of these items is kept.

Intangible assets
Intangible assets are recognised at cost of purchase or production. Standard software is amortised over three years using the straight-line method, with the amortisation charges recognised in surplus or deficit. Other intangible assets are amortised over their estimated useful life using the straight-line method, with the amortisation period being determined individually.

Impairments (tangible and intangible assets)
Tangible and intangible assets are reviewed annually for evidence of impairment. If specific evidence is identified, an impairment test is performed. If the carrying amount permanently exceeds the value in use or net realisable value, the difference is recognised as an impairment loss in surplus or deficit.

Financial assets
Financial assets are recognised at fair value if they are acquired with the intention of generating a profit from short-term fluctuations in price or if they are designated as measured at fair value (e.g. investments held without significant influence). Changes in value are recognised in surplus or deficit.

Financial assets with a fixed maturity which the entity has the intention and ability to hold to maturity are stated at amortised cost using the effective interest method. The effective interest method spreads the difference between the acquisition and the repayment value (premium/discount) over the term of the asset using the net present value method.

Other financial assets that are held for an indefinite period and may be sold at any time for liquidity reasons or in response to changes in market conditions are classified as available-for-sale and stated at fair value. Unrealised gains and losses are recognised in equity and only transferred to surplus or deficit when the financial asset is sold or an impairment occurs.

Originated loans are stated either at amortised cost (loans of less than CHF 10 million) or at amortised cost using the effective interest method (loans of over CHF 10 million).

Derivative financial instruments are used primarily for hedging or as a strategic position. Without exception, they are measured at fair value. Changes in value are usually recognised in surplus or deficit. One exception are derivative financial instruments designated as cash flow hedges, for which changes in value are recognised in equity.

Investment property

Eawag does not own any investment property.

Current liabilities

Current liabilities are usually recognised on receipt of the invoice. This item also includes current accounts with third parties (including social insurance institutions). Current liabilities are measured at their nominal value.

Provisions

Provisions are recognised when a past event has resulted in a present obligation and an outflow of resources is likely and can be reliably estimated.

Net defined benefit liabilities

Eawag's net defined benefit liabilities comprise the obligations from the pension plans of the ETH Domain's pension scheme within the Federal Pension Fund PUBLICA, which provide retirement, death and disability benefits. The net defined benefit liabilities correspond to the defined benefit obligation calculated in accordance with the methods specified in IPSAS 25 less the fair value of the pension fund assets (if necessary, adjusted for a surplus in accordance with paragraph 69b or a past service cost).

The defined benefit obligation (DBO) is calculated by external actuarial experts using the projected unit credit (PUC) method. The DBO corresponds to the present value of the benefits earned up to the valuation date, and service cost corresponds to the benefits under the applicable terms which will be earned in the following year.

The calculation is made based on information about the beneficiaries (salary, vested benefits, etc.) and using actuarial assumptions, which include both demographic assumptions (retirement rates, disability rates, mortality rates, etc.) and financial assumptions (salary trends, pension trends, returns, etc.). The amounts calculated are discounted to the valuation date by applying the discount rate. Changes in the assessment of general economic conditions may affect defined benefit liabilities.

Under the PUC method, benefit entitlements are added evenly over the expected number of years of service, rather than reflecting the actual distribution of retirement credits under the ETH Domain's pension scheme, which are graded and increase with age. The defined benefit obligation was measured based on the current membership of the ETH Domain's pension scheme as of 31 October 2016, using actuarial assumptions as of 31 December 2016 (e.g. BVG 2015 actuarial tables) and the plan provisions of the ETH Domain's pension scheme. The results were then adjusted to the 31 December 2016 reporting date, using pro rata cash flow estimates.

The impacts of changes to the pension plan (past service cost) are recognised immediately in surplus or deficit in the period in which they occur, provided that they result in vested benefits. Any additional impacts are recognised in equity, being spread evenly over the expected average remaining period of service of employees entitled to benefits. Actuarial and investment gains and losses on defined benefit plans are recognised directly in equity in the reporting period in which they occur.

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

Dedicated third-party funds

Liabilities arising from dedicated projects where revenue is classified as arising from non-exchange transactions (IPSAS 23) are presented in the balance sheet as dedicated third-party funds within non-current liabilities – non-current because the projects usually last for several years and the current portion of the liability cannot be determined.

They are measured based on the outstanding performance obligations at the reporting date, which are calculated from the total contractual project volume less services performed up to the reporting date.

Equity
Equity is the residual interest in the assets of an entity which remains after deducting its liabilities. Equity is structured as follows:

– Valuation reserves
The following are recognised in the valuation reserves without affecting surplus or deficit:

1) Revaluation reserves for financial assets which are available for sale and measured at fair value. Changes in market value are recognised in equity until the financial assets are sold.

2) Valuation reserves from defined benefit obligations. Actuarial and investment gains and losses on defined benefit obligations or plan assets are recognised in equity.

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 when the hedged transaction affects surplus or deficit.

– Dedicated reserves
Dedicated reserves in equity include the following items:

1) Teaching and research reserves (appointment commitments, teaching and research projects)
2) Infrastructure and administration reserves (fluctuations in value, construction projects)

Dedicated reserves must (with the exception of appointment commitments) have been generated. They are recognised and released within equity.

Teaching and research reserves
This item indicates that various internal commitments exist and appropriate reserves have had to be recognised to cover them. Commitments require a decision by the Directorate and it must be possible for evidence to be provided at any time.

Infrastructure and administration reserves
These include reserves for fluctuations in the value of the securities portfolio and reserves for construction projects. The reserves for fluctuations in value are determined on the basis of the investment strategy and serve as risk capital.

The reserves for construction projects relate to federal funds which have been granted and paid out for real estate projects, but which have not yet been used due to delays.

Free reserves
Free reserves comprise:

– Free reserves at the disposal of the institute's management. There are no external or internal conditions restricting the freedom to decide on their use.

– Free research reserves at the disposal of the departments. These primarily result from balances remaining upon completion of third-party-funded projects. They are used for teaching and research, and to cover losses (e.g. short-term loss of revenues, currency fluctuations). They are not, however, subject to time limits or purpose-related restrictions.

– Free reserves from the federal financial contribution. These show the funds that have not yet been used, as of the reporting date. They are not subject to any specific conditions.

Accumulated surplus/deficit
The accumulated surplus or deficit shows the cumulative results at the reporting date. It comprises the surplus/deficit carried forward, the surplus/deficit for the period and reclassifications in equity.

The surplus/deficit carried forward is accumulated annually as part of the appropriation of surplus/deficit. The surplus/deficit for the period includes the portion of the result not yet distributed.

Contingent liabilities and contingent assets
A contingent liability is either a possible obligation that arises from past events and of which the 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 or because the obligation cannot be measured reliably (criteria for the recognition of a provision are not met).

A contingent asset is a possible asset that arises from past events and of which the existence will be confirmed only by the occurrence or non-occurrence of an uncertain future event not wholly within the control of the entity. Only contingent claims on third parties come under this heading.

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

Cash flow statement
The cash flow statement shows the cash flows from operating activities, investing activities and financing activities. It is presented using the indirect method, i.e. cash flows from operating activities are based on the surplus or deficit for the period, adjusted for the effects of transactions of a non-cash nature. "Total cash flow" represents the change in the balance sheet item "Cash and cash equivalents".

4 Estimation uncertainty and management judgements

Estimation uncertainty in the application of accounting policies
Preparation of the annual financial statements in accordance with recognised accounting policies requires the use of estimates and assumptions. Estimates and assumptions are based on past experience and other factors that are reasonable and justified, such as expectations regarding the occurrence of future events. Additionally, when applying the accounting policies, decisions have to be made that may have a significant effect on the amounts reported in the annual financial statements. Although these estimates are based on management's best knowledge, actual results may differ from the estimates.

This applies to the following items in particular:

- Useful life and impairment of property, plant and equipment
  The useful life of property, plant and equipment is defined and periodically reviewed bearing in mind the current technical environment and past experience. A change in the estimate may affect the future amount of the depreciation charges and the carrying amount.

  Estimates that could lead to a reduction in the carrying amount (impairment) are likewise made in the course of the regular impairment test.

- Provisions
  Provisions involve a higher degree of estimation than other balance sheet items and therefore a higher or lower cash outflow may occur depending on the actual outcome of a past event.

- Net defined benefit liability
  The net defined benefit liability is calculated based on long-term actuarial assumptions for the defined benefit liability and for the expected return on plan assets. Those assumptions may differ from actual future developments. The determination of the discount rate and future salary trends is a key part of the actuarial valuation.

- Discount rates
  Uniform discount rates are defined for the discounting of 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 discount 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 thousand	2016	2015
Basic federal financial contribution	55,674	54,076
Performance-based allocation of funds	1,000	1,000
Various	–	198
Credit reallocation from federal investment credit	1,133	1,748
Credit reallocation within ETH Domain	–470	26
Federal financial contribution	**57,337**	**57,048**

The federal financial contribution was used to achieve the goals specified in the ETH Act (SR 414.110) and the performance mandate 2013–2016. The funds from the financial contribution were used not only to cover current operating expenses but also to finance investments in property, plant and equipment. Credit reallocations from the investment credit (20% rule) can lead to the accumulation of reserves from the financial contribution.

Federal contribution to accommodation

CHF thousand	2016	2015
Accommodation contribution	**4,162**	**4,171**

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

6 Tuition fees and other utilisation fees

CHF thousand	2016	2015
Tuition fees and other utilisation fees	**205**	**175**

Income from Peak and other courses is now recorded under "Tuition fees and other utilisation fees". In the previous year, it was recorded under "Other revenue". To facilitate comparison, this amount (CHF 175,000) has been reassigned.

7 Research contributions, mandates and scientific services

CHF thousand	2016	of which revenues (IPSAS 23)	of which revenues (IPSAS 9)	2015	of which revenues (IPSAS 23)	of which revenues (IPSAS 9
Swiss National Science Foundation (SNSF)	5,025	4,606	418	5,880	5,091	789
Commission for Technology and Innovation (CTI)	503	503	–	501	501	–
Special federal funding of applied research	4,867	3,572	1,295	3,977	3,471	506
EU Framework Programmes for Research and Innovation (FP)	2,692	2,692	–	2,762	2,762	–
Industry-oriented research (private sector)	2,018	1,279	740	2,188	1,336	852
Other project-oriented third-party funding (incl. cantons, municipalities, international organisations)	2,522	1,779	743	2,164	1,901	262
Total research contributions, mandates and scientific services	**17,627**	**14,431**	**3,196**	**17,471**	**15,063**	**2,408**

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

Industry-oriented research includes a large-scale project funded by a private foundation. 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 305,000 (previous year: CHF 1,515,000) of direct federal (SERI) funding for Horizon 2020 bridging measures.

8 Other revenue

CHF thousand	2016	2015
Licences and patents	—	–
Sales	5	8
Refunds	–	–
Other services	1	1
Building revenue	188	300
Revenue from adjustment of real estate portfolio	–	–
Profit from disposals (property, plant and equipment)	–	43
Capitalisation of own production	–	–
Other miscellaneous revenue	–35	141
Total other revenue	**159**	**493**

The building revenue includes in particular income from rental of guest house apartments.

9 Personnel expenses

CHF thousand	2016	2015
Professors	–	–
Scientific personnel	26,904	26,853
Technical and administrative personnel, apprentices, trainees	15,465	15,833
EO, SUVA and other refunds	–331	–214
Total salaries and wages	**42,037**	**42,472**
Social insurance AHV/ALV/IV/EO/MuV	2,508	2,586
Net pension costs	3,069	2,874
Accident and sickness insurance SUVA (BU/NBU/KTG)	181	187
Employer's contribution to Family Compensation Fund (FAK/FamZG)	478	472
Total social insurance schemes and pension expenses	**6,236**	**6,120**
Other employer contributions	–142	–40
Temporary personnel	–	–
Change in provisions for untaken leave and overtime	149	–119
Change in provisions for contributions to long-service awards	112	55
Other personnel expenses	592	735
Total personnel expenses	**48,984**	**49,223**

Personnel expenses are similar to the previous year's, with the sharing of personnel costs for the communal scientific library (Lib4RI) being offset by higher expenses for limited-term project-related employment and by a planned increase in technical personnel.

10 Other operating expenses

CHF thousand	2016	2015
Expenses for goods and materials	2,759	3,001
Premises costs	5,954	5,925
Other operating costs	10,473	12,745
Total other operating expenses	**19,185**	**21,672**

The four research institutes' library (Lib4RI) is managed by Eawag. In the reporting year, the associated costs, primarily for the library database and electronic literature, were divided among the four research institutes, whereas in the previous year all the costs were borne by Eawag alone.

11 Transfer expenses

CHF thousand	2016	2015
Scholarships and grants to students and doctoral students	–	–
Contributions to research projects	535	500
Expenses for participation in projects of national significance	–	–
Special initiatives	–	–
Other	535	500
Other transfer expenses	–	–
Total transfer expenses	**535**	**500**

In the reporting year, as in the previous year, Eawag contributed CHF 500,000 to the Federal Laboratories for Materials Testing and Research (Empa) project Nest.

12 Net finance income/costs

CHF thousand	2016	2015
Finance income		
Interest income	–	3
Income from investments	–	–
Fair value adjustments of financial assets	–	–
Foreign currency gains	19	69
Other finance income	–	–
Total finance income	**19**	**73**
Finance costs		
Interest expense	–	–
Other borrowing costs	–	–
Fair value adjustments and value adjustments of financial assets	–	–
Foreign currency losses	44	95
Other finance costs	8	7
Total finance costs	**52**	**102**

13 Cash and cash equivalents

CHF thousand	31.12.2016	31.12.2015
Cash	41	24
Swiss Post	4,828	4,675
Bank	982	902
Short-term deposits (<90 days)	40,700	35,700
Total cash and cash equivalents	**46,551**	**41,301**

Short-term deposits are wholly invested in federal financial instruments. The higher volume is directly related to the higher level of internal commitments and 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 thousand	31.12.2016	31.12.2015
Receivables from project contracts and donations	20,019	23,251
Other receivables	449	428
Value adjustments	–	–
Receivables from non-exchange transactions	**20,467**	**23,679**
of which current	13,895	17,802
of which non-current	6,573	5,878
Trade accounts receivables	1,476	326
Other receivables	35	57
Value adjustments	–	–
Receivables from exchange transactions	**1,511**	**383**
of which current	1,511	383
of which non-current	–	–

From 2016, receivables from non-exchange transactions and receivables from exchange transactions are recorded as current/non-current in the notes to the annual financial statements. The amounts from the previous year (2015) have been adjusted accordingly.

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

15 Prepaid expenses and accrued income

CHF thousand	31.12.2016	31.12.2015
Interest	–	–
Other prepaid expenses and accrued income	2,821	2,487
Total prepaid expenses and accrued income	**2,821**	**2,487**

Other prepaid expenses and accrued income essentially comprises the prepaid annual fees for the library databases.

16 Property, plant and equipment and intangible assets

CHF thousand	Operational equipment, machinery, tools, furnishings, vehicles	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				–			–	–	–

CHF thousand	Operational equipment, machinery, tools, furnishings, vehicles	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 01.01.2015	**29,074**	**1,504**	**57**	**30,636**	**13,009**	**3,394**	**16,403**	**47,038**	**109**
Additions	1,260	–	180	1,440	599	2,561	3,160	4,600	–
Reclassification	154	–	–154	–	4,323	–4,323	–	–	–
Disposals	–2,244	–135	–	–2,379	–237	–	–237	–2,616	–
as of 31.12.2015	**28,244**	**1,369**	**84**	**29,697**	**17,694**	**1,632**	**19,326**	**49,022**	**109**
Accumulated depreciation as of 01.01.2015	**19,197**	**1,453**	–	**20,650**	**3,196**	–	**3,196**	**23,846**	**109**
Depreciation	1,819	35	–	1,854	1,432	–	1,432	3,286	–
Impairments	–	–	–	–	–	–	–	–	–
Reversed impairments	–	–	–	–	–	–	–	–	–
Reclassifications	–	–	–	–	–	–	–	–	–
Disposals value adjustments	–1,961	–135	–	–2,096	–237	–	–237	–2,333	–
as of 31.12.2015	**19,054**	**1,354**	–	**20,408**	**4,391**	–	**4,391**	**24,799**	**109**
Balance sheet value as of 31.12.2015	**9,190**	**15**	**84**	**9,289**	**13,303**	**1,632**	**14,935**	**24,223**	–
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.

Contractual obligations for the purchase of machinery and tools amount to CHF 952,000. These are included under "Financial commitments" (Note 24).

User-specific installations are located in or on federally owned buildings and property. The increase is due in particular to the capitalisation of experimental ponds.

17 Financial assets

CHF thousand	31.12.2016	31.12.2015
Current financial assets		
Other financial assets	25,228	25,228
Total current financial assets	**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 thousand	31.12.2016	31.12.2015
Trade payables	2,027	1,557
Liabilities to social insurance institutions	789	1,222
Other current liabilities	552	1,532
Total current liabilities	**3,368**	**4,311**

Current liabilities from trade payables were somewhat higher than in the previous year, owing to payments for the scientific library. However, liabilities to social insurance institutions decreased as a result of higher advance payments. Other current liabilities also decreased, owing to expedited processing of withholding taxes by the cantonal tax authorities and a sharp decrease in I/C liabilities.

19 Accrued expenses and deferred income

CHF thousand	31.12.2016	31.12.2015
Interest	–	–
Other accrued expenses and deferred income	850	261
Total accrued expenses and deferred income	**850**	**261**

Other accrued expenses and deferred income comprise, firstly, income from IPSAS 9 projects which is only to be recognised as revenue in the new accounting period and, secondly, expenses accrued in the reporting period which will only be invoiced in the new accounting period.

20 Provisions

Overview

CHF thousand	31.12.2016	31.12.2015
Provisions for untaken leave and overtime	2,557	2,408
Other long-term employee benefits (IPSAS 25)	1,797	1,685
Other provisions	41	35
Total provisions	**4,395**	**4,128**

Changes in 2016

CHF thousand	Provisions for untaken leave and overtime	Other long-term employee benefits (IPSAS 25)	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

Changes in 2015

CHF thousand	Provisions for untaken leave and overtime	Other long-term employee benefits (IPSAS 25)	Other provisions	**Total provisions**
as of 01.01.2015	**2,526**	**1,630**	**310**	**4,466**
Creation (incl. increase)	–	55	–	55
Reversal	–	–	–240	–240
Appropriation	–119	–	–35	–154
Increase in present value	–	–	–	–
as of 31.12.2015	**2,408**	**1,685**	**35**	**4,128**
of which current	2,408		35	2,443
of which non-current		1,685	–	1,685

Other long-term employee benefits (IPSAS 25) are future long-service awards. These are calculated pro rata, taking account of staff turnover.

21 Net defined benefit liability

Eawag belongs to the ETH Domain's pension scheme within the Federal Pension Fund PUBLICA. In this pension scheme, three pension plans are maintained for employees and a separate plan for professors. Employees are assigned to a pension plan on the basis of their individual salary band. Under IPSAS 25, the plans are classified as "defined benefit" on account of the benefit commitments.

As of the end of the year, the regulatory coverage ratio of the ETH Domain's PUBLICA pension scheme, as specified in the revised Ordinance on Occupational Retirement, Survivors' and Disability Pension Plans (BVV 2), was 103.2% (2015: 100.5 %). As of the end of the year, the economic coverage ratio of the ETH Domain's PUBLICA pension scheme was 84.5% (2015: 72.7 %).

There were no pension plan amendments in 2016.

Net defined benefit liabilities

CHF thousand	31.12.2016	31.12.2015
Present value of defined benefit obligation from funded plans	–212,327	–194,901
Fair value of plan assets	152,704	144,872
Surplus (+) / deficit (–)	**–59,623**	**–50,029**
Present value of defined benefit obligation from unfunded plans	–	–
Net defined benefit liabilities	**–59,623**	**–50,029**

The increase in net defined benefit liabilities is primarily attributable to the use of a lower discount rate for the valuation of liabilities and the changeover from period to cohort life tables (demographic assumptions).

Pension costs

CHF thousand	2016	2015
Current service cost (employer)	6,365	5,801
Interest expense	784	1,403
Expected return on plan assets	–3,996	–4,330
Immediate recognition of net gains from other long-term employee benefits	–	–
Past service cost	–	–
Pension costs	**3,153**	**2,874**

The employer's net pension costs comprise the current service cost (employer) and the interest expense on pension liabilities minus the expected return on plan assets. Possible events such as plan curtailments and settlements must also be considered. Eawag's net pension costs for 2016 amount to CHF 3,153,000 (previous year: CHF 2,874,000). Net pension costs for 2017 are expected to be CHF 4,631,000.

In the reporting year, a one-time payment of CHF 3.5 million was transferred by the ETH Board to the ETH Domain pension scheme. This sum was recognised pro rata for Eawag (CHF 84,000) 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.

The employer contributions are set by the regulations, and the savings contributions are graded by age, rising with increasing age. In accordance with the valuation methods of IPSAS 25, the service cost is calculated so that the financing of the defined benefit obligation is spread evenly across the entire period of service. This can lead to differences between the employer contributions and the service cost. The employer contributions paid in 2016 amount to CHF 4,886,000 (previous year: CHF 4,753,000) and include a one-time payment of CHF 84,000 for 2016. The employer's service cost amounts to CHF 6,365,000 (previous year: CHF 5,801,000). The higher current service cost is explained by the valuation method according to IPSAS 25, based on the number of persons currently insured and the actuarial assumptions employed. The estimated employer contributions for 2017 are CHF 4,749,000.

Change in present value of defined benefit obligation during year

CHF thousand	2016	2015
Present value of defined benefit obligation as of 01.01.	194,901	180,904
Past service cost	–	–
Current service cost (employer)	6,365	5,801
Interest expense	784	1,403
Contributions by plan participants	2,699	2,578
Benefits paid	–6,732	–7,448
Actuarial gains (–) / losses (+) arising from experience adjustments	1,771	5,571
Actuarial gains (–) / losses (+) arising from changes in assumptions	12,539	6,092
Present value of defined benefit obligation as of 31.12.	**212,327**	**194,901**

Change in fair value of plan assets during year

CHF thousand	2016	2015
Fair value of plan assets as of 01.01.	144,872	146,350
Contributions by the employer	4,886	4,753
Contributions by plan participants	2,699	2,578
Benefits paid	–6,732	–7,448
Expected return on plan assets	3,996	4,330
Actuarial gains (+) / losses (–) on plan assets	2,983	–5,691
Fair value of plan assets as of 31.12.	**152,704**	**144,872**

Analysis of amounts recognised in equity

CHF thousand	31.12.2016	31.12.2015
Actuarial gains (–) / losses (+) on plan liabilities arising from changes in assumptions	12,539	6,092
Experience adjustments on plan liabilities	1,771	5,571
Actuarial gains (–) / losses (+) on plan assets	–2,983	5,691
Allowance for true-up of opening balance sheet	–	–
Effect of the limit in paragraph 69(b)	–	–
Total amount recognised in equity	**11,327**	**17,354**
Cumulative amount of gains (–) / losses (+) recognised in equity	**39,339**	**28,012**

The total amount recognised in equity for 2016 is CHF 11,327,000 (previous year: CHF 17,354,000), and the cumulative amount recognised in equity as of 31 December 2016 is CHF 39,339,000 (previous year: CHF 28,012,000).

Major categories of plan assets

Percentage	31.12.2016	31.12.2015
Liquidity	2.38	2.24
Shares	29.89	30.44
Bonds	60.40	58.21
Mortgages	0.39	0.46
Real estate	4.99	5.00
Commodities	1.95	3.65
Total	**100.00**	**100.00**

The ETH Domain's pension scheme is not known to have any financial investments with the employer, or real estate used by the employer. The expected return was determined on the basis of the asset allocation of the ETH Domain's pension scheme.

Actual return on plan assets

CHF thousand	2016	2015
Expected return on plan assets	3,996	4,330
Actuarial gains (+) / losses (–) on plan assets	2,983	–5,691
Actual return on plan assets	**6,979**	**–1,361**

The present value of the defined benefit obligation is determined annually by independent actuaries using the projected unit credit method. This requires actuarial assumptions. The discount rate of 0.2 % was determined on the basis of Swiss federal bonds.

Principal actuarial assumptions used as at the reporting date

Percentage	2016	2015
Discount rate	0.20	0.40
Underlying consumer price inflation	0.50	0.60
Expected rate of salary increases	0.90	0.90
Expected rate of pension increases	0.00	0.00
Expected rate of return on plan assets	2.00	2.75

Key actuarial assumptions used to determine the net pension costs recognised during the year

Percentage	2016	2015
Discount rate	0.40	0.80
Underlying consumer price inflation	0.60	0.80
Expected rate of salary increases	0.90	1.15
Expected rate of pension increases	0.00	0.10
Expected rate of return on plan assets	2.75	3.00

History of asset values, obligations, surplus (+) / deficit (–) and experience adjustments

CHF thousand	2013	2014	2015	2016
Fair value of plan assets as of 31.12.	138,416	146,350	144,872	152,704
Present value of defined benefit obligation from funded plans as of 31.12.	–163,599	–180,904	–194,901	–212,327
Surplus (+) / deficit (–)	–25,183	–34,554	–50,029	–59,623
Present value of defined benefit obligation from unfunded plans	–	–	–	–
Experience adjustments on plan assets	n/a	2,509	–5,691	2,983
Experience adjustments on plan liabilities	n/a	2,273	–5,571	–1,771

22 Dedicated third-party funds

CHF thousand	31.12.2016	31.12.2015
Swiss National Science Foundation (SNSF)	12,781	9,382
Commission for Technology and Innovation (CTI)	563	512
EU Framework Programmes for Research and Innovation (FP)	5,481	6,012
Special federal funding of applied research	3,284	7,102
Industry-oriented research (private sector)	–	1,774
Other project-oriented third-party funding	2,320	2,618
Donations and bequests	–	–
Total dedicated third-party funds	**24,429**	**27,401**

New research contributions were obtained from the Swiss National Science Foundation. At the same time, in the reporting year, industry-oriented research projects were completed or funds were reassigned to other project-oriented third-party funding as of the end of 2016. Reassigned project balances totalled CHF 711,000.

23 Contingent liabilities and contingent assets

Contingent liabilities

There are no contingent liabilities.

Contingent assets

There are no contingent assets.

24 Financial commitments

CHF thousand	31.12.2016	31.12.2015
Financial commitments ≤ 1 year	1,360	634
Financial commitments from 1 to 5 years	–	61
Total financial commitments	**1,360**	**695**

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.

25 Operating leases

There are no fixed-term lease agreements.

26 Remuneration of key management personnel

Remuneration of key management personnel

CHF thousand	2016	2015
Directorate	**1,455**	**1,482**

Key positions

Full-time equivalents	2016	2015
Directorate	**4.6**	**4.6**

Eawag's Directorate consists of six people: the Director, the Deputy Director 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.

27 Events after the reporting date

Eawag's annual financial statements were approved by the Director and the Deputy Director on 28 February 2017. 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 2016.

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

Reg. Nr. 1.17029.937.00123.002

Report of the statutory auditor

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

Report of the statutory auditor on the financial statements

As statutory auditor, and in application of article 35a*bis* of the Federal Act on the Federal Institutes of Technology (SR 414.110), we have audited the financial statements of the Swiss Federal Institute of Aquatic Science and Technology (Eawag) which comprise the balance sheet, statement of financial performance, cash flow statement, statement of changes in equity and notes (pages 49 to 75) for the year ended on 31 December 2016.

Responsibility of the Executive Board of the Eawag
The Executive Board of the Eawag is responsible for the preparation of the financial statements in accordance with 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 which is based on the Ordinance, SR 414.123, especially Art. 4). This responsibility includes designing, implementing and maintaining an internal control system relevant to the preparation of financial statements that are free from material misstatement, whether due to fraud or error. The Executive Board of the Eawag is further responsible for selecting and applying appropriate accounting policies and making accounting estimates that are reasonable in the circumstances.

Auditor's responsibility
Our responsibility is to express an opinion on these financial statements based on our audit. We conducted our audit in accordance with Swiss Law and Swiss Auditing Standards. Those standards require that we plan and perform the audit to obtain reasonable assurance as to whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers the internal control system relevant to the entity's preparation of the financial statements 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 entity's internal control system. An audit also includes evaluating the appropriateness of the accounting policies used and the reasonableness of accounting estimates made, as well as evaluating the overall presentation of the financial statements. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Audit opinion

In our opinion, the financial statements of the Eawag for the year ended on 31 December 2016 comply with legal requirements and the Accounting Manual for the ETH Domain. We recommend that the financial statements submitted to you be approved.

Report on other requirements

The Swiss Federal Audit Office is independent based on the Federal Auditing Act (SR 614.0) and there are no facts incompatible with its independence.

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.

Berne, 3 March 2017

SWISS FEDERAL AUDIT OFFICE

i.V

Regula Durrer
Licensed Audit Expert

David Ingen Housz
Licensed Audit Expert

Editor: Andres Jordi

Contributors: Christine Arnold, Irene Bättig, Sara Blaser (all Sprachwerk); Andri Bryner, Johann Dossenbach, Thomas Lichtensteiger, Gabriele Mayer, Anke Poiger

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

Translations: Jeff Acheson, Laurence Frauenlob

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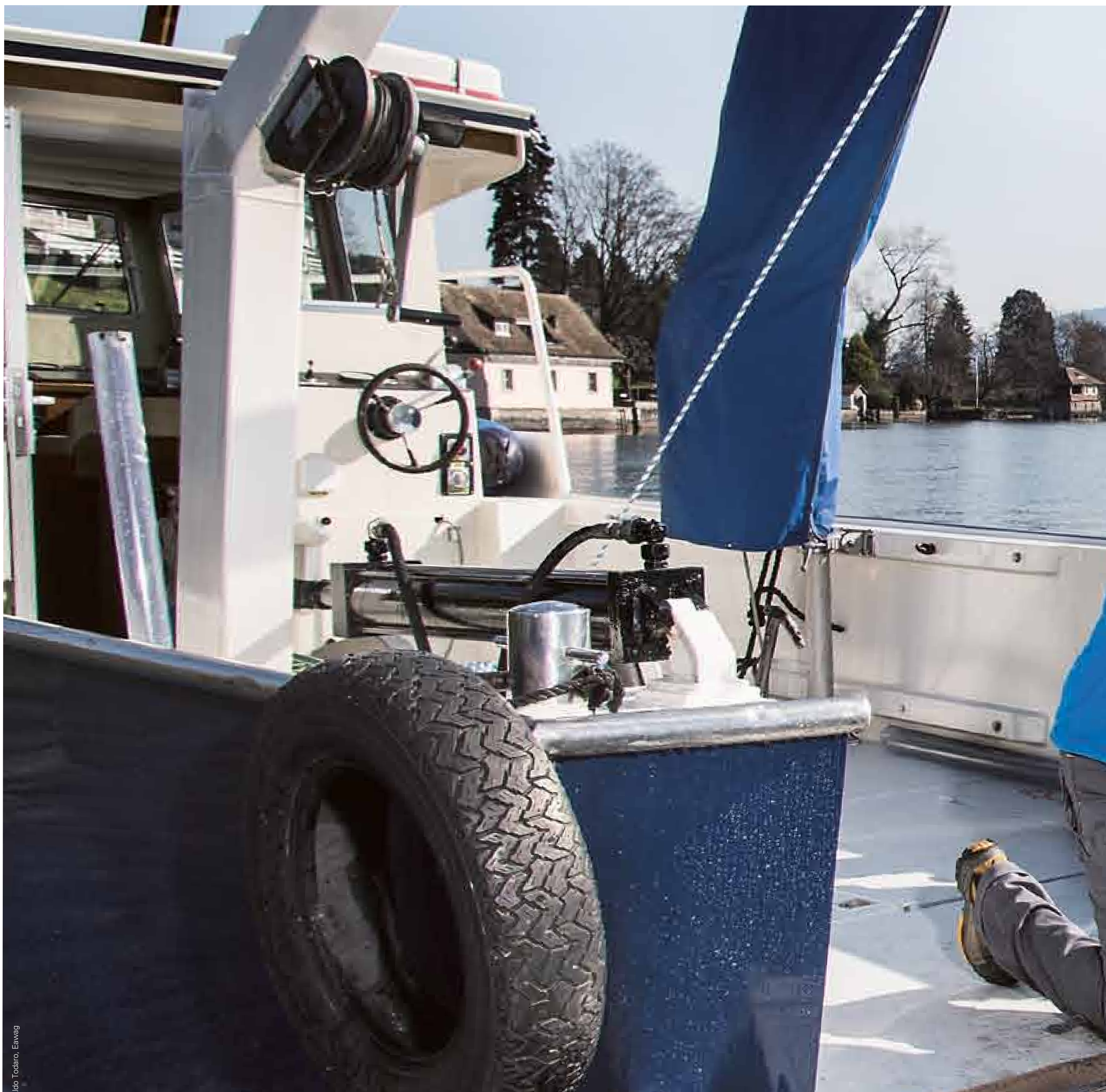
Eawag
Überlandstrasse 133
8600 Dübendorf
Switzerland
+41 (0)58 765 55 11

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

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



Aldo Todaro, Eawag