

# outcome

Knowledge and Technology  
Transfer at the UFZ



**Dear reader,**

The UFZ carries out excellent research within a wide range of topics related to the environment. It generates sound knowledge and technological solutions to manage our natural resources in a sustainable way, to the benefit of society and environment. The transfer of knowledge and technologies into society and business is an integral part of the UFZ mission and activities.

For our research endeavours, our institute has a unique infrastructure. Together with over 600 partners from all over the world, we have established a network of know-how that catalyses innovation and provides decision-makers from economics, politics and civil society with a wide spectrum of useful knowledge and solutions. The selected examples in this brochure will serve as a first insight into our broad range of transfer activities, which include the following topics:

- Awards 2019
- Examples of our Top Stories
- Excerpt from "News from the UFZ"
- Exemplary Technology Platforms

Would you like to join forces with us, e.g. to develop our innovative approaches to products or provide a solid scientific base for decision-makers? Or are you a decision maker that needs support?

Then my colleagues and I will be delighted to hear from you.

Yours sincerely,

Dr. Joachim Nöller

You can find further information on [our website](#).



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**About the UFZ**

**Helmholtz Centre for Environmental Research GmbH**

**Our Vision**

The UFZ is one of the world's leading research centres in the field of environmental research and enjoys high social recognition. It offers ways for a sustainable use of natural resources for the benefit of humans and nature.

**Our Mission**

Biodiversity, functioning ecosystems, clean water and intact soils are our natural bases of life. In light of global change, all staff at UFZ share the objective to demonstrate and promote ways in which excellent research can reconcile social development with a healthy environment. The UFZ is a reliable partner for politics, businesses and civil society in the process of understanding the impacts of human activities on the environment and to develop options for social deci-

sion-making processes. Therefore, the UFZ addresses societal challenges and creates knowledge and technologies which help to identify potential conflicts between environmental and societal demands at an early stage and to develop precautionary measures.

**Our Structure**

The UFZ was founded in 1991 and employs 1,100 people at its locations in Leipzig, Halle (Saale) and Magdeburg. The UFZ is a member of the Helmholtz Association of German Research Centres.

THEMATIC AREA  
**Environment and Society**

THEMATIC AREA  
**Ecosystems of the Future**

THEMATIC AREA  
**Water Resources and Environment**

THEMATIC AREA  
**Chemicals in the Environment**

THEMATIC AREA  
**Environmental Engineering and Biotechnology**

THEMATIC AREA  
**Smart Models / Monitoring**



## Leipzig Science Award 2019

# UFZ environmental chemist Frank-Dieter Kopinke develops microreactors for clean groundwater

Frank-Dieter Kopinke and his team succeeded in developing and transferring microreactors into practical applications that can efficiently and environmentally friendly remove chemicals from contaminated groundwater. He shares the award with Evamarie Hey-Hawkins from the University of Leipzig.

In Germany, three quarters of drinking water are obtained from groundwater as a natural resource. Environmental chemists and engineers are therefore working worldwide to develop methods and technologies by which pollutants can be removed from groundwater. The range of methods currently available extends from pump-and-treat methods, to technologies where reagents are directly injected into the aquifer and form a reaction chamber. This is where the idea of Frank-Dieter Kopinke and his team at the UFZ comes in.

He and his team have succeeded in developing new materials - so-called microreactors - which are injected into the contaminated aquifer where they can collect and chemically degrade pollutants. Microreactors are not miniature technical reactors, but porous adsorbents such as activated carbon and zeolites with built-in chemical reactivity in their pore space using suitable reagents or catalysts. The protected pore space thus becomes the reaction space. The UFZ researchers around Kopinke have so far developed microreactors that can break down pollutants by reductive processes (Carbo-Iron®) or oxidative processes (Trap-Ox®).

In addition to this new scientific approach, Frank-Dieter Kopinke's great merit lies in the exemplary combination of science and application. He is convinced: "As exciting as scientific findings can be, they alone do not (usually) change the world. It requires a transfer of knowledge and technology to actors in practice". Thus, he is not only a university lecturer and globally renowned scientist with an excellent list of publications, but is also involved in more than 50 patents, 37 of them since 1992. Numerous cooperations and joint projects with well-known companies in the chemical and environmental technology industry, but also with young start-up companies prove him to be a sought-after cooperation partner in industry and practice. Carbo-Iron®, for example, is marketed

together with the company Intrapore GmbH based in Essen. In cooperation with companies, field trials are carried out to test new products under real conditions. All this serves the common goal of successfully establishing UFZ technologies in the market. Kopinke is not acting as a lone fighter. He is supported by numerous committed scientists from his department.

The **Leipzig Science Award** honours scientists who have a Leipzig background or whose work has a direct connection to the city. The award is announced every two to three years. It is endowed with 10,000 euros.



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## Ulrich-Babel-Award 2019

# X-ray computed tomography for soil studies – Honour for an outstanding dissertation

Steffen Schlüter was awarded the "Ulrich-Babel-Award" for implementing an imaging method which aims to explore the properties of our soils during the annual meeting of the German Soil Science Society which took place in Bern from 24-29 August 2019.

Steffen Schlüter has been very active in developing and improving software tools for soil structure analysis with X-ray computed tomography (CT). Most people are perhaps familiar with medical CTs in hospitals, but the Department of Soil System Sciences works with an industrial CT that can scan small soil samples at a much higher spatial resolution to reveal the inherent structure and investigate its implications on soil functioning. Important soil functions that Steffen Schlüter covers in his research include water storage and transport, plant growth, greenhouse gas emissions and soil carbon storage.

Progress in imaging techniques like 4D time-lapse imaging or correlative microscopy is typically achieved in other scientific disciplines like life sciences or material sciences. Steffen Schlüter successfully adopted these techniques for soil science. He employed time-lapse imaging, e.g. to study soil structure dynamics in intact soil or to determine the age of roots grown in soil. With correlative imaging, he combined 3D structure information obtained via X-ray CT with biochemical information from various 2D microscopy methods to get a more holistic view on micro-environmental conditions in soil.

Steffen Schlüter leads the group "soil structure - soil functions" at the Department of Soil System Sciences in Halle.

The German Soil Science Society (DBG) awards the **Ulrich-Babel-Award** every two years to young scientists for an outstanding dissertation or publication about imaging methods in the field of German soil science.



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## Biogas Innovation Award 2019

# German Agriculture's Biogas Innovation Award goes to two female scientists of DBFZ and UFZ

During the 12<sup>th</sup> Biogas Innovation Congress on 22 May 2019 in Osnabrück, this year's science award was given to Maria Braune from DBFZ and Heike Sträuber from UFZ for their joint project "From biogas plant to biorefinery - combined production of medium-chain fatty acids and biogas".

As part of a scientific cooperation between UFZ and the German Biomass Research Centre (DBFZ), the award winners Heike Sträuber and Maria Braune developed a process for the production of the fatty acids caproic and caprylic acid from regional biomass. The target products are specialty chemicals with a wide range of applications. They can be used in the lubricant, detergent or cosmetics sector, for example. The developed process is based on an anaerobic fermentation process in which complex substrates can be used without cost-intensive pre-treatment. This process is followed by a separation and purification cascade, which aims to recover the medium-chain fatty acids from the fermentation broth. Subsequently, the products can be further processed into different chemical compounds (esters), depending on the field of application.

In his laudatory speech, Hans-Christian Schaefer from the German Federal Environmental Foundation (DBU) particularly emphasised the innovative character of the development: "The industry needs these visionary ideas that can be developed into real innovations on the basis of solid research work. With the process presented, the product range of biogas plants can be expanded and new business models can be created that help to economically operate the plants in the future. Finally, new ways are also shown how the chemical industry can use regional renewable resources and reduce fossil resources or globally traded renewable resources that are potentially less sustainably cultivated. In this way, the researchers are making a contribution to climate protection and sustainable development."

In the project "Bio-based caproic and caprylic acid - production, purification, marketing strategy – Cap-Acidity", funded by the Federal Ministry of Education and Research (BMBF), the novel process is currently being further developed in a cooperation of DBFZ,

UFZ and the University of Leipzig and the application of the fatty acids in end products is being tested by the industrial partners Fuchs Schmierstoffe GmbH and fit GmbH.

The **Biogas Innovation Award** of German Agriculture in the field of science is awarded annually at the Biogas Innovation Congress in Osnabrück. The award is endowed with 10,000 euros.



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## Research and Innovations Award in Water Science (Sultanate of Oman)

# Wastewater treatment system for warm climate zones

Shamsa Al Saadi from IATI, Oman, who did her PhD at UFZ was honoured with third place in the category "Innovation" of the Research and Innovations Award in Water Science for designing a new constructed wetlands prototype for warm climate zones.

Misallocation and pollution of water resources are the two main factors to cause water scarcity, making wastewater treatment an important element in tackling this problem. Closing local water cycles via safe collection and treatment not only eliminates water resources pollution but also provides treated water for reuse.

Especially in the arid regions of the world, millions of people are affected by water scarcity. The development of novel solutions to overcome this problem is one of the aims of the Institute of Advanced Technology Integration (IATI) in Oman. Scientists of the Research Council (TRC) of Oman in collaboration with the Centre for Environmental Biotechnology (UBZ) at the UFZ developed an innovative system for integrated wastewater treatment and water reuse.

### About the technology

According to the German design guidelines (DWA - German association for water management, wastewater and waste, 2017) conventional wastewater treatment systems, such as aerated constructed wetlands (ACWs), require a relatively large area of land. In warm climate zones such as Oman and neighbouring countries, this would lead to a lot of water being lost through evapotranspiration subsequently impairing the function of these wetlands. The new technological approach remedies this disadvantage and offers high quality treated water that complies with the most stringent treatment class, i.e. it removes 95% of BOD<sub>5</sub>, 90% of total phosphate and 90% of the nitrification. Such treated water can be used for agricultural irrigation and households, especially in arid countries.

Shamsa Al Saadi from IATI, Oman, who her PhD at UBZ, presented her results at the Water Research and Innovations Award Forum on 19 March 2019 in Muscat, Oman. There, she was honoured with third place in the category "Innovation" for her outstanding

work. Intellectual properties have been registered by the Omani collaborators. The invented system was investigated at the German demonstration site at BDZ (Training and Demonstration Centre – Decentralized Infrastructure), Leipzig, and will be implemented on a technical scale in Oman.

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The **Research and Innovations Award in Water Science** aims to enhance the role of scientific research, encourage and support innovative initiatives to find solutions for water issues and raise awareness for water in the Sultanate of Oman.



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## UFZ Research Award 2019

# EU SOLUTIONS Project – Handling the micropollutant load of European water bodies

Rolf Altenburger and the UFZ team of the EU SOLUTIONS Project received the UFZ award for their research on toxicological effects of chemical mixtures, the further development and synthesis of findings from European cooperation and their commitment to knowledge transfer.

Rolf Altenburger is considered a proven expert in the field of investigating the ecotoxicological effects that chemical mixtures can have. The head of the Department of Bioanalytical Ecotoxicology and the Research Unit “Chemicals in the Environment” at the UFZ has been researching chemical mixtures for decades - a topic still very relevant to this day. Although the environmental concentrations of individual substances have decreased, humans are constantly introducing new chemicals with new properties and unexpected effects into the environment. This makes research in this field so necessary. “Rolf Altenburger is a nationally and internationally sought-after colleague, interlocutor and advisor in science and acts as an expert for authorities such as the Federal Environment Agency (UBA), European scientific committees or the Joint Research Centre of the EU Commission,” said UFZ’s Scientific Director, Georg Teutsch, in his laudatory speech. His perseverance, commitment and scientific excellence gave new impetus to the national, European and international regulation of chemicals. Findings from his research have found their way into application.

The majority of his publications in recent years deal with the toxicity of chemical mixtures. He has also repeatedly succeeded in bringing together complementary expertise and establishing new formats at the UFZ for the exchange of information and cooperation beyond his department.

Rolf Altenburger shares the research award with a UFZ team that has successfully implemented the SOLUTIONS Project to improve European water quality, which was funded by the EU Commission with twelve million euros. The SOLUTIONS scientists succeeded in developing tools, methods and practical solutions with which priority pollutants can be identified and water quality monitored. In addition, they developed approaches to assess the risks

of chemical cocktails and to minimise pollution (for more information, please see the Top story on page 12 in this issue). “The scientists have produced recommendations that will improve and further develop the European regulatory framework,” praised Georg Teutsch. They have successfully carried out case studies to check whether the methods, models and tools they have developed really work.

The **UFZ Research Award** is granted to researchers of UFZ in recognition of outstanding scientific achievements in environmental research and is endowed with up to 10,000 euros.



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## UFZ Communication Award 2019

# The face of the Climate Office for Central Germany at UFZ

Andreas Marx is honoured with the UFZ Communication Award for his outstanding, credible and comprehensible communication on the causes and effects of climate change, in particular on the droughts of 2018 and 2019 and on his statements regarding the UFZ Drought Monitor.

As head of the Central German Climate Office at the UFZ, Andreas Marx played a major role in the UFZ’s knowledge transfer on climate research, global and regional climate change and regional adaptation strategies. In addition, he showed great commitment to press work and took part in numerous popular science events (from science nights to parliamentary events to student conferences). Andreas Marx was and still is “the face” of the UFZ Drought Monitor, which met with extremely high media interest when the drought began in 2018. He has convinced print, radio and television journalists with his credibility, great professional expertise, quick and reliable reaction as well as comprehensible and illustrative argumentation. Just how well he has succeeded in this is shown by the very large media response. Andreas Marx has thus made a decisive contribution to the visibility of the UFZ in the media and in society in recent years.

### About the Drought Monitor

A few more words about the Drought Monitor: The [UFZ Drought Monitor for Germany](#) visualises soil moisture in almost real time and in high resolution of 4x4 km<sup>2</sup>. The resulting maps are easy to understand as the numerical information is translated into five drought classes. In practice, both information and data from the drought monitor are very often used to classify the 2018/19 drought in the long term. Numerous public institutions (mainly at state and municipal level) and private companies from different sectors are the main users. This is the result of many years of work by the mHM UFZ Model System team, which has continuously developed this transferable hydrological model over a period of more than 10 years. The UFZ is the only research institution in the world that is able to set up regional hydrological models everywhere and provide reliable forecasts. Incidentally, the mHM team received the UFZ Research Award for this in

2017. Andreas Marx is responsible for the operative business and “marketing” of the drought monitor. The home page of the UFZ Drought Monitor is one of the most frequently visited websites of the UFZ (almost 600,000 page hits last year).

For example, the Saxon State Ministry for Environment and Agriculture (SMUL) also uses data from the UFZ German Drought Monitor to analyse and forecast the invasive spread of the bark beetle. Science-based models thus help to combat the catastrophe in practical terms.

The **UFZ Communication Award** acknowledges annually outstanding communication by UFZ scientists of excellent research in the media and the public. The UFZ Award is endowed with up to 3,500 euros.



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## UFZ Knowledge Transfer Award 2019

### ”Wilde Mulde“ project – a blue print for successful river revitalisation

The UFZ Knowledge Transfer Award goes to the ”Wilde Mulde“ research team with Christiane Schulz-Zunkel & Mathias Scholz (both at Department of Conservation Research) and Mario Brauns & Markus Weitere (both at Department of River Ecology).

This year’s prize winner team comes from a special project in which a truly transdisciplinary approach was taken by restoring a Mulde river section to its natural state. Actors from the field, representatives from the city of Dessau, neighbouring communities, schools and environmental associations were involved, and extensive communication and environmental education work - far beyond the usual scope - were carried out from the very beginning. As a result, scientific findings gathered during the project are now also part of school lessons in Dessau and annual Mulde River Days with guided tours and research courses are held. But also important scientific principles for river and floodplain management in Central Europe have been created, and contribute to successfully restoring large river sections of other Central European rivers to their natural state, and help to implement the National Biodiversity Strategy. Furthermore, the project was awarded the prize of the UN Decade of Biodiversity.

#### About the ”Wilde Mulde“ project

The ”Wilde Mulde“ floodplain project is particularly committed to the conservation of biodiversity. The project, which has been running since the end of 2015, aims to revitalise a section of the river Mulde and its floodplains. The UFZ is coordinating the research consortium and is contributing its expertise to nature conservation research and river ecology. WWF Germany is responsible for the overall coordination of the project and is implementing the revitalisation measures.

In addition to researchers from the UFZ in Leipzig and Magdeburg, the research consortium includes scientists from the TU Braunschweig, the University of Leipzig, the University of Applied Sciences Dresden (HTW) and the Leibniz University of Hannover. They are collecting data at five locations along the Mulde

river in order to be able to assess the ecological, chemical and functional status of the river before and after the implementation of revitalisation measures. In this way, they want to find out as to whether possible changes in status are due to these measures. The scientists are collecting information on hydraulics and hydromorphology, the retention capacity of phosphate and nitrate, as well as on pollution and sediment transport - and biodiversity.

The **UFZ Knowledge Transfer Award** acknowledges transfer activities in political consultation, participation in committees of public authorities, technology validation or standard setting. The award is endowed with up to 3,500 euros.



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## UFZ Technology Transfer Award 2019

### Fast-track help for taxonomists, beekeepers and asthmatics

Susanne Dunker was awarded the UFZ Technology Transfer Award for her research and development work on high-throughput analysis of ecological samples with imaging flow cytometry. What is behind it?

Susanne Dunker has developed a high throughput method for the quick quantification of many and varied small biological samples including algae and pollen. She has filed a patent (in review) for the novel technological design of the flow cytometer and its ecological applications. In collaboration with computer scientists, she has combined methods of machine learning to use this unique high-throughput technology and the large data streams it will produce efficiently: The combination of technology and data computing enables rapid, automated identification and quantification of microorganisms. In biodiversity research (and beyond) new questions can be answered for which the existing methods and technologies were not sufficient.

To date, flow cytometric methods have concentrated primarily on medical applications. In ecology, on the other hand, time-consuming microscopy methods are still in use. With Susanne Dunker's imaging flow cytometry, sampling capability can be increased by orders of magnitude: significantly more samples in less time and a much greater taxonomic diversity of information. Approx. 5000 cells per second can be individually analysed! The data provide information about cell shape, fluorescence (pigmentation), life cycle stage and chromosome number. Combined with computer-aided deep learning methods, species can be identified with an accuracy of more than 95%. This opens new doors for the identification of pollen diversity, which plays an important role in air quality (pollen are allergens) and wind and insect pollination. A species reference library for algae is to be established because water samples can now be analysed with higher resolution and frequency. Coexistence and resilience mechanisms of phytoplankton organisms under environmental stress will be investigated. The technology will significantly advance monitoring in terrestrial and aquatic ecosystems.

The UFZ and the German Centre for Integrative Biodiversity Research (iDiv) have expanded their cooperation with the Medical Faculty of the University of Leipzig in the field of allergology and respiratory diseases. Two new jointly operated pollen traps were added to the monitoring station on the University Hospital's roof. The aim is to capture pollen using different methods and gain new insights into the relationship between air quality, pollen diversity and allergenicity in urban areas ([UFZ/iDiv project Pollen Diversity](#)).

The **UFZ Technology Transfer Award** acknowledges completed transfer achievements or innovations in an earlier stage which have great potential to benefit society. The UFZ Award is endowed with up to 3,500 euros.



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## Top story

# SOLUTIONS Policy Briefs - Recommendations for water management

After five years of collaborative research in the EU SOLUTIONS Project, a collection of policy briefs aims to summarise the output of extensive research in the project published in more than 200 original scientific articles and make it useful for decision-making and water quality protection.

The EU SOLUTIONS Project, coordinated at the UFZ with 39 partners from 36 European countries, China, Brazil and Australia, has dealt with options for solutions in view of the micropollutant load of European water bodies and thus with the monitoring, assessment and reduction of these substances. Therefore, a large number of European and national stakeholders from politics and authorities, from the international commissions for the protection of the Rhine and Danube, but also from water suppliers was involved.

### Policy briefs provide decision-makers with recommendations for action

14 policy briefs were published at the end of September 2019. They summarise the extensive results of more than 200 original scientific papers and give recommendations which can be applied by authorities, decision-makers and monitoring laboratories and are of interest in applied research. Besides suggesting applicable approaches to monitor, model, assess and abate risks by complex mixtures of environmental contaminants in European water resources, requirements for a more coherent water and chemical regulation are identified and recommendations for a future European research agenda are given. All submissions were invited and underwent rigorous peer review. Accepted articles were published in Environmental Sciences Europe in this collection. The developed proposals were previously discussed in many stakeholder board meetings with the EU Commission and other stakeholders. Some of the proposals have already been discussed by the EU working group WFD-CIS (Water Framework Directive - Common Implementation Strategy). As a result, effect-based monitoring was taken up and, together with the SOLUTIONS scientists, a proposal for a directive was drawn up.

The research work is motivated by the prevailing situation that in the European water bodies today



The Danube, one of the four rivers that the EU SOLUTIONS Project focused on.

micropollutants occur in complex mixtures of tens to hundreds of thousands of chemicals and exert their effects as a mixture, while only a small number of individual substances are regulated, monitored and used to determine chemical status. This means that both the toxic effect of many individual micropollutants and the increased toxicity of the mixture resulting from the combination are neglected.

### [Policy briefs](#)



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## Top story

# IPBES Global Assessment 2019 and its response

Nature is deteriorating at an unprecedented rate and species extinction is accelerating with serious consequences for people around the world the new IPBES report is warning.

On 6 May 2019 the World Biodiversity Council IPBES presented the most important results and messages of its global report to the world public in Paris. It contains facts about the global state of ecosystems, scenarios regarding their future development and options for action that can serve as a knowledge and decision basis for policy, business and society. In addition to the UFZ scientists Josef Settele as co-chairman, Ralf Seppelt as lead author, other UFZ researchers and about 450 authors from over 50 countries were involved in the preparation of the report.

The 132 member states of the World Biodiversity Council IPBES met in Paris from 29 April to 6 May 2019 to adopt the Global Assessment. Between 2016 and 2018, the World Biodiversity Council had already published two thematic (land degradation, pollinators), one methodological (scenarios and models) and four regional reports (Africa, America, Asia/Pacific, Europe/Central Asia). The Global Assessment will now provide a global overview of the state of biodiversity and ecosystem services worldwide. It is the first global status report since the Millennium Ecosystem Assessment in 2005.

### The response

Federal policy makers showed high interest for the IPBES report. The invitation to the Parliamentary Breakfast on 7 May 2019 was accepted by more than 50 guests from the Bundestag and staff members of all parliamentary groups. This was followed by an invitation of Katrin Göring-Eckardt (Member of Bundestag) to the parliamentary group meeting of Bündnis 90/Die Grünen as well as an invitation to a parliamentary group meeting of the CDU/CSU parliamentary group to Josef Settele. In addition, Josef Settele, IPBES chairman Robert Watson, and their colleagues were invited to a one-hour meeting with the French President Emmanuel Macron and three of his ministers. The



media response to the presentation of the report was also very strong. There were over 30,000 media reports worldwide. In the week following the presentation of the report, Josef Settele gave more than 60 interviews to international and national media and participated in numerous press conferences, among others with the Federal Minister for the Environment, Nature Conservation and Nuclear Safety Svenja Schulze.



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## Top story

# $\mu$ bialSim: Dynamic simulation of complex microbiomes in bioreactors or human intestinal

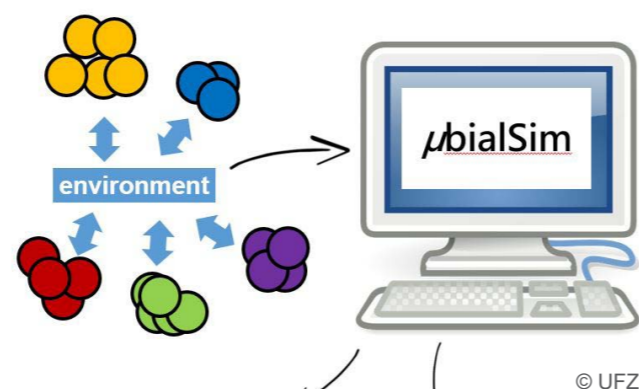
Predicting the dynamics of complex microbial communities is of increasing importance for various questions and often sheds light on the cause-effect relationships of the species involved.  $\mu$ bialSim is a new tool to explore these interactions.

Microbial communities are of high interest not only because of their increasing importance for biotechnological applications. However, their complexity makes it difficult to identify the underlying mechanisms that influence their dynamics. While experimental Meta-OMICS techniques are now routinely used to measure the composition and activity of a microbiome over time, it is still difficult to make quantitative predictions about the development of a microbiome based on such data.

### $\mu$ bialSim - a versatile simulation software from the UFZ

The UFZ simulation software  $\mu$ bialSim is based on the dynamic Flux Balance Analysis (dFBA). It is able to predict the temporal course with respect to composition and activity of microbiomes with hundreds of species under batch or chemostat conditions. The activity of individual species is simulated by the use of separate genome-wide metabolic network models where a shared pool of chemical substances allows the exchange of metabolites between species. A newly developed numerical method with flexible control of time step sizes guarantees numerical accuracy, even for example, when many species consume a substrate and thereby cause an abrupt decrease of the latter's concentration. With the focus on metabolite exchange as the main interaction,  $\mu$ bialSim enables the mechanistic simulation of microbiomes in their natural complexity. Simulated trajectories can be used to contextualize experimental Meta-OMICS data. Moreover, scenario simulations can be used to derive hypotheses about cause-effect relationships that drive community dynamics.

In a recent publication, the UFZ authors present three exemplary applications of  $\mu$ bialSim: the batch culture of a hydrogenotrophic archaeon, a syntrophic community of two, and a human intestinal microbiome



comprising 773 species.

$\mu$ bialSim is implemented in Matlab and is based on the COBRA Toolbox or the CellNetAnalyzer for FBA calculations. The source code is available under the GNU General Public License v3.0. [Link](#)

Further reading: Denny Popp and Florian Centler (2019),  $\mu$ bialSim: constraint-based dynamic simulation of complex microbiomes, Preprint on bioRxiv, [Link](#)



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## News from the UFZ

### RWInnoTec - EXIST Transfer of Research for radio wave technology

EXIST Transfer of Research is a funding programme of the German Federal Ministry for Economic Affairs and Energy (BMWi) which aims at supporting outstanding research-oriented start-up projects.

Shortly before Christmas 2018, the UFZ received the funding decision for the [RWInnoTec project](#) (in German) as part of the EXIST Transfer of Research funding programme. Building on many years of work in research and development of radio wave technology, a four-member interdisciplinary team at the UFZ Department of Environmental Engineering was given the opportunity from March 2019 to prepare the spin-off conceptually and professionally and finally found the company.

Markus Kraus is a physicist and heads the project team. Ulf Trommler is a chemist, Martin Arlt studied civil engineering and Maria Kraus is completing the team with her business expertise. Ulf Roland, head of the working group of Applied Environmental Physics, which has been researching radio wave technology for many years and developing it until ready for application, will take over the mentoring on behalf of the UFZ.

After handing in the written application in January last year, the founding team was able to convince the panel of experts in Berlin of its idea during the presentation of the project in May and obtain a recommendation for funding.

In addition to the project application being recommended for funding, numerous research projects that were successfully carried out within the innovation network RWTec formed a good basis. They demonstrated the broad application potential of radio waves in environmental and energy technology as well as in the construction industry.

The company to be founded will concentrate primarily on the remediation of road damage by developing the appropriate technical equipment. Due to the high demand and the associated potential, other areas of application, such as the drying of buildings, will remain an additional focus of the founding team. Through close cooperation with the Leipzig University of Applied Sciences (HTWK) it is planned to establish innovative processes and products and complete the

knowledge of the UFZ in the field of environmental technologies especially in civil engineering and automation technology. In addition, the company will be integrated into the innovation network RWTec in order to be able to offer the companies of the network tailor-made radio wave technology and services for their applications. This will enable the company to optimally close the existing technological gap.

### CITEPro - New technology platform launched at the UFZ

The UFZ research unit "Chemicals in the Environment" focuses on gaining a better understanding of the fate processes including transformation, biodegradation, effects of chemicals under real environmental conditions and on developing new concepts for evaluating environmental chemicals. The technology platform [CITEPro](#) (Chemicals in the Environment Profiler) will increase the capacity and efficiency of analysis and evaluation of chemicals and environmental samples. This will be made possible by automating processes in sample preparation, the exposure of cell cultures and aquatic organisms to individual substances, mixtures and samples from the environment and humans, and chemical analysis. With an international workshop on 6 February 2019, the UFZ has launched a research infrastructure that is unique in the field of environmental sciences in Germany. CITEPro is coordinated by Rita Schlichting from the Department of Cell Toxicology. The German Federation, as well as the Federal States of Saxony and Saxony-Anhalt have invested a total of around EUR 4 million into creating CITEPro.







## News from the UFZ

### Three years of CoKnow Consulting

"Making my own decisions and doing many different things" - these were Jennifer Hauck's main motivations when she founded [CoKnow Consulting](#) three years ago. Accompanied by Milina Alber and Joachim Nöller by the Knowledge and Technology Transfer department and supported by part-time contracts with DEVELOP and UPOL until the end of 2018, she at least had her swim vest on when she jumped into the cold water.

Since then, Jennifer Hauck has been supporting inter- and transdisciplinary projects with a growing team. "Facilitating inter- and transdisciplinary processes", "Methods of co-production of knowledge", "Development of social networks", "PhD planning" are only some of the topics from her current training programme. Since last year, the team has also been increasingly working on assignments outside of science. Facilitation, for example for Thuringia's Minister of Agriculture or for the Business Biodiversity Dialogue Forum 2020 (UBi 2020), enrich Jennifer Hauck's everyday life just as much as advising the Freimfelde e.V. association and supporting their strategic development. The tax office, the new data protection guideline and many other regulations also ensure that life as an entrepreneur never gets boring...

In 2019, a new business field has been added: "Mediation of conflicts". In addition, the plan is to market the comprehensive training programme and launch several new projects in which CoKnow Consulting is involved as a small company.

Jennifer Hauck's conclusion after three years: "Leading my own business is much more than what I hoped for and through joint projects with my colleagues at the UFZ I don't even have to give up working together".

### Exploitation with Quaesta Instruments Inc. (USA)

How can you reliably determine the average water content in the root zone of a large area of arable land? This question was examined and various scientific approaches were tested as part of a long-standing cooperation of the UFZ with the University of Arizona, the University of Heidelberg and the US company Quaesta Instruments Inc. At the end of 2018, this

resulted in a joint invention which was filed as a patent application with the US Patent and Trademark Office.

The invention is used to measure the water or snow content near the ground surface on different scales. It is based on previous devices of cosmic ray neutron sensors of Quaesta Instruments Inc. but increases the measurement accuracy significantly.

The inventor team with its many and complementary competences reflects the strength of the cooperation: Marek Zreda (University of Arizona) and Martin Schrön (UFZ Department of Monitoring and Exploration Technologies) have extensive expertise in measuring cosmogenic neutrons in the field. Marek Zreda is the founder of this method for the determination of soil moisture. Martin Schrön established the DFG research group "Cosmic Sense" together with the University of Potsdam and six other institutes from the German Research Foundation (DFG) in 2018. Furthermore, he and Markus Köhli (University of Heidelberg) have developed a computer model for the cross-scale simulation of cosmogenic neutrons and gained new insights into the physical principles of the measurement method. The entrepreneur Steven Hamann (Quaesta) developed the corresponding measurement instrumentation.



Possible applications include the observation of soil water content to improve the understanding of hydrological processes and support of climate models and weather forecasting. In agriculture, the invention could be used to improve irrigation systems, in construction to assess the water content of various soils. Finally, it can be applied in snow measurements for early warning systems and avalanche hazard assessment in the field of alpine hydrogeology. The technology

## News from the UFZ

is already being used in MOSES (Modular Observation Solutions for Earth Systems), subproject "Heat Waves", and will be used in TERENO (Terrestrial Environmental Observatories) in the future.

Quaesta is responsible for the market launch of the device. A corresponding license agreement has been concluded and the first royalties have been generated by the UFZ.

### UFZ measuring method for Lake Kivu monitoring

Lake Kivu is situated in East Africa, on the border between Rwanda and the Democratic Republic of Congo. Its deep water zone is known to hold not just around 250 bn m<sup>3</sup> of carbon dioxide, but also over 30 bn m<sup>3</sup> of methane. The latter is a significant and economic energy resource for Ruanda, and industrial exploitation at small scale started in 2015. The aim is not just to make use of the enormous and probably renewable methane resources, but also to prevent gas eruptions.

Due to their extensive knowledge and experience regarding limnophysics, meromictic lakes, extreme gas loads and spontaneous gas releases of lakes (see e.g. [here](#)), UFZ scientists around Bertram Boehrer from the Department of Lake Research were appointed to an international advisory panel which will accompany the exploitation and provide national scientists as well as the ministries in charge with guidelines for a responsible management of the resource.

In a first step, UFZ scientists introduced their Rwandan colleagues to the required monitoring procedures and technologies, the key element being gas load measurements in Lake Kivu. In the past, different methods were applied to this end which resulted in partly conflicting findings. A comparative measuring campaign in 2018 showed the UFZ method of *in-situ* sampling with sample bags and gas chromatography to be the most exact and reliable one, since it requires only little calibrated equipment. The required calibration can easily be carried out even in the remote areas of Rwanda.

### Vertical filter - third commercial-scale plant operational

Since 15 April 2019, trial operation at Kupferhammer site is under way.

The UFZ's V-EcoTech-Filter is proving something of a sales hit. After a series of successful pilots and two commercial plants in Leuna, a third large-scale plant is now starting to run at Kupferhammer to remove phenols and BTEX from the groundwater. As in the case of the two other large plants in Leuna, the operating company is once again the LMBV.



The V-EcoTech-Filter is a semi-natural soil filter system for groundwater remediation and was developed by a team around Roland A. Müller in the Centre of Environmental Biotechnology at UFZ. It consists of one or several vertical coarse filters and a downstream fine filter, and is an economic and efficient tool to remove a broad range of hydrocarbons from polluted aquifers. The technology was also awarded the "Deutscher Umweltpreis" (the most valuable environmental award in Europe) in 2018.

### 5th Leipzig Talks on the Water Framework Directive at the UFZ

On 28 June 2019, actors from the Federal Government, the states and associations met with scientists for the 5<sup>th</sup> time to discuss legal, organisational and fiscal implementation deficits of the Water Framework Directive (WFD) and recommendations for action on ecological watercourse development in Germany.



## News from the UFZ

The implementation of the ecological water quality objectives of the EC WFD is making little progress in Germany. Only about 8% of water bodies reached the target status by 2015. In Lower Saxony the figure was only 2%, and the management plan for the current management period up to 2021 promises only limited progress. Against this background, the Lower Saxony Ministry for the Environment, Energy, Building and Climate Protection has commissioned a research group around Moritz Reese from the UFZ Department of Environmental and Planning Law to investigate the main reasons for the implementation deficit and to identify ways of improving the legal, organisational and fiscal efficiency of ecological watercourse development.



The study shows that the implementation crisis is essentially due to deficiencies in legal enforcement, planning, organisation, equipment and financing. It is shown that inadequate institutional and fiscal implementation violates the WFD and proposals are made on how these implementation deficits could be addressed.

The "5th Leipzig Talks on the Water Framework Directive" brought together around 50 interdisciplinary experts to discuss the results and proposals of the study and to consider how the implementation crisis can be overcome in the 3rd management period and beyond. The implementation situation in the federal states of Bavaria, Hesse and North Rhine-Westphalia was presented by expert speakers. It became clear that in some respects the organisational implementation and planning of measures in these states is more effective than in Lower Saxony. Irrespective of this, the experts agreed that the Federal Government and all the federal states still have considerable efforts to make - even beyond 2027 - in order to be able to fully

implement the objectives of the guidelines, in particular with regard to planning, organisation and financing. The exchange provided numerous further insights and perspectives. The results were also published in a more detailed conference report (Reese et. al., Wasserrahmenrichtlinie - Wege aus der Umsetzungs-krise, Wasser und Abfall 21 (3), 47 – 54; 2019 - [Link](#) (in German)).

### ETC/ICM has published its first Technical Report

The European Topic Centre on Inland, Coastal and Marine waters (ETC/ICM) - led by the UFZ since 2014 - has published its first Technical Report in 2019.

Since 2014, UFZ scientists of the Department of Aquatic Ecosystem Analysis and Management have been leading the European Topic Centre on Inland, Coastal and Marine Waters, thus pooling the EU's expertise in monitoring and assessing European water resources. In the period of 2014-2018, the international consortium of the ETC/ICM consisted of 17 research institutions, organisations and national offices. For the period of 2019-2021, 15 institutions will work together to consolidate data on the use and status of water resources and evaluate them.

The 2019 Technical Report is titled "Development of a pilot 'European seafloor integrity account' assessing fishing pressure on seabed habitats". The purpose of the report is to review existing approaches to assessing the impact of fish-induced physical disturbances on seabed habitats.

The report can be downloaded [here](#).

### Renewable Energy Monitor is online

UFZ scientists from the Department of Bioenergy headed by Daniela Thrän provide an online nature conservation monitoring on the expansion of renewable energies in the electricity sector for interested parties, planners and authorities.

The necessity of restructuring the energy system and the positive effects of renewable energies on the reduction of greenhouse gas emissions are undisputed. Climate protection is an important prerequisite for the



## News from the UFZ

conservation of nature and landscape and contributes to the long-term survival of species.

For a long time, renewable energies were considered environmentally friendly per se, but as they expand, their effects on nature and the environment become more apparent leading to increasing conflicts with nature conservation objectives (e.g. bird and bat strikes on wind turbines, loss of fallow land and biodiversity due to monocultures with energy crops, or the impairment of landscape due to high-voltage power lines).

Such monitoring, which bundles the effects on nature and the environment caused by the construction and operation of plants for the generation and transmission of electricity from renewable energies, has not yet existed. However, this monitoring system could, among other things, extend national reporting on the expansion of renewable energies to include the effects on nature and the landscape and, in the medium term, gradually improve knowledge on impacts. Problematic developments in the future expansion of renewable energies could thus be identified at an early stage and avoided.

After completing the research project "Nature Conservation Monitoring of the Expansion of Renewable Energies in the Electricity Sector and Development of Instruments to Reduce the Impairment of Nature and Landscape" ([EE-Monitor](#) - in German), this monitor has now been put online for all interested parties. It provides plant-specific basic data on renewable energies for generating electricity (wind energy, photovoltaics, bioenergy and hydropower, overhead lines, underground cables) which are updated every day.

The project was supported by the German Federal Agency for Nature Conservation (BfN) with funds from the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). Funding code FKZ 3515 82 2700 UFOPLAN 2015.

### UFZ supports bark beetle control in Saxony

The bark beetle population, which has already increased in 2018 probably due to climate change and the drought, seems to be getting out of control in more and more federal states. The beetles have long since spread in the forests and are causing enormous damage - as they find ideal living conditions at the

moment which means that there will be a third brood this year. According to experts, the spread must now be stopped at all costs. Otherwise, there is an even greater risk of damage after hibernation.



"An incomparable catastrophe is happening in the Saxon forests," said Thomas Schmidt (CDU), Saxon Minister of the Environment, during a visit to the Federal Armed Forces near Flöha (central Saxony).

The Saxon State Ministry for Environment and Agriculture (SMUL) also uses data from the UFZ German Drought Monitor to analyse and forecast the spread of the pest. Science-based models thus help to combat the catastrophe in practical terms.

The [UFZ Drought Monitor](#) developed in the Department of Computational Hydrosystems visualises soil moisture in almost real time and in high resolution of 4 x 4 km<sup>2</sup> for Germany. The resulting maps are easy to understand as the numerical information is translated into five drought classes. In practice, both information and data from the drought monitor are very often used to classify the 2018/19 drought in the long term. Numerous public institutions (mainly at state and municipal level) and private companies from different sectors make use of it. The Drought Monitor website has been visited more than half a million times in the current drought discussion alone. In addition to using the information and graphics in television and radio reports, the Drought Monitor has been published more than 150 times on public print media and, last but not least, cities and municipalities also use pictures from the Drought Monitor at information events for their citizens. The UFZ Drought Monitor thus also makes an important contribution to closing the gap between the more science-based climate indicators on the one



## News from the UFZ

hand and the practical requirements on the other.

### New DECHEMA position paper about electrobiotechnology

Bioelectrosyntheses are based on the combination of enzymatic and microbial syntheses with electrochemical process steps and allow the advantages of both technologies to be optimally exploited. Bioelectrosyntheses can thus make a significant contribution to future bioeconomy. The position paper of the DECHEMA (Society for Chemical Engineering and Biotechnology) published under the leadership of Dirk Holtmann (DECHEMA Research Institute) and Falk Harnisch (UFZ Department of Environmental Microbiology) outlines the state of the art and the potential which bioelectrosynthesis has. At the same time, it also addresses the areas in which there is still a need for research. The paper thus provides an excellent overview of this up-and-coming field of research.

Electrobiotechnology already covers a broad spectrum of possible applications, from biofuel cells for wastewater purification to biosensors, the removal of pollutants from water or soil and the synthesis of complex chemicals. CO<sub>2</sub> can be used as raw material in bioelectrosyntheses and help to achieve the goals of the "National Research Strategy Bioeconomy 2030".

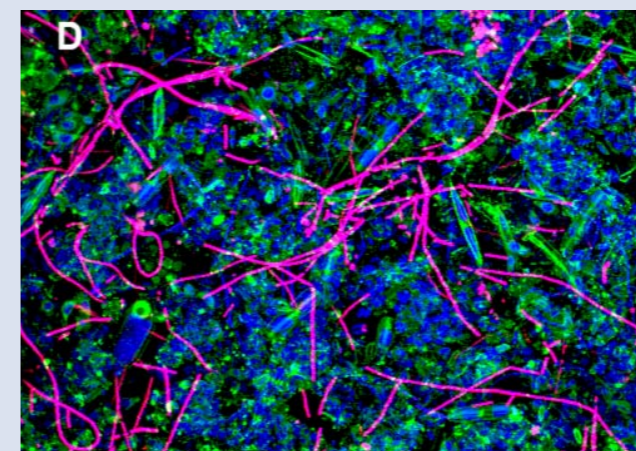
While research on biofuel cells and electrochemical biosensors is already very advanced, the development of bioelectrosynthesis is still in its infancy. The need for research ranges from a better understanding of the processes involved in electron transfer to the development of suitable electroenzymatic or microbial systems and reactor design. The authors therefore call for sustainable public funding that includes both scientific principles and cooperation between industry and academia. In their opinion, this is the only way to develop tomorrow's technology from today's promising research results and thus make a significant contribution to securing raw materials, sustainability and climate protection.

Download the [position paper](#) (in German).

## Technology platforms

### ACROSS – Validation of satellite data

[ACROSS](#) (Advanced Remote Sensing - Ground Truth Demo and Test Facilities) provides field data across different spatial and temporal scales and environmental compartments in order to enhance the interpretation of satellite data for environmental science. The UFZ partly coordinates the ACROSS infrastructure and contributes to the terrestrial platform by investigating hydrogeophysical and ecological parameters like soil moisture, temperature, carbon and water fluxes.



### Biofilm – Microscopy unit

At boundaries, microorganisms at interfaces form so-called biofilms, which play a key role in a variety of processes. While microorganisms are systematically applied in biotechnological processes, their action in biofouling or the human body may also result in undesirable effects on product quality or health. The technology platform "Biofilm" comprises several laser scanning microscopes, which allow a thorough investigation of structural and functional properties of biofilms and, therefore, contribute to a better understanding of the processes which occur in biofilms.

### Biotechnikum – Bioreactor technology

The bioreactor pilot plant consists of modern bioreactor technology for the cultivation of different microorganisms like bacteria, yeast and fungi. It offers multi- and laboratory bioreactor systems as well as a set of geometrically similar reactors for a scaling up with working volumes. The facility is completed by devices for analytics along the bioprocess and cell separation and thus, enables an integral approach for the investigation, development and optimisation of bioprocesses. [Flyer](#) bioreactor pilot plant (in German).





## Technology platforms

### CITEPro – Chemicals in the Environment Profiler

[CITEPro](#) provides a platform for high-throughput sample preparation, the automated exposure of cell cultures and aquatic organisms, and the automated analysis of the effects and chemical concentrations for large numbers of chemicals and environmental samples. The platform can increase the sample throughput of established bioanalytical, toxicological and analytical methods and is therefore suited for a wide range of applications including the spatial and temporal resolution of contamination with micropollutants in various environmental matrices from water, sediment and soil to biota and humans.



### LSI – Isotope analysis

The Laboratory of Stable Isotopes ([LSI](#)) has know-how in the analytics of stable isotopes for more than 25 years. It holds several methodological patents which are licensed and acts as reference laboratory for the International Atomic Energy Agency (IAEA). Core competences are online component specific analyses (GC, TCEA, HPCL), the development of methods for isotope analysis for gaseous, solid and liquid samples, quality control and management as well as the development and calibration of international reference materials.



### MOSAIC – Hydrogeological subsurface exploration

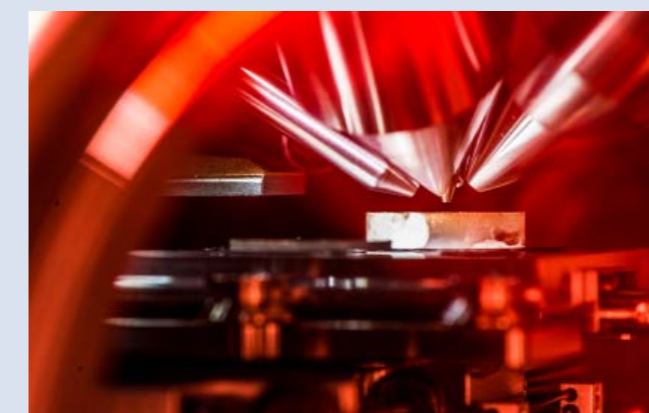
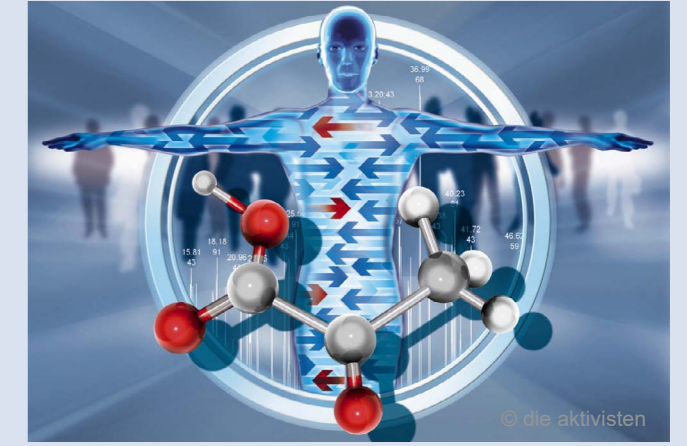
[MOSAIC](#) (Model Driven Site Assessment, Information and Control) is a platform for the model-based, high-resolution exploration of complex subsurface structures by applying and combining minimally invasive methods. The platform combines various methods such as direct push technologies, on-site analytical methods, geophysical, tomographic, as well as hydrogeological techniques. A further innovative approach is the adaptive site investigation.



## Technology platforms

### Prometheus: Metabolomic and proteomic mass spectroscopy platforms

The [Prometheus](#) platform offers most modern mass spectroscopy (GC and LS/MS) to identify and quantify exogenic and endogenic metabolites in epidemiological studies and cellular models for metabolomic analysis, and targeted and non-targeted proteomic analysis in simple (gel bands, affinity-enriched) and complex samples (extracts from cell culture, tissue, body fluids, microbial consortia). For microbial ecology, we use our Protein-SIP (stable isotope probing) approach and bioinformatics tools. All analyses combine our expertise with cutting-edge lab equipment.



### ProVIS – Visualisation of biochemical processes

[ProVIS](#) (Platform for visualisation of biochemical processes at the cellular level) provides a unique pool of scientific equipment combining imaging technologies with methods for chemical analysis to study biological samples, structures and surfaces on a nanometer scale. The technology comprises high-resolution atomic force, electron and ion microscopy as well as several mass spectrometry methods which are used to answer questions from fundamental research to applied science.

### TESSIN/VisLab – 3D-Visualisation centre

The Visualisation Centre ([VisLab](#)) provides a platform for scientists from various fields to explore and analyse complex and spatially heterogeneous data sets. By way of an interactive large-area stereo projection screen, scientists can immerse themselves in the projected environmental data and, thereby, acquire new insights into scientific questions and problems. Furthermore, the platform offers opportunities for knowledge transfer between researchers on the one hand side and to interested citizens on the other hand side.



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