Imitating sunlight – TERENO's preAlpine observatory has a new measurement chamber called the "NEE", which stands for Net Ecosystem Exchange. The special white, red and blue colored LEDs in the ceiling of the NEE chamber imitate sunlight and allow plants within the chamber to carry out photosynthesis. Unlike previously installed chambers, this allows researchers to measure the difference between CO_2 emissions and CO_2 uptake during photosynthesis. Dr. Benjamin Wolf (pictured) and Dr. Rainer Gasche have begun operating the chamber.

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

Newsletter 1/2018

CONTENTS

International TERENO Conference
October 8–12, 2018
Berlin

Improving observation

Terrestrial environmental research is constantly evolving, as the latest technologies and methods allow more precise measurements, a better understanding of processes and, ultimately, more accurate forecasts regarding future changes to our environment. The state of today's research and top-priority challenges facing the Earth and environmental science community are among the important topics at the second TERENO International Conference in Berlin in October 2018. Experts from around the world are expected to attend.

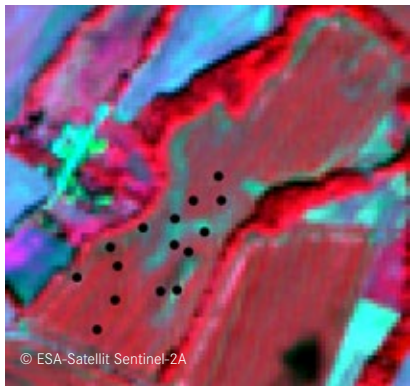
HELMHOLTZ ASSOCIATION

SMART FERTILIZATION

"AgriFusion" project develops web module for farmers

How can farmers increase their crop yields without causing undue stress on soil and groundwater? How much fertilizer is really necessary at a given location? As so often the case, it's about getting the dosage right. To help farmers determine the right amount of fertilizer required for their fields, the "AgriFusion" project is creating potential yield maps based on various data sources. Project partners are also developing an AgriFusion web module, which farmers will be able to use to calculate the yield potential of their fields.

Potential yield of fields can be derived from ground measurements (b.l.) and satelite data (b.r.).



"We are combining remote sensing data, terrain models, soil maps and yield mapping data to generate a detailed picture of a given location's yield potential," explains Katharina Heupel from the Helmholtz Center Potsdam – German Research Center for Geosciences (GFZ). Taking part in the project along with the GFZ are Weihenstephan-Triesdorf University of Applied Sciences and two companies: Fritzmeier Umwelttechnik GmbH and Geoinformationsdienst GmbH.

Ground-based reference measurements

"The GFZ's role in the project is to provide information from optical satellite and radar data," explains Heupel's colleague Dr. Daniel Spengler. To derive yield-relevant vegetation data from the satellite images – including biomass, leaf area index or chlorophyll levels – the researchers need ground-based reference measurements, i.e. validation data. For this, they rely on data validation areas in Bavaria and Brandenburg, as well as ground-based data gathered in the Demmin region. Demmin has long been part of TERENO's Northeastern German Lowland observatory, which is used by several different research institutions for calibration and validation.

Last but not least, the local knowledge of farmers is also included in the mapping process and integrated into the model. "After all, the farmers are generally the ones most familiar with their fields," says Heupel. The module is expected to be available upon conclusion of the project in October 2019.

▶ Project "AgriFusion"

EDITORIAL

Eye on Berlin

Dialogue and exchange are critical to continued progress in science and research. With our second TERENO International Conference (Berlin, October 2018), we want to give researchers from around the world the opportunity to discuss the newest approaches and latest developments in terrestrial environmental research. The task at hand is clear: we must further increase collaboration across disciplines and develop ways to forecast environmental change over the coming decades. The long-term research conducted within TERENO and other networks provides an important foundation for this.

But we need more than that. Last summer, 120 research institutions from 21 countries submitted a proposal to the European Union to make eLTER a permanent European infrastructure. This marked an important step towards even greater collaboration and an even stronger foundation for collecting long-term data (see p. 6).

The importance of such data is made even clearer by issues such as the massive decline in insect biomass in Germany. TERENO, too, is investigating these developments; our long-term insect monitoring at TERENO's Harz/Central German Lowland observatory (see p. 8) provides one such example. Biodiversity research will be another focus topic at the TERENO conference in Berlin, along with cosmic-ray neutron sensing, hydrological modeling and greenhouse gas emissions. We look forward to a lively exchange in Berlin!

But first: I hope you enjoy this issue of the TERENO newsletter.

Sincerely, **Harry Vereecken**

TERENO Coordinator


© University of Copenhagen

"A TRENDSETTER FOR HYDROLOGICAL OBSERVATION"

Interview with Danish hydrogeologist Prof. Karsten Høgh Jensen, member of TERENO advisory board

Karsten Høgh Jensen, Professor at University of Copenhagen, is an expert for hydrogeology. He is director of the Danish Hydrological Observatory HOBE and member of the TERENO advisory board since its start in 2008. In 2017 Karsten Jensen was honored with the Helmholtz International Fellow Award. In addition to the € 20,000 in prize money, the scientist received an invitation to conduct research at one or more Helmholtz centers.

Prof. Jensen, congratulations for receiving the Helmholtz International Fellow Award. Which Helmholtz center do you want to visit and what will be the topic of your research in Germany?
I mainly want to visit Forschungszentrum Jülich but the Centre for Environmental Research could also be interesting to visit as I share research interests with this center as well. Our group has collaborated with the Agrosphere Section of the Institute of Bio- and Geosciences in Jülich for many years and I would like to further expand the collaboration between the groups. This could also involve exchange of students at all levels. Hydrological observation and modeling at catchment scale has been my main research interest in recent years and this is a research topic I share with the Agrosphere section. This will therefore be a natural topic for collaboration during my visits.

Sustainable water management gets more and more important. In your opinion, what are the key research questions in hydrology?
Sustainable water management requires a solid scientific understanding of the hydrological processes, their mutual interaction and their integration at catchment scale. We need to expand our knowledge of these processes and this is where hydrological observatories come into play.

What are the main tasks of these observatories?
In dedicated hydrological observatories we can carry out integrated field observations and experiments at different spatial and temporal scales using traditional but not least innovative ground-based, air- and satellite-borne sensors in order to understand how catchments respond to seasonal, inter-annual and long-term dynamics as well as extreme events. Most importantly hydrological observatories are necessary platforms for development and testing of spatially distributed hydrological models, which can provide integrated descriptions of the hydrological dynamics at catchment scale. Such models are required in order to carry out sustainable water management at catchment scale.

You have been a member for the advisory board since the beginning of TERENO. How would you assess the development of TERENO?
TERENO has experienced a tremendous development over the years and it has been a trendsetter for hydrological observation and observatories around the world. The activities and the collaboration with TERENO have been of immense inspiration for our HOBE project in Denmark. The observation and modeling platforms developed by TERENO and also the research results produced are indeed impressive. I very much look forward to the forthcoming TERENO conference where I expect that new exiting research results from TERENO will be presented.

What should be the next steps for TERENO?
I commend TERENO for its commitment to making the data available to all interested parties through the data portal TEODOOR. Future activities in TERENO could include expansion of observation modes to atmospheric processes. Upscaling findings from the TERENO sites to regional scale would also be of significant importance.

You mentioned the HOBE project, which exists since more than ten years. What are the main results?
One of the main drivers behind the HOBE project was to obtain better estimates of the water balance at different spatial scales and not least at catchment scale. Through the research activities we have obtained a much better understanding of the hydrological processes in Skjern catchment including their quantification and associated uncertainty. This applies particularly to precipitation where improved bias correction models have been developed and to energy fluxes where the dynamics over different land surfaces have been analyzed. Integrating these findings and data from satellite platforms in a hydrological model the water balance at catchment has come to much better closure.

And what are your plans for the future?
The future of HOBE is unsure as we have not yet secured funding to maintain the full infrastructure. Through national funding three flux stations have now become part of the ICOS network and we will be able to continue the measurement program for these stations until 2021. The remaining part of the infrastructure will probably need to be closed down in 2019 unless new funding appears. In this regard we are hoping that the new European Hydrological Data Platform ENOHA may help.

Why is it important to strengthen international cooperation?
Because we need to share knowledge and experience gained under different climatic and hydrological conditions such that the research findings can be generalized. We also need to share experiences with new instrumentation. A very important issue is that a common data platform is established such that data collected at different sites can be archived for the future and made readily available for other researchers for hypotheses testing and validation of models.

Prof. Jensen, thank you very much!

TERENO INTERNATIONAL CONFERENCE OCTOBER 8–12, 2018 IN BERLIN

International TERENO Conference provides overview of current terrestrial environmental research

For five days in mid-October, the world of terrestrial environmental research will focus its attention on Berlin as TERENO hosts its second TERENO International Conference. The conference is a chance for experts from around the world to review and discuss the latest approaches and developments. Participants from all Earth and environmental science disciplines can look forward to 15 sessions on a wide array of topics. The conference will focus primarily on the major environmental challenges brought about by climate and land-use change. Each of the 15 sessions will begin with keynote lectures by leading experts and include a mix of oral and poster presentations. The program also includes excursions to the Telegrafenberg at the Helmholtz Center Potsdam – German Research Center for Geosciences (GFZ), to SoilCan lysimeter sites at the Leibniz Centre for Agricultural Landscape Research (ZALF), and to the German Aerospace Center's site in Berlin-Adlershof.

Conference location:
Umweltforum, Pufendorfstr. 11, 10249 Berlin

Additional information on the conference program, including various sessions and excursions, is available at:

▶ www.ufz.de/tereno2018

Dates and deadlines:

Registration: open now (early-bird discount until July 15, 2018)

Abstracts: must be submitted by May 31, 2018

HIGHLIGHTS

Focus on long-term environmental research networks:

One of the big challenges facing today's environmental researchers is forecasting environmental change over the coming decades. Long-term environmental research is the key to understanding the processes and impacts of changing environmental systems. Various national and international networks, such as ILTER, ICOS, eLTER and TERENO are tackling this challenge. TERENO's October conference will bring together representatives of various environmental research networks to discuss new approaches to integrated environmental observation. Among the new activities to be presented in Berlin is the new Helmholtz initiative MOSES (Modular Observation Solutions for Earth Systems) – a network focused primarily on investigating dynamic environmental events such as droughts and floods.

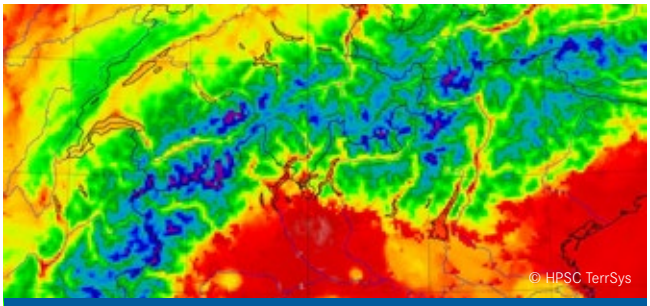
Innovative measurement methods and data management:

Innovative new measurement methods – whether ground-based, air-based (remote sensing) or via the latest Earth observation satellites – provide scientists with an increasingly accurate look at the current state of our environment and the changes it undergoes. The TERENO conference in Berlin will present a number of new measurement methods, including cosmic-ray neutron sensing for measuring subsurface soil moisture, new approaches to biodiversity monitoring, as well as advances in remote sensing. Technological advances in environmental monitoring, however, also create new challenges as data volumes grow and need to be managed. This will be another focus topic at the 2018 conference.

Integrated environmental research:

Integrated approaches to environmental research – ones that allow collaboration between various disciplines – are essential to understanding the complexities of structural and functional ecosystem change. At this year's TERENO International Conference, scientists will present the many facets of modern environmental research: everything from biodiversity research, hydrological modeling and soil research, to researching greenhouse gas interactions and measuring bio-geochemical processes in the soil-plant-atmosphere system.

FALL SCHOOL FOR SUPERCOMPUTER MODELING



TerrySMP is able to predict air temperature, for example.

As in many other disciplines, supercomputing is becoming more and more important for terrestrial modeling – not just for climate research, but also for hydrology or georesources research. In September 2017, 31 young scientists from around the world gathered in Bonn for the second Fall School of the Centre for High-Performance Scientific Computing in Terrestrial Systems (HPSC TerrSys) to learn more about terrestrial modeling and data assimilation in supercomputing environments.

The program focused on application of the Terrestrial Systems Modeling Platform (TerrSysMP), a modeling system developed by a team of scientists based in Jülich, Bonn and Cologne. Participants from a range of geoscientific disciplines learned how to use such fully coupled model systrems, where hydrologic, land surface and atmospheric models interact. Fall School sessions included extensive daily hands-on training, which is key to helping young scientists better understand such complex modeling tools and use high performance computing (HPC) systems efficiently. Along with practical exercises using the Jülich supercomputers, the program included lectures by HPC specialists from the Jülich Supercomputing Centre as well as European and American experts. Topics included Big Data analyses and visualizations as well as geoscience topics such as the use of hydrological models to evaluate the role of groundwater in the climate system.

The Fall School 2017 received additional support from the EU project Energy Orientated Centre of Excellence in computing applications (EoCoE). In 2018, the Centre for High-Performance Scientific Computing in Terrestrial Systems will again host a Fall School in cooperation with the the Geoverbund ABC/J, albeit this time in Ghana, West Africa, in the context of the Pan-African Soil Challenge, funded by the German Federal Ministry of Education and Research.

▶ Dr. Klaus Görgen E-mail: k.goergen@fz-juelich.de
▶ Dr. Wendy Sharple E-mail: w.sharples@fz-juelich.de

TERENO WORKSHOP CELEBRATES 10 YEARS

In September 2017, TERENO conducted its annual workshop for the tenth year in a row – this time organized by the Karlsruhe Institute of Technology's Institute of Meteorology and Climate Research (IMK-IFU) and held in beautiful Garmisch-Partenkirchen. More than 60 experts convened to take part in lectures and workshops focused on the interaction between soils, plants and atmosphere. TERENO's annual workshop is a chance for TERENO researchers as well as guests from other research organizations to meet and discuss their latest projects and findings.

Excursion to the Schneefernerhaus research station at the Zugspitze

The broad spectrum of lecture topics included: remote sensing data for terrestrial research, direct and indirect effects of elevated CO_2 levels on ecosystem matter fluxes, and the use of cosmic ray measurements for hydrological process studies, to name just a few. The coordinator of the Helmholtz project MOSES Dr. Ute Weber updated participants on the status of activities related to the highly mobile and flexible modular observation system MOSES, which is designed, for example, to capture data on short-and long-term impacts of heat waves or hydrological extremes. Lecturers were also joined by several young researchers, who presented their work in the various TERENO observatories. A poster session provided workshop participants with the opportunity for a more in-depth look at ongoing TERENO projects and activities.

Three special discussion forums focused on the interaction between TERENO, MOSES and the Integrated Carbon Observation System (ICOS) initiative, as well as TERENO activities in the area of cosmic ray measurements. Workshop participants also considered which topic areas in the area of integrated modeling would be suitable for a more comprehensive approach involving multiple research centers.

The independent scientists on the TERENO advisory board praised TERENO's very successful research activity, which has gained considerable visibility internationally. To wrap up the workshop, an excursion to the Zugspitze provided members of TERENO's advisory board and scientific steering committee with the opportunity to familiarize themselves with the Schneefernerhaus environmental research station and its work in the area of altitude and climate research.

▶ TERENO Workshop 2017: Program and lectures

ON THE WAY TO A EUROPEAN RESEARCH INFRASTRUCTURE

eLTER conference in Malaga discusses next steps

All eyes are on Brussels among Europe's environmental researchers. In summer 2017, 120 research institutions from 21 countries submitted a proposal to the European Union to include the European Long-Term Ecosystem and Socio-Ecological Research Infrastructure (eLTER) – a European network of over 160 test areas (see TERENO Newsletter 2015/1) – in the EU's ESFRI Roadmap, which would make eLTER a permanent European infrastructure. Several TERENO members are among the institutions taking part.

ESFRI, which stands for European Strategy Forum on Research Infrastructures, was founded in 2002 with the goal of establishing and operating a common European research infrastructure across various disciplines. In late 2018, ESFRI will decide whether to integrate eLTER into its infrastructure.

At the three-day meeting of eLTER members in Malaga in late November 2017, it was clear that the ESFRI submission had generated a lot of momentum and enthusiasm. 89 participants from 28 countries convened in Malaga to learn about developments thus far, and to discuss long-term goals. Discussions centered on topics such as scientific requirements (which requirements should eLTER focus on and how can these be met?) and the future of eLTER within ESFRI (how can the existing eLTER infrastructure continue to develop within the ESFRI framework?). Common standards for the observatories emerged as an important issue. Another eLTER goal is to increase collaboration with countries beyond Europe, which is why attendees in Malaga also included Hank Loescher, Director of the National Ecological Observatory Network (NEON), USA, and Beryl Morris, Director of the Terrestrial Ecosystem Research Network (TERN) in Australia.

The eLTER community is optimistic. eLTER as a European infrastructure would provide an additional boost to ecosystem, socio-ecological, and Critical Zone research in Europe – clearly an important step towards improving research on global change and its impact on ecosystems and biodiversity.

▶ eLTER

FINAL SYMPOSIUM FOR THE GERMAN-POLISH ICLEA PROJECT

Human and landscape evolution were the key topics of the excursion to Lausitz.

Integrated Climate and Landscape Evolution Analyses (ICLEA) was a virtual Helmholtz center, which brought together German and Polish scientists for a five-year collaborative project to research climate change and landscape evolution in northern and central Europe since the last ice age. From June 7–9, 2017, some 100 scientists met at the Helmholtz Center Potsdam – German Research Center for Geosciences (GFZ) for ICLEA's final symposium.

"The long-term mission of ICLEA was to provide a substantiated data basis for sustained environmental management based on a profound understanding of processes at all relevant time scales," says ICLEA coordinator Dr. Markus J. Schwab from the GFZ. To this end, ICLEA researchers from GFZ, the University of Greifswald, the Brandenburgische Technische Universität Cottbus (BTU) and the Polish Academy of Sciences Torun, applied innovative research methods from the fields of limnogeology, geomorphology, soil science, hydrology, dendrochronology and remote sensing – with the help of research infrastructure provided by TERENO's Northeastern German Lowland observatory.

Climate change and landscape evolution in the Baltic lowlands since the last ice age were the main topics discussed at the symposium. It has been shown that since thousands of years humans impacted stronger on the landscapes as previously thought. On the other hand, lake level fluctuations underwent higher amplitudes during natural conditions during the beginning of our present interglacial than observed today. A main conclusion was that the evolution of our landscapes is very complex and many questions still remain elusive. Some of these like abrupt climate change and interactions between man, climate and the environment were taken up by invited international experts. The intense discussions demonstrated that more research is needed to fully understand our landscapes and their changes.

ICLEA Final Symposium 2017:
Abstract volume and excursion guide

▶ DOI: http://doi.org/10.2312/GFZ.b103-17037

▶ ICLEA

MOBICOS: NATURAL TESTING CONDITIONS IN A PROTECTED ENVIRONMENT

Since 2012, the Helmholtz Center for Environmental Research (UFZ) has operated a network of eight mobile laboratories called MOBICOS, which are used to research the impacts of climate and land-use change on streams. Measurement instruments and other analytical equipment housed within the containers allow researchers to study the impact of environmental oscillations on ecological processes and functioning.

UFZ researchers are using MOBICOS, for example, to investigate the impact of climate and land-use change on material fluxes. Their recent work has focused on a new approach for investigating the relationship between the transformation of dissolved organic matter (DOM) and bacterial activity. In another project, UFZ researchers were able to analyze very precisely how hydrodynamics in streams influences the structure and composition of biofilms. Their research indicates that biofilms become more compact when flow velocity and turbulence in the streambed are high and fluctuate both temporally and spatially.

Fast and easy to move: MOBICOS container

Mobile labs offer flexibility

The container-based MOBICOS labs offer near-natural experimental testing conditions. Unaltered stream water can be directed via flow-through devices to testing tanks inside the MOBICOS for analysis and ecological experiments. MOBICOS give researchers the flexibility to adjust testing conditions and equipment according to their needs, and allow them to simulate the impact of land-use changes – how ecosystems react, for example, to stressors such as excessive nutrient loads. Researchers can also investigate the effects of changes in water temperature or pollution load.

Another MOBICOS benefit: because the labs are housed in containers, the experiments and equipment are protected against damage from flooding or vandalism. The containers' simple, compact design also makes it easy to move them to other locations, which is ideal for large research areas such as the TERENO observatories. "In short, MOBICOS opens up entirely new perspectives in stream research," says Dr. Helge Norf, who coordinates the research platform.

Kamjunke, N. et al. (2017). *A new approach for evaluating transformations of dissolved organic matter (DOM) via high-resolution mass spectrometry and relating it to bacterial activity.* Water research, 123, 513-523.

▶ Doi: 10.1016/j.watres.2017.07.008

Risse-Buhl, U. et al. (2017) *The role of hydrodynamics in shaping the composition and architecture of epilithic biofilms in fluvial ecosystems.* Water research 127: 211-222.

▶ Doi: 10.1016/j.watres.2017.09.054.

▶ MOBICOS

THREE QUESTIONS FOR CARSTEN MONTZKA

Jülich geographer Dr. Carsten Montzka is the new co-lead of a working group for validating soil moisture satellite data within the Committee on Earth Observation Satellites (CEOS), an international association of remote sensing experts.

Mr. Montzka, what is the focus of your working group?
We are part of a subgroup of the CEOS Working Group on Calibration and Validation, which defines standards used by researchers around the world to validate satellite data. Within this subgroup, our focus area is soil moisture.

Why is validation important?
Satellite technology and measurement methods are getting better and better, but it is still essential to validate results to ensure the quality of the data and the products derived from it. Global satellite measurements of soil moisture, for example, have a resolution of 10 to 40 kilometers. You cannot assess the quality of this data with just a few measurement points that have a volume of a few cubic centimeters.

What is required instead?
To check the accuracy of the satellite data you need networks, such as the TERENO observatories. Of course these networks must also achieve a certain level of precision. In dialogue with the entire research community we produce a handbook, which serves as a guideline. As an example, soil probes are not the only way to generate reference data for comparing with satellite data. Cosmic ray sensors can be used as well, for example those installed at TERENO sites. But we still need to clarify the level of quality required for reference data, for example, or how many reference points are needed. We make sure to maintain an ongoing discussion with other researchers so that, ultimately, everyone can benefit from "good practice" examples.

▶ CEOS subgroup "Land Product Validation", Focus Area: soil moisture

FEWER AND FEWER INSECTS

International study sparks interest / UFZ researchers measure wild bee populations

Attracting attention in 2017 was a study by German, Dutch and English researchers (Hallmann et al. 2017), which showed that the biomass of flying insects in Germany has declined by over 75% in the last 27 years. The cause of the decline remains unclear and researchers still need to investigate how the decline varies among different insect species. Long-term research at the TERENO Harz/Central German Lowland observatory is contributing to the effort.

Grey-Backed Mining-Bees are specialized on specific willows.

Since 2010, scientists from the Helmholtz Centre for Environmental Research – UFZ have been observing wild bee populations at six primarily agricultural sites at the TERENO observatory in Germany's state of Saxony-Anhalt. According to the red lists of endangered species, the diversity of bee species in both Saxony-Anhalt and Germany overall is in decline. Of the 561 bee species native to Germany, only 207 are not considered endangered. "All the more surprising to have found 270 different bee species in our insect traps in intensively used landscapes," says UFZ researcher Dr. Mark Frenzel. "However, the data available up to now do not indicate a decrease in the number of bees during the sample period between 2010 and 2015. There were fluctuations, of course, as in 2013, when we saw two so-called 'generalist' species appear in tremendous numbers: Andrena helveola and A. haemorrhoa, neither of which depend on specific plant types or nesting habitats for survival."

The UFZ researchers activate their traps every year between April and September. In spring and early summer, each trap is emptied three times at 14-day intervals. In each test area measuring approximately 16 square kilometers (4 x 4 km), sixteen insect traps are placed within the transition zone between agricultural fields and semi-natural habitats such as hedgerows and forests. This is an important difference to the study of Hallmann et al. (2017) which focused mainly on conservation areas only. "But this does not change the fact proved by their study – that this decline is in fact a widespread phenomenon," points out Frenzel. "At the same time, it demonstrates the importance of continuous long-term measurements following the same protocols – especially in case of insect communities, which are important in terms of their huge biomass and their functions in ecosystems as well."

Sign of landscape change

Wild bees in particular play a crucial role for native crops and wild plants since, along with honey bees, they are among the most important pollinators. Quite many wild bee species, however, specialize in just a few plant species, or even just a single plant species. This makes them much more dependent on the availability of specific nesting and feeding habitats, while the honey bee can rely on beekeepers for this. Wild bees are therefore considered a good indicator species. Changes in bee fauna, for example, can reflect local landscape changes.

"At our research sites, we still do not have clear evidence of a relationship between changes in bee communities and land use," reports Frenzel. "Our results indicate that factors such as temperature and precipitation are major determinants of abundance and composition of communities." Additional research is still required here, as the time series up to now is not sufficient to provide robust results. Hallmann et al. (2017), for example, suspect that increased agricultural land use is primarily responsible for the decrease in insect biomass, and believe that climate change or landscape changes are not likely causing the drop.

Influence of climate not clear

But scientists disagree here. "Climate cannot be ruled out as an important factor, since the authors could not include all climatically relevant factors," says Prof. Josef Settele, head of the Animal Ecology group at UFZ, in an interview with the Science Media Center. "As an example, climatic effects on the landscape level, such as higher temperatures in combination with increased nitrogen input, can lead to more dense vegetation. This, in turn, can result in a cooler microclimate and mask other effects."

Many questions remain open, and new insights – such as those generated at the six sites in theTERENO Harz/Central German Lowland observatory – will continue to enrich the picture. "Even at sites with little semi-natural habitat and comparatively fewer bees we discovered significant diversity of bee species," says Frenzel. "However, although many species are occurring at the sites, only very few generalist species contribute most individuals. This led us to conclude that only a small number of generalist species are doing most of the pollination in the investigated landscapes."

Hallmann CA, Sorg M, Jongejans E, Siepel H, Hofland N, Schwan H, et al. (2017). *More than 75 percent decline over 27 years in total flying insect biomass in protected areas.* PLoS ONE 12(10): e0185809

▶ Doi: doi.org/10.1371/journal.pone.0185809

Creutzburg, F., Frenzel, M. (2016). *Langzeit-Untersuchung von Wildbienen in Agrarlandschaften in Sachsen-Anhalt im TERENO-Projekt (Hymenoptera: Apoidea).* Entomologische Zeitschrift 126 (4), 225 – 240.

▶ www.researchgate.net/publication/316601606

▶ Access to the bee data (wild bees)

▶ Science Media Center: 75 percent decline in total flying insect biomass (only in German)

CHEMICAL REACTIONS IN SOIL ANOTHER SOURCE OF NITROUS OXIDE

Soil samples from Wüstebach site

Over the last several years, agrosphere researchers at Jülich working with Prof. Nicolas Brüggemann have thoroughly analyzed soil samples of large-scale sampling campaigns at the Wüstebach site in TERENO's Eifel/Lower Rhine Valley observatory. In doing so, Brüggemann and his team have found that chemical reactions in the soil are another source of the greenhouse gas nitrous oxide (N_2O). Up to now, N_2O formation in soils has been associated mainly with microbial nitrogen conversion processes.

As part of their soil analysis, the Jülich research team measured important soil properties such as carbon content, nutrient content and pH levels, but also considered nitrogen conversion processes in the soil and their relationship to nitrous oxide emissions. This involved applying a new method developed in Jülich to determine the concentration of hydroxylamine (NH_2OH) in the soil (see TERENO Newsletter 2014/1). Hydroxylamine is a highly reactive intermediate in the first step of nitrification – a process in which microorganisms convert ammonium to nitrite and nitrate. "We were able to show that the potential nitrous oxide formation, i.e. the N_2O emitted from the many different soil samples as measured in the lab, was closely related to NH_2OH concentrations in soil," explains Brüggemann. "In short, the more NH_2OH the soil contained, the greater the N_2O emissions measured in the lab."

Lab experiment confirms analysis

Brüggemann's team used stepwise multiple regression to identify other important control variables of N_2O formation in addition to soil NH_2OH concentration; these included pH levels as well as organic carbon and manganese content of the soil. To better understand these relationships, they conducted a special lab experiment, preparing artificial soil samples with varying levels of pH, organic material and manganese dioxide (MnO_2). The researchers then added the same amount of NH_2OH to the different soil samples and measured the resulting N_2O formation. The experiment thoroughly confirmed the results of the forest soil analysis. "It demonstrated that a purely chemical process in the soil can generate significant amounts of nitrous oxide from NH_2OH, as long as microorganisms in the soil release just small amounts of NH_2OH," says Brüggemann.

Liu, S. et al. (2017). *Interactive effects of MnO_2, organic matter and pH on abiotic formation of N_2O from hydroxylamine in artificial soil mixtures.* Scientific Reports 6,:39590.

▶ Doi: 10.1038/srep39590

TRACKING DISSOLVED ORGANIC CARBON AND NITRATE DYNAMICS IN FOREST STREAM WATERS

Research over the last two decades indicates that concentrations of nitrate (NO3-) and dissolved organic carbon (DOC) are increasing in fresh water systems all around the world. Scientists have long known about the correlation between DOC and NO3- concentrations, but they do not yet fully understand why this correlation exists. It also remains unclear why DOC and NO3- concentrations – in forest streams, for example – are high or low at different times of the year. Studying the Wüstebach stream in Germany's Eifel region, agrosphere researchers from Jülich and the University of Bonn have determined that groundwater and subsurface runoff play an important role in the process.

On Earth, the biogeochemical cycles of nutrients such as nitrogen and carbon are closely linked. Increasing concentrations of NO3- and DOC causes excess nutrient enrichment, known as eutrophication, as well as coloring (brownification) of water bodies "This negatively impacts water quality, and requires an additional chemical process to remove the coloration from drinking water, which means additional costs," explains Dr.

Monitoring station at the Wüstebach stream

Roland Bol from Forschungszentrum Jülich, one of the authors of the study.

The research team was particularly interested in factors influencing lag time of DOC and NO3- in the Wüstebach stream. Traditional methods of water transit time analysis were combined with Wavelet Transform Coherence (WTC), a special method for analyzing different time series. "This made it clear that runoff significantly impacts DOC and NO3- transport depending on which type of runoff dominates the stream water at a given location: slower moving groundwater or faster flowing surface water," explains Susanne Weigand, University of Bonn, who is primary author of the study. When stream water dominated, increasing DOC concentrations corresponded to a nearly concurrent drop in NO3- concentrations. This was also the case when neither surface nor groundwater was dominant. However, the situation was different when groundwater runoff dominated. In this case, the difference between both concentrations was significantly less; in addition, it took up to several months before changes in both concentrations could be observed.

Weigand, S. et al. (2017) *Spatio-temporal dependency of dissolved organic carbon to nitrate in stream- and groundwater of a humid forested catchment – a wavelet transform coherence analysis.* Vadose Zone Journal 16.

▶ Doi: 10.2136/vzj2016.09.0077.

KIT JOINS THE BAVARIAN CLIMATE ALLIANCE

In 2017, the Karlsruhe Institute of Technology's (KIT) Campus Alpine joined the Bavarian Climate Alliance based in Munich. KIT's Campus Alpine, located in Garmisch-Partenkirchen, is used by the Institute of Meteorology and Climate Research – Atmospheric Environmental Research (IMK-IFU), which is one of six Helmholtz centers involved in TERENO. The Bavarian Climate Alliance brings together partners from the private sector, scientific community, politics and society to raise awareness for climate protection in Bavaria, disseminate information on climate-related issues, and recommend action measures. IMK-IFU now brings its scientific expertise to the alliance.

▶ Bavarian Climate Alliance

JÜLICH WEATHER RADAR GETS AN UPGRADE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The weather radar operated by Forschungszentrum Jülich and located at the Sophienhöhe in TERENO's Eifel/Lower Rhine Valley observatory is back online after its recent upgrade. With motors, control units and receiving units now replaced, the radar delivers a much stronger reception signal with less static. The upgrade was necessary because replacement parts for important components such as the radar's drive motors are no longer available today. In an effort to avoid damage to the motor, which could result in a complete breakdown of the radar over a longer period, the radar's antennae platform had seen only limited use. The new components ensure that replacement parts will be available in the future, and that the radar can remain up and running over the long term. The cost of the upgrade, in the amount of €445,000, was covered by the Helmholtz Association, the Agrosphere section at Forschungszentrum Jülich, and the DFG special research project Transregio 32. Jülich agrosphere researchers have operated the radar since 2009 in cooperation with the Meteorological Institute of the University of Bonn, which operates an identically constructed radar in Bonn. The "twin" radars can also be coupled to deliver additional data.

▶ Radar data online

RESEARCH AREA IN SPAIN EXPANDED

The regional Earth observation platform in Picassent, Spain – operated by Jülich agrosphere researchers together with their colleagues from the Universitat Politècnica de València – has been expanded to include an additional research site. Along with a citrus field near Picassent, the research team has now also installed measurement instruments in an area near Olocau, where they are researching the effects of droughts as well as of occasional flash flooding. TERENO activities in the Mediterranean region (see TERENO Newsletter 2016/2) are financed by the Helmholtz initiative ACROSS.

TWIN SATELLITES OBSERVING EARTH

On March 7, 2017, the European observation satellite Sentinel-2B was launched into orbit to join its "twin" satellite Sentinel-2A, which had been launched some two years earlier. Circling the Earth 768 kilometers above the ground, both Sentinels are busy monitoring changes in land-use, land-cover and vegetation. Equipped with multispectral imagers, 2A and 2B fly over the same spot every five days generating optical imagery with a resolution between ten and sixty meters. Data from the mission is available free of charge and is a valuable resource for TERENO researchers as well. At TERENO's Demmin site, scientists from the Julius-Maximilians-Universität (JMU) Würzburg had done preliminary work for the Sentinel-2 mission (see TERENO Newsletter 2016/1) with support from the German Remote Sensing Data Center (DFD/DLR). The Sentinel satellites, which were developed by the European Space Agency (ESA), are part of the European Commission's Copernicus program.

▶ The ESA's Sentinel-2 mission

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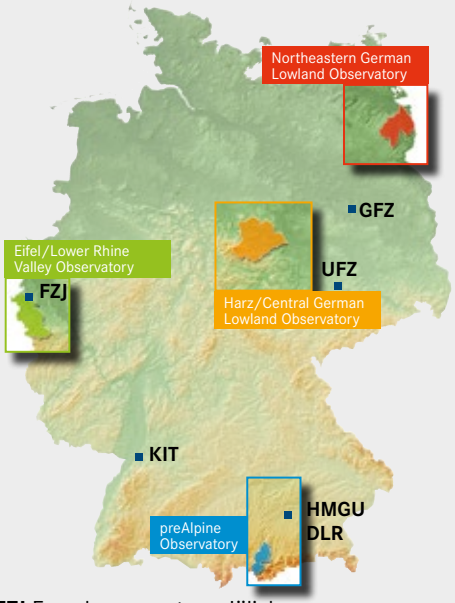

FZJ Forschungszentrum Jülich (Coordination)

DLR German Aerospace Center

KIT Karlsruhe Institute of Technology

HMGU Helmholtz Zentrum München, German Research Center for Environmental Health

UFZ Helmholtz Centre for Environmental Research

GFZ Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences

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