In the Butterfly Monitoring Germany (TMD) citizen scientists have been recording butterflies on a voluntary basis. To this end, special study plots have been set up at TERENO sites (see page 7).

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

Newsletter 2/2022

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2ND TERENO-OZCAR CONFERENCE

25–28 September 2023 in Bonn, Germany

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HELMHOLTZ ASSOCIATION

12th TERENO WORKSHOP: FROM OBSERVATIONS TO MODELLING

About 70 experts met in Garmisch-Partenkirchen from 8 to 11 November 2022 for the 12th TERENO Workshop. The event, organised by Karlsruhe Institute of Technology's Institute for Meteorology and Climate Research (IMK-IFU), was held under the motto „From Observation to Modelling".

In fine autumn weather, the workshop was rounded off with an excursion to the German Weather Service's Hohenpeissenberg observatory and the neighbouring TERENO site at Fendt.

With its annual workshop, the TERENO initiative offered participants an opportunity to exchange ideas with each other as well as with national and international partners. This was greatly appreciated all around, especially after the Corona break. After more than a decade of measurements, their integration into hydrological, biogeochemical and biodiversity modelling was presented and discussed in expert lectures and workshops. The focus was not only on measurements from the various TERENO observatories, but also from other observatories.

After the opening by Prof. Hans Peter Schmid, Director of IMK-IFU, and the report by Prof. Harry Vereecken on TERENO highlight activities in 2022, a broad spectrum of technical presentations was on the programme. Different approaches at site, catchment, regional and national scales were presented, such as the use of remote sensing and process-based models as well as AI applications for hydrological and biogeochemical issues. The implementation of measurement and simulation results into decision support tools and products for stakeholders was also discussed, especially with regard to sustainable agriculture.

For the first time, the TERENO workshops hosted a cross-Helmholtz exchange between engineers, technicians and scientists, with keynote speeches and lively discussions on the topic of sensor data workflow and quality control and assurance. Due to the very positive experience, this is to become a fixed component of the annual TERENO workshops in the future.

During the workshop, the TERENO advisory board, composed of independent scientists, also met and praised the TERENO research, which in their view has been very successful.

EDITORIAL

Germany must do more

From Germany's perspective, the last few months have been less than encouraging for efforts to combat climate change. The results of the UN Climate Change Conference in Sharm El-Sheikh, Egypt, fell well short of expectations. A short time before, the Council of Climate Experts set up by the German government had warned that Germany would miss its climate protection targets by 2030 if greenhouse gas emissions were not reduced more significantly. In October, Germany had to buy emission rights worth several million euros from other EU countries because it had not met EU targets for greenhouse gas emissions in areas such as transport and buildings between 2013 and 2020. The emergency program presented by the Federal Ministry of Transport in July to meet climate targets in the transport sector leaves a gap of 261 megatons of greenhouse gas emissions by 2030.

In fact, it should be clear: Germany must do more. The consequences of climate change can already be seen today. For example, in the TERENO's Harz/Central German Lowland observatory: More than half of the coniferous forest in the catchment area of the Rappbode dam has died in the past four years. Such developments have consequences. If the forest is missing as a filter for water, the quality of the drinking water with which the dam supplies around one million people deteriorates. UFZ scientists have investigated what should be done (see page 3). In this issue, you can also read how we plan to record the response of trees to climate extremes (pages 3 and 4), how TERENO uses citizen science approaches (page 7) and how we bring climate research closer to schoolchildren (page 9).

Happy reading!

Your **Harry Vereecken**

Coordinator TERENO

RECORDING THE RESPONSES OF FORESTS TO EXTREME EVENTS

Measurements at the TERENO site Wüstebach

The drought of recent years has left many forests in Europe severely weakened and thus more susceptible to wood parasites. Some regions have already lost half of their tree cover. A new joint project aims to create the ability to record growth reactions and stress of important Central European forest tree species in real time. For that purpose, the MW^3 project, which is funded by the Waldklimafond of the the Federal Ministry of Food and Agriculture, is developing a standardized monitoring system. In addition to RWTH Aachen University and the University of Marburg, TERENO members Forschungszentrum Jülich, Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences and Helmholtz Centre for Environmental Research - UFZ are involved in the project.

The TERENO monitoring platforms provide the basis for the planned monitoring system, which will record the most important key parameters for a cross-scale growth analysis. To this end, the team is coupling ground-based measurement data, satellite-based remote sensing and tree modeling. Meteorological parameters, sap flow, stem growth, soil water, and high-resolution spectral radiation data, among others, are recorded from different locations. The data are used in simulations and modeling to calculate energy, water and carbon balances.

CLIMATE CHANGE IS AFFECTING DRINKING WATER QUALITY

The water stored in reservoirs ensures our supply of drinking water. But climate change is endangering water quality. This is due to rising nutrient concentrations as a result of climate-induced forest loss. A research team from the Helmholtz Centre for Environmental Research – UFZ has determined this in a model study of Germany's largest drinking water reservoir: the Rappbode reservoir in the TERENO's Harz/Central German Lowland observatory.

In the catchment area of the Rappbode reservoir, which supplies about one million people with drinking water, the consequences of climate change are clearly visible. "Over the past four years, the Rappbode catchment area, characterized by conifers, primarily spruce, has lost over 50 percent of its forest ," reports UFZ hydrologist Prof. Michael Rode. The reason for this is the long periods of drought in the years 2015 to 2020. The massive loss of forest also has consequences for the drinking water reservoir. Forests filter the water, bind nutrients and are therefore necessary for good water quality. The fewer nutrients - i.e. nitrogen or phosphorous compounds - contained in reservoir water, the better it is for drinking water treatment. "This makes it more difficult for algae to develop, making drinking water treatment in the waterworks easier and more cost-effective," explains UFZ lake researcher Dr. Karsten Rinke.

Germany's largest drinking water reservoir: the Rappbode reservoir

Surprising impact

Nutrient management now faces major challenges, as the UFZ model study shows. Using data collected for over more than ten years in the TERENO network, the research team has calculated various scenarios of how climate-induced deforestation will affect the water quality up to the year 2035. "For an anticipated deforestation of up to 80 percent, the Rappbode predam will experience an 85 percent increase in dissolved phosphorus concentration and a more than 120 percent increase in nitrogen concentration within only 15 years," says UFZ hydrobiologist Dr. Xiangzhen Kong. This would result in 80 percent more diatoms and even more than 200 percent green algae. "Forest dieback as an indirect consequence of climate change has a more pronounced effect on reservoir water quality than direct effects of climate change such as elevated water temperature. We were actually surprised by the extent of this effect," Kong sums up.

The results for the Rappbode reservoir could be applied to other reservoir catchment areas in similar regions, says Michael Rode. The UFZ expert recommends: "Nutrient input to reservoir catchment areas should be reduced even more than previously, reforestation projects with drought-resistant tree species should be further promoted and reservoir systems should be adapted to the impending developments with selective water removal strategies."

Xiangzhen Kong et al. (2022). *Reservoir water quality deterioration due to deforestation emphasizes the indirect effects of global change. Water Research 221.*

▶ DOI: 10.1016/j.watres.2022.118721

Müritz National Park: measuring rainfall underneath the canopy

RAIN MEETS TREE CANOPY

Forests influence the water cycle in various ways, and the characteristics of tree canopies are an important factor. In TERENO's "Northeast German Lowlands" observatory (TERENO NorthEast), scientists have analysed data on precipitation's passage through the forest canopy, the water demand of trees, and groundwater recharge. The results show how important long-term measurements are in recording the effects of global change.

Northeast Germany receives less precipitation than other parts of Germany. This makes the region particularly vulnerable to climate change. In addition, the groundwater level has dropped in many locations in recent decades. "Since the landscape is largely characterised by forest, it is important to better understand its role in the landscape water balance. With regard to sustainable landscape management, it is particularly important to compare different tree species and forest stands," says Dr Theresa Blume from the Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, and scientific spokesperson for TERENO NorthEast.

Forest as a protective factor

In general, forests reduce surface runoff, i.e. the runoff of precipitation directly on the soil surface, – through three different processes: high water absorption and storage capacity of forest soils, the water use by trees, and storage of precipitation water in the canopy, and its direct return to the atmosphere through evaporation. "A reduction in surface runoff is mostly positive, as it reduces the likelihood of floods occurring, but also erosion and pollutants entering water bodies. In addition, more water is usually stored in the landscape in return, which is then available for humans and the ecosystem over a longer period of time," says Theresa Blume.

However, storage in the canopy and subsequent evaporation lead to changes in the amount, spatial patterns and dynamics of the precipitation reaching the soil surface. "Especially in forested regions where water is sometimes scarce, it is important to understand how different forest stands influence and reduce the much-needed precipitation, as this input is relevant for the water supply of the trees on the one hand and for groundwater recharge on the other," explains the hydrologist.

How much precipitation penetrates the forest canopy is strongly influenced by the precipitation characteristics and the properties of the forest stand. Finding out exactly how these factors, including their seasonal changes, interact and how climate change affects them is a major challenge for research. "This can only be achieved with long-term monitoring in different forest stands. Thanks to six different forest stands, TERENO NorthEast offers ideal conditions for this," Theresa Blume emphasises.

Deciduous trees favour groundwater recharge

In their investigations, she and her colleagues from the GFZ found that in summer, on average only 28 to 43 percent of the precipitation reaches the ground. In winter, it is between 33 percent for young pines and 56 percent for beech. Mixed forests, on the other hand, behave like deciduous forest stands in summer and like pine stands in winter. "We assume that leaves become less efficient as storage units during high precipitation intensities and yield to the force of the rain, while this is less pronounced in the less flexible pine needles and wooden components of the canopy," the GFZ researcher surmises.

The scientists compared their observations with the trees' water requirements and groundwater recharge. "Deciduous forest stands are advantageous in terms of groundwater recharge due to the higher throughfall in winter. Especially in the study region, groundwater recharge in summer is very low to non-existent due to the water uptake by the trees and the overall not very high precipitation amounts," Theresa Blume sums up. From her point of view, such data collections show how diverse and complex the effects of global change are - and how important a broad setup of the observatory and long-term measurements are in order to record changes.

Theresa Blume et al. (2022). *Comparative analysis of throughfall observations in six different forest stands: Influence of seasons, rainfall- and stand characteristics.* Hydrological Processes, 36 (3), e14461.

▶ DOI: 10.1002/hyp.14461

Martin Theuerkauf et al. (2021). *Holocene lake-level evolution of Lake Tiefer See, NE Germany, caused by climate and land cover changes.* Boreas, 51(2), 299-316. DOI: 10.1111/bor.12561

▶ https://doi.org/10.1111/bor.12561

OZCAR AND TERENO: IDEAL PARTNERS

In 2023, TERENO and its French partner, the Observatoires de la Zone Critique: Applications et Recherche (OZCAR), are hosting their second joint international conference. After the successful prelude in Strasbourg in 2021, it is now off to Bonn. Prof. Harry Vereecken from Forschungszentrum Jülich, coordinator of TERENO and member of the conference's Scientific Committee, explains in an interview what makes the conference so special.

Prof. Vereecken, TERENO organised the first two international conferences in 2014 and 2018 on its own, what is the advantage of a joint conference?
In general, it is always highly valuable to work together in science. A joint conference, especially with partners from different countries, also promotes international cooperation, in this case Franco-German cooperation. A partnership also broadens expertise; at our conference, the French partner brings scientific excellence in the field of "critical zone" research in particular. Events organised by partners from different countries can also help to reach even more people and networks. Last but not least, together we can organise such a conference every two years and not every four years as before.

And why OZCAR as a partner?
OZCAR is a similar network to TERENO. Both initiatives consist of multidisciplinary, well-equipped observatories and have many common research topics that complement each other, as in the mentioned "critical zone" research. In addition, both aim to advise policy makers and other stakeholders on issues such as water, soil and biodiversity. And both are committed to Europe. Not least thanks to the cooperation in the European Long-Term Ecosystem Research Infrastructure (eLTER RI), a close collaboration has grown over the years. In short: OZCAR and TERENO are ideal partners.

What does the conference offer?
It gives all interested parties the opportunity to intensify the exchange and cooperation with other networks worldwide and to learn about the latest findings and developments – of course also from TERENO and OZCAR. It is important to us that the conference contributions cover a broad spectrum of topics, not only hydrology and soil science, but also ecology and socio-ecology, for example. The conference's multidisciplinary nature makes it unique.


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2nd TERENO-OZCAR CONFERENCE

25–28 September 2023 in Bonn, Germany

Deadlines for the conference

1 March–1 June 2023
Abstract submission

15 July–16 September 2023
Conference Registration (book by 14 August for a rebate!)

▶ www.tereno-conference2023.de

GFZ WITH NEW MANAGEMENT

Susanne Buiter has been the new Scientific Director at the Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences since May 2022. The Dutch woman replaces Niels Hovius, who had led the GFZ as acting Scientific Director since November 2020. Buiter has been Professor of Tectonics and Geodynamics at RWTH Aachen University since 2020. Previously, she worked for more than a decade in various positions at the Geological Survey of Norway NGU.

For Susanne Buiter, environmental monitoring is one of the pillars of the GFZ: "The joint GRACE-FO satellite mission of the US space agency NASA and the GFZ shows that we are currently experiencing the fourth year of drought in five years and that Germany's total water storage is at its lowest levels since 2018. But gravity field measurements cannot capture how this specifically affects landscapes. For that, we need other satellites like the German EnMAP satellite, but especially regional observatories like TERENO's Northeast German Lowland observatory which is coordinated by GFZ. We can compare the data on vegetation, soil and soil-atmosphere exchange processes that we collect there with aircraft- and satellite-based information from remote sensing."

▶ More about Susanne Buiter


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© M. Mauder

MOVE TO DRESDEN

For more than twelve years, Matthias Mauder of the Karlsruhe Institute of Technology's Institute of Metereology and Climate Research was a mainstay on TERENO's preAlpine observatory team. Among other things, he was involved in the setup and operation of the eddy covariance long-term measurements, and active in the Atmosphere Coordination Team and the TERENO Scientific Steering Committee. Now he has taken over the professorship of meteorology at the Technische Universität (TU) Dresden. There he will continue to work on measurements of the exchange of energy, water and carbon between ecosystems and the atmosphere to investigate feedback between land use and climate. As Principal Investigator of the ICOS ecosystem sites of TU Dresden, he will continue to cooperate closely with the TERENO community. We thank Matthias Mauder for his tireless commitment and wish him continued success.

NEW PROFESSORSHIP

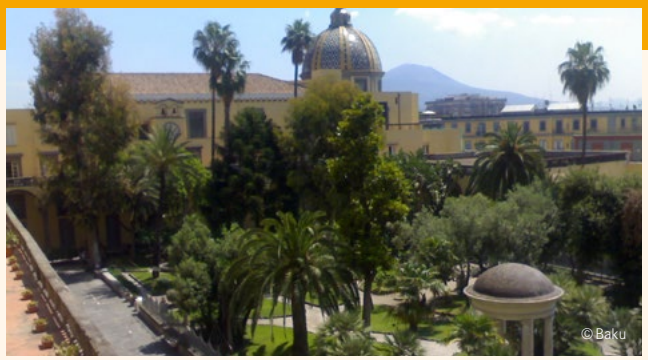
In July 2022, Nadine Rühr became professor of Climatic Ecophysiology at the Karlsruhe Institute of Technology (KIT). The professorship is supported by the Helmholtz Initiative and Networking Fund, with which the Helmholtz Association promotes new research topics, talents and the transfer of research results to industry and society. Together with her research group Plant Ecophysiology at the Institute of Meteorology and Climate Research of KIT-Campus Alpin (IMK-IFU), Nadine Rühr investigates how trees and forests respond to climate change. She focuses on the direct and long-term effects of extreme drought and heat, which she addresses using physiological, biogeochemical and ecological methods and modelling approaches. The aim is to deepen our understanding of the role of forests in climate change and hence to contribute towards strengthening the climate-resilience of forests (see TERENO Newsletter 1/2020). She is also a member of TERENO's Scientific Steering Committee.

▶ Research group Plant Ecophysiology at IMK-IFU


© KIT

8th GALILEO CONFERENCE OF THE EUROPEAN GEOSCIENCES UNION

12–15 June 2023 in Naples, Italy


© Baku

Since 2017, the European Geosciences Union (EGU) has organised the Galileo Conferences. The focus is on exchange and discussion of current geoscientific issues; therefore, about half of the conference time is reserved for debate and dialogue. Around 100 international experts are expected to attend the 8th EGU Galileo Conference in 2023. The theme of the event, co-organised by Forschungszentrum Jülich, is "A European vision for hydrological observations and experimentation".

In Europe, there are numerous national, very well equipped hydrological observatories. These include, for example, the TERENO observatories, but also the HOBE hydrological observatory in Denmark and the OZCAR network in France, both partners of TERENO. These facilities could serve as the basis for a network of European data and experimentation platforms, which could make the data from such observatories easily accessible to the research community. It could also provide models and tools for data analysis and hydrological forecasting. The aim of the conference is to improve the networking of existing observatories, but also to discuss research in such research platforms and their further development. The following main topics are planned:

- Innovative geophysical sensing methods in hydrological and critical zone research
- Hydrological monitoring and modeling with the support of UAS and satellites
- From hydro-geophysical observations to predictions (e.g. data assimilation, AI)
- Using stable isotope tracking to support hydrological process understanding
- Quantifying regional hydrological change impacts
- Big data science in hydrological research.

Further information:

▶ www.egu-galileo.eu/gc8-hydro

WHEN CITIZENS DO RESEARCH

In the future, citizens should be more involved in research. The "Citizen Science Strategy 2030 for Germany" shows how this can be achieved. There are already numerous citizen science projects in Germany, including at the TERENO observatories.

Whether counting insects, taking water samples or checking soil parameters: Collecting data means a lot of effort. It is not always possible for researchers to record everything that would actually be desirable. When citizens get involved here and volunteer to measure, count and collect, this is an important contribution to science. For some years now, such activities have been promoted through so-called citizen science projects. In its 2021 coalition agreement, the Federal German Government announced that it would further strengthen Citizen Science.

Strategy 2030 presented

Citizen Science is not just about data collection, however. In the future, citizens could, for example, contribute more to making the results of research better known or even develop new questions for science. It is an important goal of Citizen Science that science, society and politics "jointly find knowledge-based socio-political solutions for central challenges of our society", says Prof. Aletta Bonn on the occasion of the presentation of the White Paper "Citizen Science Strategy 2030 for Germany" in April 2022 in Berlin. The scientist from the Helmholtz Centre for Environmental Research – UFZ, the University of Jena and the German Centre for Integrative Biodiversity Research (iDiv) is one of the coordinating lead authors of the White Paper.

The publication, which was produced in a two-year participatory process, names 94 concrete recommendations for action in 15 fields to further develop and permanently anchor citizen science in Germany. The fields include networking and exchange, a culture of recognition, integration into educational and decision-making processes, and accompanying research. For example, a social impact indicator for citizen science based research is proposed, which could contribute to the reputation of an institution or a person in a similar way to an indicator for scientific publication.

Citizen scientists: observing nature

PROJECTS AT TERENO SITES

In the Butterfly Monitoring Germany (TMD) - a joint project of the UFZ and the Society for Butterfly Conservation (GfS) - volunteer counters have been regularly recording butterflies on more than 500 routes, so-called transects, throughout Germany since 2005. Some of these have been set up specifically in the TERENO study areas. In the meantime, an extensive and meaningful data set with over 2 million individual observations is available. Butterflies are considered excellent indicators of the status of terrestrial biodiversity. "The comprehensive TMD data enable us to analyse and interpret the population trends of many species," says UFZ researcher Alexander Harpke.

The FLOW project enables citizens to study streams and small rivers in their vicinity - for example, to measure nutrient concentrations and oxygen levels, record aquatic insects and mussels, or determine pesticide concentrations. Among the 75 measuring sites are also locations of TERENO's Harz/Central German Lowland observatory. FLOW is a joint project of the UFZ, the iDiv, and the German environmental and conservation NGO, BUND.

Both projects use the newly developed BioMe platform of the UFZ as the basis for the web application and data portal. The project participants thus have the possibility to record, archive and manage their data online via web application or mobile app. The BioMe platform offers a modular construction kit for data acquisition, management and visualization, in order to be able to sustainably realize citizen science projects, for example.

At the Demmin site, for example, the AgriSens DEMMIN 4.0 project is underway, in which the project partners are developing citizen science strategies for involving farmers (see TERENO Newsletter 2021-2). The project, coordinated by the Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, aims to enable farms to work more sustainably and conserve resources in the face of climate change. Remote sensing data will help to fertilise and apply plant protection products in a targeted manner.

Farmers are also involved in the ADAPTER project, which is coordinated by Forschungszentrum Jülich and the Climate Service Center Germany (GERICS). The project partners develop and provide innovative information products for weather- and climate-resilient agriculture, for example on the water balance and long-term regional climate change (see TERENO Newsletter 2021-1). Computer simulations are used to produce daily forecasts. The calculations also incorporate data from a network of soil moisture sensors designed in cooperation with stakeholders from agriculture. The measuring sites also include parts of TERENO's Eifel/Lower Rhine Valley observatory.

▶ White paper "Citizen Science Strategy 2030"

In German:

▶ Project ADAPTER

▶ Project AgriSens DEMMIN 4.0

▶ Project FLOW

▶ Project Butterfly Monitoring Germany

Crop growth and water balances:

IMPROVING THE PREDICTIVE CAPABILITY OF MODELS

Crop growth models are also used to assess the impact of climate change on crop production and ecological matter balances at a site. However, the predictive capability of locally calibrated models for the coupled prediction of both factors under changing climate conditions has hardly been researched. With the help of TERENO data, an international team has now tested this.

Crop growth models are often calibrated using soil and environmental data from a site. This involves checking how far the model calculations deviate from the measured values. The disadvantage of this approach: a model calibrated in this way can only be used for sites with similar climatic conditions. In addition, previous model comparisons were mostly focused only on crop growth, although climate changes always has an impact on water and material balances depending on soil properties. An international team has now compared 11 different models taking these aspects into account.

To do this, the researchers used data from the TERENO-SOILCan lysimeter network. In the network, lysimeters with intact soil monoliths were moved from one site to another to simulate the effects of climate change. For example, monoliths were moved from the Dedelow site to the warmer and wetter Selhausen and to the warmer and drier Bad Lauchstädt. "We calibrated the models with the data from Dedelow, then ran them with the climatic boundary conditions of the respective new location and then compared them with agronomic and environmental measurement results," reports Dr Jannis Groh from University of Bonn. The result: While the models calculated well-fitting predictions for Bad Lauchstädt, they could not provide satisfactory predictions for agronomic measurement data (i.e., yield) for Selhausen.

Two effects could possible be the cause: "On the one hand, the climatic conditions in Selhausen are outside the range of the data from Dedelow, and on the other hand, the models do not sufficiently take into account certain soil and plant processes that can, however, be relevant under other climatic conditions, such as heat stress," says Groh. Therefore, future simulations should take more account of soil-related data, such as water flows and system conditions. These are key to improving the predictive capability of the models.

Jannis Groh et al. (2022). *Same soil, different climate: Crop model intercomparison on translocated lysimeters.*
Vadose Zone Journal, Volume 21, Issue 4.
▶ DOI: 10.1002/vzj2.20202

BLUE-GREEN ALGAE AS CLIMATE MARKERS

An important task of climate research is to determine whether climate changes are caused by humans, or are due to natural variability. In his dissertation, Dr Ebuka Nwosu from the Helmholtz Centre Potsdam German Research Centre for Geosciences GFZ proved that cyanobacteria - also known as blue-green algae - are suitable markers that can help answer this question. During his investigations in Lake Tiefer See in Mecklenburg-Western Pomerania, a site in the TERENO's Northeast German Lowlands observatory, he made another interesting discovery based on his findings: "Humans have influenced the lake ecosystem not only in the last two centuries since industrialisation, but already several millennia before," says the researcher, who comes from Nigeria.

Ebuka Nwosu while taking samples on Tiefer See lake

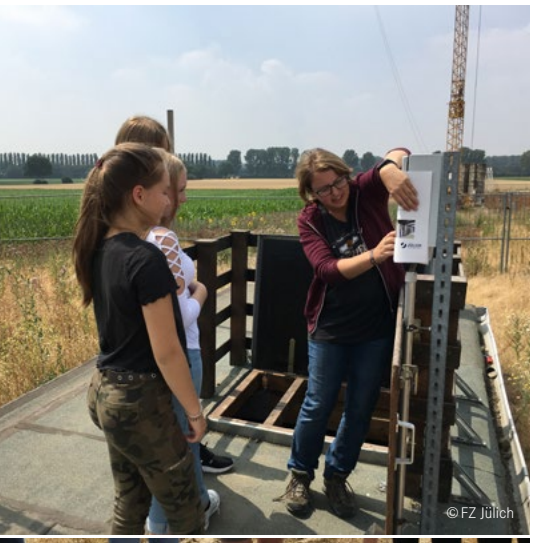
Cyanobacteria are the oldest known organisms that carry out photosynthesis. When the water temperature rises or more nutrients are available, they multiply. However, high levels of blue-green algae can degrade water quality. Some strains are even harmful to humans and animals. Nwosu and his colleagues collected samples with cyanobacteria from different places in the Deep Lake - from sediment cores taken from 11 metres of sediment depth from the deepest part of the lake, from sediment traps that collect sediment loads between the bottom and the water surface, and from water samples. Sediments are valuable climate archives because the components they contain can be thousands of years old.

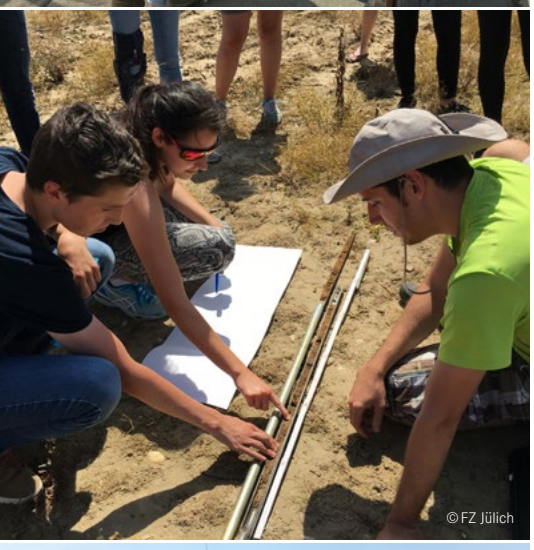
The GFZ researchers conducted microbiological and geochemical analyses on their samples, determined the age, number and composition of the cyanobacteria found, and combined their results with archaeological, climate historical and limnological data. "We were able to determine from the DNA of the cyanobacteria that the bacterial populations formed different clusters over the last 11,000 years - depending on climate changes and phases of intensive human influence. Humans have not only influenced the composition of the populations: the greater their influence, the more cyanobacteria," Nwosu summarises.

Ebuka Nwosu. (2022). *Sedimentary DNA-based reconstruction of cyanobacterial communities from Lake Tiefer See, NE Germany, for the last 11,000 years.*
▶ DOI: 10.25932/publishup-56359

FROM THE SCHOOL BENCH TO THE LAB (II)

Discovering the world of science, experimenting or even doing research yourself – in Germany there are numerous opportunities to get young people excited about science. They range from competitions such as "Jugend forscht" ("youth do research") to trial courses at a university, to student laboratories. The Helmholtz Centers participating in TERENO also regularly host students.





Pupils during the excursion to the TERENO site Selhausen

The JuLab school laboratory has been a an integral part at Forschungszentrum Jülich since 2005 - here, school classes and courses can deepen their knowledge in one of the research centre's subject areas through their own experiments and get a taste of laboratory air themselves, away from normal school lessons. For particularly interested children and young people, there are also programmes lasting several days during the holidays.

At the Institute of Biosciences and Geosciences, Agrosphere most of the school cooperations also run through this facility. Classes working on the topic of soil at JuLab learn about measurement methods used at TERENO sites, for example, to record soil respiration or the leaf area index during visits to the institute. In interactive sessions, the students gain insight into the role of these parameters in the global balance of matter and climate. Teachers and other educators - also from kindergartens - have already received further training at the JuLab and discussed with scientists how environmental research findings can be implemented in an age-appropriate way.

Once a year, at the beginning of the summer holidays, there is a visit to Selhausen. Pupils who are interested in biology as a career field then go on an excursion to the TERENO site during their one-week career exploration internship. Those who complete an internship of several weeks at the institute may even help with maintenance work and sampling at TERENO sites. Pupils can also spend up to three days at the institute during the Girls' and Boys' Days.

Most of these activities were temporarily reduced during the pandemic. However, the JuLab and the schools themselves always have ideas for new formats: For example, Institute Director Prof. Harry Vereecken was available for an online interview with an upper secondary school's course on "Education for Sustainable Development". One of the results that the upper school students want to work toward: A new experimental kit for lower school students on the topic of soil in the context of sustainability.

Involved in campaigns

The German Aerospace Center (DLR) also offers school labs at various locations - including Neustrelitz, which includes the TERENO site in Demmin. In the DLR_School_Labs, children and young people learn about current science projects at DLR institutes directly through experiments. One of the topics in Neustrelitz is research on climate change and its consequences on a regional scale. Specifically, it is about the collection of geo-bio-scientific data, which are necessary to both record and understand the consequences of climate change.

"To help high school students understand what this means, we involve them in field campaigns that we conduct annually in Demmin," says Prof. Erik Borg from the Neustrelitz site of the Earth Observation Center at DLR. During these field campaigns, remote sensing data and data products are calibrated and validated. For example, researchers examine to what extent information collected by satellite sensors matches measurement data on the ground. "In introductory lectures, participating scientists teach the students and their teachers about the motivation, implementation and documentation of in-situ campaigns," says Erik Borg.

In addition, the pupils learn how to deal with measured data time series, for example, what challenges can arise when dealing with measured data and what must be observed in order to interpret data correctly. Since DLR is conducting the campaigns in cooperation with Neubrandenburg University of Applied Sciences, the pupils also have the opportunity to exchange ideas with students involved in the campaigns and thus gain an insight into student research work.

▶ JuLab School Laboratory (in German)

▶ DLR_School_Lab Neustrelitz

For 18 years, Georg Teutsch led the UFZ.

GEORG TEUTSCH BIDS FAREWELL

On 1 July 2022, Prof. Georg Teutsch's term as Scientific Director of the Helmholtz Centre for Environmental Research – UFZ has ended. His successor is Prof. Rolf Altenburger. For 18 years, geohydrologist Georg Teutsch led the UFZ and during this time also decisively shaped the development of TERENO. As one of the founding fathers of the TERENO idea, he has supported the establishment and expansion of the initiative with great commitment since 2007. The positive development of TERENO as a network as well as the TERENO's Harz/Central German Lowland observatory, which is managed by UFZ, also bears his signature.

Georg Teutsch began his professional career in 1976 by studying geology at the University of Tübingen. He earned his master's degree at the University of Birmingham in the United Kingdom. After a two-year stopover as a research assistant at the University of Tübingen, he took a position as a hydrogeologist with the Ministry of Agriculture and Water in Saudi Arabia from 1982 to 1983. He then returned to Tübingen, wrote his doctoral thesis, went to the University of Stuttgart, and then decided to return to Tübingen. There he was director of the Center for Applied Geosciences (ZAG) until 2003. In 2004, he took over as Scientific Director of the UFZ.

In this function, he assisted greatly in launching TERENO and supporting its scientific strategy over the years. He has been motivated by the personal and professional conviction that a close link between modelling and observation is crucial to ensuring that the environmental sciences are equal to current and future challenges. Commenting on TERENO's importance for German water research in our newsletter interview (issue 2011/2), he said: "TERENO plays a very important role. For one thing, you can't understand complex systems just theoretically or with a few simplified laboratory experiments. For this, you need field sites that are suitably highly equipped in terms of instruments and thus create the necessary information redundancy for process and parameter identification. In addition, we are increasingly required to transfer the process relationships understood in detail to large scales, for example catchment or river basin. The methods used for regionalization in this process, which always involve the need for intelligent simplification, can only be verified at real test sites such as those provided by TERENO."

TERENO would like to thank Georg Teutsch for the many years of fruitful and successful cooperation and his outstanding support, and to wish him all the best for upcoming projects.

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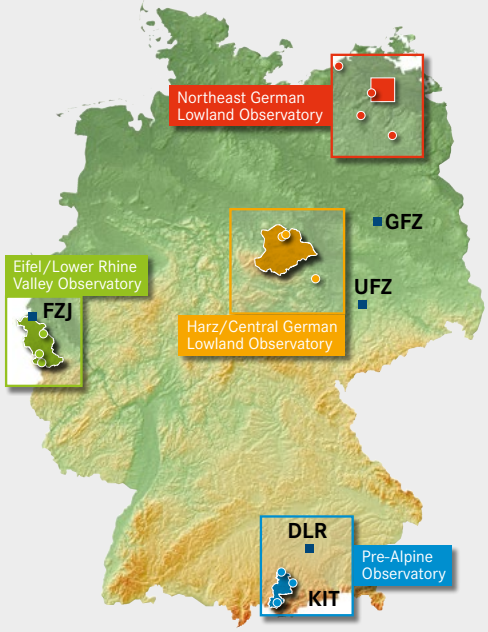

FZJ Forschungszentrum Jülich (Coordination)

DLR German Aerospace Center

KIT Karlsruhe Institute of Technology

UFZ Helmholtz Centre for Environmental Research

GFZ German Research Centre for Geosciences

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