TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

NEWSLETTER

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Photo: M. Mauder, KIT/IMK-IFU

An attraction for students too: Katja Heidbach, a Geography student at LMU Munich (left), is doing research at the TERENO observatory "Bavarian Alps/pre-Alps" as part of her diploma thesis on energy balance in grassland areas. Here she is assisting Carsten Jahn, an engineer at the Karlsruhe Institute of Technology (KIT), with maintenance at the Fendt research station.

A COMMON CHALLENGE

Climate research must pool its forces

The impact of climate change is already making itself felt around the world. For example, scientists at the TERENO observatory in the Bavarian Alps/pre-Alps are seeing the snow level in the Alps and pre-Alps take a hike north. The risk of flooding is on the rise. TERENO makes it possible to monitor local climate changes in selected regions and to draw the necessary conclusions. This newsletter showcases a number of TERENO activities including the launch of a new highly sensitive weather radar, continued efforts to equip the TERENO observatories with modern measuring instruments, as well as research into current phenomena. Scientists in other countries are researching similar problems and looking for ways to manage and solve them. Extending opportunities for collaboration and exchange is to everyone's benefit. TERENO is a key driver of cooperation within Europe. The Federal Ministry of Education and Research (BMBF) regards the project as an important building block for a European research infrastructure, as the interview with senior ministry official Wilfried Kraus makes clear.

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KNOWLEDGE ON THE GROUND

TERENO Advisory Board meeting in Garmisch-Partenkirchen


Photo: Quelle: KIT/IMK-IFU

Members of the TERENO Advisory Board on their way to the TERENO measuring station "Graswang"

The second meeting between TERENO's Advisory Board and TERENO leaders took place on October 18-19, 2009. The Advisory Board is made up of 12 independent climate and environmental research experts from all around the world and provides TERENO with advice and support on scientific questions. The meeting was hosted by the Department of Atmospheric Environmental Research at the Institute for Meteorology and Climate Research (IMK-IFU) at the Karlsruhe Institute of Technology (KIT) in Garmisch-Partenkirchen.

Presenting concepts and infrastructure

Attendees spent the first day of the meeting visiting the IMK-IFU run TERENO measuring station "Grasswang", which is located in the Ammer catchment area and is part of the TERENO observatory "Bavarian Alps and pre-Alps". Researchers at the station study how climate change affects the interaction between the biosphere, hydrosphere and atmosphere in grassland ecosystems within the Alpine region. These studies are facilitated by an in-situ open land simulation experiment along natural temperature and precipitation gradients. In a presentation to the Advisory Board, IMK-IFU researchers outlined their research programme as well as the infrastructure and equipment made possible through TERENO funding. These included a lysimeter network and rain radar as well as an eddy covariance station which measures carbon dioxide exchange and evapotranspiration - the evaporation of water through plants and soil.

Positive feedback

The Advisory Board, chaired by the US hydrology expert Professor Richard P. Hooper, held its meeting the next day at the IMK-IFU. Following welcoming remarks by Professor Hans Peter Schmid from the IMK-IFU and TERENO coordinator Professor Harry Vereecken from the Forschungszentrum Jülich (FZJ), members of the TERENO Scientific Steering Committee presented scheduled measuring campaigns and investments as well as their planned implementations in the individual TERENO observatories. Together with the Advisory Board, the Scientific Steering Committee also discussed data management and other possible ways to develop the TERENO concept for the comprehensive long-term study of terrestrial ecosystem processes. Advisory Board members welcomed the progress made to date and approved the proposed TERENO implementation plan. In the concluding discussion, the Advisory Board recommended that data and results from the TERENO sites be published and made available to the wider research community as soon as possible.

[Implementation plan]

Inspection of the lysimeter network being built in Graswang


Photos: KIT/IMK-IFU

Alpine view: scientists from the KIT Institute for Meteorology and Climate Research at work in Garmisch

EDITORIAL


Photo: Chris Taube

Research across borders

Dear Readers,
Climate change is a global challenge. The TERENO project focuses on the effects of climate change at a regional level. Although the project infrastructure is based in Germany, we are looking beyond our own borders. In the same way that we can learn from the experiences and insights gained in other countries, our work can also be of international benefit. Not just our research results, but technology and know-how too. For example, the same climatic developments which we are observing are also taking place in other parts of Europe and beyond. It might be possible to apply our findings to these different regions. It is crucial that we agree on common standards to ensure that results can really be compared with one another. To this end TERENO has established itself as an important partner in Europe. Collaborations with our closest neighbours are of course particularly relevant to TERENO, projects like the HOBE Center for Hydrology in Denmark. At the same time, TERENO is also involved in European initiatives. The EU project EXPEER (Distributed Infrastructure for Experimentation in Ecosystem Research) and the European network of observatories ICOS (Integrated Carbon Observation System) are just two examples, and are showcased in this issue. One thing is clear: in order to find answers to pressing climate questions we have to join forces – across disciplines and national borders.

I wish you enjoyable reading!

Harry Vereecken

TERENO-Coordinator

WATER FINDS ITS WAY

HOBE examines the Earth's hydrological cycle

Numerous measuring devices monitor physical, chemical and biological processes

Typical Danish countryside: the area around the river Skjern

The sun heats up the sea, the water evaporates, and the wind carries it across the land. It falls as rain into rivers or seeps through the soil into the groundwater. It can be captured as drinking water or flows back into the sea. With the HOBE Center for Hydrology one of the costliest research projects for the exploration of this water cycle was founded in Denmark.

Researchers have long been intrigued as to how exactly the water cycle functions and how to quantify the different terms in the hydrological cycle. TERENO for example needs this knowledge to be in a position to conduct an exact analysis of the effects of climate change on regional water sources. In the face of threatening water shortages research into water is highly relevant for society as a whole: growing cities need more drinking water. However because of global warming and the pollution of rivers fewer and fewer resources are at our disposal. Therefore scientists are trying to use models to determine the exact extent of groundwater reserves.

Information about groundwater resources

The HOBE Center for Hydrology in Denmark is one of the costliest research projects in this field. It is financed privately: the Villum Kann Rasmussen Foundation set up by the Danish company Velux made more than four million euros available for the project in 2007. The research is intended to supply information about the existing groundwater resources in Denmark and improve globally valid models for such calculations which up to now have shown obvious shortcomings: for example calculations suggested that the groundwater level in Denmark in 2003 was 50% less than in 1992. In reality water reserves were in all probability equal, it is just that the measuring methods and models have improved significantly during this time.

Three universities, the Danish Meteorological Institute and the geoscientific agency GEUS are involved in the HOBE Center. The researchers built an observatory in the catchment area of the Danish river Skjern, where the physical, chemical and biological processses and the interaction between them are scrutinised. The roughly 1,500 square kilometre area was chosen carefully: „The landscape around Skjern is very diverse", explains HOBE coordinator Karsten Høgh Jensen from the University of Kopenhagen. „It contains landscape structures typical for Denmark such as low lying flood plains and hilly ice-age moraines." Also of interest for the scientists: the region's sandy earth cannot store much water and is therefore especially vulnerable to climatic changes.

Oil industry know-how

Alongside standard measuring methods the HOBE researchers are using new instruments such as the SKYTEM system which was developed at the University of Aarhus. It is based on a technique which up to now has been used primarily to check for the existence of oil. A helicopter equipped with transponders flies over an area transmitting electromagnetic impulses through the earth, which generate electrical currents underground. A highly sensitive receiver measures the reaction. In this way it is possible to create an accurate topograhical map of the occurrence of groundwater down to a depth of roughly 200 metres, which in hilly terrain or towns has up to now proved too costly using standard measuring techniques. SKYTEM measurements allow scientists to determine how polluted the groundwater is and distinguish between fresh drinking water and salt water.

After going through quality control, data from the HOBE project is fed into an internet-based database, making it easily accessible for future research projects. HOBE itself will run for five years after which it is intended to be carried forward with alternative funding. TERENO would like to see the project continue. „HOBE shows that regional long-term observations of climate changes are of significance in other European countries too", says TERENO co-ordinator Harry Vereecken. Vereecken and Jensen are members of the Advisory Boards of their respective organisations; they would like to further extend their cooperation in the future. ■

[HOBE Center for Hydrology]

HOBE coordinator Karsten Høgh Jensen

HOW THE GREENHOUSE EFFECT INFLUENCES THE GREENHOUSE EFFECT

TERENO works closely with European and global networks

Without greenhouse gases the Earth would be an arctic desert. Plants and soil constantly release gases such as water vapour, carbon dioxide (CO2), methane, and nitric oxide (N2O) into the air through respiration and organic degradation processes. In so doing they contribute to raising the Earth's surface temperature by 33 degrees Celsius to an average of 15 degrees Celsius. However, industrialisation has led to ever increasing amounts of greenhouse gases being churned out into the atmosphere. The consequences are increased global warming and climate change. Together with other TERENO partners, the Karlsruhe Institute of Technology (KIT) wants to find out how climate change, eco systems, and the interplay of greenhouse gas production and absorption by plants and soil influence each other. This aligns them with European and global networks for greenhouse gas research.

Imminent dangers from out of the ground

„In addition to CO2, methane and nitric oxide are also playing an increasingly important role in climate change", explains Professor Hans Peter Schmid from the KIT Institute for Meteorology and Climate Research. For example, changes in agricultural land use, such as more intensive farming or forestry, lead to changes in hydrology and microbial activity in the soil. When combined with global warming, these can lead to increased levels of methane being released. This is one of the reasons for the rapid growth in global methane levels in the atmosphere, which in turn spurs yet more global warning. The increasing levels of nitric oxide in the atmosphere are being driven by the use of fertilizers, both intentional and unintentional, as the nitrogen in the fertilizers causes soil-based bacteria to produce more N2O. "While we know a lot about the individual processes, what we are dealing with here is a family of processes, which influence each other" explains Schmid. "As a result, we have to consider all of the factors, such as the interaction between water vapour, temperature, solar irradiation, and rainfall, as well as the amount of greenhouse gases which are released and absorbed by plants and soil". To this end TERENO is equipping its observatories with additional measuring instruments.

The goal is to develop models which can be applied to different ecosystems with a degree of flexibility. This would enable researchers to apply measurements taken on a smaller scale to larger areas and to make predictions. "Only then will we be able to gauge what the consequences are, and take targeted measures" says TERENO coordinator Professor Harry Vereecken from the Forschungszentrum Jülich (FZJ). As such, TERENO is an important partner of the planned European network of observatories ICOS (Integrated Carbon Observation System) which is set to study greenhouse gas exchange in Europe. The TERENO data on CO2 exchange will be made available to the scientific community via the global network FLUXNET. ■

[ICOS-Network]

Top: Eddy covariance station at the Graswang measuring station in the upper Ammer catchment area
Bottom: Installation of eddy-covariance-instruments above the highmoor/mountain pine area Hochmoor-Spirkenwald at the TERENO station "Schechenfilz", Upper Bavaria

International cooperations with TERENO partners (selection)

- Center for Ecology and Hydrology, Edinburgh/UK
- DIGISOIL Collaborative Project
  http://www.igr.ro/proiecte/digisoil/
- ENTRANCE HGF-JL - ENvironmental TRANsition of Chinas Ecosystems under predicted climate change
  http://www.imk-ifu.kit.edu/75_792.php
- EXPEER – Distributed Infrastructure for Experimentation in Ecosystem Research) coordinated by L'Institut National de la Recherche Agronomique - INRA (Dr. Abad Chabbi), France
- FLUXNET
  http://www.fluxnet.ornl.gov/fluxnet/index.cfm
- HOBE - Center for Hydrology, Denmark
  http://www.hobecenter.dk/
- Hydrogeophysics and Ecohydrology (MoU)/ Lawrence Berkeley National Laboratory/USA
- ICOS - Integrated Carbon Observation System
  http://www.icos-infrastructure.eu/
- Joint Research in the field of agrosphereic research
- LTER-Europe – European Long-Term Ecosystem Research Network
  http://www.lter-europe.net
- KLIMZUG-NORD
  http://klimzug-nord.de/
- Institute of Atmospheric Physics, Chinese Academy of Sciences
- iSoil – Interactions between soil related sciences
  http://www.isoil.info
- NitroEurope IP
  http://www.nitroeurope.eu/
- PEER – Partnership for European Environmental Research
  http://www.peer.eu
- PROCEMA HGF-VI - Regional Precipitation Observation by Cellular Network Microwave Attenuation and Application to Water Resources Management
  http://www.imk-ifu.kit.edu/1179.php
- RSSC-West-Africa - "Regional Science Service Center for West Africa"
- SMOS - Soil Moisture and Ocean Salinity
  http://www.esa.int/esaLP/LPsmos.html
- Tel Aviv University/Israel
- The Water Institute (Unversity of Waterloo)
  http://www.uwaterloo.ca
- University of Szczecin/Poland
- WESS – Joint Research Centre Water & Earth System Science
  http://www.wess.info

“JOINING FORCES”

EXPEER promotes European network

Forests, meadows, fields and rivers each have their own unique habitat. The impact of global climate changes on these ecosystems is equally diverse. The EU project EXPEER (Distributed Infrastructure for Experimentation in Ecosystem Research) is spear-heading research at a European level. TERENO is one of the 37 partners. “In the future, climate issues will need to be addressed at a global level, that’s why we have to join forces”, stresses Steffen Zacharias from the Helmholtz Centre for Environmental Research (UFZ) and a member of the TERENO Coordination Team.

EXPEER supports the utilization of existing European research infrastructures. “For example, with EXPEER we are able to support young European scientists to visit and work at TERENO observatories” TERENO coordinator Heye Bogena from the Forschungszentrum Jülich (FZJ).


Photo: Expeer

Map showing the locations of the 37 partners of the EU project EXPEER

Recreating climate change

Scientists should be able to use and analyze the collected data all around the world. To this end EXPEER will establish standards for collecting data. Additional data is intended to spur further analyses. As of next year the UFZ will experiment with agricultural cultures or grassland in large greenhouses, in which researchers will be able to control the precipitation rate or temperature and observe how plants react. “Recreating climate change in miniature” explains Zacharias.

Scientists at the FZJ are also developing methods within the framework of EXPEER that will make it possible for local data from EXPEER observatories to be applied to larger areas in Europe through remote sensing data and modeling. “The combination of experimental data and modeling will allow us to get a better handle on biogeochemical material flows in Europe, for example of water, carbon and nitrogen” explains Professor Harrie-Jan Hendricks-Franssen from the FZJ, who is coordinating this sub-project.

In the long-term, researchers want to develop models which will enable them to make predictions on a larger scale. “It would be like it is with the weather. A farmer could pull up a soil moisture forecast on the internet that would help him decide when to irrigate his crops”, explains TERENO coordinator Professor Harry Vereecken from the FZJ. ■

Geophysical site investigation at the TERENO observatory „Harz/Mid-German Lowlands“


Photo: Steffen Zacharias/UFZ

CLIMATE RESEARCH'S CRITICAL ROLE

An Interview with Wilfried Kraus from the Federal Ministry of Education and Research

Protecting the climate is above all a global challenge. Germany and Europe are leading the charge. They must build on this role and make it an international one. Senior ministry official Wilfried Kraus, head of the Sustainability, Climate, Energy Department at the Federal Ministry of Education and Research (BMBF) explains how climate research will make this possible.

Senior mininstry official Wilfried Kraus

The BMBF has been a rigorous supporter of climate research in Germany for years: to what end?

It is absolutely clear that we have to stop or at least slow down the rate of climate change. That is why Germany has pledged to cut greenhouse gases by 25% by 2020 compared to 1990 levels. Beyond that, we have to find ways to adapt to changes in the climate. With this in mind we need to gain a better understanding of the climate system and develop concrete practical strategies. A solid data base is essential, and will benefit researchers all over the world. In addition, it could also serve as an impetus for the UN Intergovernmental Panel on Climate Change (IPCC).

What is Europe's role?

Germany and Europe are at the vanguard of climate research. We want to develop this role and use it to spur climate protection and safeguard against negative climate outcomes. But Europe should not limit itself to its immediate sphere of influence, such as with the IPCC. Instead it should, for example, assist developing countries and emerging markets in scientific capacity building. The BMBF has earmarked up to 90 million for the setting up of regional research centres devoted to climate change and adapted land management in South and West Africa over the next few years. The aim is to improve the resources available to African scientists, find solutions for current climate-related problems in the region and improve its ability to adapt to them, particularly in the area of land management.

What are Europe's climate research plans?

The EU is currently developing a Joint Programming Initiative on this issue to consolidate Europe's climate knowledge. It will call for a more intensive exchange of data and results as well as better coordination of research activities. This will make research more efficient, and policy making too. The European Institute for Innovation and Technology (EIT) is already active. The EIT has set up Knowledge and Innovation Communities (KICs) to improve Europe's competitiveness – in research and education. The KIC for climate research was set up in December 2009. The list of partners includes well-known universities, research organizations and businesses. Furthermore, preparations are underway for the EU's Eighth Framework Programme (FP8) for research which will start in 2012.

What is the significance of these preparations?

FP8 will set out which areas of climate research the EU will provide funding for over the following seven years. In the last two programmes Germany was one of the leaders in climate research. Of course that is something we want to see continue. The BMBF is currently working on recommendations together with representatives from science and industry. They will already be put forward this year, and will hopefully find their way into the EU's work schedules.

What can TERENO achieve for Europe?

Although TERENO has a national infrastructure scientists from other countries can benefit from its experiences. A number of its findings can conceivably be applied to other regions in Europe or to other continents. Furthermore, researchers within the framework of TERENO don't just collect local data, they also run climate simulations and develop climate models. This brings them into contact with researchers from various backgrounds and different countries, as evidenced by the long list of international partners. TERENO is also an important building block for a European research infrastructure as it cooperates with existing or planned European ESFRI Initiatives.

Since the 2009 summit in Copenhagen progress in global climate protection has been derailed. Can the indirect route of research cooperation get things back on track?

In the short-term I think that it is highly unlikely, there is far too little consensus. But maybe something can be achieved in the medium-term. Countries with strong economic growth, like Brazil, Russia, India, China, South Africa, as well as developing countries such as Vietnam, are very interested in environmental and climate research cooperation. The BMBF recently introduced a new funding measure, CLIENT, which focuses on these very countries. The aim is to support international partnerships which develop and implement environmental and climate protection technologies and services. The hope is that this will reduce environmental pollution in the partner countries and contribute to global climate protection. A positive side effect of increasing climate knowledge and capacity building in these countries would be a greater consensus on global climate goals. ■


Photo: André Künzelmann/UFZ

The Bode catchment area is predominantly rural

AN EXTENSIVE MONITORING NETWORK

UFZ sets up hydrological observatory in the Bode catchment area

The long-term monitoring of environmental processes in hydrological catchment areas is one of the main tasks of the TERENO observatories. To this end, scientists at the Helmholtz Centre for Environmental Research (UFZ) are setting up a hydrological observatory in the catchment area of the Bode, which is located in the TERENO observatory "Harz/Mid-German Lowlands".
With its source in the Harz mountain range, the 169 kilometre long Bode flows into the Saale, which is an important tributary of the Elbe. Its catchment area contains one of Germany's largest drinking water reservoirs, the Rappbode-dam. The catchment area spans approximately 3,300 square kilometres, an area larger than the federal state of Saarland. Agriculture is the main land-use, and places considerable pressure on surface water and ground water, in particular through phosphorous and nitrogen pollution.

Wide ranging precipitation gradients

The Bode catchment area has been well documented. An extensive, multi-faceted network of monitoring stations has collected valuable long-term observational data on, among other things, runoff discharge formation, water quality and climatological aspects. No other region in central Germany has such a wide-ranging precipitation gradient. Annual precipitation ranges from around 1.500 millimetres in the low mountain region to 400 millimetres in the river system's lower course.
Research at the observatory encompasses a wide spectrum of disciplines covering everything from pure water research, soil research, biodiversity research and climate research to socio-scientific analysis. As a first initiative scientists at the UFZ selected two characteristic sections of the catchment area. Each has a particular site, which is being monitored more intensely and in greater detail: the Sauerbach site in the Geesgraben section and the Schäferbach site in the Selke section. The UFZ is working closely together with the Magdeburg-Stendal University of Applied Sciences at the Schäferbach site. In addition to selective small-scale monitoring the scientists from UFZ are also using remote sensing techniques to capture important information on the regionalization of the respective environmental parameters. They plan to use this data to create models, which will be able to predict future developments within the catchment area. ■

WESS RESEARCHES THE BODE

The hydrological observatory in the catchment area of the Bode river is also an important test site for the new research initiative Water & Earth System Science (WESS). The interdisciplinary centre - a cooperation between the Helmholtz Centre for Environmental Research (UFZ) and Tübingen University, the University of Hohenheim and the University of Stuttgart - focuses on the effects of global climate change and changes in land use on regional flows of material and water as well as the development of appropriate climate-adaptation strategies.

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MEASURING RAINFALL WITH GREATER ACCURACY

Weather radar operational – data available online

Let it rain. The TERENO observatory in the Eifel/Lower Rhine Valley has it covered. As of 12 October 2009 the Sophienhöhe site in the district of Düren boasts a new technological attraction –
the weather radar from the Forschungszentrum Jülich (FZJ) is up and running. The station, which cost euro1.4 million, makes it possible for scientists to measure and forecast rainfall within a 100 km radius to an even greater degree of accuracy than has up to now been possible. "We can hone in to within 200m of a particular location, and what is more, we can predict whether it will rain, snow or hail" explains TERENO coordinator Professor Harry Vereecken from the FZJ.
The new station, which is positioned on top of a 34-metre high tower, will also be able to measure wind levels. Its modern technology facilitates early detection of floods and storms. The station also delivers detailed data on the consequences of climate change at a local ecosystem level. The FZJ is operating the station in combination with the Institute of Meteorology at the University of Bonn, which has an identical weather radar. This provides a unique opportunity to improve rainfall analysis and forecasting.
The data benefit other institutions too. For example, the German Meteorological Service can improve its forecasts, and the local water boards as well as energy company RWE can optimize reservoir management and other aspects of the water supply. Data have been available on the TERENO homepage since April 2010. ■
[Data of weather radar]



Photos: FZ Jülich

Professor Harald Bolt, Member of the Board of Directors at the Forschungszentrum Jülich, cuts the ribbon at the opening ceremony for the weather radar

Press coverage

"Rain? We've finally got it covered"
WDR, 12.10.2009

"Super-radar forecasts weather to within 200 metres"
Bild-Zeitung, 13.10.2009

"Early storm warnings. New weather radar station close to Jülich even measures how big the raindrops are"
Westdeutsche Zeitung, 13.10.2009

"Radar charts climate change. New station at the Sophienhöhe site has many applications"
Kölner Stadtanzeiger, 13.10.2009

"Spot-on weather forecasts"
Dürener Zeitung, 13.10.2009

"Rain, hale, snow. The Jülich weather radar supplies detailed data"
Generalanzeiger Bonn, 20.10.2009

INCREASING RESEARCH INTO LAKE LEVEL DECLINE

Research on declining lake levels is underway at the TERENO observatory in the North-East German Lowlands

Lake levels have declined significantly at numerous lakes in north-eastern Germany, a trend which scientists have been monitoring since the 1980s. The decline in water levels is often linked to global climate change. However, the hydrological processes responsible for the declining lake levels have yet to be fully understood.

Setting the record straight

To this end, it would be useful to examine past developments and compare data from current observations with data from periods when there was a dominant lake level climate, such as in pre-medieval times. That is exactly the approach being taken by scientists from the GFZ German Research Center for Geosciences at the TERENO observatory in the North-East German Lowlands. By combining modern hydrological and lake level monitoring with data from natural archives such as tree rings and lake sediments, the researchers hope to find evidence for anthropogenic and natural causes and connections of variations in the water level.

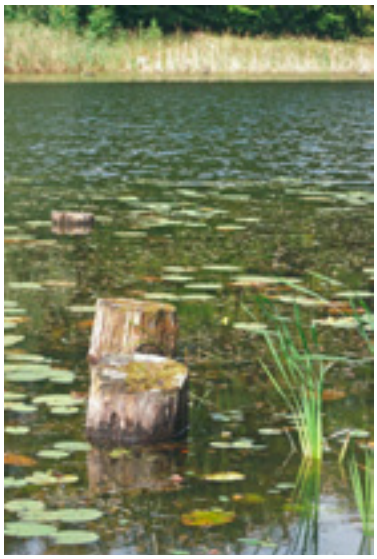
Their findings could determine if the current phenomenon is due to global warming, whether it is man-made, or a combination of both. If that is the case, then the separate factors will need to be disentangled and quantified. “We want to find out whether recent decreases in water levels are unusual in their speed and extent, or if similar changes have occurred before in the last few thousand years. Analogous situations in the past could tell us more about potential future consequences on the lake and catchment ecosystems” explains Dr. Ingo Heinrich from the GFZ, who is coordinating the dendroclimatological studies of the TERENO project at the GFZ.

Surprises from the depths

As a first step, key lake sites and various forest ecosystems within the TERENO observatory were selected for in-depth study: lakes Redernswalder, Krummer, and Fürstenseer, and the Rohrhahngrund site. The receding water line at these lakes had revealed something surprising. Numerous tree stumps had been brought to the surface. First analysis of the tree rings showed that the trees had not been under water for long. They had been planted in the 1920s and were cut in 1952. Interestingly, according to further studies at Lake Redernswalder the water level must have been at least as low as today between 1920 and 1950. Within just 30 years the water level must have risen to the peak in the 1980s, only to fall again to its current low. Scientists at the GFZ maintain that this shows just how highly dynamic and sensitive a lake ecosystem can be. Further comprehensive analysis of tree rings, lake sediment cores and other data sources such as historical documents will need to confirm these first results for Lake Redernswalder. By the same token, the other lakes will also need to be examined in more detail.

Looking into the future via the past and present

In the course of their studies, researchers have not limited themselves to analyses of dead tree trunks found in the lakes, but have branched out to sample living trees up to 400 years old around Lake Redernswalder. By examining these trees, researchers hope to gain insights into their reactions to climate dynamics since 1600 AD, and in particular, to the extraordinary changes in the twentieth century. The millimeter-thick samples of pine cores are currently being examined at the GFZ. Further chemical-physical examinations are planned to reconstruct past hydroclimatic conditions. Dr. Heinrich and the GFZ-team are receiving support from Dr. Karl-Uwe Heußner from the German Archaeological Institute (DAI). Together, the project partners are examining historical and archaeological timber samples from the region to derive detailed climatic information for the last thousand years, which will in turn provide further insights into fluctuations in lake water levels. Combining an appreciation of past developments with a better understanding of fundamental ecological processes is the key to developing new models, which will predict future developments with the help of precise evidence of the past.



Photos: GFZ

Unexpected discovery: tree stumps revealed by decline in water level at Lake Redernswalder
A second surprise: initial analyses showed that the trees had been planted in the 1920s and were cut in 1952

GFZ and ZALF Join Forces

The GFZ German Research Centre for Geosciences and the Leibniz Centre for Agricultural Landscape Research (ZALF) are joining forces in the future to pursue the TERENO research project “SoilCan”. Both institutions have signed a contract to jointly operate fully-automated lysimeter systems at the Dedelow test site. Their collaboration, along with the lysimeters, mark important additions to the TERENO observatory in the North-East German Plain.

WINNER TAKES ALL AT THE POOL

Researchers in Leipzig pit water fleas against mosquitoes

Photo: Elnur/Fotolia

A fast developer: the mosquito

Summer has arrived. And with it the days of that sting-happy pest which does its main damage at night: the mosquito. Within the framework of TERENO scientists at the Helmholtz Centre for Environmental Research (UFZ) have been researching natural solutions to guard against future attacks. Their solution: small crustaceans such as water fleas crowd out mosquito offspring.

Foreign species on the offensive

Most people find mosquitoes a nuisance, but they don't consider them dangerous. That could change in the course of climate change. Heavy rainfall, flooding, and high temperatures could lead to a rise in wetland areas such as pools and swamps – ideal spawning grounds for the little blood-suckers. In addition, such conditions could attract foreign species which transmit diseases such as malaria. "The tiger mosquito, which is reviled in the tropics and sub-tropics as a carrier of the infectious disease dengue fever, has already become established in various countries in southern Europe, Switzerland, and partly also in Germany", reports UFZ researcher Dr. Matthias Liess.

Successful trials

In the course of their study at the Middle Elbe Biosphere Reserve near Dessau, the UFZ researchers monitored numerous pools where mosquito larvae and crustaceans were found to be present during one seasonal cycle. They came to the conclusion that these habitats could not support both species at the same time. "In the long run, mosquito offspring were unable to compete for desirable food such as algae", explains Dr. Liess. To compensate for this disadvantage mosquito larvae develop at record speed: they are ready to fly their watery nest after around two weeks – long before the competition has reached the same point in development. Researchers at the UFZ employed a two-pronged strategy to counter this rapid rate of growth: the biological pesticide BTI kills the mosquito larvae, while the introduction of water fleas thwarts attempts from adult mosquitoes to repopulate the pool. This approach could lead to a reduction in the use of poisonous insecticides. The UFZ has already completed successful trials in Germany and Cameroon. A patent is pending. ■

RESEARCH AIRCRAFT MEETS SPACE SATELLITE

Scientists from Jülich and Helsinki improve soil moisture measurements

Photo: FZ Jülich

Measuring campaign takes off: the research aircraft Skyvan

Photo: Raphael Thelen

An interested onlooker: TV presenter Ranga Yogeshwar (l.)

The challenge is clear: the rate of climate change has to be, at the very least, slowed down. At the same time, many of the connections between climate and climate change have yet to be studied in sufficient detail. Just one example is the interaction of soil moisture and the salt content of the oceans with short- and long-term atmospheric developments.

This particular gap in our understanding is being addressed by the European Space Agency's (ESA) research satellite SMOS (Soil Moisture and Ocean Salinity). The SMOS satellite uses a radiometer to measure the brightness temperature of the earth's surface from a distance of 760 kilometres. This makes it possible for conclusions to be drawn about soil moisture and ocean salinity. "Up to now we have only been able to refer to imprecise or geographically limited data, despite the fact that they are key factors in the global water cycle", explains Dr. Carsten Montzka from the Forschungszentrum Jülich (FZJ), who is supervising the parallel SMOS-CalVal project.

How accurate?

However up to now the recordings of ESMOS were only low resolution. As a result, there have been a number of additional close-range measuring campaigns in recent months. One such campaign was undertaken by the research aircraft „Skyvan" from the Aalto University School of Science and Technology. With the collaboration of the FZJ it flew over various regions in Europe while taking pictures of the Earth's surface with the SMOS satellite. The TERENO observatory in the Eifel/Lower Rhine Valley is one of the European SMOS test sites. The aircraft took to the skies from Hangelar near Bonn in order to take soil moisture measurements from the TERENO observatory in the Eifel/Lower Rhine Valley alongside the SMOS satellite. Researchers will be able to verify the accuracy of the satellite recordings with the data they collected.

Television presenter Ranga Yogeshwar joined interested on-lookers for Skyvan's stopover in Hangelar. As a physicist he also once worked in Jülich. "Nobody knew exactly how accurate the satellite recordings were, so it makes sense to validate the satellite's instruments in the light of what we know now ", he explained.

The validation process will be completed over the next few months, so that the accuracy of the satellite data can be factored into future analyses. "This information will help us to gain a better understanding of the climate and thereby improve on weather forecasts, and also make it easier to predict droughts and flooding", explains Carsten Montzka. ■

[SMOS Cal/Val]

A MODEL FOR CENTRAL EUROPE

When forest and agriculture meet – the research platform „Höglwald“

Under scientific observation for more than 25 years: the Höglwald in Bavaria

About 40 kilometres north-west of Munich is the Höglwald, a pine forest over 100 years old. At first glance it does not seem unusual for a region characterized by a mixture of forests and intensively farmed land. And yet there is something out of the ordinary: for more than 25 years scientists have been using it as a long-term forest research platform. As such, it is an important component of the TERENO observatory in the pre-Alps.

Long-term consequences of nitrogen input and forest conversion measures

The Höglwald is marked by high nitrogen input from the air which has lead to an oversaturation of nitrogen in the ecosystem. The consequences are high nitrate contamination of the leachate and high greenhouse gas emissions from the soil in the form of nitrous oxide (N2O).

The Division of Atmospheric Environmental Research at the Institute for Meteorology and Climate Research (IMK-IFU) at the Karlsruhe Institute for Technology (KIT), one of six TERENO partners, is running a number of long-term investigations in the Höglwald. Among other things it is researching the long-term effects of nitrogen input and the consequences of forest conversion measures on the system's overall greenhouse gas balance. It was for this purpose that fully automated monitoring systems were installed at three research areas in 1993, where they have been measuring the exchange of greenhouse gases between the soil and the atmosphere all year round. With the help of measurements collected via a 50 metre high tower, researchers can also determine the flows of water vapour and carbon dioxide within the ecosystem.
Within the framework of TERENO, scientists at the IMK-IFU are planning to assess the exchange of trace gases at the interface between forest and agriculture. To this end, they intend to install fully automated monitoring systems in an agricultural area that borders directly on to the Höglwald. These systems will be identical to the ones that are already set up in the Höglwald and will be extended with further instruments in order to measure the amount of ammonia which is introduced into the forest through agriculture. ■

TARGETED MANIPULATION

Experimental Research Station Bad Lauchstädt explores ecosystem behaviour

Founded in 1895, the experimental research station in Bad Lauchstädt can look back on a long tradition. As far back as 1902 a longitudinal experiment was started which is still going strong, one of the oldest of its kind in the world. In it, scientists are examining long-term nutrient dynamics as a function of agricultural usage. Today the research station is part of the terrestrial ecology division of the Helmholtz Centre for Environmental Research (UFZ). It is also an experimental platform of the TERENO observatory in the Harz/Mid-German Lowlands and a component of the German and European network for Long Term Ecological Research (LTER).

Improved understanding of complex relationships

The research programme at Bad Lauchstädt covers both basic ecological research and the sustainable use and protection of ecosystems. Gaining insights into the complex relationships within these systems is at the heart of the programme and is only possible through targeted experiments. To this end, scientists at the UFZ target specific environmental factors which they then manipulate in the course of their experiments. Their targets could be influential factors which have come about through changes in the climate, in land use or in the system's species pool. By observing the ecosystem's reactions they can draw conclusions about the fundamental mechanisms of action and processes involved.

To give a few examples, they are examining carbon and nitrogen dynamics in agrarian ecosystems, analysing trace gases as a function of soil usage and the water cycle. They are also researching food chains within ecosystems, the role of certain groups of species within ecosystems and so called succession processes, namely changes in the ecosystem.

Bad Lauchstädt: 13.5 hectares of space for research

The site spanning 13.5 hectares offers the opportunity to examine diverse ecological systems experimentally within different parameters of time and space: over the course of a single season or numerous decades, from a small- or large-scale spatial perspective. In addition, researchers can carry out experiments in climatic chambers, in heated or unheated greenhouses as well as in the open air. ■


Photo: Johannes Werhahn, KIT/IMK-IFU

The rain radar in the Ammer catchment area collects data on rainfall within a 50 kilometre radius

READY FOR THE RAIN

Three rain scanners extend TERENO monitoring network

The TERENO network continues to add to the metrological infrastructure at its observatories. In 2009, the Federal Ministry of Education and Research (BMBF) allocated funds for three rain scanners within the framework of TERENO-ICOS (see page 4). The x-band weather radar systems have a 60 centimetre parabolic antenna, which operate at a frequency of around 9.41 gigahertz and a peak capacity of 25 kilowatts. Two of the scanners have already been built, the third is under construction. Scientists will use them to improve their rain data and to determine rainfall rates to a greater degree of accuracy.

The new weather radar systems collect data on rainfall within a 50 kilometre radius. They convert the data they receive in to minute-by-minute averages. Every hour the raw data are transmitted by DSL or UMTS connections to the respective TERENO data centres. The next step is to clean up any interference in the signals and convert the information into rainfall rates. To do this, the TERENO scientists draw on their own rainfall measurements as well as measurements taken at surrounding monitoring stations run by Germany's National Meteorological Service (DWD) and the water authorities.

Two systems go

The rain scanner for the Ammer catchment area in the observatory "Bavarian Alps/pre-Alps" was installed on top of a 16-metre high tower and set up on the 950-metres high Kirnberg mountain in the middle of the Ammer catchment area. In addition, a 10-metre high tower was outfitted with a weather transmitter and was placed right next to the rain radar. The transmitter records the wind, air pressure, temperature, humidity and rainfall, and also transmits these data online. The second rain scanner is located at the observatory "Eifel/Lower Rhine Valley". It sits atop a 36-metre high measuring tower in the south-west of the Rur catchment area at the Wüstebach test site in the Eifel National Park (see newsletter Nr. 1/2009). The scanner began operating in June 2010. It closes the gap in the rain radar monitoring network of the weather radar Sophienhöhe/Jülich and the Institute of Meteorology at the University of Bonn.

A site has been selected for the third scanner in the observatory Harz/Mid-German Lowlands. ■




Photo: FZ Jülich (2), KIT

Installing a lysimeter: the open-ended cyclinder is filled with soil from the ground (left). Scientists then lift the full lysimeter out of the ground and insert the measuring devices (middle). When they are finished the only parts which are visible on the surface are air holes and lightning rods (right).

SOILCAN:

installation gains pace

Work on setting up the infrastructure for the TERENO project "SoilCan" has been underway since March 2010. "SoilCan" exposes soil monolithes to differing climatic conditions to study how global change impacts matter and water fluxes in the soil (see TERENO newsletter 1/2008). There are currently 84 fully automated lysimeter systems in place at seven different sites within the TERENO observatories. Each is equipped with modern wireless technology to collect and transmit data. An additional 32 systems will be set in place by September 2010 to complete the network. The lysimeters are filled at different sites and set up along a temperature and precipitation gradient within and between the observatories. ■

TERENO observatory	Location	Number of networks	Annual mean temperature	Annual mean rainfall
Eifel/Lower Rhine Valley	Selhausen	24	10°C	720 mm
	Rollesbroich	6	8°C	1150 mm
	Wüstebach	6	7,5°C	1200 mm
Bavarian Alps and pre-Alps	Scheyern	6	7,4°C	803 mm
	Fendt	18	8,2°C	1030 mm
	Rottenbuch	12	5,5°C	1400 mm
	Grasswang	6	4,5°C	1600 mm
	Garmisch-Partenkirchen	6	6,7°C	1296 mm
Harz/Mid-German Lowlands	Bad Lauchstädt	18	8,8°C	487 mm
	Sauerbach	6	9°C	530 mm
	Schäfertal	6	6,9°C	630 mm
North-East German Plain	Demmin	6	8,1°C	555 mm
	Dedelow	6	8,7°C	483 mm

TERENO observatories with lysimeter networks

REGIONAL RESEARCH, GLOBAL APPLICATIONS

TERENO presents its work at the Deutsche Welle Global Media Forum

Scientists are relatively good at predicting global climate change. But when it comes to regional changes things get more difficult. There is a lack of models and also of knowledge about the local effects, which can be markedly different from region to region. This is the focus of the large-scale TERENO project, which is run by six Helmholtz Association Centres and cooperates with numerous universities and other institutions. Participating scientists presented their measures, aims and future directions during a workshop at the Deutsche Welle Global Media Forum, which took place in Bonn in June. Over the course of the three day meeting more than 1500 participants from 95 countries discussed the topic of "climate change and the media".

Still see the need for more research on the causes of climate change: Stefan Emeis, Harry Vereecken, Clemens Simmer und Stefan Klotz (from left to right)

"Science and society will definitely benefit from the findings of TERENO"

Stefan Klotz

"We need data covering a longer time-span, which we can analyse to develop the necessary models", explained TERENO coordinator Professor Harry Vereecken from the Forschungszentrum Jülich (FZJ) at the workshop moderated by science journalist Claudia Ruby. That is why TERENO is scheduled to run for 15 years - setting it apart from other projects. "We are not just looking at climate change from the perspective of one particular field, but are bringing together different disciplines", Harry Vereecken stressed.

"We are bringing together different disciplines"

Harry Vereecken

Researching tomorrow's ecosystem, today

To this end, TERENO is setting up four observatories, which provide a representative cross-section of German landscape types. Here too, climate changes are already forseeable. "The snowline in the Alps and pre-Alps is taking a hike north. Instead of snow we can expect more frequent rain, making dangerously high water levels and flooding more likely" said Professor Stefan Emeis from the Institute for Meteorology and Climate Research at the Karlsruhe Institute of Technology (KIT), one of the six TERENO partners. Flora and fauna are also changing - there are winners and losers. "The copper beech will suffer from worsening growth conditions in northeast and southwest Germany and will probably be cut back, whereas the walnut tree will spread", explained Dr. Stefan Klotz from the Helmholtz Centre for Environmental Research (UFZ). In addition, flora and fauna influence each other reciprocally: fewer bees and bumblebees will mean a reduced level of pollination, which in turn will reduce the amount of fruits and seeds of many plants.

Furthermore, climate change will alter the parameters for agriculture. The loss of fertile soil, the decline in water accessibility and the resulting necessity to increase productivity makes it abundantly clear: ecological consequences have considerable economic consequences too. "Because climate changes are steadily progressing we have to speed up our learning", asserted Clemens Simmer, a professor at the University of Bonn who works closely with TERENO. That is why researchers are not concentrating solely on climate change. They carry out simulations and physical experiments in order to find out today how an ecosystem might look a few years down the line.

TERENO data improve weather forecasting

The audience were especially keen to know how the general public and other countries would be able to benefit from the insights gained by the project. As they found out, TERENO has a lot to offer. Scientists at the four observatories work closely together with local authorities. TERENO data are also meant to help the German Meteorological Service to improve weather forecasts and flood warnings. There are close collaborations with scientists from other countries, the cooperation with the Centre for Hydrology – Hydrological Observatory (HOBE) in Denmark is just one example. "These collaborations help us to evaluate our data", stressed Stefan Emeis. Contacts are not only restricted to Europe. TERENO supports plans for a similar network of observatories to be set up in the Mediterranean area, including North Africa. "We are very happy to receive scientists from Africa and other parts of the world. The important thing is that they apply their newly acquired knowledge back at home", emphasized Clemens Simmer. Then TERENO scientists will in turn be able to benefit from their findings.

"We have to speed up our learning"

Clemens Simmer

In response to the question whether after 15 years of this large-scale project all essential questions will be laid to rest, all four TERENO scientists answered with a resounding "No"." Society keeps on developing, and so does science. New questions will arise. It might be the case that our findings generate even more questions than we have today", surmises Stefan Emeis. Stefan Klotz focused attention on the long time spans over which developments take place within an ecosystem: "A field can be newly tilled every year. Regenerating productive, species-rich grassland takes at least five to ten years, and forests need centuries. That's why long-term data are so important. And no matter which questions will be put in 15 years or more, science and society will definitely benefit from the findings of TERENO." ■

"International collaborations aid data evaluation"

Stefan Emeis

[Deutsche Welle Global Media Forum 2010]
[The workshop is available as an audio file]

WHEN THE WATER DISAPPEARS

Conference sheds light on current hydrological problems in north-eastern Germany

The water budget in the North-East German Lowlands is „under stress“. Ground water levels and water levels of groundwater-fed lakes have dropped in many places by one to two meters in the past twenty to thirty years. Streams are also drying up more often in summer time. 130 science, industry and government experts, as well as representatives from environmental groups, came together in Potsdam to discuss the extent, causes and consequences of the problem, as well as how best to adapt to it. The meeting “Current problems in the water budget in north-eastern Germany: trends, causes, solutions” took place in Potsdam on April 22-23 2010 and was co-organized by acatech - the German Academy of Science and Engineering and TERENO partner the GFZ German Research Center for Geosciences.

The experts identified various responsible factors: the residual effects of hydro amelioration for intensive agricultural practices in the 1950s up to the 1980s, the dominance of high water consuming pine- (mono-) cultures in forests, and climate change. On top of that agriculture on a large scale and mining at a local level place additional strains on the water supply. The call from nature conservationists to set a “maximum level of water reserves in the landscape” also partially conflicts with established land-uses.

Emphasis on intelligent management

Future scenarios for the coming decades indicate that the problems will only get worse. Additional conflicts could crop up – unless they are countered through intelligent water management. What is needed is a two-pronged approach: plugging preventable ‘leaks’ in the region’s water budget and finding a new balance for existing water demand on a case by case basis. Research has an important role to play by, for example, monitoring and modeling of water budget changes as well as by revitalizing the water budget of rivers, lakes and peatlands. These findings are of particular relevance for the TERENO observatory in the North-East German Lowlands, where historical, current and future changes in the water budget are a research focus.

Conference materials can be downloaded from the acatech website; comprehensive conference proceedings will be published in autumn 2010.

[Abstracts of the Conference]

Top: The Great Fürstenseer Lake near Neustrelitz has seen its water level fall by around 1.2 metres over the last 30 years
Middle: The Löcknitzwiesen near the municipality of Kloster Lehnin have been successfully rehydrated
Bottom: Trial run - workshop participants had to build their own test measurement system

SETTING COMMON STANDARDS

Intensive course on the fundamentals of micrometeorological flow measurements

All four TERENO observatories are equipped with monitoring stations, which measure flows of energy and trace gases with the help of the so-called eddy covariance method. The collected data provide important information on the global carbon cycle and terrestrial green house gas emissions. In April the Department of Atmospheric Environmental Research at the Institute for Meteorology and Climate Research (IMK-IFU) decided to create a forum for the discussion of the eddy covariance method as well as specific aspects of micrometeorological measurements. They offered a week-long on-site intensive course at the Karlsruhe Institute of Technology (KIT) in Garmisch-Partenkirchen. Of particular significance for TERENO was the emphasis placed on reaching a common consensus on certain standards regarding instrumentation, installation, and quality control as well as strategies and programmes for data analysis.

A total of 19 scientists from TERENO partner institutions the Forschungszentrum Jülich (FZJ), the Helmholtz Centre for Environmental Research (UFZ), the KIT and the University of Trier attended the course. Their schedule was divided between morning sessions on the theoretical fundamentals of the eddy covariance method and a hands-on component in the afternoons. Participants were given the opportunity to operate an exemplary measurement system and to analyse the data they collected.

Bringing together different philosophies

The course covered topics ranging from the theory of the atmospheric boundary layer and the heated controversy over quality control to the question of how to negotiate the unavoidable gaps in the data if one wishes to compile monthly or yearly exchange currents. Feedback from the mixed group of eddy-novices, data users and tower operators was very positive. “If only I‘d had such a good lecture on turbulence when I was at university”, was a frequent comment.

Putting their knowledge into practice proved to be a good exercise in working out differences. While the TERENO participants soon came to a consensus on the measurement technology, they still have questions about how best to interpret data. For example, some have chosen to use programmes, which they have designed themselves, of course according to personal ‘philosophies’. Their plan is to hold a follow-up meeting–as soon as all of the groups have collected their initial data–to further develop common strategies for data analysis.

More information in a new format

TERENO has redesigned its homepage. In addition to the makeover, visitors will also notice that the site is easier to navigate and has more content. New sections include TERENO goals, organisation and workshops. The updated homepage includes detailed information on the infrastructure at the TERENO observatories. Some data is already even available online, including images from the weather radar from the Forschungszentrum Jülich (FZJ). Visitors can also view profiles for all of the Coordination Teams. Of course the site also includes a download area as well as all issues of the newsletter. ■

[www.tereno.net]

PUBLICATIONS

Proven potential

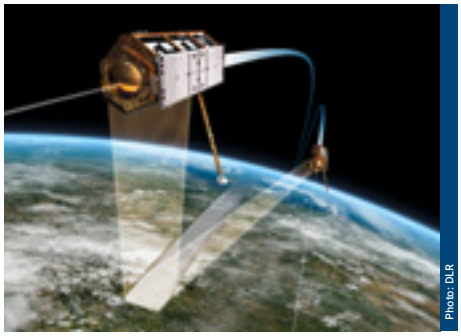
Wireless sensor networks are ideally suited for real-time, large-scale monitoring of soil moisture. Initial tests of the wireless sensor network "SoilNet", developed by scientists at the Forschungszentrum Jülich (FZJ), have established its potential. In the course of a four month study, over 6 million measurements were relayed via 1200 sensors installed at measuring points within the catchment area of the Wüstebach stream, which is part of the TERENO observatory in the Eifel/Lower Rhine Valley. The paper presents the first results of a statistical and geostatistical analysis of the data.

H.R. Bogena, M. Herbst, J.A. Huisman, U. Rosenbaum, A. Weuthen, and H. Vereecken. 2010. Potential of wireless sensor networks for measuring soil water content variability. Vadose Zone Journal, doi:10.2136/vzj2009.0173 ■

[www.vadosezonejournal.org]

Lift-off for radar satellite TanDEM-X

Germany's second Earth observation satellite TanDEM-X began its first mission in space on 21 June 2010. It was launched into orbit by a Russo-Ukrainian satellite-launching rocket at the Baikonur Spaceport in Kazakhstan. Together with its twin "TerrarSAR-X", which has been circling the Earth since 2007, it will send back observations of the Earth over the next three years. This information will be used to construct a 3D model to a greater degree of accuracy than has up to now been possible. TERENO will also be able to make good use of the high-resolution elevation model. Individual coordination teams will use it as a basis for the geographical coding of image data and as an input parameter for various hydrological models. TanDEM-X will also be able to record information on 2D vegetation structure. The satellite mission is a joint project between the German Space Agency (DLR) and Astrium GmbH with funding from the German Federal Ministry of Economics and Technology (BMWT). ■



Flying in formation in space: The two satellites TanDEM-X und TerraSAR-X measure the entire Earth's surface

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DLR	German Aerospace Center
KIT	Karlsruhe Institute of Technology
HMGU	Helmholtz Zentrum Muenchen, German Research Center for Environmental Health
UFZ	Helmholtz Centre for Environmental Research
GFZ	Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences