TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

NEWSLETTER

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www.tereno.net

Photo: Anton Prado PHOTO - Photolia.com

Unpredictable precipitation levels, extreme weather events and longer periods of drought – climate change has already become very noticeable in West Africa and the Mediterranean region. TERENO is helping to establish observation networks in these regions

CONNECTED ACROSS BORDERS

SHARING KNOWLEDGE

TERENO offers several interfaces for scientific networking – both throughout Germany and internationally. As an example, TERENO scientists are contributing their know-how and experience to two new projects outside Germany: the partner project TERENO-MED in the Mediterranean region and the large-scale international project WASCAL in West Africa. Both projects involve establishing observation networks to better understand the local impacts of global change and develop appropriate adaptation measures. As Professor Reinhard Hüttl from the GFZ German Research Centre for Geosciences explains in his interview on page 3, TERENO also serves as a model in Germany.

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ACCOLADE FOR YOUNG SCIENTISTS

Two new Helmholtz-University Young Investigators Groups conduct research at TERENO observatories

They are young, have a doctorate and a research position abroad under their belts, and now they want to work on improving climate and landscape development forecasts by leading their own research groups. Dr. Torsten Sachs from the GFZ German Research Centre for Geosciences in Potsdam and Dr. Matthias Mauder from the Institute for Meteorology and Climate Research (IMK) Atmospheric Environmental Research at the Karlsruhe Institute of Technology are two of 20 young scientists selected by the Helmholtz Association. They will each receive funding of around 250,000 euros per year for the next five years, allowing them to set up and lead their own research groups. Both projects are set to start in 2012.

Gas development in the marshes

The young researchers both make use of the comprehensive measurement infrastructure at the TERENO observatories. Torsten Sachs (34) monitors the climate relevant exchange of the greenhouse gases carbon dioxide and methane in rewetted marshes at the TERENO observatory "North-East German Lowlands". "Soil, vegetation and atmosphere are closely linked. We have to understand the vertical exchange of gases and energy in order to incorporate it properly into climate models. Up to now, data on these energy and gas flows have mostly been limited, covering a few hectares. Scaling up data to a region like Mecklenburg-Vorpommern, which spans 2.3 million hectares, is currently a highly tentative business," says Sachs regarding the problems with existing models.

Closing the energy balance gap

Achieving higher measurement complexity is also the focus of the project which Matthias Mauder (34) is pursuing at the TERENO observatory "Bavarian Alps/pre-Alps". "Our aim is to record all the scales of relevance to the exchange between biosphere and atmosphere in order to solve the energy balance closure problem. At the same time, we will be able to obtain a more detailed picture of the effects of atmospheric warming on the environment". The project was able to close a more than 20-year old gap: previous measurements which have also been used as the basis for climate and weather models only account for 70 to 90 percent of the total energy used. According to the fundamental laws of physics, however, no energy is ever lost.

CAREER BOOST

Through its support for young investigator groups, the Helmholtz Association provides talented young scientists with the ideal entry path into a career in science. In addition to leading their own research groups, the young researchers are given the opportunity to gain teaching experience at a partner university. Furthermore, a tenure option is also available in the long-term.

Helmholtz Young Investigators Groups


Photo: Bernhard Edmeier


Photo: Sina Muster


Photo: IMK-IFU

Torsten Sachs (top and bottom images) and Matthias Mauder (right) conducted field measurements during earlier projects; in the future they aim to do research with their own teams of junior researchers at TERENO observatories

EDITORIAL


Photo: Chris Taube

BEYOND BORDERS

Around the world, observatories are being established to measure and analyse the impact of global change on our environmental systems. This is an important step in the right direction, because the impact of change can vary greatly when considered at the regional and local level. At the same time, international cooperation and knowledge-sharing are crucial to developing mitigation and adaptation measures faster and more effectively. One thing is clear: climate change is and will continue to be a global challenge. Knowing this, we conceived and organised TERENO with close links to the international research community – from the numerous international experts on our Advisory Board through to collaborative projects and networks such as ICOS or ExpeER. Today, new TERENO initiatives continue to strengthen international ties. As an example, TERENO-MED is creating an observation network in the Mediterranean – a region where the impact of climate change is already clearly measurable. A joint initiative of several Mediterranean countries, the purpose of TERENO-MED is to develop solutions and management strategies. West Africa is another region where the effects of climate change are already being felt. As part of the large-scale international project WASCAL, Germany is assisting ten African nations with the establishment of an observatory network designed to develop better climate prediction capability and adaptation measures. And we are stepping up collaborative efforts with our neighbours next door. At the virtual institute ICLEA, TERENO scientists are working together with counterparts in Poland to better understand the development of the lowland areas along the border of northern Germany and Poland. It is our desire to strengthen these global ties and continue to expand our international network in the years to come.

I hope you enjoy your read!
Sincerely,

Harry Vereecken

TERENO Coordinator

“SKIN CARE” FOR THE EARTH

Soil research in Germany is breaking new ground. An interview with Professor Reinhard Hüttl, chairman of the Board at GFZ


Photo: GFZ

Reinhard F. J. Hüttl has served as chairman of the Helmholtz Centre Potsdam, German Research Centre for Geosciences (GFZ) since June 2007

Ever-increasing demands are being put on the Earth’s soil. Global change is also causing soil research to rethink. Professor Reinhard Hüttl – chairman of the GFZ German Research Centre for Geosciences in Potsdam, who is also vice president of the Helmholtz Association and president of acatech, the German Academy of Science and Engineering – calls for the repositioning of, and renewed emphasis on, soil research. In this interview he outlines his “critical zone” approach and the objectives of the nationwide soil research network.

What makes the soil issue so important?

Soil is one of our most important resources. It provides a habitat, and, at the same time, serves as a basis for the supply of food and necessary raw materials. In addition, as the “Earth’s skin, it plays a significant role in material and energy cycles and fulfils important cleaning functions for the atmosphere, and the hydrosphere in particular. However, soil is not an unlimited resource. Despite this fact, it receives much less attention than air and water. This must change.

What challenges do we face?

Global change is putting increasing pressure on the world’s soil. In many places, soil productivity is declining, while, at the same time, the disappearance of available ground surface is a global phenomenon. The causes are manifold: from the effects of climate change to the growing world population and the increasing demand for biomass. For example, the chemical industry has already replaced 13 percent of its oil consumption with biomass, and the aviation company Lufthansa is currently experimenting with biofuels. We need to ask ourselves now what our needs will be in 2050: with regard to food needs for people and animals, or biomass in general. Is it even possible to make soil more productive without harming it? What contributions can the soil make to climate protection in the future, through carbon capture for example?

What does that mean for research?

Soil research is fragmented, especially in Germany. We need to reposition soil research, and devote more attention to it so that we can meet the challenges we face. To do that, we need to put adequate structures into place, better national and international networks and new research approaches to analyse the climate effects on the soil. For too long, the emphasis has been on conventional production issues – in agriculture, forestry, horticulture and partly also in geography. Today we have to approach the issue from a different angle. Our approach is the so-called “critical zone”.

What is the “critical zone”?

We can’t just think of soil as the uppermost layer of the Earth’s crust. Instead, we should think of it as a connection to the layers that lie beneath it, particularly with regard to water. At the same time, it is an interactive interface to the biosphere, atmosphere and hydrosphere. That is why sustainable soil use is absolutely essential.

What steps have you taken so far?

First of all, we pooled our resources within the Helmholtz Association. That is how the Helmholtz Climate Initiative REKLIM (Regional Climate Change) grew out of our research area “Earth and Environment”, for example. A variety of partner organisations are involved in REKLIM. In addition, the Helmholtz Association is committed to setting up and running cross-programme infrastructures and observatories, such as the research and monitoring platform TERENO. It is also currently investing in the creation of a national soil research network. This platform, established at the German Academy of Science and Engineering, has a list of partners including numerous universities, research institutions and associations. It also has links with industry.

What objectives does the network have?

The network partners aim to establish a common set of priorities and initiate research projects. We want to secure funding for these projects, not just from the federal ministries, but from the European Union, too. The EU’s next framework programme for research which starts in 2014 under the name “Horizon 2020” is one great opportunity. In a similar way to the Bio-Economy Council, the “soil” network could give recommendations which would then lead to the development of a national research programme. Furthermore, the goal is to work together to build an infrastructure for research and make the associated potential level of competence available to all the participants.

Could TERENO serve as a model here?

TERENO is a perfect example of linking potential, and an excellent basis for initiating common externally-funded projects. The project is also important because the observatories provide the space necessary for research to be carried out. The new generation of scientists also benefits, instead of pursuing purely theory- or lab-based research, they have the opportunity to identify and tackle problems on the ground. That is exactly the concept we are committed to with the Helmholtz-University Young Investigators Groups. It is therefore especially pleasing that two new young investigators groups established by the Helmholtz Association are cooperating closely with TERENO (see page 2).

SOLVING WATER-RELATED PROBLEMS

TERENO-MED: Creation of a Mediterranean Observation Network

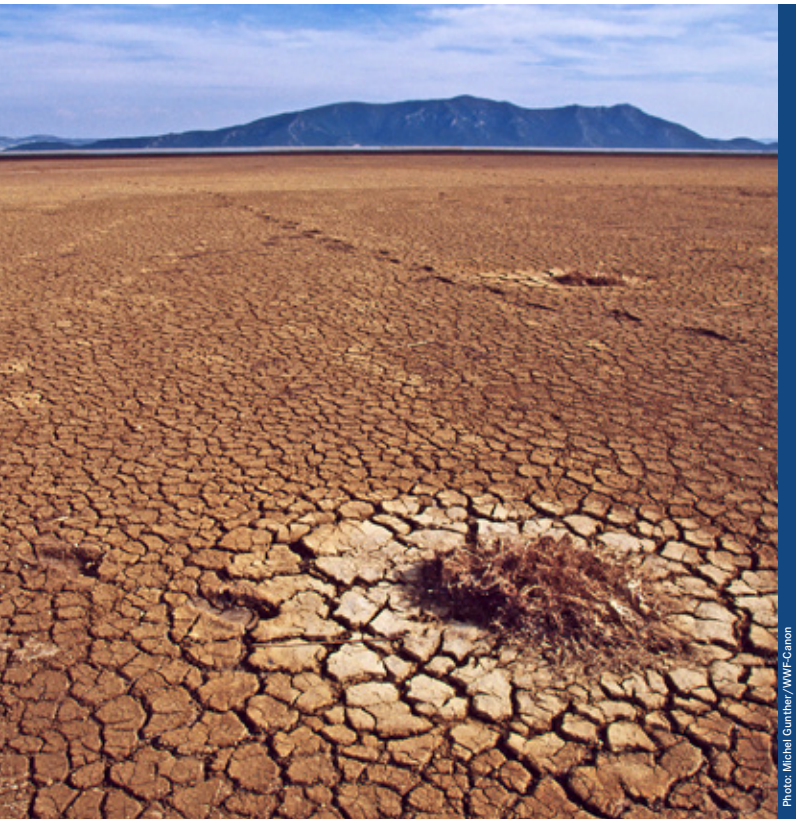

Photo: Michel Gunther / WWF-Canon

The Ichkeul National Park in northern Tunisia – a UNESCO World Heritage Site – is also threatened by global warming

Water is often in short supply in the Mediterranean. Many countries in the region are frequently beset by droughts. The rare rainfall events are often heavy and thus cause flash floods and landslides. In a recently published report, the Intergovernmental Panel on Climate Change – IPCC warns that droughts and heavy rain events are anticipated to increase, particularly within the Mediterranean area. A new TERENO-partner project, the observation network TERENO-MED, is set to research these and other aspects of the water balance.

TERENO-MED is a collaboration between the Helmholtz Centre for Environmental Research (UFZ) in Leipzig and the Forschungszentrum Jülich, with the UFZ coordinating the project. Its objective is to study the effects of population development, changes in land use and economic and climate change on water resources in the Mediterranean region. Funding will begin early 2012, with 6.8 million euros earmarked for the project.

The TERENO-MED network is planned to span eight to ten observatories in representative regions of the Mediterranean. Initially, the focus will be on the water cycle, explains Dr. Steffen Zacharias, TERENO coordinator at the UFZ. Potential locations include the South of France, Spain, Italy, Greece, Cyprus and Turkey, as well as countries in Northern Africa and the Middle East. TERENO-MED provides funding for basic measuring equipment to capture important hydrological and meteorological parameters. In addition to weather and soil moisture stations, devices to monitor ground water and runoff at river gauges, the list of equipment will extend to wireless soil moisture networks and so-called rain scanners – radar units that detect precipitation within a 50 kilometre radius in high spatial resolution. Initial instrumentation is scheduled for the second half of 2012.

Cooperation across borders

"Climate change is already having a clearly measurable impact in the Mediterranean," says Zacharias. Securing the water supply – in particular to agriculture - is one of the greatest challenges facing the region. Groundwater is being overused in many areas. Although Spain is one of the driest countries in Europe, huge quantities of fruit and vegetables are produced here. Almost one million hectares of agricultural land are irrigated by groundwater. As a result, many aquifers are overexploited, causing the groundwater-levels to sink.

According to Zacharias, TERENO-MED can contribute significantly to solving water-related problems and develop management strategies for this and other semi-arid regions. The project will also help to implement the European Commission's directive on water scarcity and droughts and the EU programme "Horizon 2020".

The TERENO-MED planning and start-up phase is scheduled to run until 2013. Participating researchers are currently reaching out to competent project partners in the Mediterranean. In France, these efforts have already been successful. A series of French research activities have joined forces around the topic "The Mediterranean Environment" to form the "MISTRALS"-initiative. One of the partners is the SICMED network, which monitors changes in land use and its effects on ecology and water budget, thus sharing many aspects with TERENO-MED. Both research networks aim to develop strategies to promote sustainable development in the Mediterranean region, and will therefore strengthen their collaboration. To this end, a cooperation agreement has already been signed. In the medium-term, there are plans to launch a comprehensive Euro-Mediterranean project on this topic.

Water Science Alliance involved

The infrastructure set up by TERENO-MED in the Mediterranean region is also an important research basis for the Water Science Alliance (see Newsletter No 2/2011). This initiative was founded with the goal of strengthening water research in Germany and positioning it better at a national and international level. One of the six key research areas identified by the Water Science Alliance is the "Complex water management in the Circum-Mediterranean region".

In the long-term, TERENO-MED is set to assimilate further aspects of the TERENO-concept designed in Germany – beyond research into the water cycle – such as the effects of land use change on biodiversity or greenhouse gas flows.

Photo: Wikipedia

ADAPTING TO CLIMATE CHANGE

Support for West Africa: TERENO participates in the international large-scale WASCAL programme


Photo: privat

West Africa is strongly affected by climate change. Periods of drought follow on the heels of years marked by heavy floods. Agriculture is particularly hard hit: farmers see their livelihoods under threat, hunger and poverty loom on the horizon. Germany is lending its expertise to the countries concerned so that they are better placed to counter the negative consequences of climate change. Scientists from the TERENO project are also participating in the international large-scale programme in West Africa set to begin in spring 2012.

The German Federal Ministry of Education and Research (BMBF) launched the international and interdisciplinary research initiative WASCAL (West African Science Service Center on Climate Change and Adapted Land Use) in 2010. The aim is to strengthen climate-related expertise in West Africa, to enhance resilience and develop the necessary adaptation strategies. Ten West African countries are collaborating on the project: Benin, Burkina Faso, the Ivory Coast, Gambia, Ghana, Mali, Niger, Nigeria, Senegal and Togo. WASCAL is organised around three principle components: a joint competence centre, a core research programme and a graduate research program that helps to advance the education of young scientists through the foundation of seven graduate colleges. WASCAL is coordinated by the Center for Development Research at the University of Bonn.

TERENO a role model

"The expertise that we have built up in TERENO is one of the reasons why we were asked to become involved in WASCAL and to help set up something similar in West Africa," explains climate researcher Professor Harald Kunstmann from the Institute for Meteorology and Climate Research (IMK-IFU) at the Karlsruhe Institute of Technology (KIT), who is also a member of TERENO's Scientific Steering Committee. Scientists from the Forschungszentrum Jülich (FZJ) are responsible for data transfer and data management, while their colleagues at the German Aerospace Center (DLR) are responsible for the remote sensing part of the programme. Kunstmann himself heads WASCAL's climate division. Together with other researchers and in cooperation with the WASCAL Competence Center, national weather services, and the World Meteorological Organization, he is helping to set up a hydroclimatological measurement network.

"What TERENO and WASCAL have in common is the concept of setting up terrestrial observatories. The motivation comes from the realisation that science needs long-term measurements in order to monitor and quantify changes in the environment," explains Kunstmann. These data are the key to improving model systems, which are ultimately an important tool in helping West Africa look and plan ahead.

www.wascal.org

WASCAL OBJECTIVES:

- Strengthen the research infrastructure in West Africa related to climate change
- Pool expertise of partners
- Promote networking among researchers and at international level

MEASURES TAKEN NEED TO WORK FAST

An interview with the German WASCAL Coordinator Dr Manfred Denich from the Center for Development Research

Why is a project like WASCAL necessary?
Most of the 300 million people in West Africa depend on agriculture for their livelihoods, which in turn, is dependent on the rainy season. We still don't know what the long-term effects of climate change are in detail, but even today, it is clear that periods of drought are getting longer and that it is becoming more difficult to forecast the start of the rainy season. Rainfall is becoming more variable, and extreme rainfall is also becoming more common – which poses a huge problem for agriculture. WASCAL is fighting for adapted land-use in West Africa. The focus is not simply on stopping climate change, but also on introducing measures that take effect quickly. Examples include the introduction of new plant varieties, making changes to planting dates or irrigation technology.

How is WASCAL going to achieve this?
On the one hand, we want to strengthen the expertise of West African scientists so that one day they can discuss issues with industrialised nations at international climate conferences on equal terms. We are also building huge databases related to climate and land-use in these ten countries. That is something that, unlike in Germany, had not existed before in developing countries. The evaluation of these data can help scientists and politicians to secure the food supply of local communities – under changed climate conditions. In the long-term, the aim is for the partner countries to take full charge of the project.

What is TERENO's role?
TERENO is quite the role model. After all, its aim is to use the data collected in Germany to develop better climate projections, thereby paving the way for adaptation measures to climate change. That is exactly what we are aiming for. We learn from TERENO and are trying to select the measures taken in Germany that would work in West Africa, and put them into action.


Photo: privat

Raising livestock in Burkina Faso: WASCAL helps to ensure a steady food supply in the face of changing climate conditions

EXTENDING COLLABORATION

Advisory Board visits TERENO observatory "Harz/Central German Lowland"

TERENO seeks to attract more scientific partners from other institutions to its observatories in order to provide a further stimulus to the existing possibilities for interdisciplinary research. The Advisory Board also placed an emphasis on extending collaboration when it met in the town of Blankenburg (Harz) in Saxony-Anhalt at the end of September 2011. The international committee, which consists of twelve climate and environmental researchers and supports TERENO in scientific questions, meets annually for an on-site review of the programme's progress. The Advisory Board, chaired by the US hydrology expert Dr Richard P. Hooper, particularly welcomed the increasing growth in national and international research cooperations. Other topics of discussion included how to further raise TERENO's national and international profile.

Following an introduction by Professor Georg Teutsch, Scientific Managing Director at the host institution, the Helmholtz Centre for Environmental Research – UFZ, Professor Harry Vereecken from the Forschungszentrum Jülich (FZJ) opened the meeting by providing an overview


Photo: UFZ

On-site inspection: Members of the Advisory Board listen and learn about measuring instruments

of TERENO's activities. His talk included up-to-date reports on the development of the TERENO observatories, international collaborations and plans for the future, such as TERENO-MED (see page 4) and WASCAL (see page 5). A variety of scientists then went on to give presentations on the latest research activities at the individual observatories. The day was completed with an evening poster session, which further underlined the wide scope of TERENO's existing research programme.

The second day of the meeting was spent on a field excursion to the TERENO observatory "Harz/Central German Lowland". The group of scientists visited the research area "Schäfertal". Working in cooperation with the Magdeburg-Stendal University of Applied Sciences, researchers are developing the site as an intensive measuring area for monitoring soil moisture dynamics. Attendees also visited the Rappbode Dam. A monitoring platform is currently being set up within the catchment area of Germany's largest drinking water dam to provide comprehensive monitoring of the dam's matter balance (see page 10).

Advisory Board Meeting 2011 agenda and supporting materials

THE TERENO COMMUNITY IS GROWING

Second Workshop held in Potsdam

Animated discussions at the TERENO workshop in Potsdam: the guests included environment experts Kurt Roth (above left) and Christian Mätzler (above right)


Photos: Elisabeth Gantz/GFZ

The second TERENO Workshop held in Potsdam at the end of January attracted some 150 participants – double the number who attended the workshop held in Bonn last year (see Newsletter 2/11). The rise in attendance is testimony to the expanding TERENO community – and can surely also be attributed to the significant progress that has been made at the individual centers over the past year. Following a welcome speech by the Scientific Executive Director at the GFZ German Research Centre for Geosciences and Vice-President of the Helmholtz Association, Prof. Reinhard Hüttl, TERENO Coordination Teams also presented their research results. In addition, internationally recognized experts gave lectures on topics relevant to TERENO, such as environmental physicists Prof. Kurt Roth at the University of Heidelberg and Prof. Christian Mätzler at the University of Bern. The interdisciplinary discussion spurred by the combination of research updates and presentations by invited speakers continued well into the night. Dr. Mike Schwank, coordinator of the TERENO observatory Northeastern German Lowland gave a positive summary: "With its broad reach, the event made a valuable contribution to the growth of the TERENO community and the constructive development of this major project".

NEWS

NEW MEMBERS

TERENO has announced two new appointments for its Advisory Board: Canadian water expert, Professor Jeffrey J. McDonnell, and Dutch ecologist Professor Bas van Geel. Jeffrey McDonnell has been the Richardson Chair in Watershed Science at Oregon State University since 1999. In July 2012, he will join the Global Institute for Water Security at the University of Saskatchewan in Saskatoon Canada as a professor for hydrology. A recognized expert in watershed management, Prof. McDonnell has received several awards, including the John Dalton Medal from the European Geophysical Union and the Gordon Warwick Award from the British Geomorphological Research Group. In 2011 he was selected as the Birdsall-Dreiss Distinguished Lecturer for the Geological Society of America. Bas van Geel has taught and conducted research at the Institute for Biodiversity and Ecosystem Dynamics at the University of Amsterdam since 1978. His major research focus is on paleoclimatology and paleoecology in the Quaternary period – the most recent period in the Earth's history – which began some 2.6 million years ago.

THE NEW TERENO BROCHURE

Much has happened since TERENO was founded in 2008: Numerous projects have been launched, a new observatory was opened and international initiatives, such as TERENO-MED, have taken form. The recently released TERENO brochure, available in both English and German, presents the TERENO initiative and its objectives and provides an overview of the four TERENO observatories as well as the current projects and activities. The brochure is available for download at:

www.tereno.net

RESEARCH AT A NATURAL LANDSCAPE LAB

The Virtual Institute ICLEA at the TERENO Observatory "North-East German Lowlands"

The North-East German-Polish Lowlands are turning into a natural landscape laboratory. As of 1 January 2012 the Helmholtz Association is funding the new Virtual Institute ICLEA "Institute of Integrated Climate and Landscape Evolution Analyses", which has strong ties with the TERENO Observatory "North-East German Lowlands".

"We want to gain a better understanding of the effects of global change on the evolution of this young landscape since its formation at the end of the last ice age. We are particularly interested in finding out more about the interactions between the natural and anthropogenic processes which have an influence on how this landscape evolves," explains spokesperson for the project, Professor Dr. Achim Brauer from the GFZ German Research Centre for Geosciences in Potsdam. The GFZ is also managing the virtual institute.


Photo: Achim Brauer

A joint ICLEA effort: German and Polish scientists take lake sediment samples

Better insights into the regional effects of global change

The innovative ICLEA concept integrates current hydrological and climatic data – made available through the TERENO-infrastructure – with long time series taken from the natural climate and environmental archives as well as historical remote sensing data. "Geodata with seasonal resolution are particularly valuable," says Achim Brauer, as they enable us to detect changes to the geological past that have taken place at time scales that people can understand. Armed with this information, the researchers hope to learn how climate change impacts regional landscape development. Understanding these processes is an important basis for the development of future adaptation strategies. This will be the first time that the North-East German-Polish Lowlands have been investigated in their entirety. The multinational project also marks a contribution to the strengthening of German-Polish scientific cooperation. Project partners include the Polish Academy of Sciences in Torun, the University of Greifswald, and the Brandenburg University of Technology Cottbus.

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www.iclea.de/#english

POOLING COMPETENCIES

Helmholtz Virtual Institutes bring together the key competencies of the Helmholtz Centres and universities to create centres of excellence of international standing in important research areas. Other national or international partners may be involved as associated partners. Virtual Institutes receive up to a maximum of 600,000 Euros per year from the Helmholtz Association's Initiative and Networking Fund. Funding is provided for five years. In addition, each centre has its own funding source, bringing the total amount of annual funding to as much as 900,000 Euros.

Pact for Research and Innovation

RADIOMETER MOUNTED ON A CRANE

In the service of science: Researchers from the FZ Jülich install a radiometer on an old construction crane, extending the radiometer's range

Research opportunities at the TERENO Observatory "Eifel/Lower-Rhine Valley" have recently been given a boost with the help of a converted construction crane. The 20-metre high crane, located in Selhausen at the research field operated by the Forschungszentrum Jülich (FZJ), has been fitted out with a radiometer which will help scientists determine surface soil moisture. so far, the radiometer, financed within the framework of TERENO, stood on a 10-metre platform above the field. It has now been raised to loftier heights, and while securely attached to the crane, it can rotate 360 degrees and is directly aimed at the field. Researchers are therefore able to cover a wider research area. Additional measuring equipment can also be secured to the crane rig, such as various cameras. These can be used to conduct research, for example, photosynthesis activity in the vegetation cover.


Photos: FZ Jülich

SEEING THE WOOD FOR THE TREES

The Field day provides insights into progress at the TERENO Observatory "North-East German Lowlands"

It was a rather chilly summer's day, but while the temperature was low, enthusiasm was high: Around 25 researchers from the TERENO Observatory in the North-East German Lowlands met for a field day at the end of August to share their latest research results. The group included staff from the Müritz National Park and scientists from the GFZ German Research Centre for Geosciences, the Neustrelitz site of the German Aerospace Center (DLR) and the Technische Universität Berlin. Professor Reinhard Hüttl, chairman of the Board of GFZ, who is also vice president of the Helmholtz Association and president of acatech, the German Academy of Science and Engineering, also took part.

The venue was at the Great Fürstenseer Lake, which is located at the heart of the Müritz National Park. Timed perfectly to coincide with the field day, the scientists were able to celebrate a premiere: with the help of a small raft they retrieved sediment samples from the bottom of the lake for the first time. The first probe, which measured a good one metre long, is expected to provide information on climate and landscape history when it undergoes laboratory analysis. Additional probes have already been sent down even deeper into the lake's ground. The lake, which spans some two square kilometres, is considered to be a sensitive indicator of landscape changes. Over the last 30 years the lake level fluctuated strongly and, in general, has dropped by over a metre. Whether as a result of human intervention in the drainage system, changes in landscape use or due to climate change – that is what the scientists are trying to establish.

Professor Achim Brauer cautions against any premature conclusions: "It is not the case that every short-term rise or fall in water levels can be ascribed to long-term climate change. We are dealing with a highly complex system subject to a wide range of factors. We will only be able to unravel these various factors by pursuing truly long-term observations, while at the same time examining the past. That is the basis for being able to make better predictions on future developments".

Photo: GFZ

Safe and sound: Long tubes are used to collect samples from the bottom of Lake Großer Fürstenseer

History of a lake level

The group made its way along the banks of the lake to a site in the forest. Here, Dr Knut Kaiser presented one of roughly 30 soil profiles which he has examined from around the lake with the help of students. These profiles, dated by geochronological methods and archaeological finds provide interesting insights into the lake's development. Lake sands, for example, suggest that this site, where now a forest is flourishing, had previously been underwater. Meanwhile, as a result of anthropogenic soil erosion, the lake shore experienced a build-up and drying-up by deposition of wind-borne sand. The geographer referred to the easily visible sediment layers and soil horizons to illustrate the site's history over the past thousand years, as well as the history of human settlement at the lake. For example, an approximately two metre rise in the water level above the lake's current level which this profile highlights, coincides with the transition of Slavonic settlers to the subsequent German community, which took place in the 13th century. At another site, the team discovered pottery shards and pieces of charcoal during excavations at this important position, which date back to that time.

Down deep and up above: Preparing the floating platform to collect samples from the bottom of the lake; the gondola transports researchers up high to examine the canopy

Water research with fibre optic cables

Hydrologist Theresa Blume and dendrochronologist Ingo Heinrich of the GFZ are researching the complex effects of geology, climate, weather and vegetation on the lakes. They are working together at a site located deep within the forest, on the shore of Lake Hinnensee, which is connected to Lake Fürstensee. Like many lakes in the region it does not have a surface water tributary but is totally dependent on ground water and rainwater. Theresa Blume is researching where and at what rate cold ground water flows into the lake by running fibre optic cables along the lake bottom. The optical properties of the cables change according to water temperature. When laser light is sent through the cable, the reflexion of light determines to within one meter where the water in the lake is cool or warm.

Reconstructing fluctuations

Just a few meters away from the banks of the lake, Ingo Heinrich has set up numerous tree measuring stations which monitor the growth of selected trees over the course of the seasons. Among other things, the researchers measure increases in the trees' diameter and sap flow. This makes it possible to link hydrological and dendrochronological data and determine, for example, at what point in summer the tree switches from soil to groundwater supplies. These new insights will, in turn – through the connection with biochemical and anatomical wood measurements in annual tree rings – make it possible to reconstruct historical pre-instrumental water balance fluctuations.

An hour's drive away from the lake, the field day participants turned their attention underground. The DLR satellite station Neustrelitz maintains a network of six lysimeters in Rustow, located within the DEMMIN test site. They are part of TERENO-SoilCan, the largest lysimeter network in the world. SoilCan monitors the effects of changes in climate and land use on material flows and soil fertility, as well as water availability and quality.

The growth of the leaves

The field day ended on a high point, literally, with a visit to a research platform that dangles off a huge crane just outside Drönnewitz, near Demmin. PhD student Anne Clasen glides over the treetops in a gondola, using spectroscopy to examine the crowns of the trees. The collected data is used to match up the condition of the tree crowns with information garnered from aerial and satellite imagery. Those with a head for heights were invited to accompany crane operator Clasen, something that GFZ chair Reinhard Hüttl was happy to do. He was very impressed with the progress that has been made and again stressed the importance of TERENO, both for the Helmholtz Association's Research Field "Earth and Environment", but also for the development of collaborations with universities and institutes from other scientific organizations

At the TERENO observatory "Northeastern German Lowland", scientists examine the impact of climate and land-use changes on lakes and soil. Occasionally, this means going underground

Photos: GFZ

MEASURING STABLE ISOTOPES DIRECTLY IN RIVER RUNOFF

Automatic water measurement station "Erkensruhr" has started operation

Successful inspection: The expanded gauge station "Erkensruhr" with its new climate-controlled measurement container

There are big changes underway in the southern part of the Eifel National Park. The spruce forests which have stood for around 60 years and cover large swathes of the National Park are being converted into deciduous forests that are more suited to the local climate conditions. The Eifel National Park Forestry Service has already planted more than 300,000 young deciduous trees as part of the initiative. TERENO is monitoring the effects of this project alongside its long-term research on the effects of regional climate change on the water and nutrient balance. The necessary data are being collected with the help of a new automatic water measurement station.

The catchment area of the Erkensruhr River, a tributary of the Rur River, has been particularly impacted by the renaturation project. The researchers expect that the measures will result in changes in runoff behavior, e.g. a higher peak runoff and higher concentrations of sediment and nutrients in the water. In order to monitor actual developments, the "Erkensruhr" runoff gauge was extended by a measurement container, equipped with a variety of state-of-the-art instruments for taking and analysing water samples. The University of Bonn is also taking part in the project, as the catchment area lies within the three research areas covered by the Transregional Collaborative Research Centre 32 (TR32).

Testing the pilot station

A multi-parameter probe collects information on, for example, changes in water temperature, electrical conductivity and pH levels. A liquid-water isotope analyser enables researchers to continually monitor oxygen and hydrogen isotopes in the runoff of the Erkensruhr River with a high temporal resolution. The analysis device uses a new innovative process to determine the isotopic composition of water with the help of laser absorption spectroscopy directly in situ. "If the technology at this pilot station proves successful, then additional monitoring gauges could be equipped accordingly and a measurement network could be set up," says Dr. Andreas Lücke from the Forschungszentrum Jülich (FZJ).

Monitoring drinking water

Alongside their investigations in water chemistry, the researchers are also assessing particulate and dissolved organic substances that are transported in the water, with the aim to characterize them geobiochemically and identify their origin. These new insights are intended to shed light on the processes involved, and to better predict future developments, with particular emphasis on the carbon cycle and the quality of drinking water. There is scientific evidence of increases in the surface water concentration of organic materials in the low mountain regions of Central Europe dating back to the 1990s. Water quality and drinking water production are adversely affected by this trend (see also the article on the Rappbode Dam). In the next research stage, therefore, the "Erkensruhr" catchment project will be linked with studies into the input dynamics of the Rur drinking water dam.

The list of organisations partnering with the Eifel National Park administration, the FZJ and the University of Bonn in the "Erkensruhr" project, includes the regional water and energy supplier ENWOR-WAG and the Wasserverband Eifel-Rur, which is the local water association operating the Rur drinking water reservoir.

TROUBLED DRINKING WATERS

New UFZ dam observatory investigates increases in dissolved organic carbon

The Rappbode Dam, located in the Harz region, is Germany's largest drinking water dam, supplying water to more than one million people. At the same time, it is an important research focus of the TERENO observatory "Harz/Central German Lowland". Scientists from the Helmholtz Centre for Environmental Research - UFZ are investigating a phenomenon which causes serious headache to the management of drinking water dams. The concentration of dissolved organic carbon (DOC) in water is on the rise at many sites, a trend which is adversely affecting water quality and drinking water production.

Scientists have been following this development for around 20 years. As well as numerous lakes, drinking water dams have been hit particularly hard. "More DOC in the water requires a more elaborate purification process. In addition, when the water is disinfected with chlorine, potentially harmful by-products are produced," explains Dr. Karsten Rinke, Head of the Department of Lake Research at UFZ Magdeburg. There are also financial consequences for waterworks: the cost of treating water increases.

There is still no scientific consensus as to why DOC-levels are on the rise. A possible explanation is that climate change is causing heavier rainfall, which leads to more organic matter being washed into the water. In order to understand what is really happening, more research needs to be done regarding the production processes and transport of dissolved organic carbon. "This hasn't been possible up to now due to a lack of high-resolution spatial and temporal monitoring. We are bridging that gap with the new Rappbode Dam observatory," says Karsten Rinke.

Reliable forecasts

Ten automatic measurement stations record the concentration of DOC not only at the dam and its outflow, but also in the main tributaries, the rivers Bode, Hassel and Rappbode, which are also impounded by auxiliary dams. This way,

The Rappbode Dam supplies the region with drinking water

UFZ researchers want to estimate imports of matter and investigate the related processes. At the same time they will be able to find out more about the role of climate change and land use change on matter dynamics in and around the reservoir.

The aim is to provide reliable forecasts of the development in DOC concentration, and to develop strategies to reverse or minimise the trend. To this end, the UFZ is in close collaboration with the local dam authority, the Talsperrenbetrieb Sachsen-Anhalt, and the remote water supply Elbe-Ostharz. Previous studies have shown that approximately one third of the DOC in the dam can be broken down. The UFZ-researchers want to find ways to promote and improve the efficiency of this effect.

PUBLICATIONS

Many lakes in the Berlin-Brandenburg region contain ever less water. Tree stumps have begun to reappear in some lakes, like the Redernswalder See. As part of the TERENO project, scientists are researching hydrological processes to determine why water levels rose over the last century and why they are falling today

THE WATER DEFICIT IN BERLIN-BRANDENBURG AND ITS IMPACTS

The climate change debate has highlighted the need to better understand both the long- and short-term impacts of regional environmental changes. These changes are often the result of many different aspects, making it all the more difficult to identify individual factors. The change in the water balance in the Berlin-Brandenburg region over the past 30 years is an example of such a regional change. The groundwater recharge throughout the area is in decline, leading to decreases in groundwater, lake levels and fluvial discharge. This is the result of both complex, regional human impacts, such as long-term effects of hydro-melioration and changes in forest composition, and the general effects of climate warming.

The changes in the regional water balance have an enormous impact on existing ecosystems as well as on society in general: wetlands dry up, biodiversity decreases, the productivity of grasslands and forests decrease and conflicts of interest become more frequent. A number of measures have been undertaken to begin tackling the region's water deficit problem, such as land use optimisation, wetland restoration and the re-establishment of mixed deciduous forests.

According to the authors of this paper, there are still not enough empirical studies on this issue. They discuss the need for multidisciplinary research efforts at various scales for both identifying and explaining water balance changes and developing adaptive strategies. They also underscore the need for inter-regional comparisons in this effort. The paper goes on to explain why the efforts must also include a continuous or even expanded monitoring of hydrological changes.

Germer, S., K. Kaiser, O. Bens, R. F. Hüttl. *Water balance changes and responses of ecosystems and society in the Berlin-Brandenburg Region – a review.* Die Erde 142, 2011 (1-2), pages 65-95.

www.die-erde.de/DIE_ERDE_2012-12_Germer_S.pdf

MEASURING AIR TEMPERATURE WITH THE LANDSAT 7 SATELLITE

Changes in air temperature are important indicators for climate change. A proven method for mapping such changes is the analysis of satellite images. Scientists from the German Aerospace Centre (DLR) have enhanced the approach by modifying the temperature-vegetation index method (TVX method) for use with Landsat 7 Enhanced Thematic Mapper Plus (EMT+) data. The method that requires multispectral data consisting of bands in the red, near-infrared and thermal spectral range, allows for the area-wide mapping of instantaneous temperatures. The Landsat 7 satellite, launched in April 1999 by the US National Aeronautics and Space Administration (NASA), is part of NASA's Earth Observing Systems (EOS) research programme and is equipped with the multispectral ETM+ sensor.

The researchers applied the TVX method to a multi-temporal dataset from nine ETM+ scenes. The satellite images cover large parts of northeastern Germany, including DLR's Durable Environmental Multidisciplinary Monitoring Information Network (DEMMIN) test site. This represents the first time that the TVX method has been applied to fine spatial resolution data and a central European region. The spatial resolution of the satellite-derived air temperatures is approximately 60 meters. A comparison with in situ measurements showed an average error of approximately 3K (RMS).

Wloczyk, C., E. Borg, R. Richter, K. Miegel. *Estimation of instantaneous air temperature above vegetation and soil surfaces from Landsat 7 ETM+ data in northern Germany.* International Journal of Remote Sensing, 2011, Vol. 32, Issue 24, pages 9119-9136. doi: 10.1080/01431161.2010.550332.

TERENO – A GERMAN CONTRIBUTION TO GLOBAL CHANGE RESEARCH

Our environmental systems are being shaped and altered by global change. Investigating these changes in a comprehensive manner – which includes understanding the multi-compartment interactions beyond the various temporal and spatial dependencies – remains one of the central challenges for environmental research today. A number of initiatives around the world have begun establishing integrated environmental observatories in an effort to tackle these challenges. TERENO, a joint project run by six Helmholtz Association research centres, is one such initiative. The large-scale project based in Germany provides plenty of opportunities for linkages to other research programmes. As this publication illustrates, these networks span both national and international levels. The paper places TERENO in the international research context and describes the project's various conceptual approaches that are employed to explore terrestrial energy, water and matter fluxes.

Zacharias, S., H. Bogena, L. Samaniego, M. Mauder, R. Fuß, T. Pütz, M. Frenzel, M. Schwank, C. Baessler, K. Butterbach-Bahl, O. Bens, E. Borg, A. Brauer, P. Dietrich, I. Hajnsek, G. Helle, R. Kiese, H. Kunstmann, S. Klotz, J. C. Munch, H. Papen, E. Priesack, H. P. Schmid, R. Steinbrecher, U. Rosenbaum, G. Teutsch, H. Vereecken. *A network of terrestrial environmental observatories in Germany.* Vadose Zone Journal, 2011, Vol. 10, pages 955-973. doi:10.2136/vzj2010.0139.

MAPPING SOIL MOISTURE WITH REMOTE SENSING – A COMPARISON

Surface soil moisture plays a key role in regulating water and energy exchanges between the land and atmosphere. Accurate estimates of surface soil moisture are essential in many research fields, including agriculture, hydrology, and meteorology. This is no easy task, however, as soil moisture varies greatly, both spatially and temporally. Remote-sensing methods are used to help overcome this challenge. The study evaluates two remote-sensing methods for mapping the soil moisture of bare soil – L-band radiometry, which retrieves the brightness temperature of the Earth's surface, and ground-penetrating radar (GPR), which uses electromagnetic radiation surface reflection.

To compare these, , the scientists conducted a field experiment at the Selhausen test site, part of TERENO's Eifel Lower Rhine Valley Observatory. Using both methods, the researchers mapped the soil moisture after controlled heterogeneous irrigation. Invasive time-domain reflectometry (TDR) measurements were used as a reference. While both L-band radiometry and GPR techniques were able to reproduce the irrigation pattern, significant differences were seen in the retrieved absolute moisture values. The discrepancy is a result of the different sensing depths and areas of the two remote-sensing methods, as well as their different sensitivities to soil surface roughness. In the case of GPR, the effect can be eliminated by operating at low frequencies (0.2-0.8 GHz).

In a comparison of GPR and TDR mapping, the root mean square (RMS) error between soil moisture measured was 0.038 m3·m-3. With L-band radiometry, the rms error decreased from 0.062 (horizontal polarisation) and 0.054 (vertical polarisation) to 0.020 m3·m-3 (both polarisations) after accounting for roughness using an empirical model. This model required calibration with TDR reference measurements. Monte Carlo simulations showed that approximately 20% of the reference data were required to obtain a good roughness calibration for the entire test area.

Jonard, F., L. Weihermüller, K. Z. Jadoon, M. Schwank, H. Vereecken, S. Lambot. *Mapping field-scale soil moisture with l-band radiometer and ground-penetrating radar over bare soil.* IEEE Transactions on Geoscience and Remote Sensing, 2011, Vol. 49, No. 8, pages 2863-2875. doi: 10.1109/TGRS.2011.2114890.

At TERENO's Selhausen site, scientists from the Forschungszentrum Jülich tested two remote sensing techniques designed to measure soil moisture as precisely as possible: L-band radiometry (pictured is a mobile radiometer) and ground penetrating radar

3-D FOREST OBSERVATIONS

Satellite mission Tandem-L: Monitoring dynamic processes on Earth with great accuracy for the very first time

the future, Tandem-L can be used to better monitor forest changes. Pictured here is the „Hohes Holz" woodland, one of the locations within the TERENO observatory "Harz/Central German Lowland"

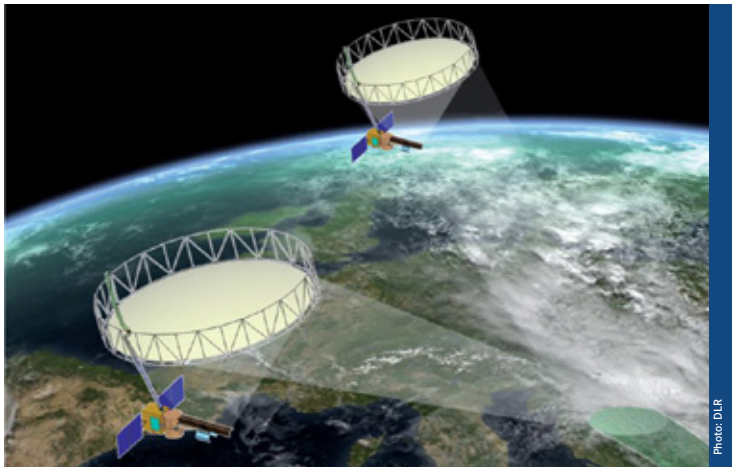
Around the world in seven days: The satellite mission Tandem-L aims to capture 3-D images of the Earth's surface with unprecedented accuracy. Under the Tandem-L proposal, new images of our planet would be sent back every week, with a particular focus on producing an inventory of the world's forests. The satellite will collect information on tree height and structure while simultaneously analysing the forest floor.

The data will help to improve our understanding of the role that forests play in the global carbon cycle. The information is highly valuable at a regional level too. For scientists at the TERENO observatories, for example, it can be used to map regional land use changes as well as their impact on the global cycle. In addition, Tandem-L can record melting processes in areas of snow and ice and measure the deformation of volcanoes – to within a millimetre, from an altitude of over 600 kilometres.

Professor Irena Hajnsek from the German Aerospace Centre (DLR) presented the project at a conference organised by NASA at the beginning of October 2011. Leading scientists from the USA met to discuss strategies for researching the global carbon cycle, and lent their support to the Tandem-L initiative.

The mission that the DLR aims to carry out in cooperation with NASA is based on two satellites flying in close formation to scan the Earth's surface and produce 3-D images of vegetation, soil, and areas of ice and snow. New advances in areas such as antenna and monitoring technologies make it possible for the satellites to provide comprehensive updates of these images within a week, thereby monitoring dynamic process to a high degree of accuracy for the first time.

The Tandem-L mission conducted jointly by NASA and DLR deploys two satellites that orbit together and scan the earth's surface using radar



Unique data

"We are able to collect systematic, global data with a high spatial resolution within a short time period – which is unique," says Irena Hajnsek. "Researchers all over the world from a wide range of research areas will benefit – climate research, hydrology or research into the cryosphere to name just a few examples". The satellite mission would build on Germany's leadership role in Earth observation.

For example, Tandem-L is able to show to a high degree of accuracy, where a forest is located world-wide, , where it is being forested, and where its condition is deteriorating. "Tandem-L therefore provides us with a tool for the global monitoring of forest conditions and changes. Germany would be the only country in a position to make this information available to political decision makers," explains Irena Hajnsek. Monitoring forest structure, height and changes in forest composition – caused by factors such as forest management, deforestation or storm damage – could make an important contribution to gaining a better understanding of the role that biomass plays in the global carbon cycle. The images, which are set to have a resolution of up to three metres, would be ideal support material for policies to combat climate change, such as the proposed REDD+ agreement which provides support for forest maintenance and expansion in developing and emerging countries.

The 300 million euro project is ready to be implemented as soon as a financing commitment has been secured from the German federal government.

The Tandem-L Mission Proposal

Tandem-L – A Satellite mission (in German)

PUBLICATION

Krieger, G., I. Hajnsek, K. Papathanassiou, M. Younis, A. Moreira. *Interferometric synthetic aperture radar (SAR) missions employing formation flying.* Proceedings of the IEEE, 2010, 98 (5), pages 816-843. doi: 10.1109/JPROC.2009.2038948. ISSN 0018-9219

REGULAR DATA UPDATES – JUST LIKE THE WEATHER REPORT

Using data assimilation to improve terrestrial environmental forecasting

Data assimilation has become an important element in weather forecasting. With the help of numerical simulations and up-to-the-minute measurement data, it makes it possible to adjust weather forecasts in response to the actual weather developments. Scientists from several universities and Helmholtz Centres are now developing numerical algorithms that will enable this technique to be applied to terrestrial environmental research. TERENO observatories will be supplying the necessary data.

Modelling forecasts always deviate from reality to some degree. This can be due to several different factors. The model's predictions might be based on flawed observation data; sufficient data might not be available; the parameters that are fed into the model might deviate significantly from real-life conditions; or it may be that certain processes or components have not yet been integrated into the model, because these processes are not yet well enough understood. Data assimilation is a technique that allows scientists to overcome some of these limitations and create models that simulate reality as closely as possible. In meteorology in particular, data assimilation has become a crucial tool. It allows weather forecasts to be updated and adjusted several times a day based on the latest atmospheric data.

Although it has become standard practice in meteorology, data assimilation has hardly been used in terrestrial environmental research so far. "We want to use data assimilation to combine the various systems into an integrated model," explains Prof. Harrie-Jan Hendricks-Franssen from the Institute of Bio- and Geosciences (IBG) at the Forschungszentrum Jülich (FZ Jülich). "This includes modelling subsoil, soil, vegetation and land surfaces, as well as the atmosphere and stratosphere. And this has not been done so far." Nine partners from various universities and Helmholtz Centres (see box) have joined forces to pursue this goal and have submitted a joint grant application to the German Research Foundation (DFG).

Simplifying water management

With the results of their research, the team hopes to improve long-term forecast models so that factors such as soil moisture can be analysed and predicted more accurately over large areas. This is especially important for agricultural production. If inadequate soil moisture levels are expected, farmers can be notified early and have time to make the necessary adjustments to their irrigation. These kinds of models could also help to simplify water management in semi-arid regions. Water scarcity represents a regular threat in these regions, where dry periods extend over several months, and where more accurate forecasts would greatly simplify water management efforts. This can also help to improve weather forecasting. A more accurate measurement of soil moisture results in a more realistic analysis of the water and energy exchange between earth and the atmosphere.

From improved weather forecasting will also benefit arable farming

For their data assimilation, the research group will require extensive, real-time data measurements, including data on vegetation, runoff, groundwater and soil moisture levels, as well as meteorological measurements such as precipitation data from weather radars. But while meteorological stations and decades of weather observation have generated an extensive pool of atmospheric data, this kind of long-term data is not available for soil, water and vegetation. This is where TERENO comes in. The well-equipped TERENO observatories – along with TERENO's remote sensing data – will provide exactly this kind of information.

As a first step, the researchers want to use the data to develop a computer model that simulates real-life conditions as closely as possible. Because of the complexity of climate models, and the huge amount of data involved, a supercomputer is required. Virtual measurements – including data on soil moisture, runoff and evapotranspiration – are then compared with actual measurements so that the model can be fine-tuned and developed further.

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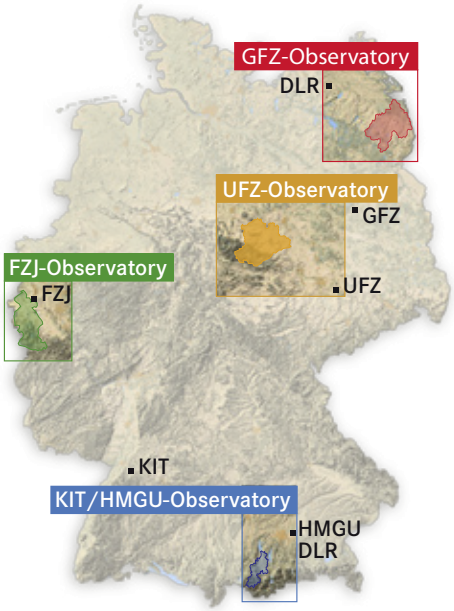

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KIT	Karlsruhe Institute of Technology
HMGU	Helmholtz Zentrum Muenchen, German Research Center for Environmental Health
UFZ	Helmholtz Centre for Environmental Research
GFZ	Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences