TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

NEWSLETTER

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HELMHOLTZ | ASSOCIATION

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Concerted effort: scientists from the FZJ and colleagues at the Eifel National Park constructing the meteorological tower at the Wüstebach site

TERENO UNITES CLIMATE RESEARCH

An infrastructure for everyone

The TERENO environmental observation network which spans the whole of Germany is taking shape. Numerous measuring stations have become operational, and initial research activities are underway. The Helmholtz Association Centres are not the only participants in this. Through collaboration with universities, research institutes, other organizations and institutions, new insights are being won into climate and environmental research. For example, TERENO is working closely together with the Transregional Collaborative Research Centre 32 (TR32) run by the German Research Foundation (DFG) in order to hone climate models. Initiating and promoting collaborations is one of TERENO's main aims. The project serves as a research platform to help all those involved pool expert knowledge and resources.

CONTENTS

VALUABLE DATA

Remote sensing test site to be integrated into the TERENO observatory in the North-East German Lowlands

The TERENO observatory in the North-East German Plain, managed by the GFZ German Research Centre for Geosciences, is being expanded with the addition of the DEMMIN test site. DEMMIN (Durable Environmental Multidisciplinary Monitoring Information Network) is developing remote sensing methods for agriculture, forestry, and the environment. Remote sensing captures information about the conditions in a given agricultural site, which can be used to improve crop production, yield, and quality.


Photo: Dirk Jahnecke

Signal exchange: corner-reflectors on the ground allow radar sensors to be calibrated

The test site is the result of a collaboration since 1999 between the German Aerospace Center (DLR) and the Demmin Network (IG Demmin), an association of the region's farmers. The district of Demmin is located in the federal state of Mecklenburg-Vorpommern, some 200 km north of Berlin. The area bears the marks of the last ice age, featuring a landscape common to the entire region covered by the TERENO observatory in the North-East German Lowlands. Various moraines have been left behind by the glaciers. Now the landscape is characterised by wide fields, rolling hills, and large forests, as well as numerous lakes and rivers.

In accordance with the TERENO remit, the regional effects of global change and how it impacts on ecosystems, land use, infrastructure and basic human living conditions are to be examined in the DEMMIN test site. With this in mind long-term scientific monitoring is essential. "Remote sensing will play a vital role, as it provides us with comprehensive real-time data from a wide area," explains Dr. Erik Borg from the DLR, head of the test site. The results are to be combined with on the ground measurements and analysis of geological archives.

Spot-on data

The Demmin Network spans some 30,000 hectares. The area serves as a particularly suitable agricultural site for remote sensing. On the one hand there is a great diversity in the area's topography, soil, and water conditions. On the other hand, individual fields measure between 50 and 200 hectares. This makes them ideal candidates for remote sensing, allowing researchers to pinpoint data received from the sensors to any particular spot. With the help of fixed monitoring networks in the test site, remote sensors, such as radar systems, can be continually adjusted to optimize results. In 2004 an agrometeorological weather monitoring network was added to the system, which collects data on weather conditions.

The long-standing collaboration between the DLR and the Demmin Network has already resulted in a significant amount of both on-site and remote sensing data for the analysis of short-term changes and longer-term trends. "The data provided by DEMMIN is extremely valuable for the long-term observation of the test site. Integrating the test site into the observatory has been a valuable scientific contribution," explained Dr. Oliver Bens, Head of Staff of the Scientific Executive Board at the GFZ. ■

EDITORIAL


Photo: Chris Taube

A platform for everyone

Dear readers,

TERENO is growing. Its observatories are developing at a great pace. New partners such as the DEMMIN site have come on board, measuring towers and weather radars systems are being built, remote sensing networks are starting to deliver results, and research aircrafts have taken to the skies. One of the key roles of TERENO is to serve as a research platform which is at the disposal of other non-university research institutes and universities. It provides the ideal platform for a cooperative approach to exciting research questions, a shining example of which is the collaboration with the three universities of Bonn, Aachen, and Cologne, which are part of the Transregional Collaborative Research Centre 32, funded by the German Research Foundation (DFG). Further collaborations with TERENO observatories are in the pipeline. Current partners include other research institutes, national and nature parks, and biosphere reserves. Specialist knowledge and resources are being drawn together in order to move forward terrestrial research. The current edition of the TERENO newsletter will give you an idea of the progress which is being made. I wish you enjoyable reading!

Harry Vereecken

Coordinator of the TERENO Project


Photo: Edgar Zabel

The great outdoors: meadows, forests, and fields dominate the flat landscape around the town of Demmin

A STRONG RESEARCH PARTNERSHIP

TERENO and the Transregional Collaborative Research Centre 32 investigate the soil and the atmosphere

Carbon dioxide, water vapour – wherever one looks soil and plants are releasing materials and energy into the atmosphere or absorbing them from it in return. The quantities involved vary however, a forest for example generating very different levels compared to a field. The key factor is determining to what heights the various levels are maintained, and how they affect the climate. That is exactly what scientists at the Transregional Collaborative Research Centre 32 (TR32) run by the German Research Foundation (DFG) are researching.

Field under surveillance: Scientists from both universities and research institutes work together to measure energy and matter exchange with the atmosphere

"Up to now climate predictions have failed to take into account these different patterns in the landscape in sufficient detail. That's why it is so difficult to scale down global prognoses to a regional level" says Clemens Simmer, professor of meteorology at the University of Bonn and coordinator of the TR32. The researchers are now aiming to hone climate models so that better regional predictions can be made. This would also lead to improvements in the quality of weather forecasting. To this end, scientists from various disciplines have to find out more about the exchange of energy and materials between land surface, vegetation and the atmosphere. Hydrologists, for example, chart the flow of water from top soil to ground water. Pedologists examine how well different kinds of soil store water and carbon dioxide. And finally, mathematicians are producing new methods for combining data and different models and for making sense of information gathered from geological measurements.

Pooling resources

The climate project fits in well with the work being undertaken by TERENO, even geographically, as both focus on the Eifel-Lower Rhine Basin region. "A lot of the data which the researchers from the TR32 are producing is also of interest for TERENO", explains Dr. Alexander Graf, a researcher at the Forschungszentrum Jülich (FZJ) and a member of the TERENO coordination team 'Atmosphere' . The FZJ is coordinating the work undertaken at the region's TERENO observatory and is also involved in the TR32. It was therefore pertinent to collaborate closely, an example being reconnaissance flights. Scientists have set up masts in selected fields and installed different sensors at varying heights. These sensors measure, amongst other things, carbon dioxide, temperature, wind speed, air and ground humidity. Several times a year a motorised glider flies over the masts and measures the same parameters at an altitude of approximately 100 metres. "This gives us a very clear picture of the flows of materials and their dispersal" says Alexander Graf. Initial results show an extremely complex mixture. Depending on the weather situation the pattern of activity on the ground can be traced far up into the atmosphere or, alternatively, it is over-ridden by the patterns in the atmosphere after just a few metres.

Model example of cooperation

While TERENO brings state-of-the-art sensors to the joint project, most of the scientists involved come from the institutions affiliated with the TR32. The comprehensive data will benefit both projects. "That's exactly how we envisage cooperation. Here expert knowledge and resources are pooled for the benefit of everyone involved, with TERENO providing a well established infrastructure through its network of observatories" explains Harry Vereecken from the FZJ and coordinator of the TERENO project. It is often not possible for universities to build up such a complex and long-term infrastructure. For their part, the universities contribute their expert knowledge to TERENO. "Our collaboration is a showcase example of how universities can participate in large-scale research" sums up Clemens Simmer.

MILLIONS OF EUROS IN FUNDING

The Transregional Collaborative Research Centre 32 "Patterns in Soil-Vegetation-Atmosphere Systems: monitoring, modeling and data assimilation" has been run by the German Research Foundation (DFG) since 2007. The project will receive around 2 million euros funding annually until 2010; a continuation is planned until 2018. The TR32 is a collaboration between the universities of Bonn, Cologne, and Aachen, and the FZJ.

www.tr32.de

TERENO PARTNER UNIVERSITIES

- RWTH Aachen University
- University of Augsburg (as of 2010)
- University of Bayreuth (as of 2010)
- University of Bonn
- BTU Cottbus
- TU Dresden
- University of Greifswald
- University Halle-Wittenberg
- University of Hohenheim
- University of Cologne
- University of Leipzig
- Magdeburg-Stendal University of Applied Sciences (FH)
- TU München
- University of Potsdam
- Regensburg University of Applied Sciences
- University of Regensburg (as of 2010)
- University of Rostock
- University of Stuttgart
- Tübingen University

INTERNATIONAL PARTNERS

- Institute of Atmospheric Physics at the Chinese Academy of Sciences
- Centre for Ecology and Hydrology, Edinburgh/UK (as of 2010)
- University of Stettin/Poland
- Tel Aviv University/Israel

In addition TERENO has collaborations with numerous institutes from the Leibniz Association, with research projects run by the Deutsche Forschungsgemeinschaft (DFG), biosphere reserves, national parks, nature parks, environmental agencies, the German Meteorological Service (DWD) and others.

A BOOST FOR CLIMATE RESEARCH

An interview with Hartmut F. Grübel


Photo: André Künzelmann/UFZ

The large-scale TERENO project receives around 12 million euros in funding from the Federal Ministry of Education and Research. Former director of Subdepartment 72 Culture, Earth and Environment Hartmut F. Grübel has followed the project since its inception. He sees it as an important step in promoting and combining research on the causes of climate change and protection from its consequences. According to Grübel, TERENO will come to be regarded as an essential infrastructure for cooperation between the various branches of research.

What is Germany's role in climate research?
Germany plays a meaningful and very important role internationally in its research on the causes and effects of global climate change. Europe and Germany are leading the way in climate and research policy. We can draw upon an excellent research landscape with high quality universities and a number of other non-university research facilities, which rank among the best in the world. However, if we really want to tackle man-made climate change then just about every player in the political arena, both national and international, needs to work together. The role of research is to provide the necessary bases for action. That is why the federal government has developed a high-tech strategy for climate protection.

How does TERENO fit into this strategy?
Up to now public interest has focused mainly on the gloomy and threatening aspects of climate predictions. If we simply carry on with 'business as usual' then the predicted consequences of changes in the climate will indeed come true. A responsible climate protection policy will help us prevent that from happening. To this end, we need a scientifically sound and precise assessment of the effects which have already happened and can be measured. In addition, they need to be tracked via a monitoring programme. We have to be aware of the effects our future counter measures will have, and of where we will have to countersteer more vigorously or take precautions with even stronger protective measures. For that purpose a country-wide scientific infrastructure is necessary. That is exactly what TERENO's remit is. The fact that the Helmholtz Association is dedicating its centres to take care of this long-term task strengthens and underlines an effective division of labour in the German research landscape. Individual institutes and universities could not take on that burden alone. That's why I consider TERENO to be in such good hands with the participating Helmholtz centres. This is underlined by the "Climate Initiative" which the Helmholtz Association has incorporated into its research programme, and which has an all-inclusive approach.

What are your hopes for TERENO?
We are anticipating that TERENO will give rise to a further model infrastructure - supported and developed within the Helmholtz Association as a country-wide network for on-the-ground observation of climate changes. It is intended to bear fruit for German climate research at a national and international level in terms of recognition, as a prized resource, and as a stimulus for collaboration. And perhaps even as a trend-setter. At the same time, it brings together ecological, social and economic issues. Such connections need to be strengthened. One thing is clear: support for TERENO is intended to be an infrastructure boost for the whole of German climate research.

What does that mean?
As many partners as possible, scientific and otherwise, should take part in TERENO or benefit from it. TERENO can serve as an ideal bridge between climate research and adaptation strategies. On the one hand it will lead to improvements in climate observation and prediction at a regional and local level. That makes the project interesting for National Parks, agricultural and tourist organizations, to name just a few examples. On the other hand it provides a nation-wide infrastructure for large research projects on the climate and the consequences of climate change. TERENO will have a combination of diverse tools for observing the earth at its disposal, such as satellites, planes, and lysimeters - the ideal package for partners such as universities who are unable or unwilling to purchase such equipment. An example of how this can work in practice is provided by the participation of the universities of Bonn, Aachen, and Cologne in the Transregional Collaborative Research Centre "Patterns in Soil-Vegetation-Atmosphere Systems: Monitoring, Modelling and Data Assimilation". This is exactly what we want to achieve with our high-tech strategy, on as wide a basis as possible.

What effect can TERENO have internationally?
TERENO is intended to - and it certainly will - play a part in consolidating Germany's place in climate research and in strengthening its international standing in climate protection. I have already spoken about my hope that the project could have what it takes to be a successful export. For example, our scientific cooperation with Africa could benefit, say in questions relating to climate induced changes in land use or water management. ■

For more information on Germany's high-tech strategy for climate protection:
www.bmbf.de/pub/the_high-tech_strategy_for_climate_protection.pdf

FOREST IN TRANSITION

An ideal research area: the Wüstebach in the Eifel National Park

The "Wüstebach", a stream located in the Eifel National Park, presents a pretty idyllic picture. The perfectly preserved flora and fauna along its banks attract nature-lovers in large numbers. And these days it is also a popular destination for scientists from the Forschungszentrum Jülich (FZJ). The stream's upper catchment area is one of the central test sites covered by the TERENO observatory in the Eifel-Lower Rhine Basin and the Transregional Collaborative Research Centre 32 "Patterns in Soil-Vegetation-Atmosphere Systems", run by the German Research Foundation (DFG).

Scientists at the site employ numerous meteorological, pedological and hydrological sensors to measure the forest's water and vegetation cycles. Carbon dioxide is the main focus of this research. "In the age of climate change we are interested to find out how much carbon dioxide is absorbed or released by the different ecological systems. We measure the flow of carbon dioxide over plants and are then able to calculate the net impact that this greenhouse gas has on the landscape at this particular spot" explains FZJ researcher Dr. Thomas Pütz, who is a member of the TERENO steering committee, and is coordinating work at the Wüstebach site. In addition, scientists want to find out more about the interaction between soil, vegetation, and the atmosphere.

Deciduous trees instead of spruces

It's as if the Eifel National Park were made to fit the TERENO remit to research the regional and local effects of climate change. It has the typical regional forests which scientists are interested in. What is more, the national park's management are currently converting the areas of forest which were for a long time used for timber production into a more natural mixed deciduous forest. Scientists at the FZJ are co-ordinating this process together with colleagues at the universities of Bonn, Aachen, and Trier.

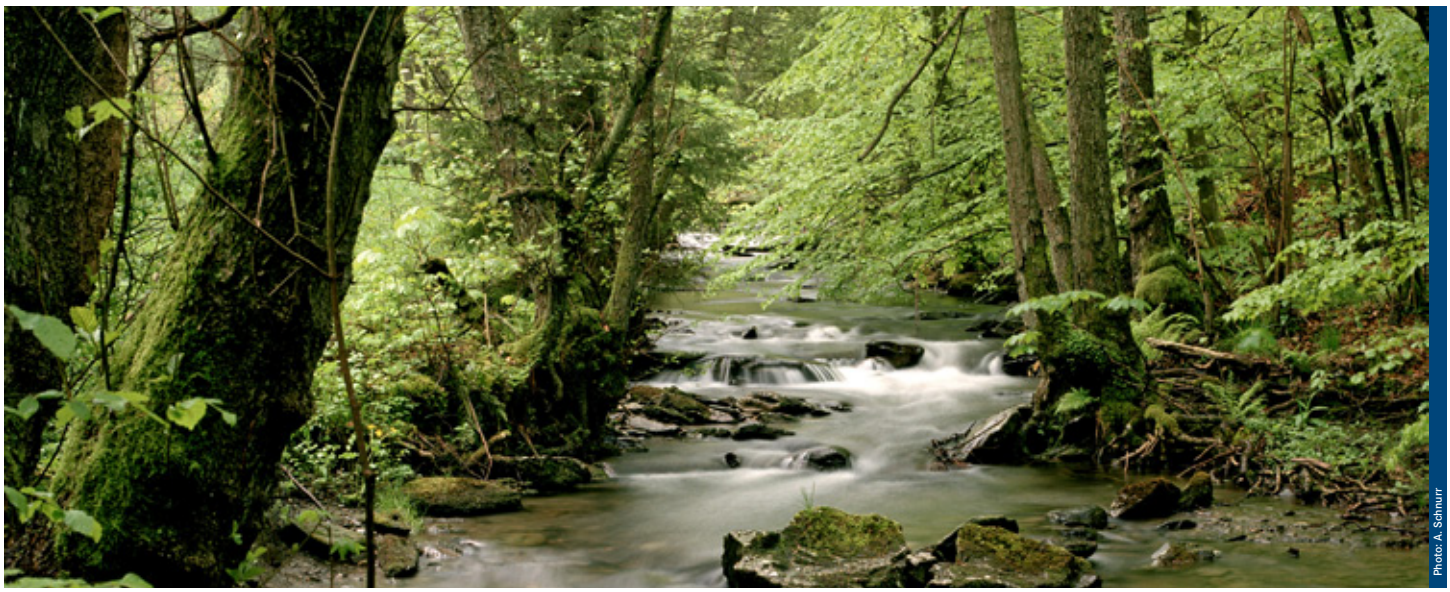
The aim is to evaluate the effects of this change in the identity of the forest on water and vegetation. Up to now no fundamental research has been done on this. For example, do the changes have an impact on water quality? Are there any alterations in the amounts of carbon and nitrogen, both in the soil and in the atmosphere? What do the changes mean for flora and fauna? In order to find the answers to these questions, researchers have, amongst other things, installed a tower measuring 36 metres, water quality measuring stations, and a cutting-edge network of soil sensors. "SoilNet" is a wireless sensor network developed by scientists at the FZJ, whereby soil humidity is measured by sensors at three different depths. Wireless transmitters relay the data to a receiver, which in turn sends the data on to the FZJ.

Come rain or ...bats

The measuring tower is also something of a novelty. Officials at the Eifel National Park and the administrative district of Euskirchen issued a special permit for it to be built, as the construction of buildings is normally prohibited in the national park. They were happy to make an exception for the scientists however, who make meticulous efforts to ensure that their research does not upset the area's ecological balance.

Firmly anchored: the measuring tower at the Wüstebach site

Activities at the TERENO site benefit the Eifel National Park Forestry Office as well as universities and other institutions. These outside agencies are welcome to install additional measuring systems at the tower and to make use of the project data. There are plans for all kinds of devices to grace the lofty heights, ranging from a rain scanner to a bat detector. "The data will flow into a network, which will be accessible to all of the cooperating partners" explains Dr. Michael Röös, from the research division at the Eifel National Park administration department. This too is an important principle at the heart of TERENO; encouraging targeted collaborations with other institutions.



An idyll in the Eifel: the Wüstebach

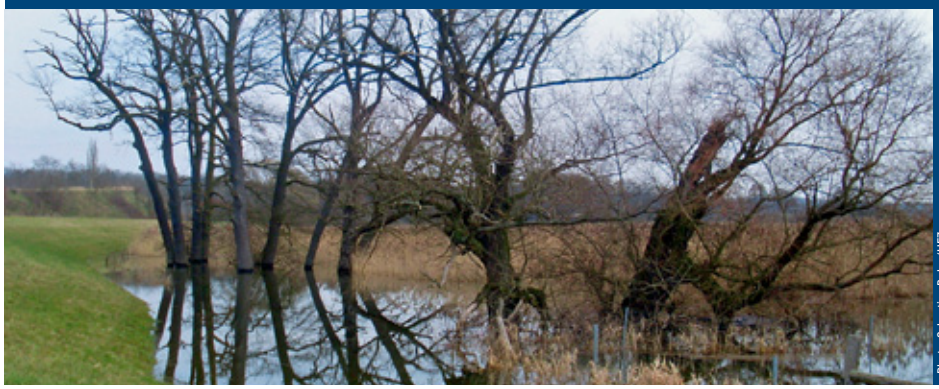


Photo: Sebastian Bolze/UFZ

Revitalised: the floodplains surrounding the river Elbe were inundated once more following the relocation of the dyke


Photo: Tilo Arnhold/UFZ


Photo: UFZ

Researched (see bottom) and "selected" (see top): the ' Roßlauer Oberluch' site

LIFE RETURNS

Flood Plain Research Area a Selected Site in the "Land of Ideas"

Germany is presenting itself as a "Land of Ideas". Every day a new "selected site" steps into the spotlight. One of these 365 sites chosen for 2009 is the TERENO research project "More space for the Elbe". The idea behind this project is the first relocation of a dyke on the Middle Elbe affecting such a large area. It improves flood protection and promotes the regeneration of the flood plains. Work at the 'Roßlauer Oberluch' site is been jointly undertaken on a scientific level by the Helmholtz Centre for Environmental Research (UFZ).The area near the town of Dessau-Roßlau in Saxony Anhalt is one of the sites of the flood plain research platform, which is part of the TERENO observatory in the Harz/Mid-German Lowlands. Scientists are currently analysing the effects of relocating the dyke on the region's natural environment and inhabitants. The project is regarded as a model for the whole of Germany.

The "Roßlauer Oberluch" was awarded its "selected site" status on May 12. To mark this occasion the UFZ, together with the UNESCO Middle Elbe Biosphere Reserve, sent out invitations to an open day at the site. Around 500 scientific colleagues, local residents living close to the dyke, pupils, students, farmers, and conservationists got an impression of the TERENO research activities and monitoring sites.

A new move: dyke relocation

For a long time, kilometre-long dykes were considered to be the only effective protection from flooding on the Elbe and Oder rivers. However, flood protection on the Elbe alone claimed up to 80 per cent of the natural habitat in the flood plains. Yet the risk of flooding remains in many areas, even though in recent years dykes have been extended and raised. By relocating the dyke at the "Roßlauer Oberluch" a former flood plain of 140 hectares is being reconnected to the river and a valuable flood plain habitat restored. "This is the first time a project like this has been undertaken in Germany, and it offers us a unique opportunity to examine the effects on nature and mankind especially in rapidly changing climatic conditions" explains Mathias Scholz from the UFZ, scientific coordinator of the TERENO flood plain platform. At the interdisciplinary research platform over 40 scientists from the UFZ and other research institutes answer ecological questions, establish correlations, and examine the hydrology of flood plain landscapes. Their results are particularly important for every large-scale natural habitat reclamation project. In the future 15 dykes are to be relocated along the Middle Elbe, affecting a total area of some 2,600 hectares.

BETTER FORECASTS, EARLIER ALERTS

New weather radar station at the Sophienhöhe site

The TERENO observatory in the Eifel-Lower Rhine Basin will soon boast a new weather radar station. The station will serve as an early warning system for floods and storms. The range of the radar coverage will amount to approximately 100 km. Work at the 290 metre high Sophienhöhe site in the district of Düren, began in August at the instigation of the Forschungszentrum Jülich (FZJ). It is expected that the station will begin operating in the autumn. At 1.4 million euros, the station is one of the TERENO project's most substantial investments.

The weather radar station will enable researchers to predict regional rainfall with greater accuracy than previously possible. "With this innovative radar we will be able to predict more accurately whether it will rain or hail. That's something which has until now not been possible to do with weather radar systems, such as those operated by the German Meteorological Service," explains Dr. Heye Bogena, TERENO-project coordinator from the Institute of Chemistry and Dynamics of the Geosphere at the FZJ. Beyond that researchers are able to measure wind speed and direction. Other institutions should also be in a position to benefit from the data. Therefore the station will be networked with the radar stations of the Meteorological Institute in Bonn and the German Meteorological Service.

In addition researchers at the FZJ also intend to use the new weather radar system to provide data to be in a better position to predict regional flooding. North Rhine-Westphalia is hit time and time again by floods often affecting wide areas - not only on the Rhine but also on smaller rivers. In recent years the Eifel region has been particularly affected by local flooding causing significant damage. As Dr. Bogena points out: "Radar is therefore a perfect extension of our capacity to track the weather at the observatory".


Photo: Ralf-Uwe Limbach, FZ Jülich

Autumn launch: the new weather radar station

HIGH YIELD AND ENVIRONMENTALLY FRIENDLY

Researchers test-run agroforestry systems for the agriculture of the future in Scheyern

Heavy rainfall, extreme drought periods, stronger storms, and rising temperatures: climate change is confronting agriculture with new challenges. Yet it is not only the rapidly changing environmental conditions which are responsible for the increase in pressure. Less and less land is being cultivated for food production. At the same time, the world's population is on the increase, and consequently so is the demand for food and raw materials, for example to generate energy. As a result, the agriculture of the future must be highly productive. "And yet at the same time agricultural production and land use have to be managed in an environmentally sustainable manner. That is our main challenge", explains Prof. Jean Charles Munch, scientific director of the Scheyern Research Station, run by the Helmholtz Center Munich. Together with the Forschungszentrum Karlsruhe (FZK), the Center coordinates the TERENO observatory in the Bavarian pre-Alps.

One possible approach is to pursue new types of land use, such as agroforestry systems, whereby trees and shrubs are planted on the same plot as agricultural crops and in such a way so as not to impede crop management. These are the types of systems which scientists at the Helmholtz Center Munich are researching in cooperation with the Technical University Munich (TUM) as part of the TERENO project. "At the research platform in Scheyern, which is unique in Europe, we can develop strategies to make cutting-edge agricultural practices possible, and all this under the concrete, working conditions of a fully operational farm" explains soil ecologist Munch. How can crop yield be sustainably increased? What are the concomitant risks for the respective ecosystem and for human health? How can such risks be reduced?

Modern land use put to the test: plantation of numerous parallel rows of trees in arable fields

Trees in the fields

Agroforestry sytems allow more efficient water use than traditional cultivation methods, with positive repercussions for water supply management and the biodiversity of agricultural systems. For farmers, this could open up opportunities for the use of fallow land, without requiring any major interference with nature, while at the same time preserving valuable functions of the ecosystem, and perhaps even furthering them.
Two agrarian cultivation systems, each covering an area of 50 hectares, have been set up by the Scheyern station. No mineral-based fertilisers and pesticides are used in the fields which are being ecologically managed. In the fields which are being managed according to an integrated system, mineral-based fertilisers and pesticides are only used as and when required. Scientists have selected certain fields in both systems as agroforestry planting sites. In these fields wide rows of arable land alternate with rows of trees. Researchers have planted five different types of fast-growing trees. They hope to harvest initial results after five years, with answers to questions about the efficiency of agroforestry systems, the interaction between the respective ecosystems, and the effects which such systems have on atmospheric gas levels, as well as the quality of the crops which are produced.

Carbon in the ground

The focus of the research is not simply to produce renewable raw materials in an environmentally sustainable way with efficient use of limited water amounts. In addition, agroforestry is considered to be a system which allows additional reserves of carbon to be stored in agricultural ground, potentially helping to reduce levels of carbon dioxide in the atmosphere and thereby offsetting the green house effect. Scientists around the world are looking for additional and long-term ways in which carbon can be absorbed by forests and agricultural land. The long-term experiment in Bavaria could help agroforestry systems to break through into the mainstream. "We often have visitors in Scheyern who are eager to find out more about the work we are doing" reports Jean Charles Munch.

Researchers in Scheyern are also working on the subject of ozone. The gas is harmful to plants; it disrupts the sensitive process of photosynthesis, whereby plants absorb carbon dioxide. Scientists at the Helmholtz Center, together with colleagues in Munich and Freiburg are in the process of examining how increased ozone levels are influencing the growth of poplars and what effect these stressed trees are having on the environment. To this end they are partly using the same poplar clones as in the agroforestry experiment. This research is tied in to a European-wide ozone monitoring project, which collates data gathered at various local sites. ■

SCHEYERN – SCIENCE WITH TRADITION

Benedictine monks founded the monastic agricultural estate Scheyern in the 12th century, under the name Schyrenhof. Scientific work was also undertaken there; in 1803 the Scheyern monk, Gabriel Knogler (1759 – 1838) wrote the first meteorological textbook in the German language. This tradition is being carried on today. Since the end of agricultural production in 1990 scientists there have been researching ecosystems knowledge toward environmentally friendly agricultural practices. The Helmholtz Center Munich has been the tenant of the estate since October 2005. ■

SIGNALS FROM DEEP DOWN

'SoilNet' and Co.: Workshop presents new sensor systems for measurements in the ground

The ground holds many a secret, one of them being soil moisture, which has an impact on rainfall and evaporation, and thus on the regional climate. But researchers are still a long way off from knowing all the answers. How for example does soil moisture content vary at different sites? How does soil humidity change over a longer period of time? In order to get closer to the answers there is a need for measuring instruments which can determine both soil moisture and the temperature just below ground level.

In July the Forschungszentrum Jülich (FZJ), together with Oregon State University, within the context of TERENO, invited around 35 experts from Europe and the USA as well as representatives from various companies to a three-day workshop in Jülich. The aim was to present different sensor networks and to provide a forum for participants to share their experiences.

"Our device is able to give very accurate soil moisture readings, without the results being too heavily influenced by clay minerals or other organic substances in the ground. It is therefore not only suitable for use in various types of soil, but is also reliable, cost-efficient and durable" explains Ansgar Weuthen from the FZJ to the participants in the workshop, standing in the middle of the forest in front of a hole approximately 50 centimetres deep and well wrapped up to keep off the rain and ticks. Then it's down to work. The researchers carefully insert eight sensors into the ground at varying depths. Then they fill the hole with earth, leaving a little space at the very top to bury a small box, which is connected to the sensors via wires. Just a short while later a small, inconspicuous marker in the soil is the only remaining evidence of the digging work.

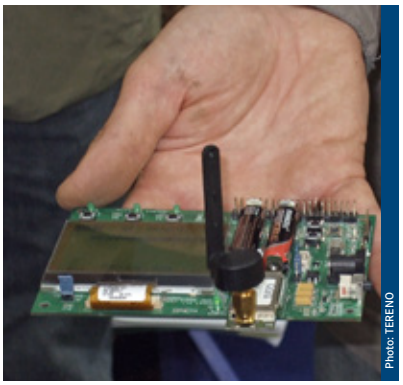
Wireless data transfer

The box contains an important element of the measuring instrument: the radio transmitter device which sets up the wireless connection to the outside world. The underground sensors relay their readings to the transmitter in the small box just below ground level, which comprises a memory unit and a processor, and transmits data to a router via radio signal. "As the data is sent from underground we have to pay very close attention to the transmission range" stresses Ansgar Weuthen. The router relays the data to a computer at the FZJ. This way there are hardly any restrictions on how often measurements can be taken and they are collected in what is basically real-time. The researchers decide at what time intervals measurements are to be taken and transmitted. The sensors record measurements every 15 minutes, and it takes just seven seconds to relay the data from the boxes to the FZJ. "When the central processing unit isn't receiving data it is in standby mode, which saves energy and increases the durability of the batteries supplying power to the individual units" says the Jülich scientist. The central processing unit stores data for one week. If, at any time, the radio connection should fail, the data is sent out with the next transmission. Another advantage of the FZJ design is the fact that its individual components are simple, inexpensive, and widely available.

This solution makes it possible to set up a whole network of measuring sensors, and explains why researchers at the FZJ decided to call their design "SoilNet". The system is already up and running. In autumn 2008 researchers began installing it at the Wüstebach test site in the Eifel National Park (see page 5), which is part of the TERENO observatory in the Eifel-Lower Rhine Basin. Since August 2008 some 900 sensors at 150 measuring points have been delivering data on soil moisture, temperature, and conductivity. As the test site is some distance away from the FZJ data is sent to the research institute by radio signal via the General Packet Radio Service (GPRS).

Learning from others

"SoilNet" generated a lot of interest among workshop participants. "The wireless solution is especially exciting, as we are also planning soil-based experiments. We have already approached our colleagues at the FZJ" says Peter Haas from the Vienna University of Technology. Above all the fact that he was given the opportunity to try out "SoilNet" for himself was something he found very helpful. Other groups of researchers also presented their designs at the workshop, for example "Smile Net" and "Decagon". "This has given us a lot of new ideas" said Carsten Leven from the University of Tübingen, which is a partner in the currently evolving research institute Water & Earth System Science. As the institute would also like to set up sensor networks he especially wanted to learn from the experiences of colleagues at other organisations. The workshop was also important for TERENO's further development, as the other observatories will also be equipped with sensor networks for measurements in the ground. ■



Getting their hands on new technology: at the workshop in Jülich participants were not only introduced to new sensor systems but were able to try them out for themselves

Additional information online:

Workshop: www.tereno.net/dist_sens
SoliNet: www.fz-juelich.de/icg/icg-4/index.php?index=739

MEASURING WITH LIGHT

DTS technology opens up new possibilities – workshop in Denmark shows how

Just before lift-off: using balloons to measure air temperature

Temperature is an important parameter in environmental monitoring. Scientists can use temperature to track and record environmental processes, such as the interaction between surface water and ground water. Scientists presented a promising technique to measure these types of interactions at a one-week workshop in the Danish town of Køge in June. The technique is called Distributed Temperature Sensing (DTS). Around 50 researchers from various disciplines took part in the workshop, which was organised by the University of Copenhagen's HOBE observatory together with TERENO.

DTS can record even minute differences in temperature at high spatial resolution even over longer distances, up to a total distance of several kilometers. In addition, this method makes it possible for temperatures to be measured at short time intervals. DTS achieves these results through the use of fibre optic cables. A light impulse is sent through the cable by a laser. Differences in temperature along the length of the cable cause variations in the light which is reflected. There are changes in both the length and the intensity of the waves. Researchers are able to capture this data. By analyzing the relationship between certain scattering components they can calculate the temperature of the fibre optic cable at the point of reflection. "This means that the fibre optic cable is the real temperature sensor," explains Thomas Vienken from the Helmholtz Centre for Environmental Research (UFZ).

Also suitable for the air

At the workshop DTS experts such as John Selker from the Oregon State University, Scott Tyler from the University of Nevada, and Nick van de Giesen from the TU Delft, gave a detailed account of the technique and its possible applications. The theoretical background did not sideline the practical aspects of the technique however. Participants at the workshop planned their own independent DTS measurement projects, which they subsequently carried out at a test site not far from where the workshop was being held. The exercises included, for example, measurements of the temperature in the ground and the distribution of temperature along a river bed. "We learnt first-hand how to use the instruments and the fibre optic cables, got practical experience collecting measurements, and found out about the particularities of evaluating, interpreting, and assessing measurement results" reports Thomas Vienken.

The workshop culminated in one more special challenge: an extremely complicated experiment to measure air temperatures at varying altitudes. The experiment required numerous loops of DTS cable to be attached to two balloons. The balloons then rose more than ten metres above the ground. The special arrangements of the loops in the cable made it possible to simultaneously measure vertical and horizontal variations in air temperature both over a stream and in the transition area to the bordering fields.

In addition, several manufacturers of DTS systems were represented at the workshop, so workshop participants were able to compare different technical solutions. The event was deemed a complete success by both workshop participants and organisers. "We want to use DTS at TERENO to monitor the interaction between ground water and surface water. In the future we are thinking about using this method to monitor variations of the soil water content. The advantage of DTS over other methods is its ability to achieve high spatial and temporal resolutions in measurements over longer time spans - and with easily manageable technical input at that" says Steffen Zacharias from the UFZ.

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KIT	Karlsruhe Institute of Technology
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UFZ	Helmholtz Centre for Environmental Research
GFZ	Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences