



TERENO – SOLUTIONS FOR THE 21ST CENTURY

Global Change from a Regional Perspective

Global change has triggered a number of environmental changes, such as alterations in climate, land productivity, water resources, atmospheric chemistry, and ecological systems. Finding solutions to the impact of global change is one of the most important challenges of the 21st century. TERENO is embarking on new paths with an interdisciplinary and long-term research programme involving six Helmholtz Association Centres. TERENO spans an Earth observation network across Germany that extends from the North German lowlands to the Bavarian Alps. This unique large-scale project aims to catalogue the long-term ecological, social and economic impact of global change at regional level. Scientists and researchers want to use their findings to show how humankind can best respond to these changes.

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KEEPING AN EYE ON THE ENVIRONMENT

TERENO: A new project on the regional impact of climate change

How does global change specifically impact ecosystems, land use and infrastructure at the regional level? The new large-scale project TERENO (TERrestrial ENVIRONMENTal Observatories) intends to deliver the answers. The project – run by six Helmholtz Centres – is the most comprehensive study to date on the long-term, regional consequences of global change.

“In the past, we lacked the observation data and interlinked observatories needed for documenting changes over a longer time span,” explained Prof. Harry Vereecken from the Forschungszentrum Jülich, who coordinates the large-scale project TERENO. Besides the Forschungszentrum Jülich itself, the German Aerospace Center, the Forschungszentrum Karlsruhe, the Helmholtz Zentrum München, the Helmholtz Centre for Environmental Research, and the German Research Centre for Geosciences – GFZ are contributing to the project.

Financed with twelve million euros of start-up funding provided by the Helmholtz Association, these partners are setting up four observatories in Germany: The Eifel Lower-Rhine Basin to the west, the North-Eastern German lowlands near the Baltic sea, the greater Leipzig-Halle region in middle Germany, and the Alps and alpine foothills in the south. These observatories embrace many different kinds of landscapes and provide a representative cross-section of German landscape types. Using the data obtained from these observatories, scientists want to improve environmental models for a better prediction of global change effects in terrestrial systems. These models can also be utilised to develop measures for adapting to climate change, such as optimised irrigation systems in farming. The project is initially scheduled to run for 15 years.

Using state-of-the-art methods from the fields of environmental technology, geophysics and remote sensing, the scientists record and

then analyse environmental data collected by ground, air and space-borne sensors. Besides climate data, this involves observations of water and soil quality, vegetation, and biological diversity. TERENO draws on existing monitoring stations of the Helmholtz Association, upgrades

“TERENO helps us to collect and analyse unique data. With this data, we plan to further expand Germany’s leading position in environmental research.”

Peter Dietrich (UFZ)

them or builds new ones. Mobile monitoring platforms are also used. An interdisciplinary approach is taken. In addition, the scientists and researchers not only focus on the ecological consequences, but also study the social and economic impact of climate change.

Open to cooperation

TERENO builds on the close links that exist between the research institutions in Germany. The project is already collaborating closely with facilities of the German Research Foundation (DFG), with universities, and with other partners such as the National Parks of the Eifel, Harz and Müritz, and the Biosphere Reserves Schorfheide-Chorin and Elbe. “We are actively seeking partners for cooperative efforts. A key element in our research strategy involves linking up TERENO with other networks worldwide,” explained Vereecken. ■

EDITORIAL



Photo: Helmholtz-Gemeinschaft

TERENO closes a gap

Dear Readers,

By establishing TERENO, the Helmholtz Association has provided climate impact research with new impetus. We still know far too little about the environmental changes and the effects triggered by global change. We lack data that has been collected in smaller regions over a longer period of time. Only with data like these can we recognise and understand long-term regional changes and from these derive the strategies needed for avoiding and adapting to these changes. TERENO closes this gap. The project is an important addition to the Helmholtz Association’s Research Field “Earth and Environment”. At the same time, TERENO serves to ensure that the activities previously undertaken in the field of climate impact research, both within the Helmholtz Association as well as between the various research institutions in Germany, are linked up together even more closely. The “TERENO Newsletter” will regularly report on TERENO’s activities and its results. And it will additionally aim to encourage research facilities and universities to look for ways of cooperating with scientists or research institutes. I wish you pleasant and interesting reading.

Jürgen Mlynek

President of the Helmholtz Association



Photo: TERENO

DATA FROM SPACE

Exactly how moist is the soil of the continents and how salty is the ocean surface? Questions like these are being explored by the European Space Agency’s satellite mission SMOS (Soil Moisture and Ocean Salinity). Scientists hope that this will enable them to draw conclusions on the global water cycle and its significance for climate fluctuation. The TERENO Observatory coordinated by the Forschungszentrum Jülich is one of these investigation sites. The soil moisture measuring instruments, the weather radars, and the runoff and climate stations installed as part of TERENO help to verify the data received from the SMOS satellite. ■



Photos: Chris Taube



RECOGNISING RISKS, CREATING PROFILES, TAKING MEASURES

TERENO Kickoff Meeting in Berlin: Presentation of the research programme

Surprises also happen in science. Atmosphere researcher Hans Peter Schmid from the Forschungszentrum Karlsruhe experienced just such a surprise in Indiana/USA in 2004. After spending six years monitoring the exchange of carbon dioxide between forests and atmosphere, he saw that this had suddenly increased. This change had been triggered by crickets (cicada) that only leave their underground hideouts once every 17 years in order to reproduce. "This shows how important long-term observations are. Only by carrying out work like this can we gain a broader insight into the ecosystems and so develop better predictive models," explained Schmid at the Kickoff-Meeting for TERENO held in Berlin on 22 September 2008.

More than 70 guests from universities, research facilities and organisations, such as the Federal Environment Agency or the Eifel-Rur Water Board, had come to find out more about the TERENO research programme. As Gerd Wessolek, Professor of Site Research und Soil Protection at the TU Berlin, sees it, the universities will have to contribute to such networking projects in the future: "The way science is organised is changing. And so TERENO provides a forum for discussing, coordinating and agreeing future research proposals."

The Members of the Advisory Board for TERENO also met in Berlin for the first time. The twelve environmental experts from all around the world elected US researcher Richard P. Hooper as their chairman. "The Board is excellently appointed. We will introduce our experience and will contribute to the project with our advice," said the newly-chosen chairman.

Besides the interaction between the atmosphere and the ground surface as such, the researchers are also studying questions of species diversity. The research agenda includes studies on how climate change influences the water cycle. New models aim to give greater consideration to differences in the landscape and to the complex processes taking place in the ecosystems. In addition, the objective is to adapt agriculture and soil usage better to local conditions. TERENO supports this, for example by monitoring the condition of the soil, the nature of the ground and the water resources and reserves in even greater detail so that new models can be developed to forecast regional climate and weather conditions. In addition, scientists are also collecting economic and sociological data, such as income and population growth. Building on their wide range of studies and investigations, the scientists aim to develop risk profiles to help decision-makers in their regional planning. ■

"TERENO enables us to reflect the impact of global climate change at regional level and provides us with a basis for adaptation strategies – because climate always has a regional context."

Oliver Bens (GFZ)

SOILCAN OBSERVES THE GROUND

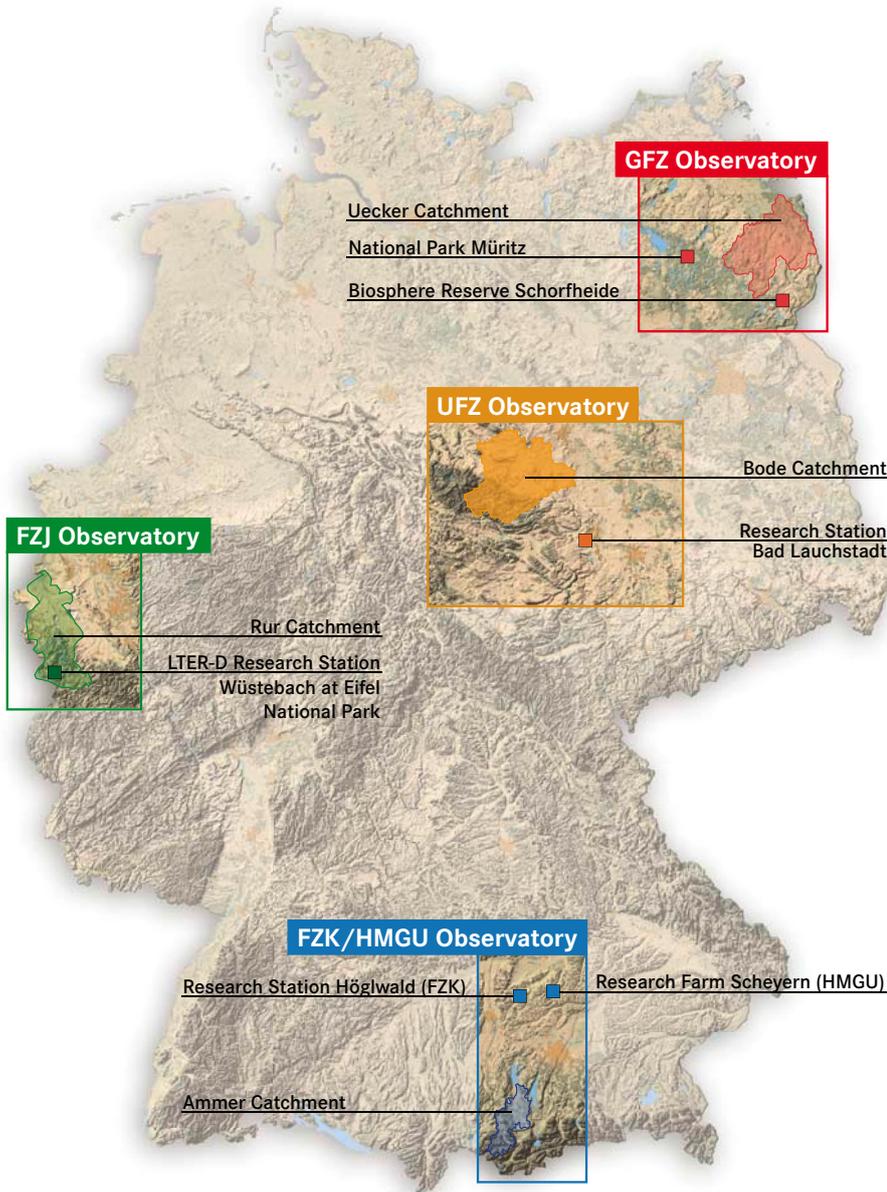
"SoilCan" is the name of the latest component to join TERENO. The project is financed by the Federal Ministry of Education and Research with 3.6 million euros and exposes soils to differing climatic conditions to study how global change impacts the matter and water fluxes in the soil. This means setting up and networking an array of lysimeters in each of the TERENO observatory areas. Lysimeters are metal cylinders that are open at the top and contain a soil core that has been obtained by sinking the cylinder into the ground. Using smart technology and sensitive measuring devices the researchers can examine the role played by water and soil structure in the transport of matter, for example, nutrients. The data are transmitted wirelessly and so can be monitored in real time. The lysimeters are used at the various TERENO sites to simulate climate changes in the current experiments. The researchers also want to measure the greenhouse gas emissions. ■

TRACKING DOWN GREENHOUSE GASES

Soils and plants emit trace gases, such as carbon dioxide, into the air. Are these biogenic emissions affected by the local climate and what consequences does this reaction then have for the climate? These questions are being studied by the Forschungszentrum Karlsruhe in the sub-project "TERENO-ICOS". An additional 2.75 million euros will flow into upgrading the TERENO Observatories with further metrological instruments. This will make it possible to carry out long-term observations on how greenhouse gases are exchanged between the biosphere, hydrosphere and atmosphere. TERENO is collaborating closely on this with the European Observatories Network ICOS (Integrated Carbon Observation System), which is examining the exchange of trace gases in Europe and neighbouring regions. ■

UNDER OBSERVATION

The TERENO Network of National Observatories



Map of Germany with the observation regions of TERENO

- **Greater Leipzig-Halle Region**
Coordination: Helmholtz Centre for Environmental Research – UFZ
- **Bavarian Alps and pre-Alps**
Coordination: Forschungszentrum Karlsruhe and German Center for Environmental Health
- **Eifel-Lower Rhine Valley**
Coordination: Forschungszentrum Jülich
- **North-East German Lowlands**
Coordination: German Research Centre for Geosciences – GFZ

“What makes TERENO so special is its observatory overarching coordination of approaches and analysis of results – from local to regional level.”

Peter Haschberger (DLR)

PARTNERS

Forschungszentrum Jülich (FZJ)

Some 4400 staff work at the FZJ on questions of health, energy, environment and information technology. The Agrosphere Institute (ICG-4) studies the transport and conversion processes taking place in soils, water catchment areas, and superficial groundwater.

German Aerospace Center (DLR)

Aeronautics, Space and Transport are the topics addressed by the DLR, which employs 5700 staff at 13 sites. The Remote Sensing Technology Institute and the Microwaves and Radar Institute in Oberpfaffenhofen are contributing to TERENO.

Forschungszentrum Karlsruhe (FZK)

The 3800 staff at the FZK work on questions of environment, energy, health and key technologies, such as microelectromechanical systems (MEMS) and nanotechnology. The Department of Atmospheric Environmental Research at the Institute for Meteorology and Climate Research in Garmisch-Partenkirchen studies how the biosphere, hydrosphere and atmosphere interact with each other.

German Center for Environmental Health (HMGU)

The HMGU and its 1800 staff focus on the interrelation between health and environment. The Institute of Soil Ecology examines how foreign substances and various forms of land use affect the habitat soil and the soil-driven water and matter balance.

Helmholtz Centre for Environmental Research (UFZ)

The UFZ examines how humans and environment interact, especially in conurbations and seminatural landscapes. The goal is to secure the natural living conditions for coming generations. 900 people are working on this in Leipzig, Halle and Magdeburg.

German Research Centre for Geosciences (GFZ)

The 890 staff at the GFZ focus on studying the System Earth and its history, characteristics, and the processes taking place within it and on the surface, as well as how the geosphere, hydrosphere, atmosphere and biosphere interact. ■

THE NORTH GERMAN MOORS AND BAVARIAN ALPS

TERENO covers a variety of different landscapes in Germany

The partners in the TERENO project have established four observatories by choosing areas that are representative of Germany and that encompass a large variety of different landscapes. Global change will impact these regions in various ways. In fact, the environment has already begun to respond to climate and land-use changes. Research and monitoring stations already exist in the four areas under investigation and are integrated into the work done by TERENO. The observatories are each operated by one or two participating Helmholtz Centres. The German Aerospace Center uses its remote sensing aircraft and space satellites to observe the regions with radar and hyperspectral sensor systems.

SUBJECTING NATURE TO MASSIVE INTERVENTION

The **Eifel-Lower Rhine Valley** is being studied by the Forschungszentrum Jülich and is characterised by the many different uses of the land in this region. On the one hand, the Lower Rhine Basin with its urbanised and intensively farmed areas, and its open cast mining has a massive impact on the ecosystem, while, on the other hand, the Eifel is part of the German “Mittelgebirge” range with its low population density. The Eifel National Park was founded in 2004. It serves as a “reference area” and so allows comparisons to be made with the agricultural and woodland landscapes that continue to be used by humans. TERENO focuses particularly on studying the Rur catchment area, consisting of around 2,400 km² that incorporates both part of the Eifel and part of the Lower Rhine Basin. Researchers want to understand how changes in land use and global climate have affected the water and nutrient balance. The region is cooperating closely with the DFG Collaborative Research Centre Transregio 32 “Patterns in Soil-Vegetation-Atmosphere Systems: monitoring, modelling and data assimilation” that has been running since 2007. ■

BETWEEN RIVERSIDE WOODLANDS AND INDUSTRIAL AREAS

The Helmholtz Centre for Environmental Research – UFZ is studying the **greater Leipzig-Halle region** that extends across southern Saxony-Anhalt, the ridges of the Harz and western Saxony. Seminatural areas and areas strongly affected by human activity meet here, for example mountain forests, riverside woodlands, expansive agricultural stretches of land, urban and industrial districts, plus open-cast mining sites. The region covers two major protected areas, namely the “Harz National Park” and the “Elbe Biosphere Reserve”. In their studies, scientists want to focus primarily on how global change affects the water and material processes, as well as the biodiversity found in the transition to seminatural, agricultural, and urban landscapes in the greater Leipzig-Halle region. ■

MINOR CHANGES, MAJOR CONSEQUENCES

The Forschungszentrum Karlsruhe and the German Research Center for Environmental Health are exploring the extremely climate-sensitive regions of the **Bavarian Alps and pre-Alps**. The large differences in altitude here mean that various climate zones can lie very close to each other. The region is above all used for farming, forestry and tourism. Even minor climate changes can have a substantial ecological and economic impact here. Hence, the region is ideally suited for the planned studies on how the climate affects seminatural and agricultural ecosystems, and what consequences derive from this. The “Alpen- und Alpenvorland” observatory includes an experimental farm, “Versuchsgut Scheyern”, which lies to the north of Munich, a permanent measuring station “Höglwald” east of Augsburg, and the catchment area for the River Ammer. ■

ENDANGERED MOORS AND SMALL BODIES OF WATER

The region in and around the **North-East German lowlands** has been formed by the ice ages and is now being studied by the German Research Centre for Geosciences – GFZ, because it offers ideal conditions for TERENO’s multidisciplinary research approach. The area under investigation extends across the protected natural landscape of the “Müritz National Park”, the historic, cultivated landscape of the “Biosphere Reserve Schorfheide-Chorin”, and the hydrological catchment area for the River Uecker. In terms of climate, the North-East German lowlands lie in the transition zone between the more maritime climate of Western Europe and the continental climate of Eastern Europe, complemented by the Baltic climate to the north and the East German inland climate to the south. The amount of rain or snow fall decreases significantly from west to east, while temperatures fall from south to north. The influence of an advancing drought is becoming ever more noticeable, leading to the moors and smaller bodies of water gradually drying out in the “Biosphere Reserve Schorfheide-Chorin”. ■



Photo: B. Eisdle



Photo: UFZ



Photo: IMK-FU



Photo: GFZ

“We want to help farmers develop state-of-the-art production methods so they can adapt to climate change.”

Eckart Priesack (HMGU)



Photo: Chris Taube

Steering Committee and Coordination Team at the Kick-off Meeting in Berlin on 22 September

2008, from left to right: Thomas Pütz (FZJ), Steffen Zacharias (UFZ), Hans Papen (FZK), Heye Bogena (FZJ), Peter Haschberger (DLR), Irena Hajnsek (DLR), Eckart Priesack (HMGU), Harry Vereecken (FZJ), Peter Dietrich (UFZ), Hans Peter Schmid (FZK), Jean-Charles Munch (HMGU), Oliver Bens (GFZ). Absent: Georg Teutsch (UFZ), Harald Kunstmann (FZK), Achim Brauer (GFZ).

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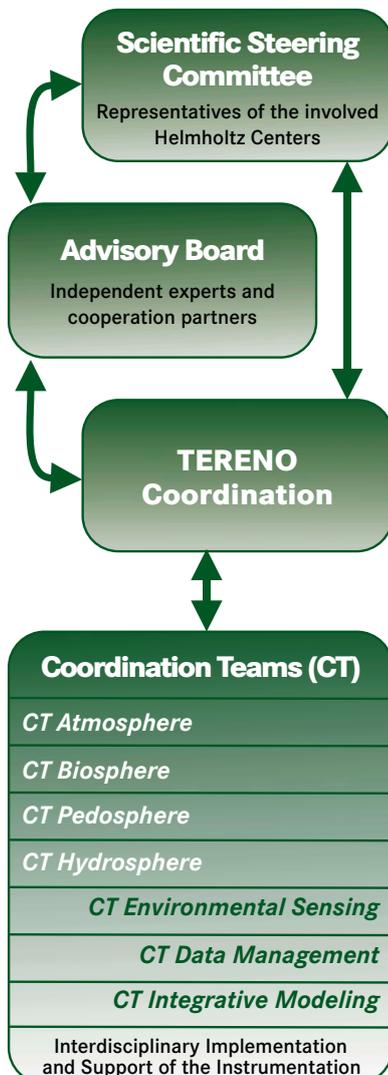
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ORGANIGRAM



SCIENTIFIC STEERING COMMITTEE

The Steering Committee is made up of the respective project representatives from the participating Helmholtz Centres. They define the goals and priorities, and are responsible for all the important decision-making, for example, regarding the equipment for the observatories or cooperation with national and international partners. The Forschungszentrum Jülich is responsible for coordinating this work. ■

ADVISORY BOARD

The Advisory Board is made up of twelve independent experts and cooperation partners from all around the world. These climate and environmental research specialists advise and support TERENO on scientific questions. The Advisory Board is chaired by the US hydrology expert **Dr. Richard P. Hooper**, who is Executive Director of the Consortium of Universities for the Advancement of Hydrologic Science in Washington, DC.

Further members are:

Dr. Malcolm W. J. Davidson, European Space Agency ESA

Prof. Dr. Markus Fischer, University of Bern (SUI) and Coordinator of the DFG Exploratories on Functional Biodiversity Research

Prof. em. Dr. Hannes Flüher, Swiss Federal Institute of Technology Zurich (SUI)

Prof. Dr. Karsten Høgh Jensen, University of Copenhagen (DK) and Coordinator of HOBE - Center for Hydrology - Hydrological Observatory

Prof. Dr. Beate Jessel, President of the Federal Agency for Nature Conservation

Prof. Dr. Hangsheng (Henry) Lin, Pennsylvania State University (USA), Coordinator of the *Hydropedology Initiative* and the *Shale Hills Critical Zone Observatory*

Prof. Dr. Russell K. Monson, University of Colorado (USA)

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Prof. Dr. Sonia Seneviratne, Swiss Federal Institute of Technology Zurich (SUI)

Prof. Dr. Volker Wulfmeyer, University of Hohenheim ■