



TERENO General Overview – Status, Network Activities, Accessibility and International Integration

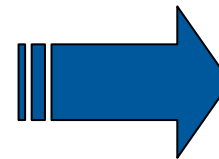
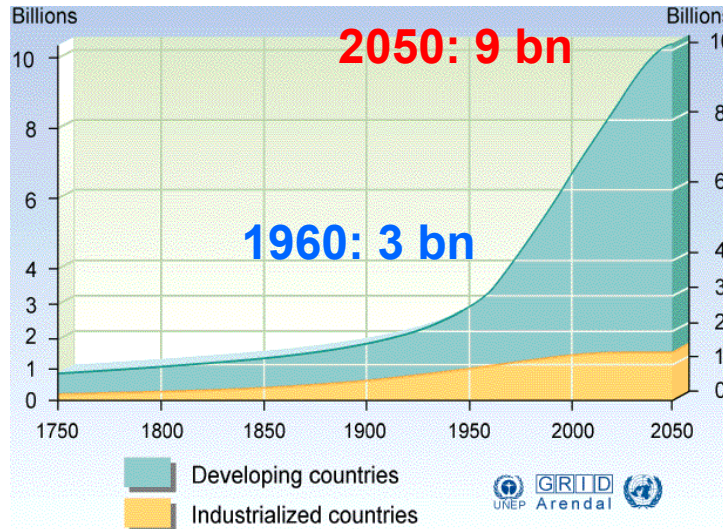
H. Vereecken, H. Bogaen

Agrosphere Institute, Forschungszentrum Jülich



Facts of Global Change

World population development from 1950 to 2050:



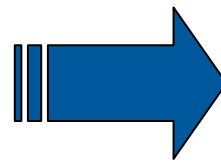
Soil, water, air and vegetation

- Climate change is affecting all compartments of the terrestrial system
- 50% of the global land surface has been changed by human activity; 23 % of the land surface is degraded in quality
- Loss of agricultural land (e.g. in China -3,5 Mio ha since 2002)
- In 2003: 2 % of the agricultural land was lost: Production of rice, corn and wheat -18%
- Worldwide loss of biodiversity
- Decline of water availability (49,000 km³ per year) and water quality
- 1/3 of the earth's annual renewable water may be affected by pollution in 2050 (Gleick et al., 1998) due to waste water



Motivation

- The effects of Global Change on terrestrial systems are regionally differentiated
- Global Change affects all compartments of the terrestrial environment (water, soil, vegetation, atmosphere) with complex feedback mechanisms
- Existing measurement networks are typically focused on specific compartments and research questions
- Long-term hydrological and ecological data are urgently needed for validating terrestrial environmental models
- There is a need for capacity building in the field of terrestrial research by bringing together different research communities



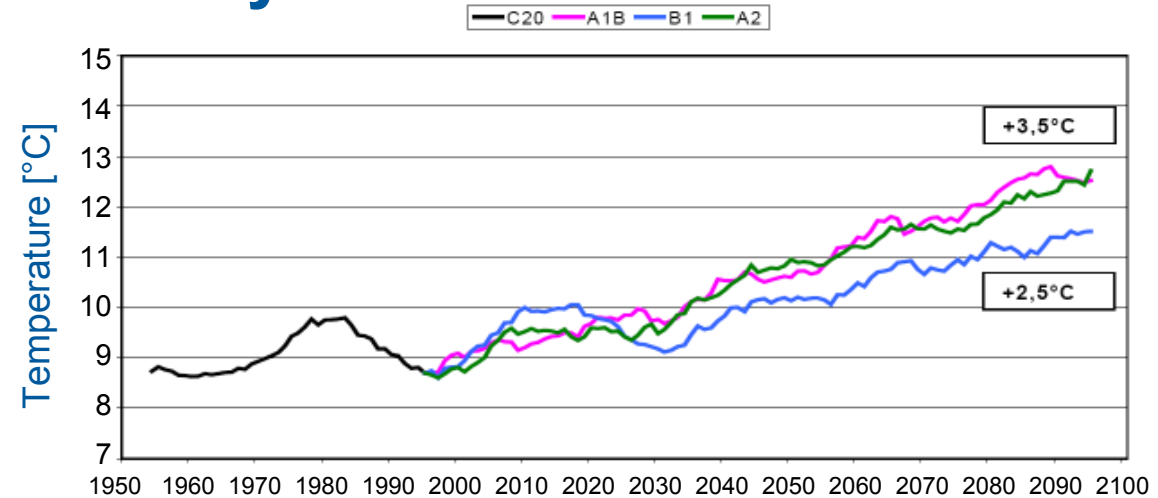
TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES



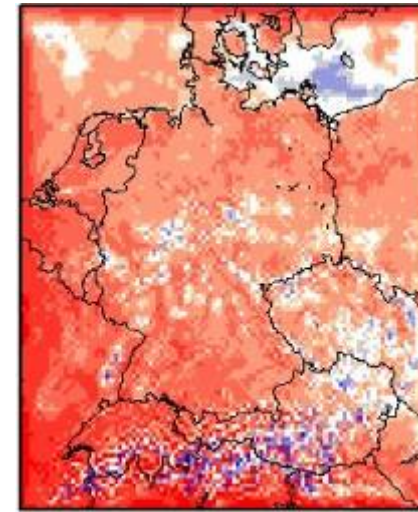
Climate Change in Germany

Climate models are projecting significant climate change in Germany in the next 100 years:

- Increase in temperature (2.5 – 3.5°C)
- Decrease in precipitation (up to 30 %)



Temperature increase in 2100 [°C]

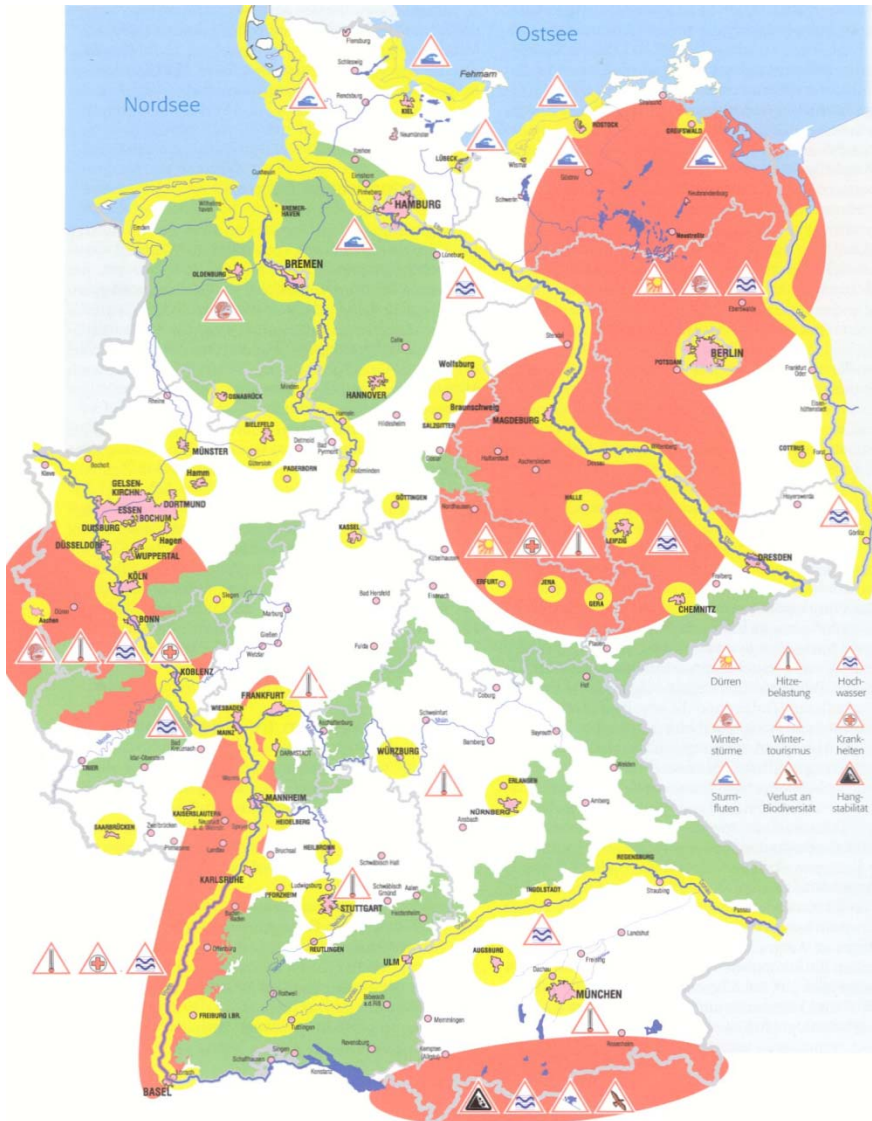



Precipitation decrease in 2100 [mm]

From
 Umweltbundesamt
 Künftige Klimaänderungen in Deutschland – Regionale
 Projektionen für das 21. Jahrhundert
 Hintergrundpapier
 April 2006, aktualisiert im September 2006



Effects of Climate Change in Germany




 Regions of high vulnerability

- Droughts
- Heat waves
- Floods
- Winter storms
- Loss of biodiversity
- Landslides

From:

Rüdiger Glaser (2008)

Klimageschichte Mitteleuropas

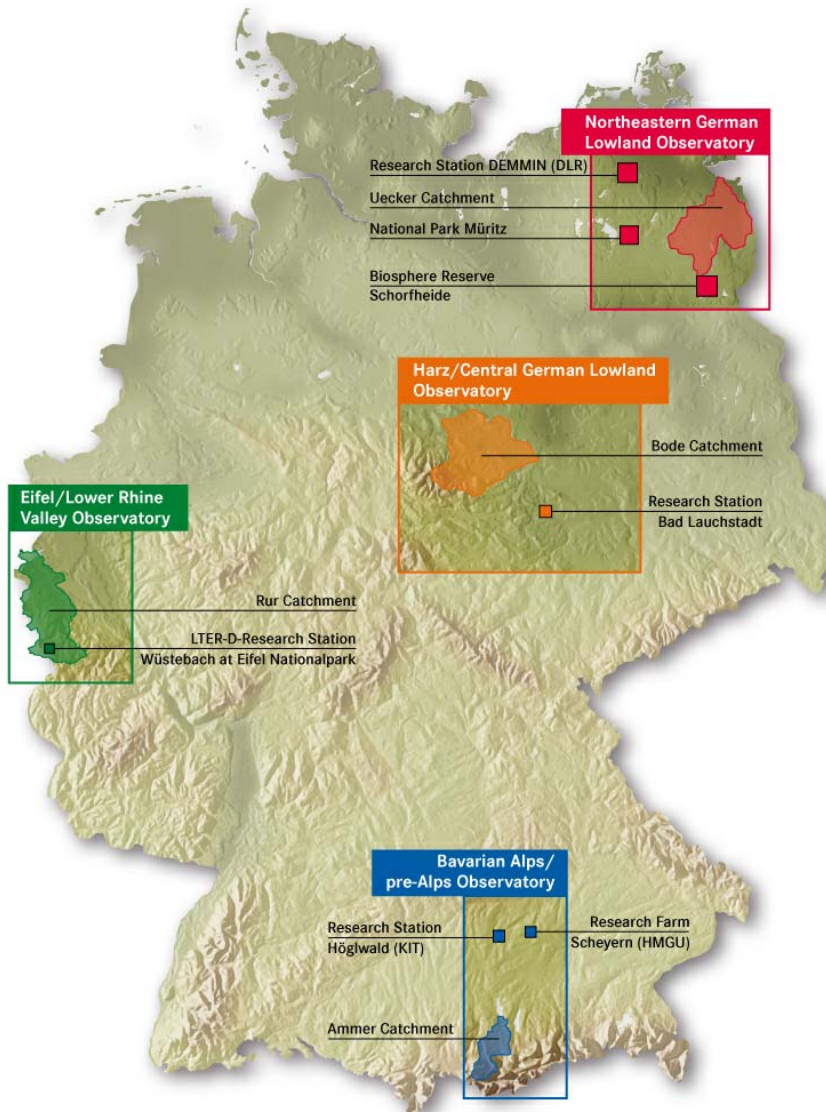
1200 Jahre Wetter, Klima, Katastrophen



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The TERENO Network



- **Northeastern German Lowland Observatory**

Coordination: GFZ

- **Harz / Central German Lowland Observatory**

Coordination: UFZ

- **Eifel / Lower Rhine Valley Observatory**

Coordination: FZJ

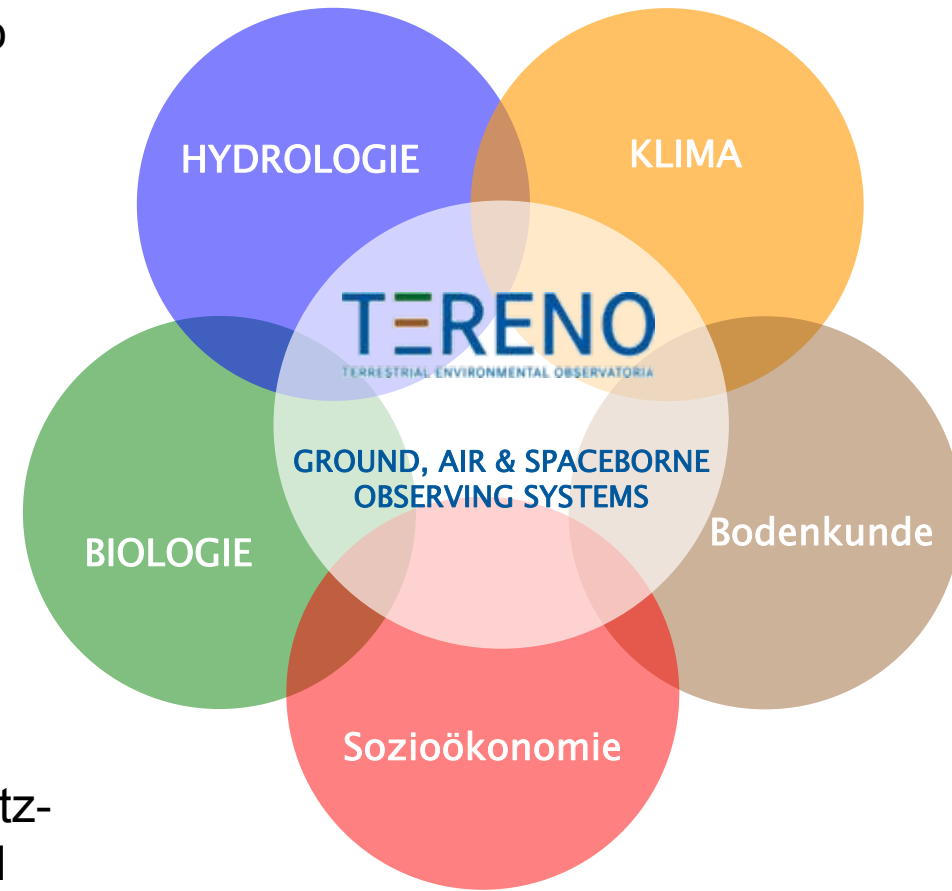
- **Bavarian Alps / pre-Alps Observatory**

Coordination: HMGU und KIT



The TERENO concept

- To bring together scientists from different scientific communities and to integrate disciplines
- To exploit the availability of novel technologies and high performance computer facilities for terrestrial research
- To establish common measurement platforms as the basis for long term data sets
- To combine observation and experimentation
- To foster synergies between Helmholtz-centers and national and international research organizations





TERENO and POF

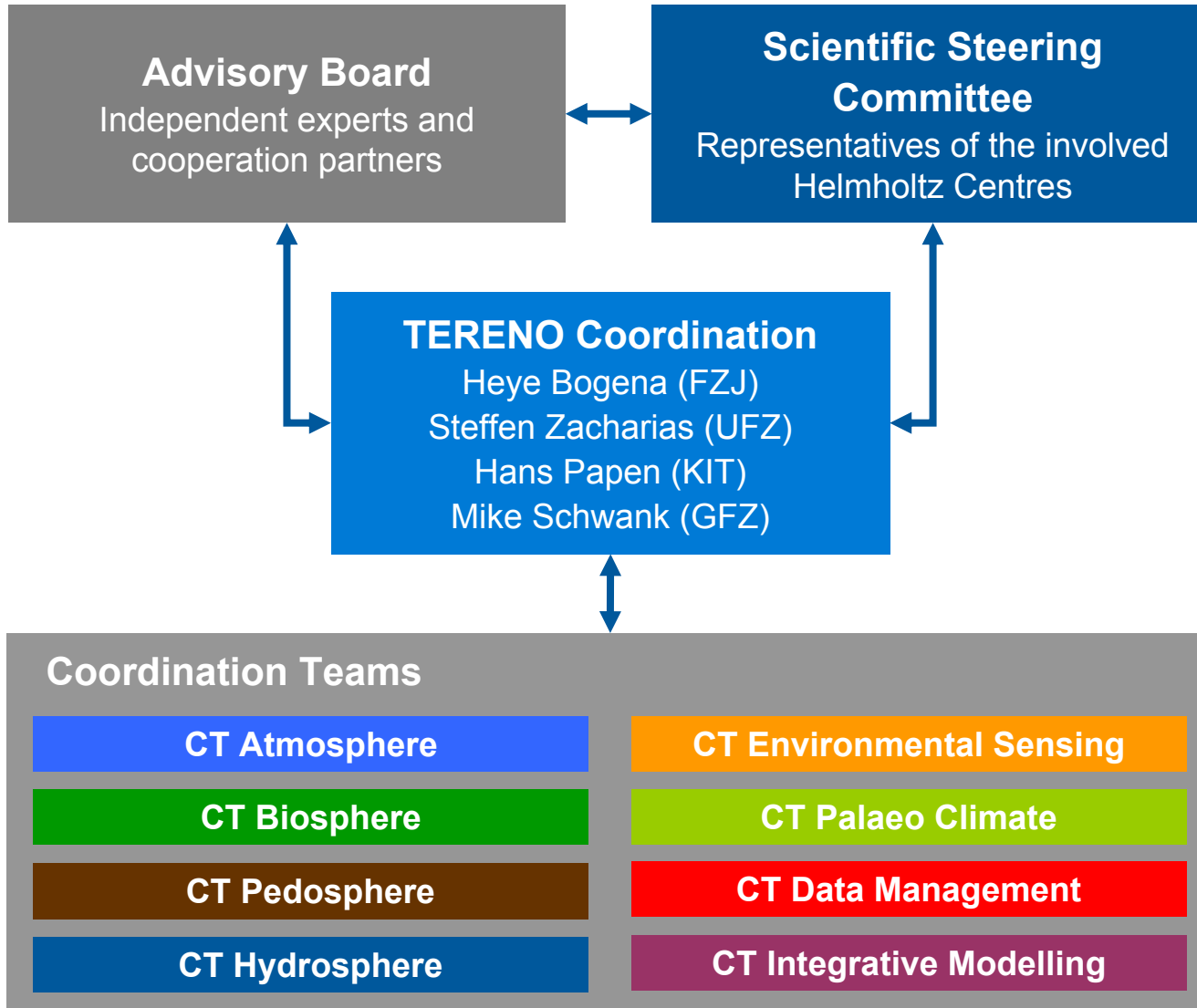
evaluated in 2008 in the framework of P4 „Terrestrial Environment“ cross-cutting project between the topics and across the programmes with the following objectives:

- To provide long-term environmental data in a multi-scale and multi-temporal mode for the scientific community
- To study long-term influence of land use changes, climate changes, socioeconomic developments and human interventions in terrestrial systems
- To analyse the interactions and feedbacks between soil, vegetation and atmosphere from the point to the catchment scale
- To determine effective parameters, fluxes and state variables for different scales
- To bridge the gap between measurement, model and management

Modelling activities in this programme are associated with monitoring, using many new techniques. This is excellent. Central in the modelling exercise are the integrated, regional studies in the Rur, Bode, Ammer and Potsdam watersheds, all in the context of the TERENO network. Results of this work are key elements of "The Helmholtz Approach to TE-Research". The panel recommends particular attention to this activity. Other modelling and monitoring efforts serve an important function for the various topics while their input is crucial to achieve top quality for the large watershed studies.



Organizational structure





Installations and/or testing at most sites: still ongoing

- Hydrological equipment (e.g. soil moisture sensor networks (see also Talk by Urike Roßenbaum), cosmic ray probes)
- Expansion of meteorological station network
- Eddy-Covariance measurement systems (see also Talk by Hape Schmid)
- Groundbased and satellite based remote sensing (see also talks by Irena Hajnsek/Erik Borg)
- Water quality monitoring (e.g. groundwater, rivers, reservoirs)
- Dual-band polarimetric coherent atmospheric transmission experiment for line integrated precipitation quantification (Bavarian Alps/Pre-Alps) (see also Talk by Harald Kunstmann)
- Lysimeters (see also Talk by Thomas Pütz)
- Chamber crane for automatic measurements of GHG exchange from lysimeters

Finalization: expected by the end of 2011



Report to AB

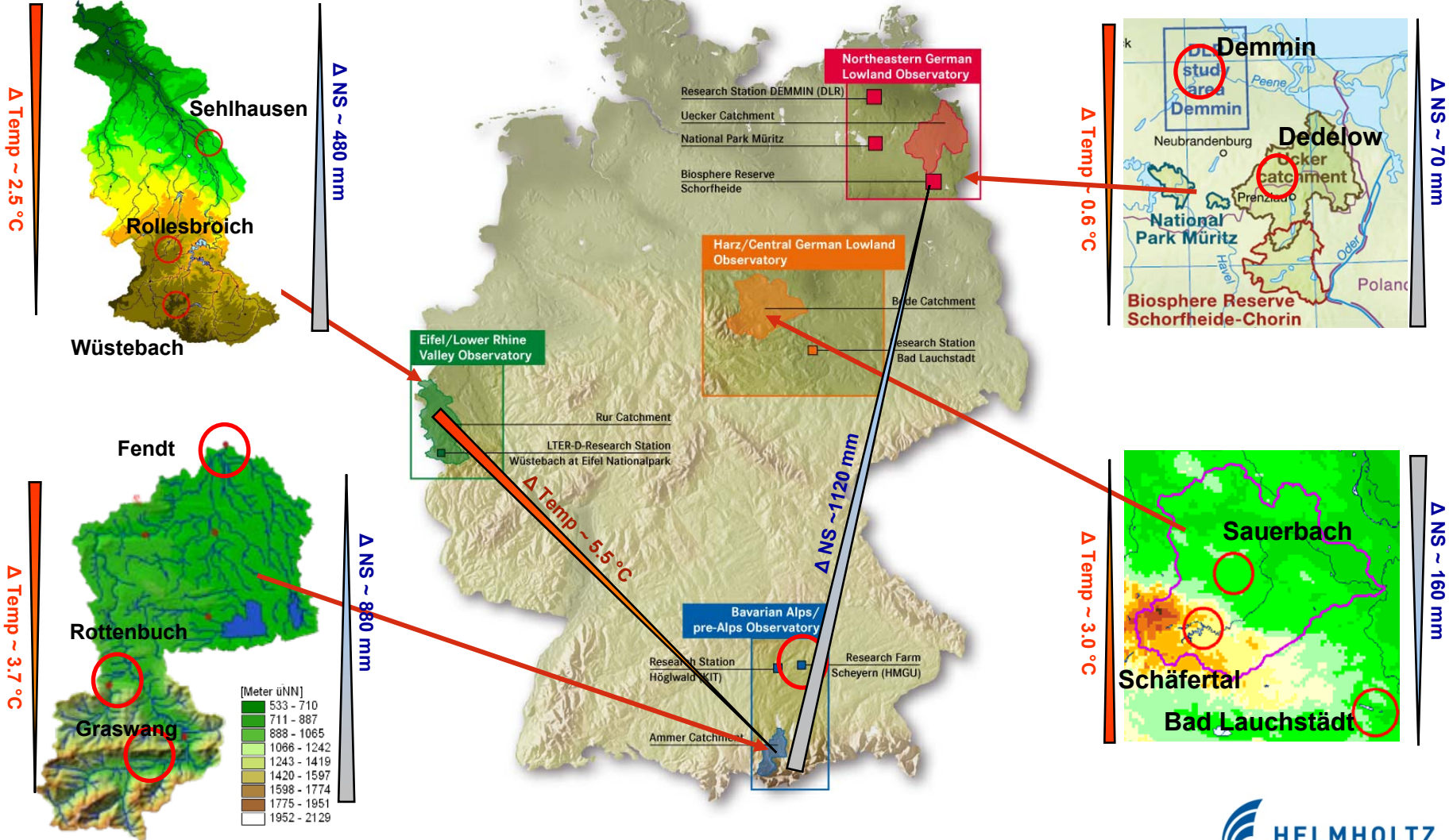
Establishment of TERENO NE will start 2011



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TERENO SoilCan





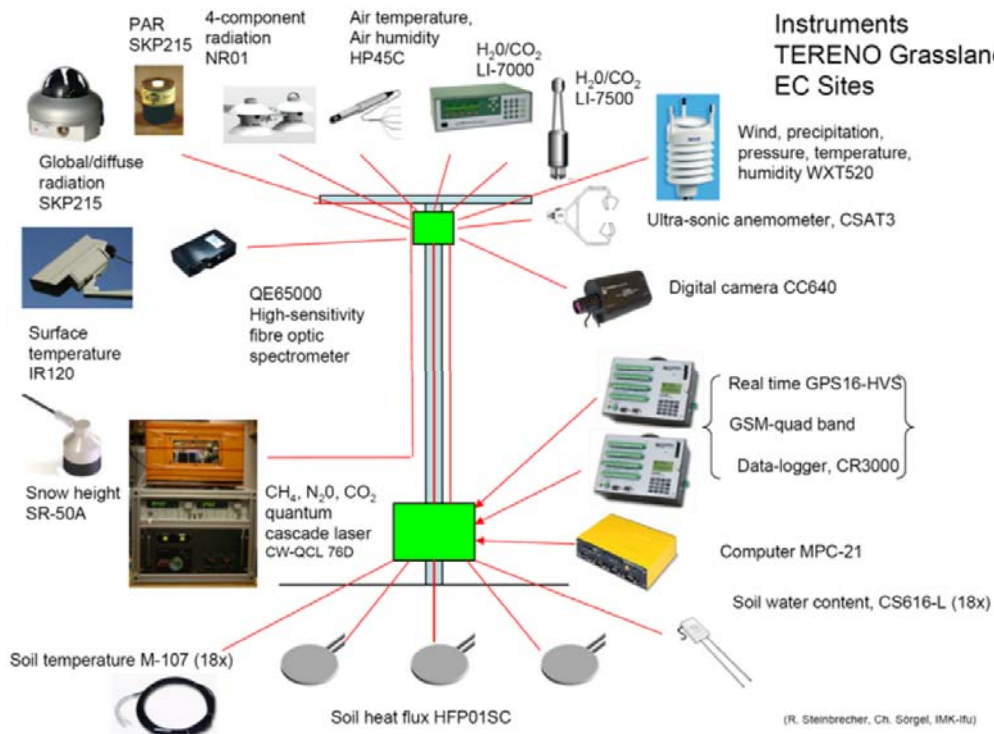
TERENO - ICOS



A European infrastructure dedicated to high precision monitoring of greenhouse gas fluxes



- ICOS Mission: “To provide the long-term observations required to understand the present state and predict future behavior of the global carbon cycle and greenhouse gas emissions.”
- 5 TERENO sites obtained additional funding to meet demands of ICOS standards
- TERENO is partner in ICOS-D
- BMBF proposal submitted in December 2010. VTi, DWD and HGF key partners

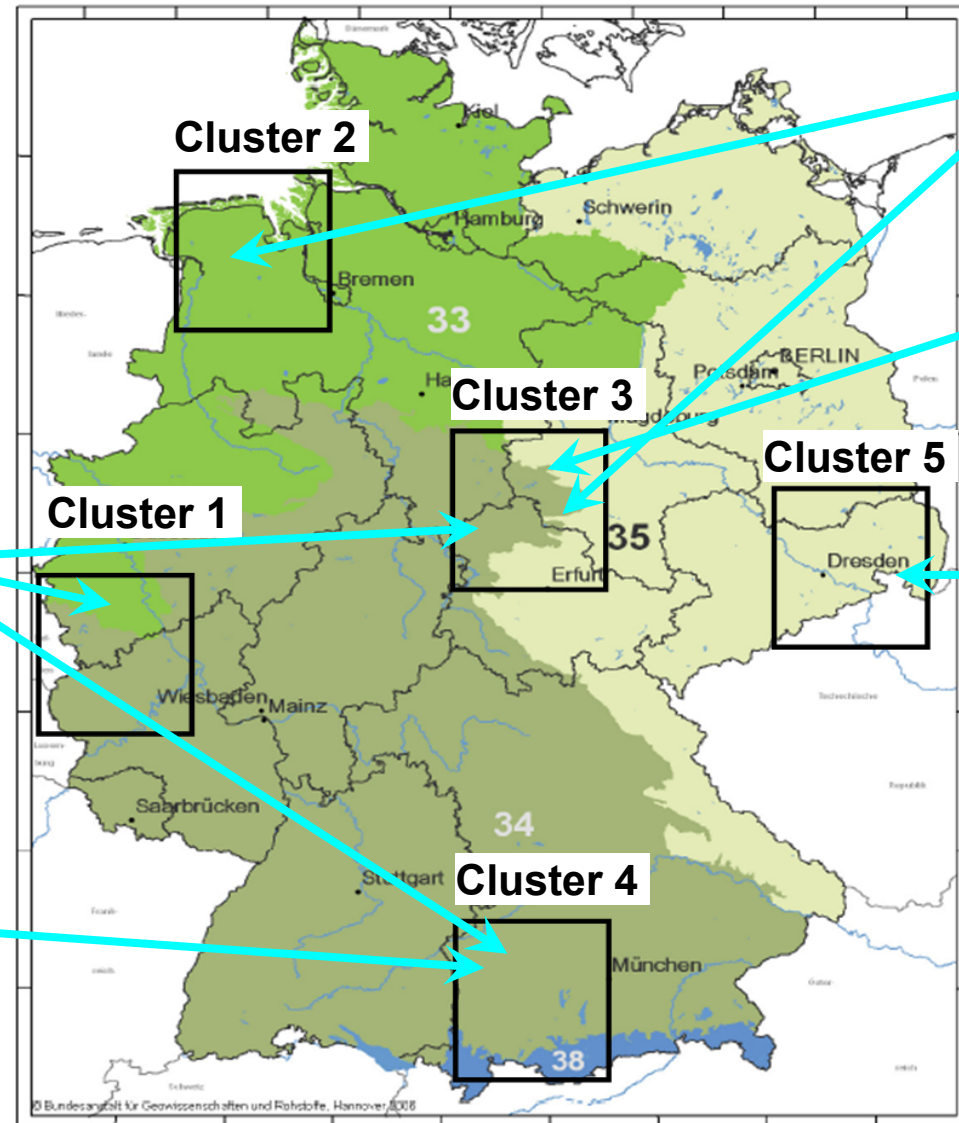




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ICOS-D Ecosystem Network

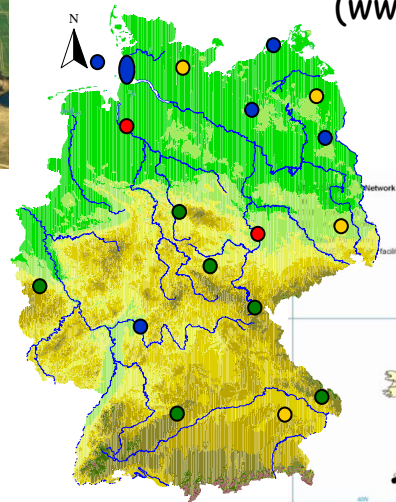




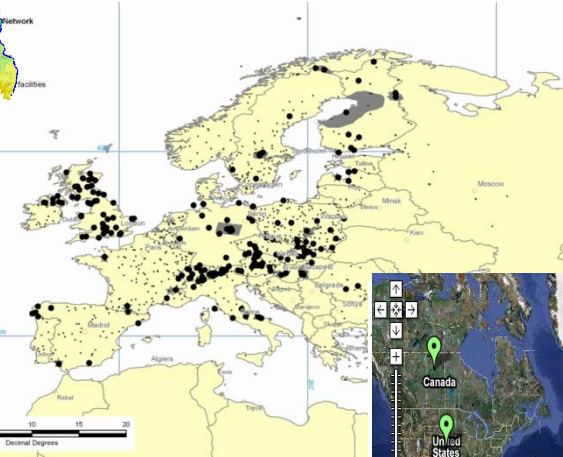
LTER: Long-Term Ecological Research



Nationale LTER Netzwerke
(www.lter-d.ufz.de)



Regionale LTER Netzwerke



Globales ILTER



local LTER sites

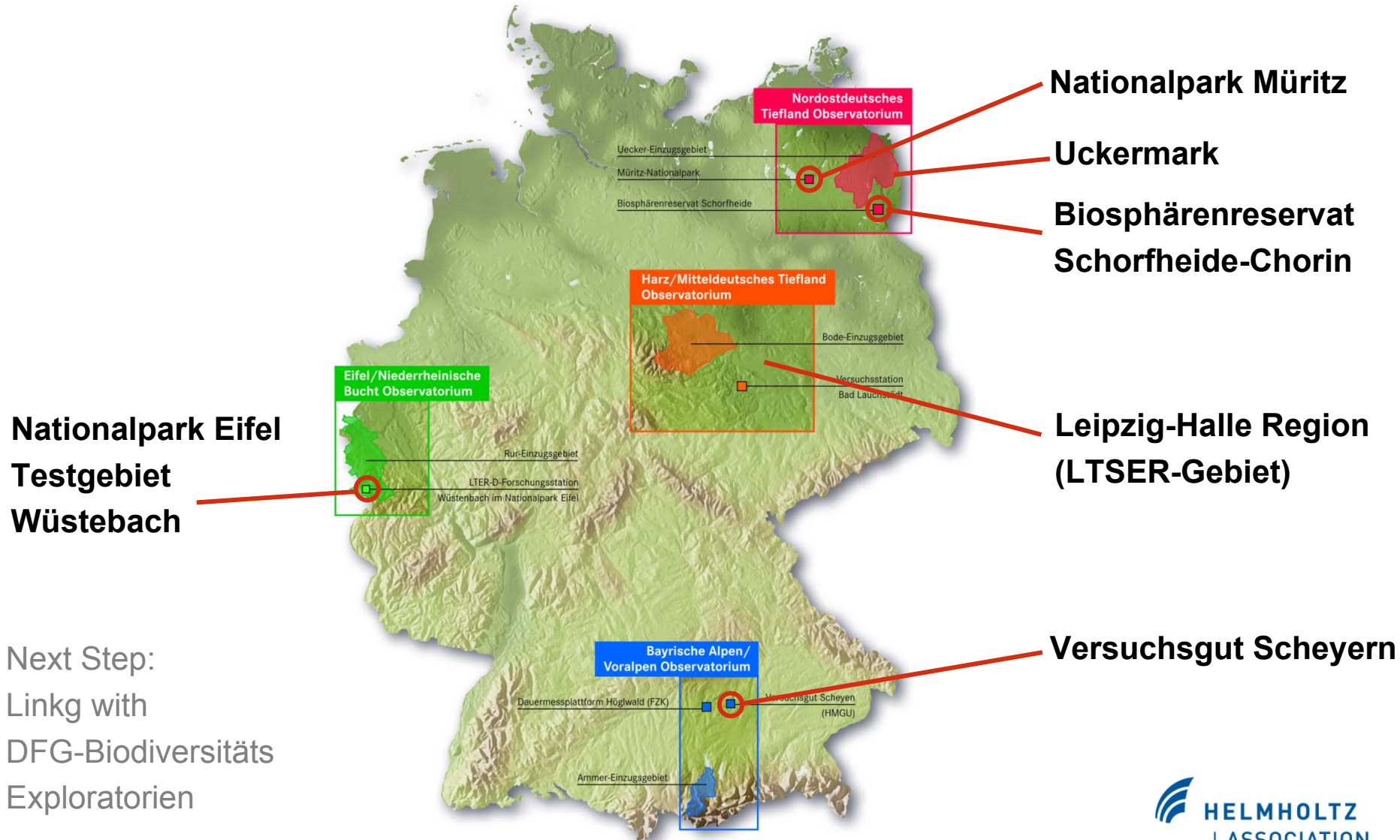




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Linking TERENO and LTER sites




Next Step:
Linkg with
DFG-Biodiversitäts
Exploratorien



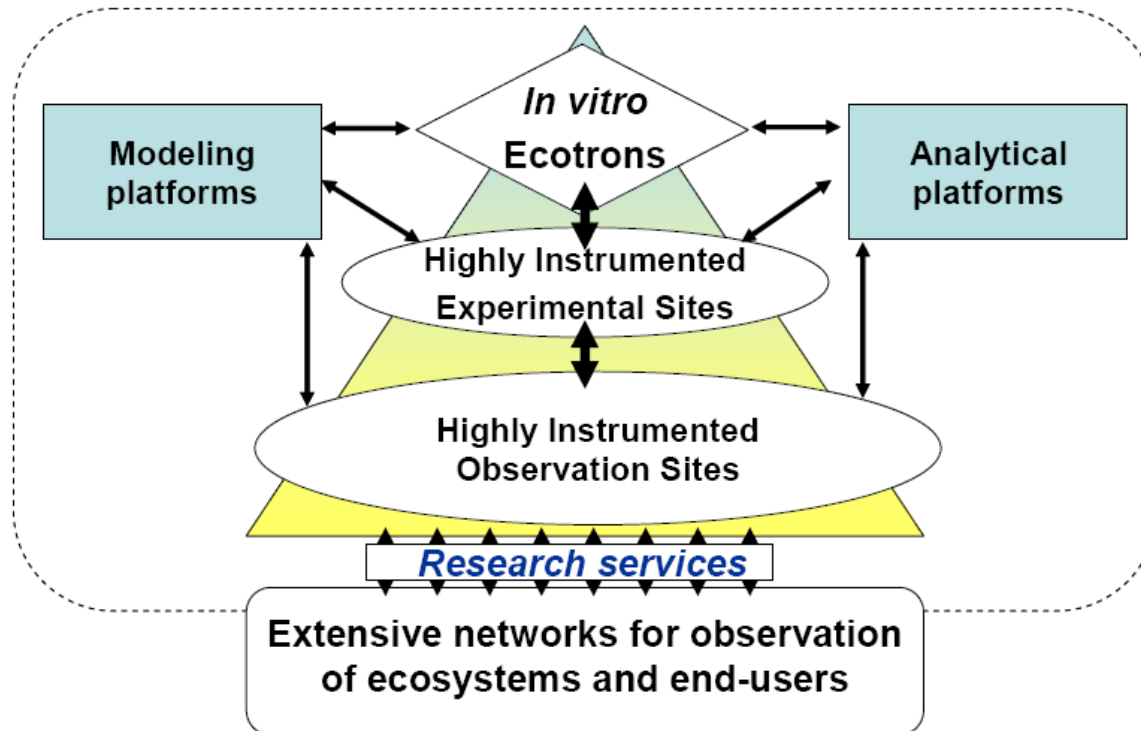
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EXPEER

	Capacities Workprogramme Infrastructure Combination of Collaborative Project and Coordination and Support Actions
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EXPEER
Distributed Infrastructure for **EXPE**rimentation in
Ecosystem **RE**search

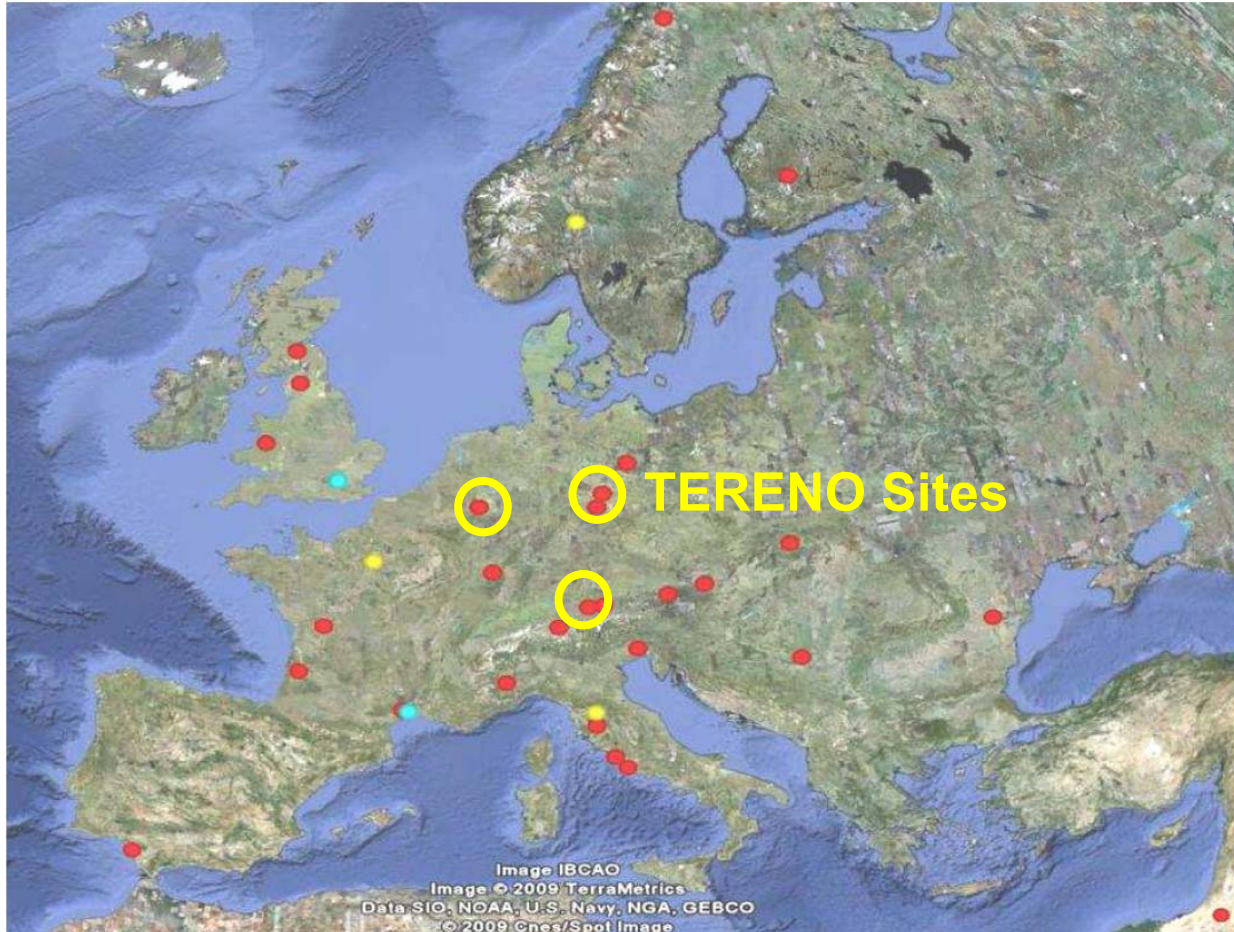


The EXPEER Integrated Infrastructure and its interface with end-users and stakeholders

In total 37 Partners



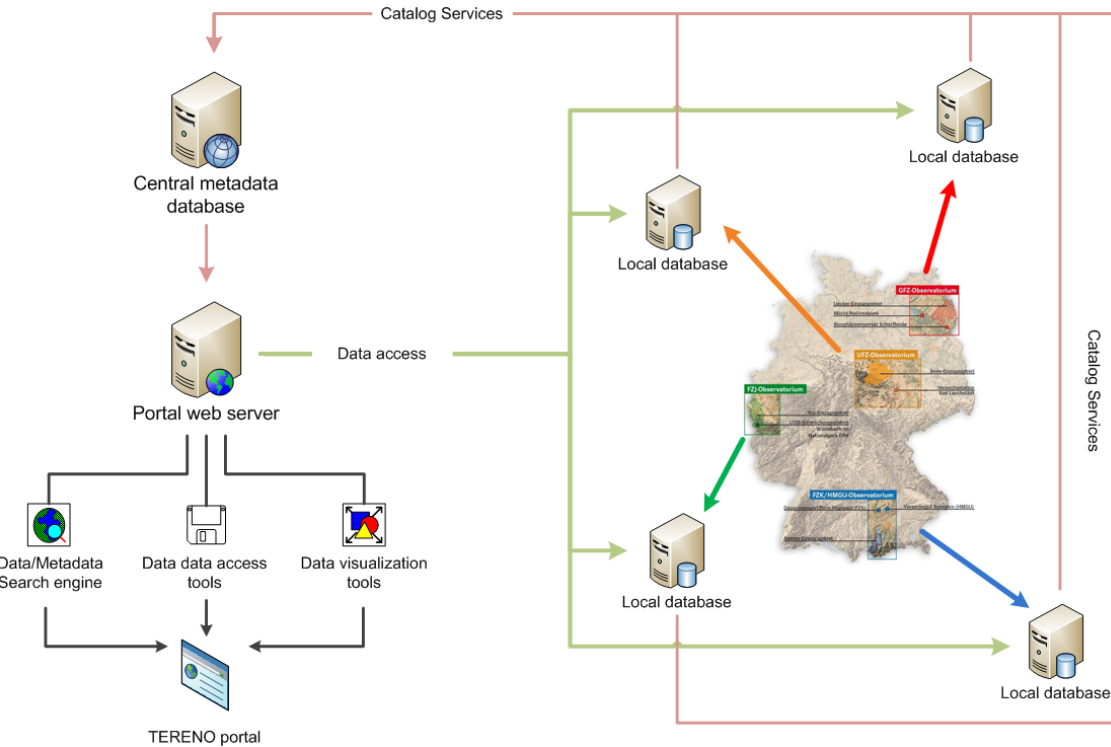
EXPEER



*Overview of the
geographical distribution of
EXPEER facilities*



TERENO Management concept + data policy



- Data management concept established
- Data policy established
- Refining data processing and analysis for TERENO EC sites including footprint analysis
- Conducting an EC-course for TERENO participants operating EC stations (at IMK-IFU)
- CT Atmosphere meeting aiming at harmonizing TERENO EC site data processing (at IMK-IFU)

Recommendation HGF: make data available



Larger DFG-Research Projects in Germany related to TERENO

Forscherguppe on data assimilation

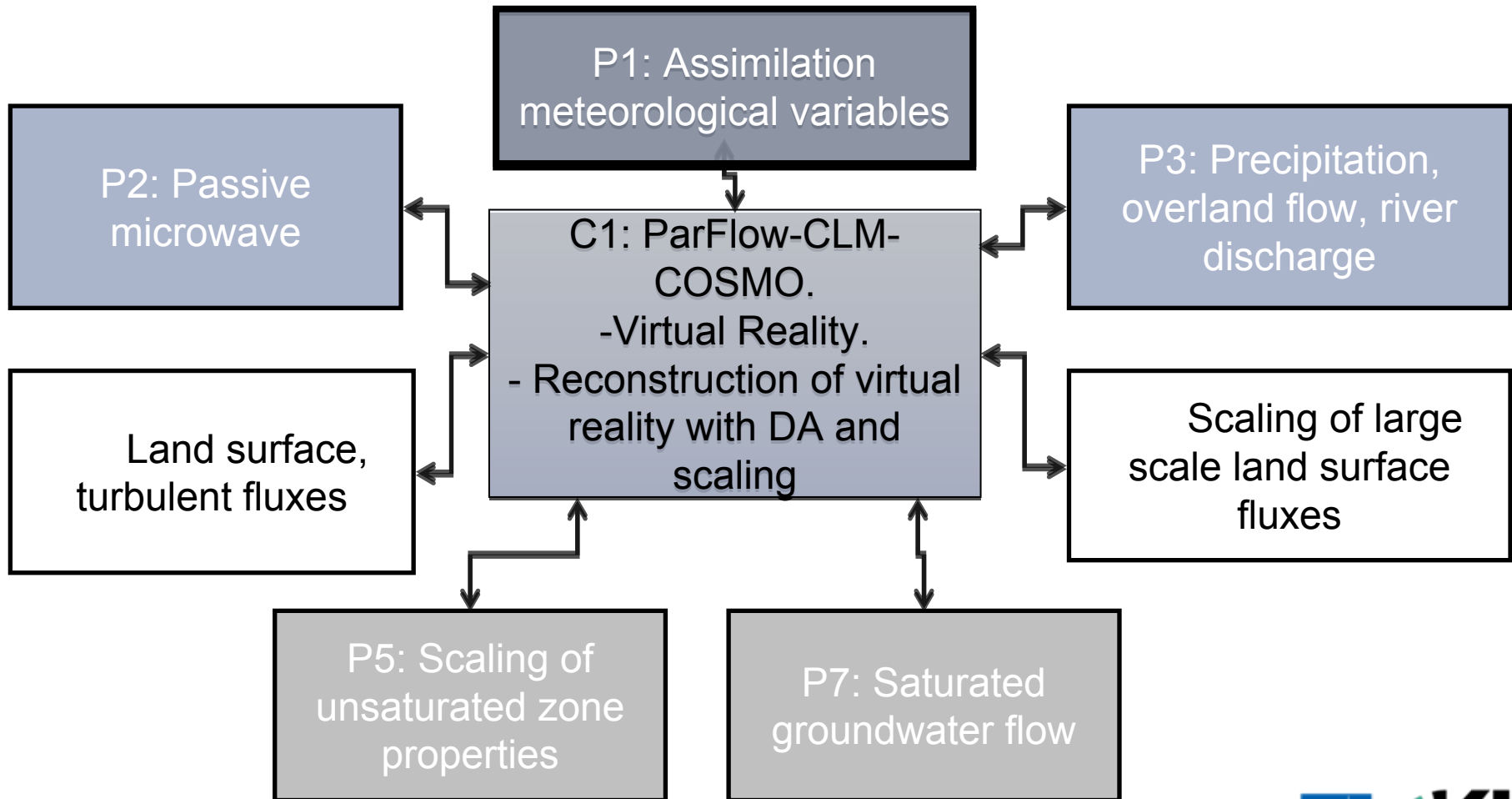
Contributions from UFZ (Prof. Attinger), KIT (Prof. Kunstmann) and FZJ (Profs. Hendricks Franssen and Vereecken)

Positive evaluation of the TR-32 on „Patterns in soil-plant-atmosphere systems: monitoring, modelling and data assimilation“ (Cooperation between Aachen, Bonn, Cologne and Jülich)

Forscherguppe „Girdling in Forests“ (in preparation)



Data Assimilation for Improved Characterization of Fluxes across Compartmental Interfaces





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Activities and Initiatives in Germany

- Improved integration with Länder and federal authorities involved in the observation of the terrestrial systems: e.g. LANUV, DWD,...
- Improved interaction with CSC and REKLIM within the framework of HGF
- Integrated in Portfolio and Pakt-II programmes: Water, Bio-Economy, Earth system dynamics and risks and Earth-System Knowledge Platform
- Establishment of an infrastructural research programme (SPP) by the DFG (Arbeitsgruppe Terrestrial Research Platforms)
- Interaction with GEO-D /GEOSS (contacts have been made, first step. Registration of TEODOOR data portal in GEOSS)
- Water Science Alliance (Coordination UFZ) and WESS
- BioEconomy: e.g. BioEconomy Science Center, ...
- HTS 2020: Sustainable production food: soil-plant interactions (Experiment and modelling)
- FONA: Near Real Time Forecasting of Soil Moisture for Water Resources Management in the Heihe River Basin, China



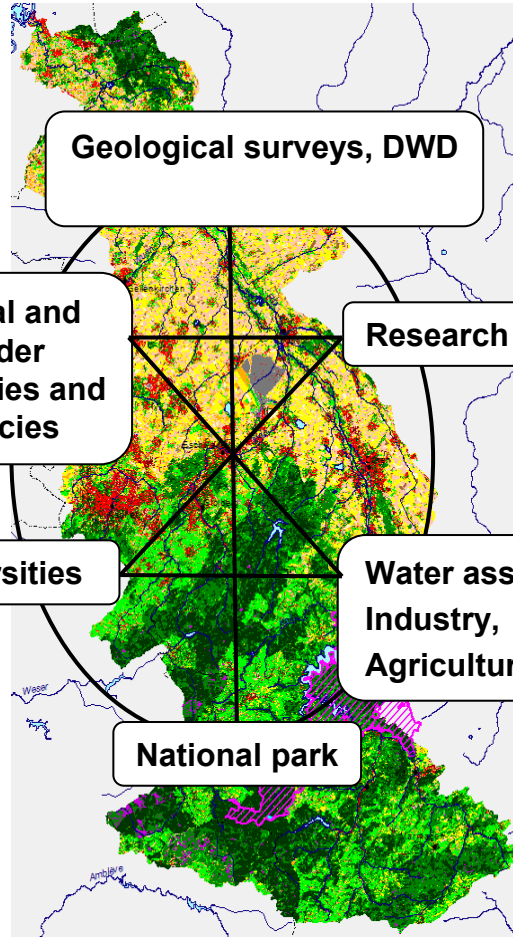
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TERENO Networking

Local

Global



Geological surveys, DWD

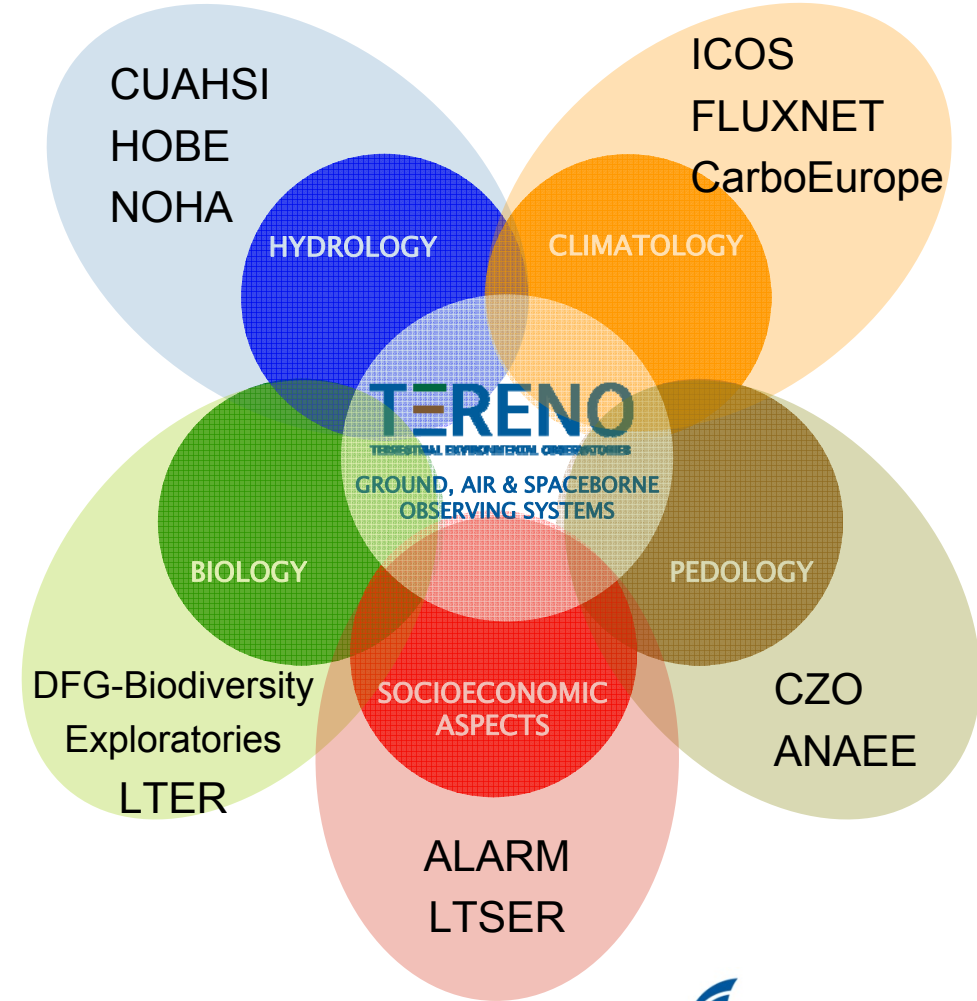
Research Center

Federal and
Länder
authorities and
agencies

Universities

Water association,
Industry,
Agriculture

National park





Peer reviewed papers: published, in press, accepted

Bogena et al. (2010): Potential of wireless sensor networks for measuring soil water content variability. *Vadose Zone J.*, doi:10.2136/vzj2009.0173

Czymzik et al. (2010): A 450 year record of spring-summer flood layers in annually laminated sediments from Lake Ammersee (southern Germany), *WRR*, in press

Graf et al. (2010): Temporal downscaling of soil CO₂ efflux measurements based on time-stable spatial patterns. *Vadose Zone J.*, in press.

Graf et al. (2010): Boundedness of turbulent temperature probability distributions, and their relation to the vertical profile in the convective boundary layer. *Boundary-Layer Meteorol.* 134:459-486.

Scharnagl et al. (2010): Information content of incubation experiments for inverse estimation of pools in the Rothamsted carbon model: a Bayesian perspective, *Biogeosciences* 7:763-776



Peer reviewed papers: submitted, in preparation

Pause et al. (2010): Soil moisture monitoring using airborne L-band brightness temperature and imagine spectrometer data – Intl. J. Rem. Sensing, submitted

David et al. (2010) The element pattern of particulate matter in stormwater effluent. Submitted to Water Science and Technology., submitted

Munch et al. (2011) Pulse emissions of greenhouse gases from arable soil in dependence of fertilization and tillage practice, in preparation, submitted to Agriculture, Ecosystems and Environment

Contribution to special issue Critical Zone Observatories in VZJ (Henry Lin) :
A view on terrestrial observatories, submitted, the tereno team



Books and proceeding contributions

- Müller, F., Baessler, C., **Frenzel, M., Klotz, S.**, Schubert, H. (2010):
Long-term ecosystem research between theory and application - an introduction
In: Müller, F., Baessler, C., Schubert, H., **Klotz, S.** (Hrsg.): *Long-term ecological research: between theory and application*
Springer, Dordrecht, S. 3-7
- Müller, F., Baessler, C., **Frenzel, M., Klotz, S.**, Schubert, H. (2010):
On the way to an integrative long-term ecosystem research - milestones, challenges, and some conclusions
In: Baessler, C., **Klotz, S.**, Durka, W. (Hrsg.): *Long-term ecological research: between theory and application*
Springer, Dordrecht, S. 447-451
- Design and importance of multi-tiered ecological monitoring networks (Jones, Bogena, Vereecken and Weltzin) in Long-Term Ecological Research: Between Theory and Application (Müller, Baessler, Schubert and Klotz)
- Rode, M., S. Zacharias and R. Shresta. 2010. How to use new online monitoring techniques to improve hydrological and water quality modelling at the catchment scale. EGU Leonardo Topical Conference Series on hydrological cycle. 10.-12.09.2010 Luxemborug



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Further developments



TERENO Observatory Northeastern Lowlands Start in 2011



Young glacial landscapes

- o Landscape development since the last ice age
- o Protected natural environments (Müritz National Park)
- o Protected cultural landscapes (Biosphere Reserve Schorfheide-Chorin)
- o Agricultural landscape (Test field DEMMIN, Ucker-catchment)

Specific goals:

Long-term landscape evolution since the last ice age from lake and tree ring proxy data



Network of the palaeo-archives within TERENO

→ Analysis of the long-term climate dynamics and landscape development



 Lake sediments

 Tree rings

Eifel, NE-Germany & Lake Ammer

Work in progress at GFZ in cooperation with external partners and contributions from FZJ

Harz

Work in progress at UFZ in cooperation with TU Dresden

Work in progress at GFZ in cooperation with DAI and Uni Göttingen



ESFRI Projects for Env. Sciences

EURO-ARGO



SIOS



IAGOS-ERI



EUFAR-COPAL

Status
2009



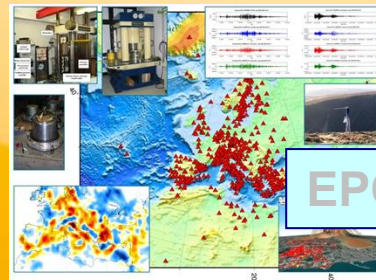
LIFEWATCH

AURORA BOREALIS

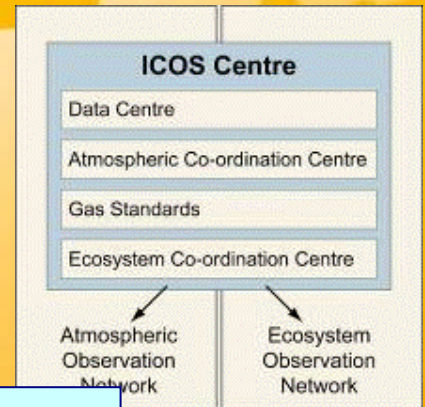
EISCAT-3D



EMSO



EPOS



ICOS



Ongoing activities at ESFRI related to TERENO

ICOS: Integrated Carbon Observation System

Strategic research infrastructure to quantify the greenhouse gas balance of Europe and adjacent regions.

ANAEE Development of a distributed experimental research infrastructure on continental ecosystems in order to analyse the response of ecosystem functions and services to climate and anthropogenic forcing and to develop simulation models for forecasting their evolution under different scenarios.

Lifewatch: Construction of an e-Science research infrastructure to explore, describe and understand the complexity of the biodiversity system.

NOHA Creation of a network of hydrological observation platforms on the basis of an interdisciplinary and long-term research program in close cooperation with leading European institutions in hydrology



EERIP



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TERENO-MED - Global Change Observatory Network for the Mediterranean Region

Objectives: To study the long term effect of climate change and anthropogenic changes on Meditterrean terrestrial systems

Countries to be involved: Spain, Marocco, Italy, Turkey, Greece, Cyprus, Israel, Egypt

Partners contacted:

Spain: CIEMAT (Centro de Investigaciones Energetica, Medioambientales y Tecnologicas)

Italy: ENEA (Italian National agency for new technologies, Energy and sustainable economic development)

Cyprus: The Cyprus Institute: Energy, Environment and Water Research Center

Greece: University of Patras

Turkey: Metu/Tubikak

Coordinator: UFZ

TERENO-partners involved: FZJ, KIT and UFZ

Funding: 50% UFZ, 50% FZJ

Total volume: 6.8 Million euro

Recommended by the evaluation committee of Programme 4 and HGF-Senate



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TERENO-Med Network



- Cooperating partner
- Partner receiving instrumentation



Basic Instrumentation of a Mediterranean Observatory

Costs in T€

• Rainscanner	150
• Station 1	
– Meteorological station	50
– Hydrological station	50
– Soil moisture and groundwater sensor network	100
• Station 2	
– Meteorological station	50
– Hydrological station	50
– Soil moisture and groundwater sensor network	100
• Station 3	
– Meteorological station	50
– Hydrological station	50
– Soil moisture and groundwater sensor network	100
• Additional infrastructure measures (z. B. power supply, data server etc.)	100
Costs per Observatory	850



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TanDEM-X - A New High Resolution Interferometric SAR Mission

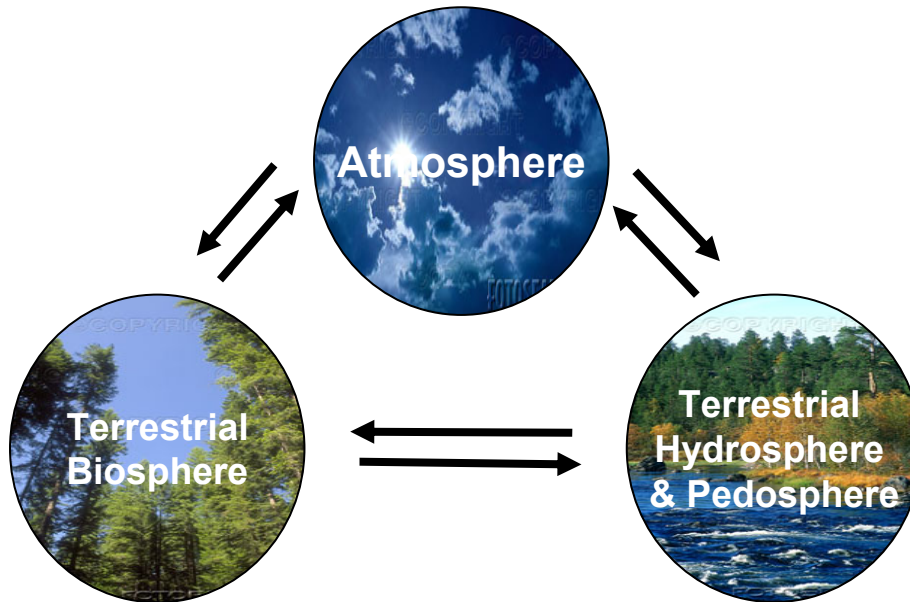


Data will be available for the TERENO-Observatories
Planned TANDEM-L
Integration of DEMMIN



Research Goals

Investigate interactions and feedbacks between different compartments:



Bridging the gap between measurement, model and management:

