Umwelt-Geräte-Technik GmbH

# NOVEL LYSIMETER-TECHNIQUES

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Management Service

# CERTIFICATE

**The Certification Body**
**of TÜV SÜD Management Service GmbH**

certifies that

**Umwelt-Geräte-Technik GmbH**
**Eberswalder Straße 58**
**D-15374 Müncheberg**

has established and applies
a Quality Management System for

**Development, production, distribution and services for measuring techniques and diagnostic instruments concerning soil-water-air analysis, construction of scientific devices for environmental technologies and environmental monitoring and lysimeter technology.**

An audit was performed, Report No. **70754154**

Proof has been furnished that the requirements
according to

**ISO 9001:2008**

are fulfilled. The certificate is valid until **2015-08-11**

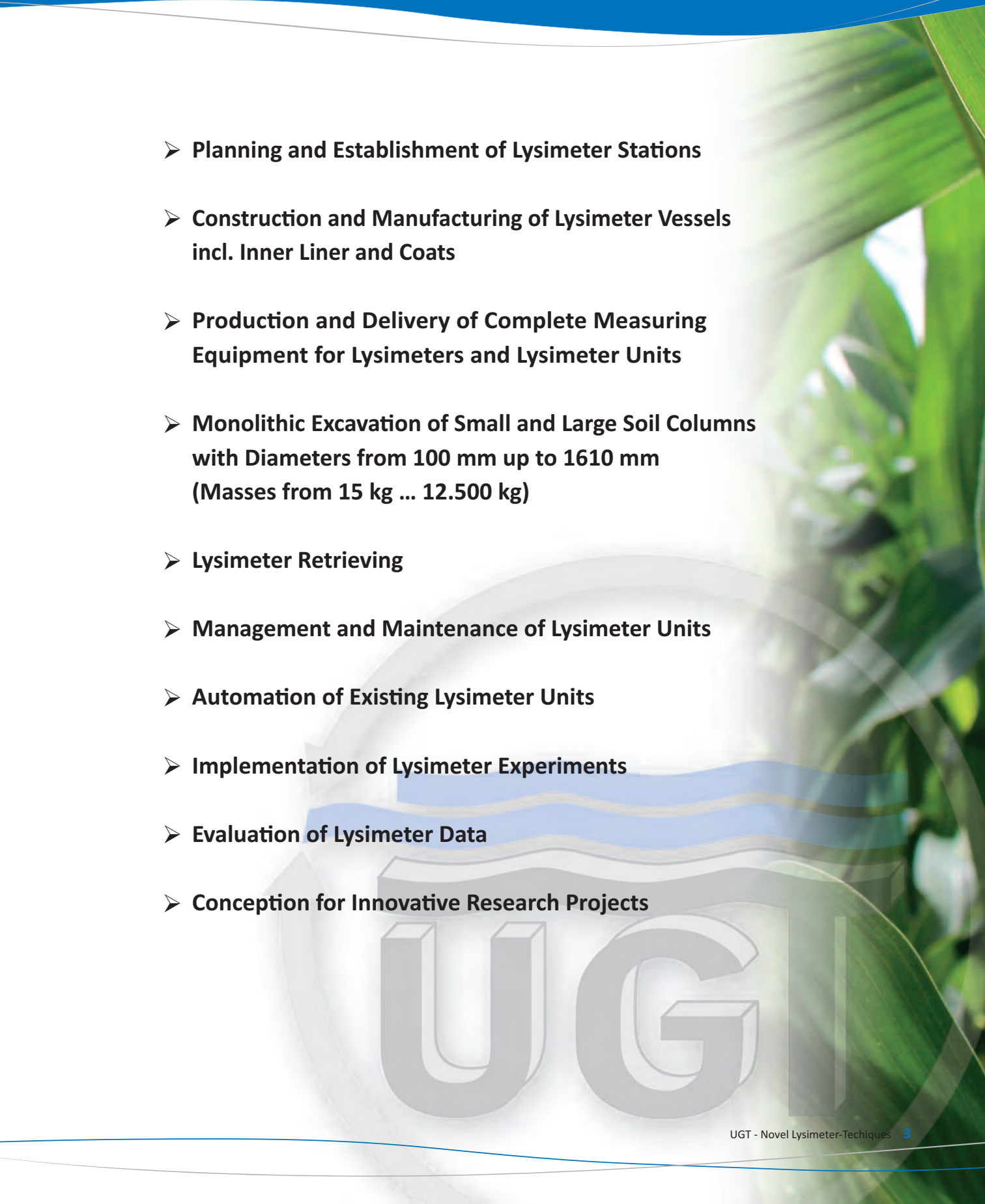
Certificate Registration No. **12 100 36542 TMS**

Munich, 2012-11-07

QMS-TGA-ZM-07-92

TÜV SÜD Management Service GmbH • Zertifizierungsstelle • Ridlerstraße 65 • 80339 München • Germany

M301-TGA-0110



- **Planning and Establishment of Lysimeter Stations**
- **Construction and Manufacturing of Lysimeter Vessels incl. Inner Liner and Coats**
- **Production and Delivery of Complete Measuring Equipment for Lysimeters and Lysimeter Units**
- **Monolithic Excavation of Small and Large Soil Columns with Diameters from 100 mm up to 1610 mm (Masses from 15 kg … 12.500 kg)**
- **Lysimeter Retrieving**
- **Management and Maintenance of Lysimeter Units**
- **Automation of Existing Lysimeter Units**
- **Implementation of Lysimeter Experiments**
- **Evaluation of Lysimeter Data**
- **Conception for Innovative Research Projects**

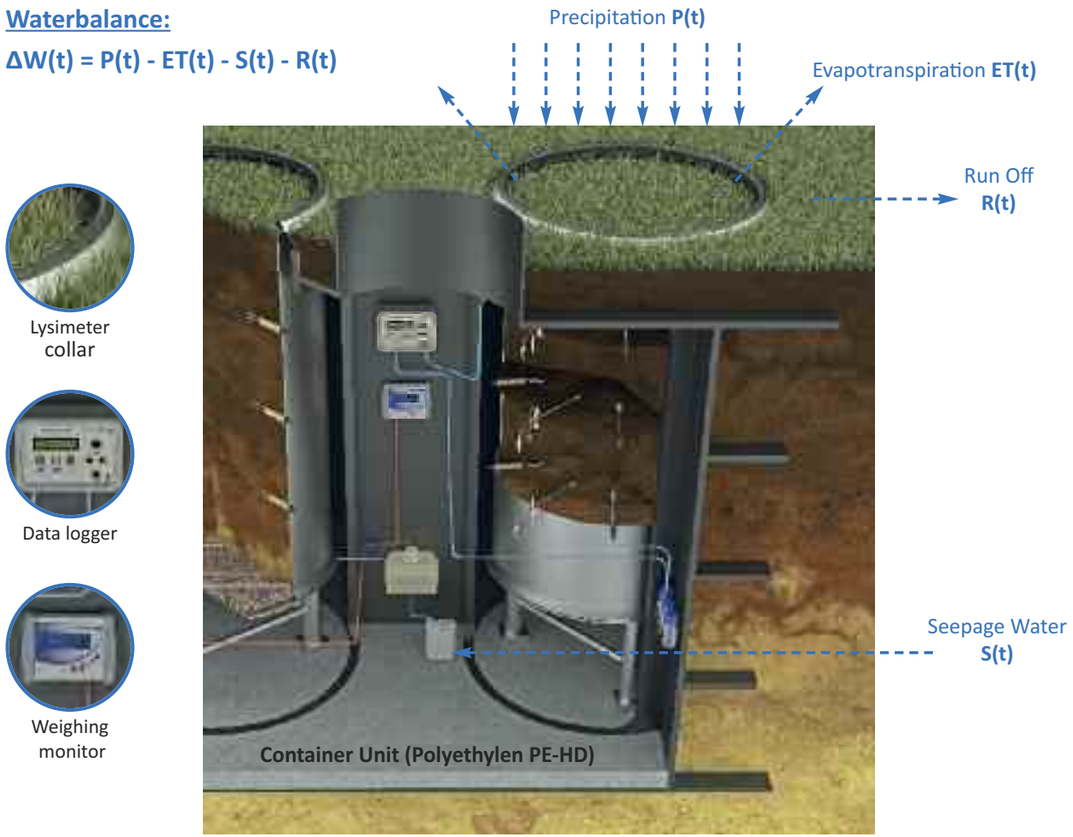
CONTENT

Lysimeters are an important tool for water-balance studies in agriculture, forestry and other environmental settings. In particular, they make it possible to quantify actual evaporation from a bare soil or actual evapotranspiration from a soil covered by vegetation.
Moreover, seepage from lysimeters can be collected, which allows an assessment of the water loss from a soil profile and thus groundwater recharge. The seepage water can be analyzed in the laboratory for its various constituents. Hence, lysimeters can be used to monitor the fate of solutes in a soil.
Weighable lysimeters can monitor the mass continuously and thus provide detailed information about water-storage changes in the soil for any time period.
In conjunction with rainfall and seepage measurements, water losses can then be specified as seepage or evapotranspiration. So lysimeters simulate the natural relation between soil, atmosphere and plants and represent the link between studies in the laboratory and in the field scale.

- There is a tendency - particulary in Europe - that direct lysimetry methods are being used more and more for studying water and solute migration in soil
- Detailed investigations of the water and solute balance forming the basis for highly accurate modelling of soil hydrological processes
- Lysimeter techniques establish as a standard method in environmental science
- Lysimeters are a common tool for studying the effect of the climate change on soil-water-plant-system

## Waterbalance:

**ΔW(t) = P(t) - ET(t) - S(t) - R(t)**








**Our flexible lysimeter design, the facilities and additional electronic measuring devices allow the investigation of various environmental questions.**

## GRAVITATION LYSIMETER

**Functional principle:**
Gravitation lysimeters are used to measure parameters for the calculation of water and solute balances in soils. Due to the high resolution weighing system the input water fractions are measured with a resolution of 0,01 mm, including dew, rime, the water equivalent of snowfall and small rates of evapotranspiration.
In connection with the additional recording of the amounts of percolating water and precipitation it also permits the quantification of the water balance of the soil column. The actual evapotranspiration can easily be derived using following equation:

$$ET_a = P - S \pm \Delta W$$

$ET_a$ ... actual evaporation (mm)
P ... amount of precipitation (mm)
S ... amount of seepage water (mm)
ΔW ... change of water storage capacity (mm, based on measuring the change of weight of the soil column over time); 1 kg = 1 l/m² = 1 mm

If the water balance is calculated correctly, the solute balance can be simply determined with sufficient accuracy using the following equation:

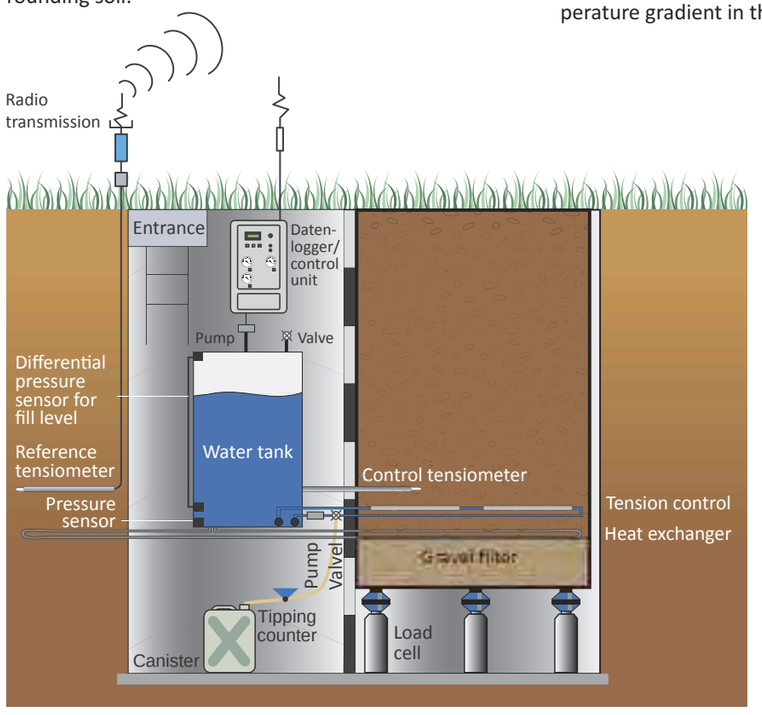
$$L = Sc \times S$$

L ... load of the solute (mg/m³)
Sc ... concentration of the solute in the seepage water (mg)
S ... amount of seepage water (l/m² = mm)

**Depiction of a UGT-lysimeter station with weighable gravitation lysimeters**

## TEMPERATURE-CONTROLLED TENSION LYSIMETER (Patent-No.: 10 2010 020 339)

The water movement in the soil is mainly defined by the present matric potential. But in usual lysimeters the matric potential in the lysimeter vessel can be very different to the actual matric potential in the field.
Hence the processes observed in a lysimeter without tension control often do not outright reflect the actual processes in the field.
Another very important parameter for the processes in the soil is the temperature profile. The temperature does not only affect hydraulic processes, but also a lot of chemical and biological processes determining the soil genesis. Without regulation the temperature profile in the lysimeter vessel is disturbed.
The temperature-controlled tension lysimeter developed by UGT GmbH enables to control both of these parameters in accordance to the actual values in the sorounding soil.




Scheme of temperature controlled tension lysimeter

**Functional principle:**
Porous ceramic bars installed at the bottom of the lysimeter connect the capillary system of the soil with a pressure regulated water reservoir. The pressure in the reservoir can be adjusted according to either the current tension at the surrounding soil measured by a tensiometer or an arbitrary value. This way it is possible to transfer the tension from the surrounding soil to the bottom of the lysimeter or to control the tension at the lysimeter bottom independent from the natural conditions.
The temperature is directly transferred from the soil to the lysimeter bottom using a heat exchanger. This way only a minimum of energy is needed to effectively regulate the temperature at the lysimeter bottom according to the effective temperature of the surrounding soil.
If needed (for example for climate research projects) the temperature can be controlled independently from the effective conditions using a temperature regulator.
Using insulated lysimeter vessels the controlled lower boundary conditions lead to a natural tension and temperature gradient in the lysimeter.

**Scientific aims:**

- Obtainment and coverage of realistic leaching water rates, by figuration of the lower basic conditions
- Coverage of the fluid and aerially stage of the leaching load without atmospheric interaction
- Biological and chemical processes under natural field temperature conditions





Hillside Lysimeter at Sierre/Switzerland

## HILLSIDE LYSIMETER

Currently unique, this lysimeter type specially developed for hillsides, fits into the surrounding slope exactly. The basic pr-requisite for this is the patented retrieval technology of UGT GmbH, which can be used without heavy equipment and can even be used in Alpine terrain.
A further development of this technology makes it possible to retrieve the monolith while retaining the natural slope of the surface and later install a lysimeter vessel with an upper edge adapted to the slope.
The lysimeter station itself is also adjusted to the slope, so that the flow processes on the soil surface are not influenced by unnatural impediments.
Apart from that it is of special interest to control the matric potential at the lysimeter bottom, because there is usually no impounded water that could be used as lower boundary and not enough space between the surface and the bedrock to make the lysimeter long enough to minimize the impact of the lower boundary. Therefore the Hillside Lysimeter is provided with the tension and temperature controlled lower boundary developed by UGT GmbH.

**Advantages:**

- Containerized station
- Weighable lysimeters
- Controlled matric potential
- Fits in the environment

Access shaft of the lysimeter station

Hillside lysimeter at Sierre/Switzerland direct after installation

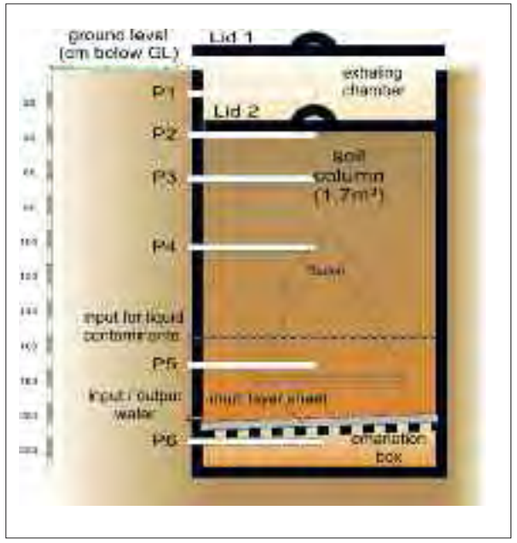
## GAS MIGRATION SIMULATOR (GAMS)

(Patent-No.: 19907461)

**Functional principle:**

The Gas Migration Simulator has been designed for the close investigation of soil-gas migration processes under quasi in situ conditions. Especially the soil-gas radon concentration can be used as an indicator for subsurface NAPL contamination. Because a NAPL contamination gives rise to anomalous low soil-gas radon concentrations in its close vincinity.

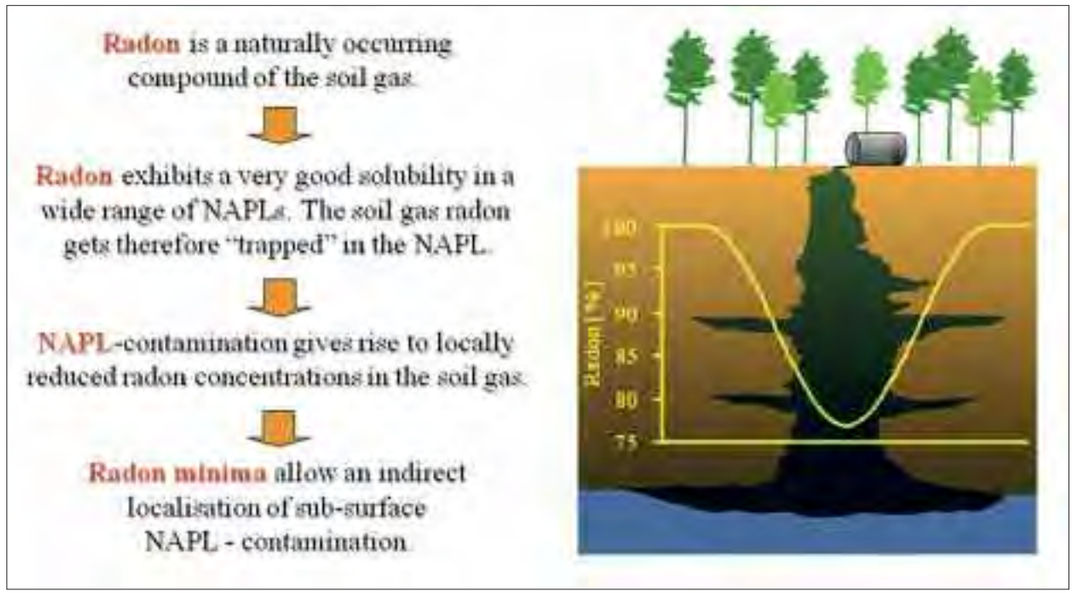
The reason for this decrease in the soil-gas radon concentration is the good solubility of radon in NAPLs, which enables the NAPLs to accumulate and 'trap' a part of the radon available in the soil pores.




Lysimeter design

## Management of Contaminated Land: Site Characterisation and Risk assessment

Radon as an innovative low-cost tool for the localisation of NAPLs in the subsurface








Model of GAMS-Station

Installation of a 4-fold gas migration simulator station

Special measuring techniques for nuclear gas particles and substances

**Containerized PE-HD GAMS-Lysimeter Station**

- Dimensions: 3,5 x 3,5 x 2,5 m
- Weight of the station: 1.600 kg
- Soil weight / single vessel: up to 5 t
- UGT GmbH can provide these stations fitted with a wide range of special measuring equipment according to the project aim

**Application possibilities:**

- Detection of soil contamination for facing risk assessment at polluted industrial sites and military bases; subsurface contamination by non-aqueous phase-liquids (NAPLs)
- Examination of the migration of dump gases or withdrawing natural gas at underground leakages
- Qualification test of sediment layers as underground gas storages
- Examination of the Radon migration in soils

Containerized PE-HD GAMS-Station

## GROUNDWATER LYSIMETER

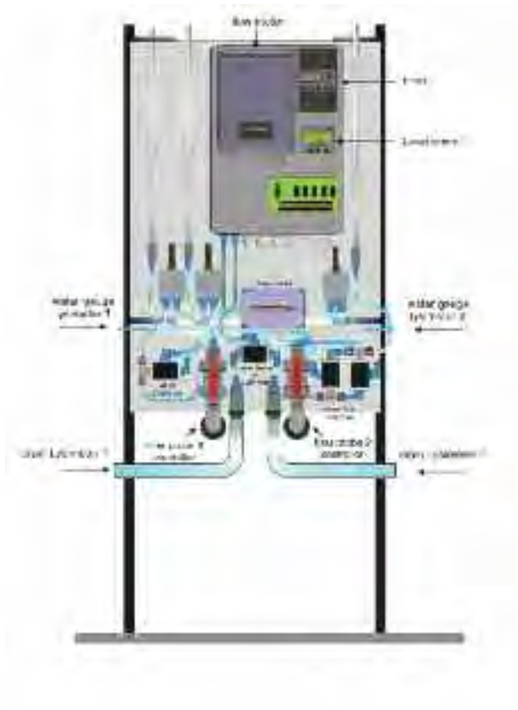
(Patent-No.: 19907462)

**Functional principle:**

The groundwater lysimeter represents a system, which is sealed at the side edges and stands in connection with its environment at the upper and the lower edge. The lower edge is characterized by the groundwater inflow $G_{in}$ and the groundwater discharge $G_{out}$. For low groundwater levels this lysimeter type has a free drainage comparable to a gravitation lysimeter.
This system is especially developed for sites being highly influenced by groundwater like floodplains for example. The water balance for such sites reads:

$$P + Pond = ET + ( G_{in} – G_{out}) \pm \Delta S$$

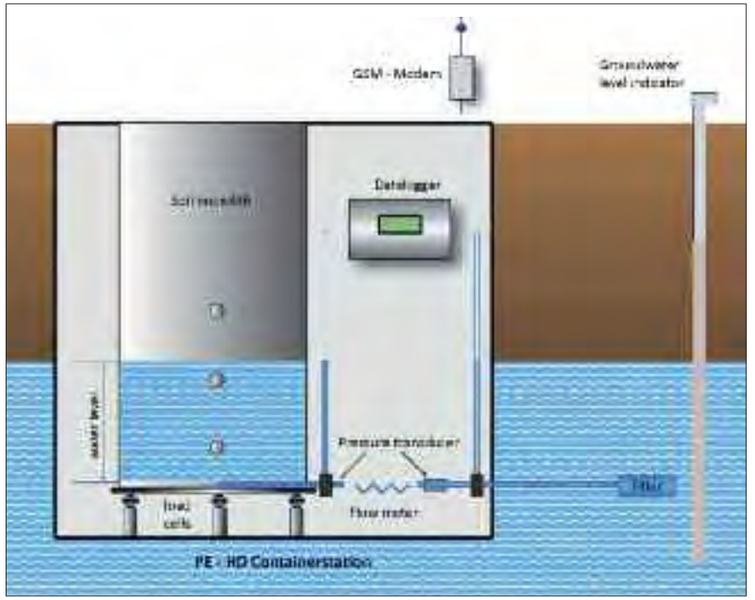
For the lysimeters precipitation **P** is measured with a rain gauge, the groundwater inflow $G_{in}$ and the discharge $G_{out}$ are measured with a flow meter. Thus the current evapotranspiration **ET** can be derived from the water balance equation. Pond is the amount of water being added in consequence of flooding. For lysimeters this is usually zero.



Tensiometers equipped to monitor the matric potential in the whole soil column

The flow meter in the lysimeter stack

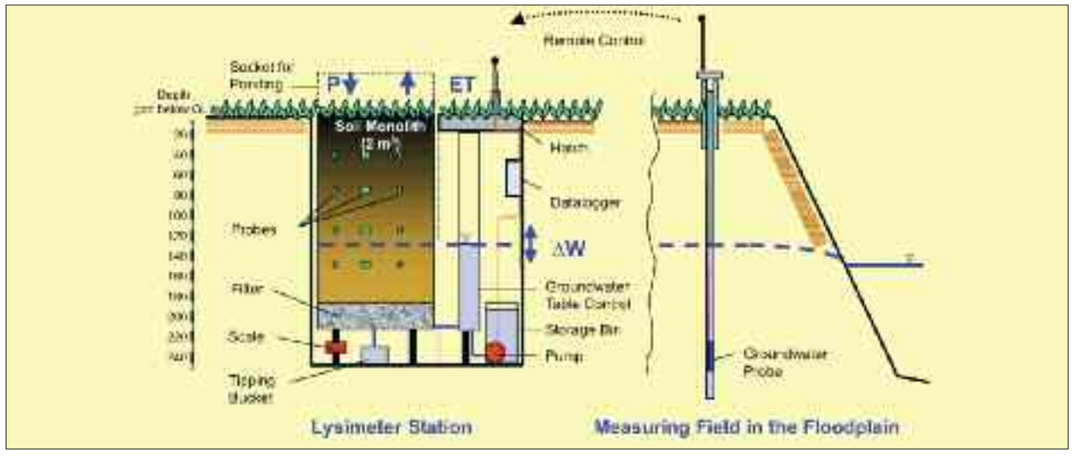





Depiction of a groundwater lysimeter without radio transmission

**Principal purposes:**

- Temporal dynamics of the groundwater formation particularly in alluvial soils
- Influence of flooding on groundwater formation and water and solute balance
- Misalignment and mobility of heavy metals, nutrients, pesticides and other pollutants by changing redox conditions

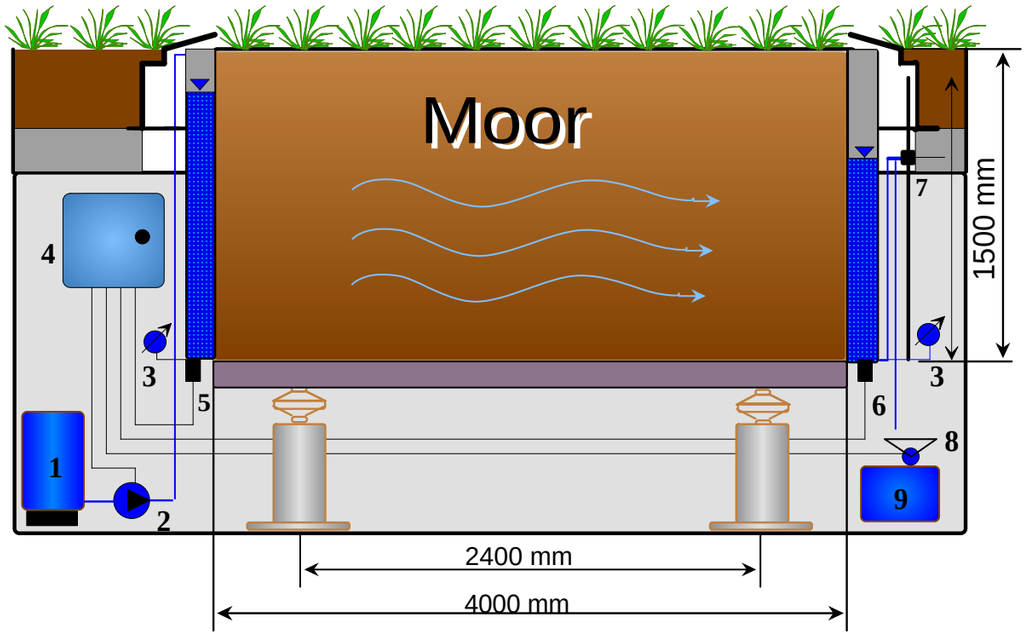



Depiction of a groundwater lysimeter with radio transmission

For lysimters built up close to the floodplain, the soil monolith and hence the waterlevel is directly connected to the groundwater via filter and tube system.
If the lysimeter is installed further away from the floodplain or the measurement points for the reference pressure are supposed to change, then the present pressure values can be send to the control unit via radio transmission.

## MOOR LYSIMETER (Patent-No.: 10353485)

**Functional principle:**
The lateral transport processes measuring lysimeter enables to determine parameters of water and solute balances of fen soils with high temporal and spatial resolution and it is used to investigate the effects of fen soil rewetting on the mobilization of phosphorus in the soil and on the surface water quality.
The groundwater level is user-defined adjustable between 0,05 and 1,45 m below surface. Different measuring systems are horizontally inserted in the lysimeter (suction probes, redox probes, tensiometers and soil air probes). The measurement of selected soil-physical and soil-chemical parameters yielded in plausible results.
The load cells are operated by a weighing monitor, which is connected to the data logger. This instrumentation makes it possible to determine the mass of the about 8,000 kg fen lysimeter (soil monolith, water, lysimeter container and framework) with an accuracy of ±100 g.
The hollow chambers arranged edgewise are equipped with an electronic water level sensor for independent water level measurement. Furthermore, the lysimeter is equipped with an active adjustment system to control the target groundwater level.




1 - Water tank
2 - Pump
3 - Manometer
4 - Control unit
5 - Pressure transducer
6 - Pressure transducer
7 - Flow rate controler
8 - Tipping counter
9 - Water tank

Scheme of a moor lysimeter

Construction of the lysimeter stack

**Principal purposes:**

- The technical realization of this lysimeter type makes it possible to carry out scenario investigations by systematic variations of the inside water levels in the in- and outlet-range and to simultaneously measure the corresponding parameters of the lateral water and solute flux.
- A combination of the investigations at the lysimeter and in situ measurements is realized and well suited for the validation and calibration of mathematical simulation models.

Putting the filled lysimeter vessel in ist place

Stack of a moor lysimeter in operation

Water sampling technology in the stack

Moor lysimeter directly after installation

## URBAN TRACK LYSIMETER

The rising claim of cities and townships to minimize the environmental impact of their traffic infrastructure enforces the inclusion of renaturation in planning and implementation of traffic routes. To prove the ecological and economical benefits of green spaces like parks, grass verges or the track bed naturation the hitherto existing qualitative valuations have to be backed up by exact measuring data.

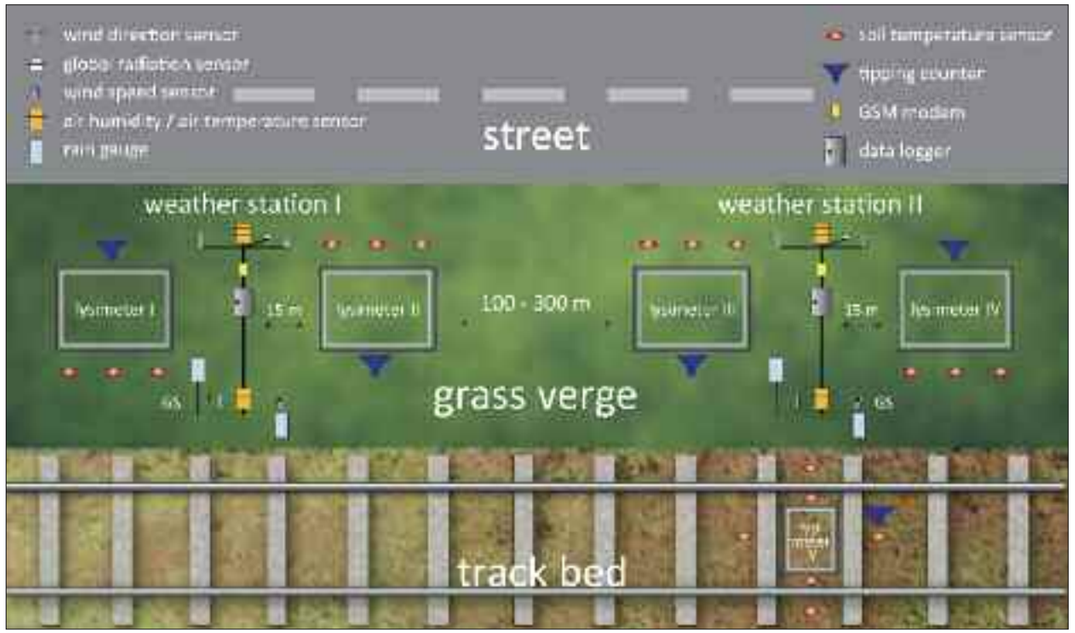
The Urban Track Lysimeter enables to estimate and optimize the water retention characteristics of different substrate and vegetation systems in track beds.
These lysimeters monitor the storage, the infiltration and the evapotranspiration of precipitable water.
Tensiometers determine the fraction of the water stored in the substrate layers that is available to plants.
In addition to the water balance measurements it is possible to carry out quality measurements to record solute flows out of and into the urban track such as dripped down lubricants or fuels.

The effect of naturation on the micro climat of the track bed is determined by recording the humidity, the temperature in the air and the temperature gradient in the track bed. Through this it is possible to prove the attenuation of heat emission from the track bed surface by heat deprivation due to evaporation.

View of the track bed with meteorological measuring station

Track bed with plants

Embedded platy lysimeter and meteorological measuring station




setup of the measuring site „Urban Track-Berlin“

Urban track bed greening with embedded platy lysimeter and meteorological measuring station

## GREEN ROOF LYSIMETER

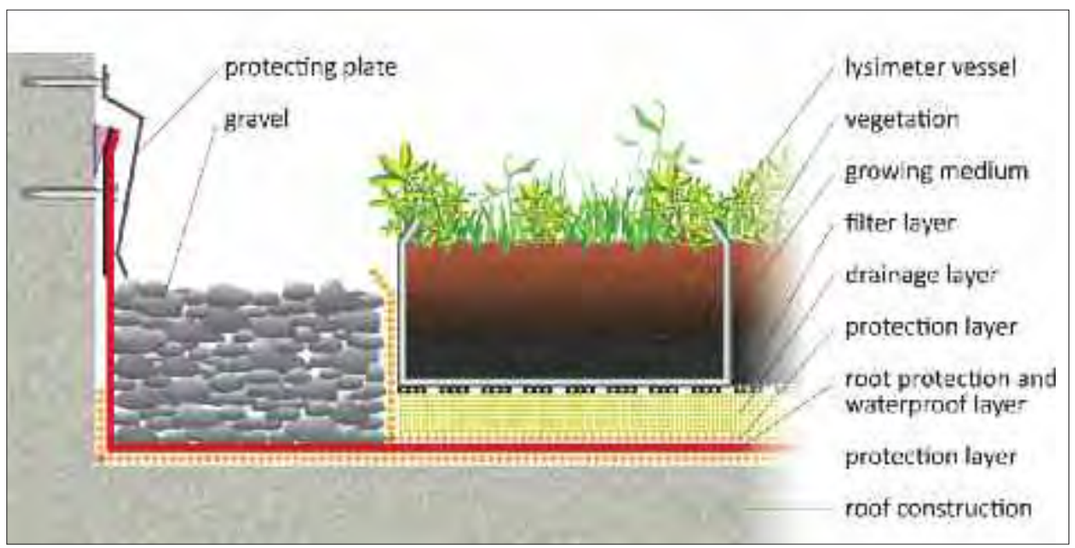
The current topics of investigations concerning the ecological roofs and urban tracks are new technological vegetation systems in order to bind particulate matter (fine dust) and development of new substrates, vegetation mats and fertilizer products.
Plants such as succulents and xerophytes are used for extensive green roofs and trains because they are low growing and require less maintenance.

**Scientific Measuring Tasks and Advantages of Green Roofs:**

- Retardation of precipitation run-off from the roof, relief of canalization and water clearing systems
- Water retention (50 – 90%) of rainwater and successive return in the atmosphere by evaporation, thereby increasing the air humidity and cooling surrounding air
- Decrease of heat irradiation of buildings in the summer period
- Air pollution mitigation due to deposition of particulate matter (PM) on the rough vegetation surface, adsorption, binding and uptake of some parts of PM

Green roof lysimeter

- Reduction of sound reflection
- Mitigation of urban problems due to their positive optical appearance and environmental impact
- Improvement of urban space quality and its aesthetical worth




Scheme of a Green Roof Construction





Measuring plots with weighable lysimeters and weatherstation

View over the test roofs with different vegetation systems

Lysimeters integrated in the green roof construction

**Universidad Autónoma Chapingo (UACH)**
**Mexico City**
**Mexico**

Pilot green roof Lomonossow University Moscow

**The DryLab** is a composition of 8 lysimeters whit a surface area of 2 $m^2$ each. The lysimeters are planted with up to 24 small trees. TDR-Probes enable the monitoring of the moisture gradient in the soil column.

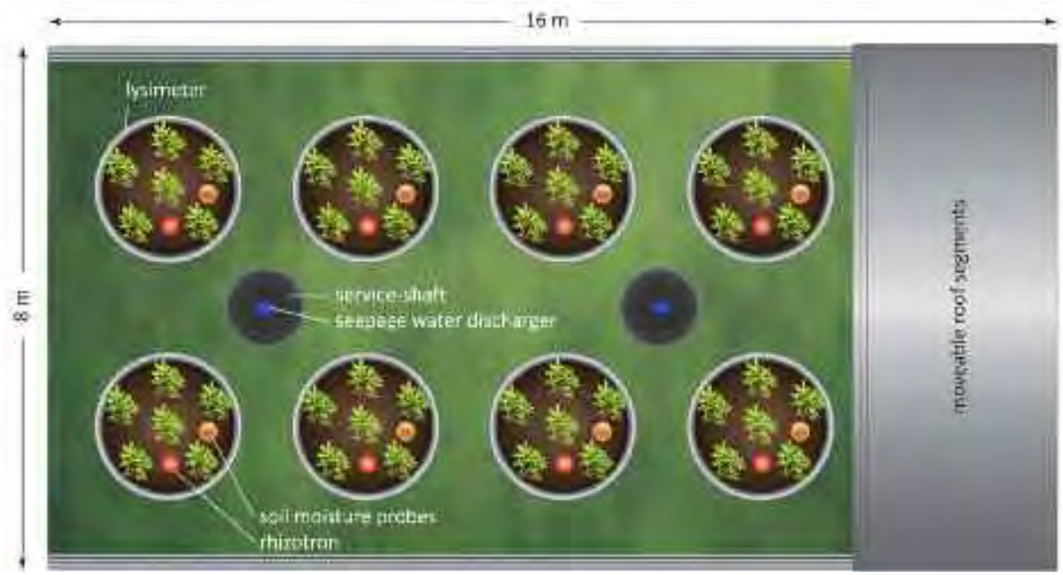
The growth of fine roots is tracked by rhizotrons, which are automatically captured by special cameras in observation tubes and deliver first results about the so far sparse investigated reaction of fine roots on drought stress.

The regulation of the natural precipitation on the test site is carried out by a temporary mobile roofing. In case of precipitation it automatically closes and covers the lysimeters.

After the end of the test (2 to 5 years) the soil columns will be excavated with the Lysimeter Soil Retriever (LSR) and sampled in layers to uncover the roots. This way versatile data about spreading of the biomass (proportioning shoot/root) and rootarchitecture are ascertainable.

DryLab areal view

DryLab under construction




DryLab Design





Root studying with rhizotrons and microcameras

Lysimeter with irrigation system and young beeches

DryLab areal view

**Functional principle:**

The DryLab is used to simulate different future settings of climate change and to check the drought assimilation of defined tree species. An outdoor laboratory like DryLab is a big advantage compared to an indoor laboratory, because all environmental impacts except the managed one are conform to the real outdoor conditions.

According to the results, indicators for drought stress can be deduced, whereas critical values can be applied as warning level for the wellbeing of trees at continuous forest monitoring.

Furthermore we get basic information about necessary test cultivations for different origins of main tree species, which allows a scientific adaption of cultivated forests to future climate changes and hence saves the versatile functions of a forest.

**The Root Laboratory/Root Stack** is located in the forest botanical garden of Eberswalde northeast of Berlin. It comprises 10 root boxes, each with a surface area of 1 $m^2$, a height of 2 m and embedded even with the soil surface. The root boxes are accessible by an underground corridor. Two side surfaces of each box are completely paned and enable to monitor the root zone of the plants and tree plantations.
The new technical equipment of the root boxes, designed as weighable lysimeters, enables to not only visually survey the roots but also to get information about the water balance and solute fluxes.
The continuous nondestructive recording of the root and scion growth of many domestic and peregrine tree species provides a quantitative registration of growth processes as well as an almost complete picture of the seasonal progression. These records are complemented by researches into the seasonal dynamics of the carbon compounds of domestic and peregrine tree species.
Altogether these experimental series are of special interest against the background of changes in climate and distribution of precipitation.

First plants at the Root Laboratory

View of the unplanted Root Laboratory including a weather station





Installation of the root boxes in the Root Stack

Root Stack with 8 lysimeters

Lysimeter with ground vegetation

Weighable lysimeter with soil hydraulic sensors

## PE-HD-CONTAINERIZED LYSIMETER STATIONS

(Europe-Patent: 1153293)

**1-, 2- & 4-fold-**
**PE-HD-containerized lysimeter stations**

**Dimensions:**

| | | |
|---|---|---|
| Heigth: | 1.5 m | ... 4.0 m |
| Length: | 2.5 m | ... 3.5 m |
| Width: | 2.5 m | ... 3.5 m |
| Material: | PE-HD | 80 / 100 |
| Weight of station: | 500 | ... 1700 kg |

**Advantages of**
**PE-HD-containerized lysimeter stations**

- Minimized costs for production, transport and installation
- High degree of pre-fabrication minimizes installation time and work
- Easy transport, relocation of used stations to new sites is possible
- Water tight and pressure resistant construction
- Low chemical reactivity

1-fold lysimeter station

2-fold lysimeter station

Two 4-fold lysimeter stations

2-fold lysimeter station





Top panel of a containerized concrete lysimeter

None containerized concrete lysimeters under construction

High grade steel lysimeter with planted hatch

According to customer requirements UGT GmbH also builts containerized lysimeter stations out of concrete, none containerized concrete lysimeters and high grade steel lysimeters. So please don't hesitate to contact us to find the perfect solution for your lysimeter station.

**Lysimeter vessels**

**Dimensions:**

| | |
|---|---|
| Heigth: | 0.5 m ... 3.0 m |
| Surface area: | 0.1 $m^2$ ... 0.5 $m^2$ (laboratory lysimeters) |
| | 1.0 $m^2$ ... 2.0 $m^2$ (in-situ lysimeters) |
| Material: | Stainless steel, PE-HD, PP, PVC |

Insertion of the lysimeter in the station

High grade steel lysimeter in winter

## LYSIMETER EXCAVATION TECHNOLOGY FOR MINERAL SOILS

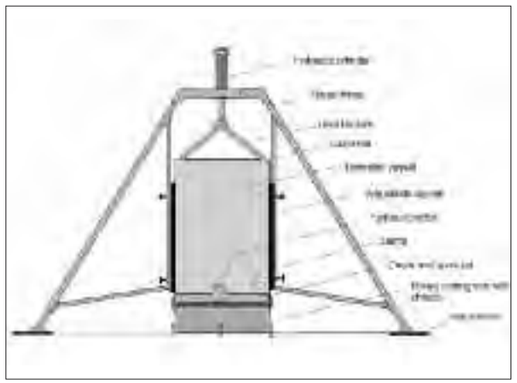
(Patent-No.: 10 048 089; 10 2005 062 896;
EP 07 712 322)

A tripod frame, which can be dismantled for transport, is used to bring the lysimeter vessel into a vertical position and hold it exactly vertical during the cutting process. The vessel is made of stainless steel and can be coated on the inside with an inert protective surface.
At the top of the frame, there is a hydraulic cylinder, which in conjunction with guard and adjustable slip rails guides the lysimeter vessel during the cutting process.
At the bottom of the vessel, there is a rotary cutting tool. It is driven by a small hydraulic motor, also located at the bottom of the vessel using a chain and sprocket arrangement. The cutting tool can be fitted with various types of chisels to adjust it to soil and site conditions.
While rotating, the cutting tool carves out the soil some cm wider than the diameter of the lysimeter vessel, i.e. it leaves an excess of 2 - 4 cm of soil all around the rim of the vessel. With its own weight as the driving force, the vessel concurrently penetrates into carved soil and shears off aforementioned excess in the process.
If necessary, an additional force can be applied by the hydraulic cylinder on top of the frame. Because the vessel slides over a soil core, which is slightly larger than itself, a tight fit between soil and vessel results.
After the desired depth is reached, the cutting tool stops rotating and the chisels are detached. This is necessary to accommodate the metal plate and the accompanying hydraulic pushing device for cutting the base of the monolith. Next, the monolith is severed at the bottom and the cutting plate left attached to the bottom of the vessel. Then a crane is employed to lift the whole assembly out of the pit.
With this cutting technique, wall friction as the lysimeter vessel penetrates into the soil is small, so that the soil monolith is not disturbed. In addition, the extraction site is only minimally affected.

The UGT GmbH developed a self-contained technology to retrieve small and large soil monoliths. With this technology we already obtained more than 500 soil monoliths of best quality. Comprising mainly the following steps:

- Cutting of the soil column/soil monolith at the side edge
- Cutting off the monolith from the natural soil of the site at the buttom
- Lifting the lysimeter vessel including the soil monolith out of the excavation pit
- Turning the lysimeter vessel for the installation of the technical devices to control the lower boundary conition

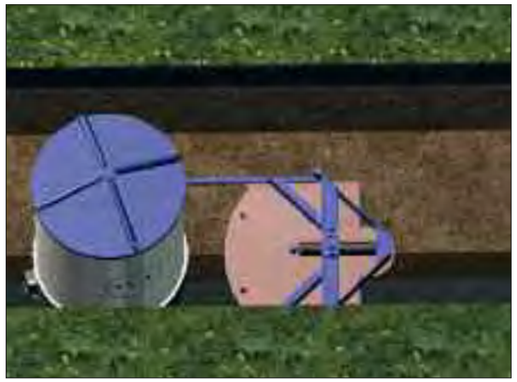
Graphic of the technology for obtaining large undisturbed soil monoliths



Schematic of the technology for obtaining large undisturbed soil monoliths







Scheme of the cutting plate and hydraulic pushing device

It is also possible to cut soil monoliths with already grown vegetation like here in a barley field.

The soil profile is clearly visible in the excavation pit.

**Advantages of the UGT excavation technologies**

- Prevention of rim effects between the soil monolith and the lysimeter vessel using special soil adapted instruments (chisel and shearing lamellas)
- No disturbance of the monolithically soil structure, like compression (no deformation) or changes of the microstructure of the soil through the application of the excavator shovel
- Axial guidance of the leveled lysimeter vessel down to the extraction depth, prevention of soil fractions
- Operation with extreme light and movable excavation tools, for the use in rough terrain, rise of the productivity and cost savings
- Detection of hindrance, e.g. stones, inclusions or other under the use of online observation (with recording) and manual interaction in the chink
- Easy movable excavation tool, e.g. eases to react on detection of hindrance, which will detract the quality of the monolith (stones, inclusions etc.)
- Well visible soil profile, as the excavation pit is not damaged
- Possibility of soil mapping after lifting the monolith out of the pit (it is visible which soil horizons or soil layers are in the vessel)
- Minimal damage of the surrounding area by using the excavation tools and no need to dig out the area around the vessel

It's even possible to take undisturbed soil samples.

## EXCAVATION TECHNOLOGIES FOR DIFFERENT SOIL COLUMNS AND MONOLITHS

The UGT GmbH adapted this excavation technique to provide you solutions for all sizes of monoliths and for all kinds of soil. Standard sizes are soil columns with surface areas of 0,03 $m^2$, 0,5 $m^2$, 1 $m^2$ and 2 $m^2$.

Cutting of a 0,03 $m^2$ (ø 20 cm) laboratory soil colum

Excavation technology for a 0,03 $m^2$ (ø 20 cm) soil monolith

Excavation Technology for a 0,07 $m^2$ (ø 30 cm) soil monolith on airport ground





Excavation Technology for a 0,5 $m^2$ soil monolith

Cutting of a 1 $m^2$ soil monolith

Excavation Technology for a 1 $m^2$ soil monolith

Excavation Technology for a 2 $m^2$ soil monolith

The base of small soil columns is cut off with steel fins, for the large monoliths a cut-off plate is used.

Base cutting with steel fins of a 0,5 $m^2$ soil monolith

Chisel and drive chain

Base cutting with a steel plate of a 2 $m^2$ soil monolith

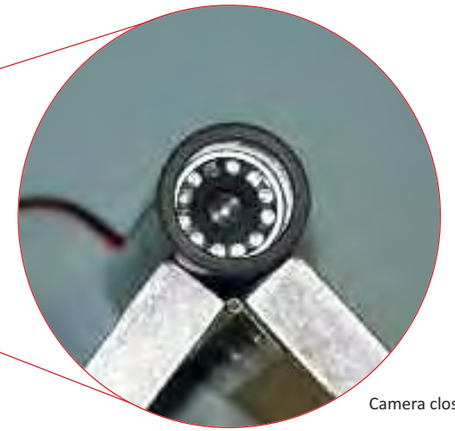
Turning of a 2 $m^2$ soil monolith





A wireless camera watches the cutting process to accomplish a well controlled cutting process

**Quality control in the excavation process**



Camera closeup

PMMA cartridges make the soil column and its layers visible additionally computer tomography enables to even look inside the soil columns to find cracks or roots

Layered soil in a PMMA cartridge

## LYSIMETER EXCAVATION TECHNOLOGY FOR ORGANIC SOILS HORIZONTAL EXCAVATION OF FEN SOILS

(Patent-No.: 10 353 485)

The lysimeter vessel is box-shaped with the following dimensions: length 4,0 m, width 1,0 m and depth 1,5 m, which is regarded as the maximum size considering the technical feasibility.
The most challenging task of the extraction procedure is the horizontal sliding of the lysimeter vessel through the natural fen. A modified cutting tool in front of the vessel assists in carving the soil monolith out of the peat, vertically on both sides and horizontally at the base.
The unfilled lysimeter vessel is inserted at the extraction site into an already prepared starting pit and aligned to a guiding system (guide tracks) adjustable in three axes. During the cutting process, this control device keeps the lysimeter vessel in its given position. The peat is sawed by cutting tools moving in opposite directions.
Depending on local conditions, the guide tracks can be mounted on excavator mattresses to achieve additional stability. At the end of the lysimeter vessel, a hydraulic plunger supports the cutting procedure. Once the vessel is filled, the lysimeter is lifted out of the extraction pit, the cutting tools are removed and the soil monolith is sealed with flange plates. The flanging is carried out in a slightly tangential position at the front of the lysimeter container to avoid any possible dislocation of the monolith. After this final step, the monolith is prepared for transport to its installation site.

Fen lysimeter vessel with monolith cutting tools

Lysimeter vessel in starting pit

Soil profile of the cut monolith

Cutting of the fen lysimeter





Vertical excavation technique for fen soils

## VERTICAL EXCAVATION OF FEN SOILS

(Patent-No.: 10 2011 006374)

Additional to the horizontal retrieval technology UGT developed a vertical retrieval technique particularly for hydromorphe and subhydromorphe soils.
The lysimeter vessel is placed horizontally in the soil and encased by two cutting tools, which move relatively against each other to apply a linear shear force to the soil. Together with the vacuum source at the top edge of the cutting tool the cutting edge prevents the unstable soil structure from overshooting and makes it possible to retrieve a stabilized soil column inside the lysimeter vessel. The vacuum can be adapted to the cutting depth.

Fen soil column with a diameter of 200 mm

Retrieved fen soil monolith with cut root

## Observation of micrometeorological flow and temperature fields near a **LY**simeter surface using **A**coustic **TOM**ographic techniques.

(Patent-No.: 10 2008 020765)

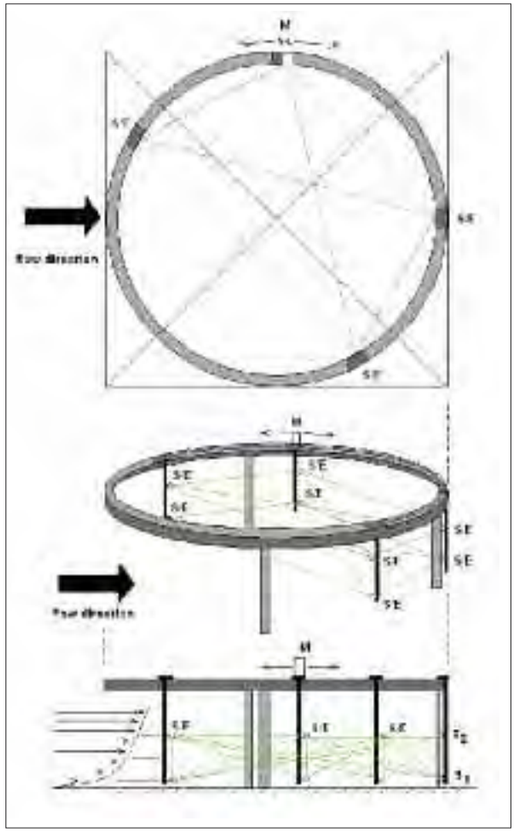
LY-ATOM uses the dependency of sound speed on temperature and flow properties along the propagation path of acoustic signals to estimate these parameters.
For this purpose, the speed of sound is calculated from travel time measurements along exactly known distances between sound sources and receivers.
By measuring the speed of sound along different sound paths over a lysimeter surface and by using tomographic reconstruction techniques it is possible to estimate spatially resolved distributions of temperature and flow properties. From these data, components of the energy balance 'Lysimeter – Atmosphere' can be derived.

**Aim:** calculate components of the energy balance 'Lysimeter – Atmosphere'
**Advantage:** no sensors on the surface of the lysimeter
**Stage:** measurement of wind and temperature
**Expansion:** additional sensors ($H_2O$, $CO_2$)
(Developed in cooperation with the Institute for Meteorology, University of Leipzig)

**Micrometeorological measurement system**

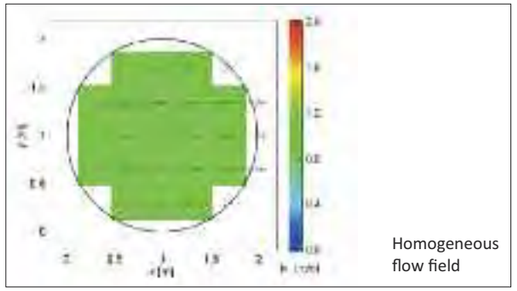
**Hardware:**
- adjustable frame
- step motor and gear (M)
- 8 sound sources (S)
- 8 sound receivers (E)
- lysimeter

**Software:**
- signal generation
- signal processing
- signal analysis
- graphical representation
- controlling step motor

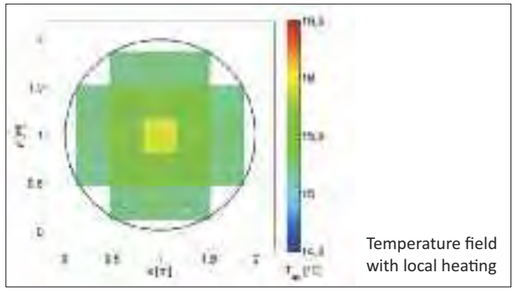


Schematic view of the **LY-ATOM** system

**Parallel reconstruction of (synthetic) velocity and temperature field near lysimeter surfaces**



Homogeneous flow field



Temperature field with local heating



LY-ATOM / ACOUSTIC CHAMBER

Measurement in the atmosphere near soil surface using the **LY-ATOM**

Acoustic chamber on a lysimeter

Ultrasoundsensors and intake port for the gas analyzator

The first experimental set-up consists of eight pairs of sound sources and receivers which are located in two height levels and which are fixed at a ring construction. Along the construction the acoustic sensors can be rotated stepwise to vary the sound paths through the remotely sensed air volume.
The control of the measurement process as well as the adjustment of measurement parameters is done via a special software user interface. Furthermore, separate software solutions exist which enable the user to reconstruct temperature and flow distributions from traveltime measurements and position data of the acoustic sensors.

## ACOUSTIC CHAMBER

Based on the positive results of the LY-ATOM project a subsequent research project called „Acoustic Chamber" was started in cooperation with the Institute for Meteorology of the Leipzig University and the Institute for Hydrology and Meteorology of the Dresden Technical University. Aim of this project was to quantify the interaction between soil surface, plant population and atmosphere and energy and material flow, especially evapotranspiration.

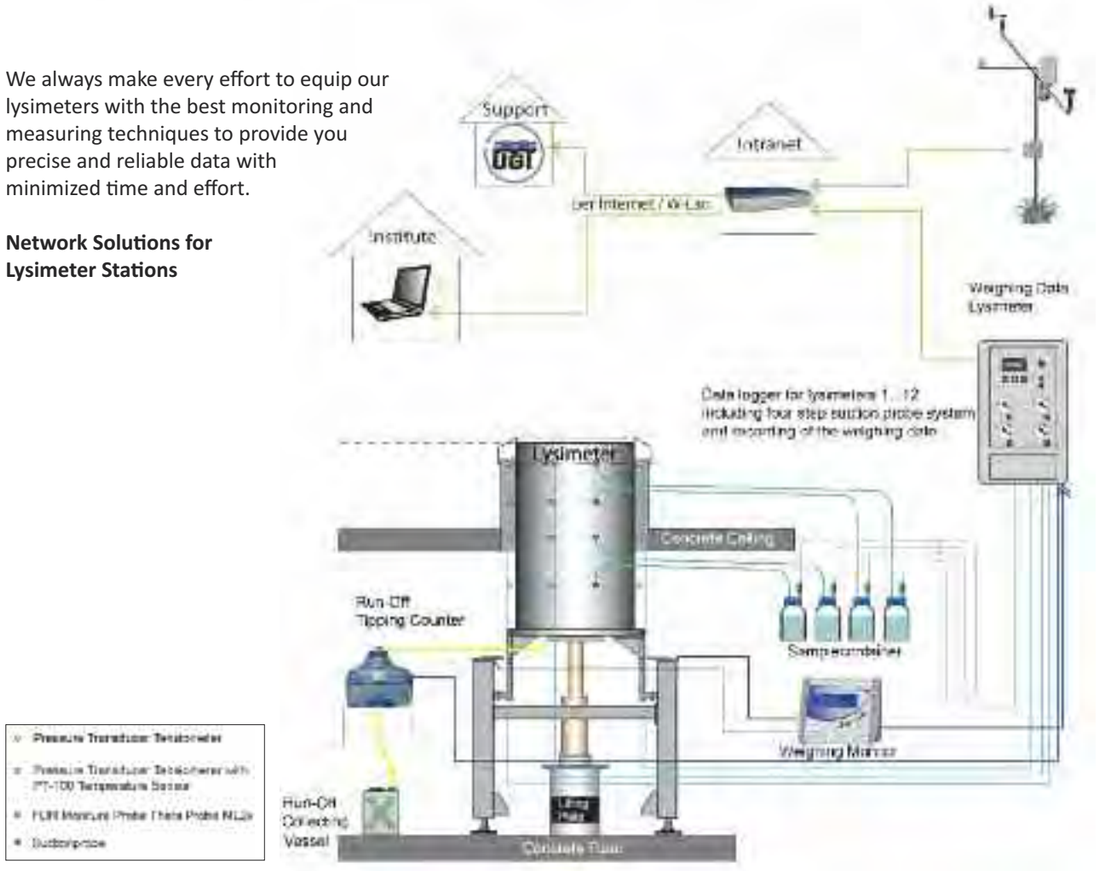
With the aid of runtime measurement by correlation analysis of acoustic sound paths, the air temperature, wind speed and wind direction is determined contactlessly above the measuring surface (e.g. a lysimeter) in different levels. Based on these data, the energy and material flow, especially evapotranspiration, can be detected by using the gas concentration changes along the flow lines, determined with different gas analyzers and temperature sensors.

To place the sensors correctly a height adjustable frame was developed that is able to „grow" along with the vegetation.

The frame is easy to move and to install with two persons in about one working day. We offer the „Acoustic Chamber" in various stages of expansion as a rent- or buying system for different kind of applications.

We always make every effort to equip our lysimeters with the best monitoring and measuring techniques to provide you precise and reliable data with minimized time and effort.

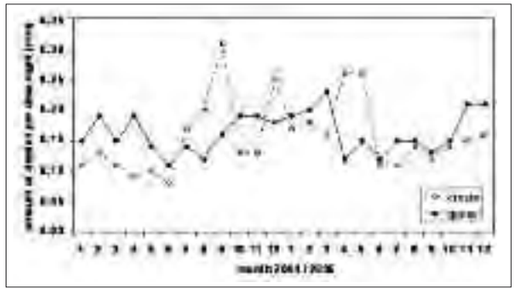
**Network Solutions for Lysimeter Stations**




To get all important information we built up automated measurement systems. Using a server it is possible to connect these networks to the internet and/or your intranet. The connection to the internet enables us to provide you with a maximum of customer service and you can read out your data everytime you want.
The comserver software and the UGT-software form a unit in the communication between PC and UGT data loggers. The data of all loggers can be saved automatically to a preselected directory of the network in an adjustable time interval.

Central data station

Weighing monitor

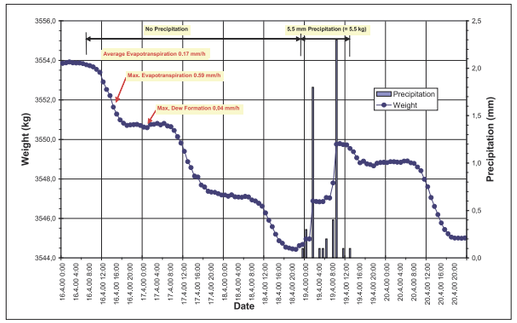


Monthly means of the dewfall over 2 years

## Automated chemical analysis of seepage water

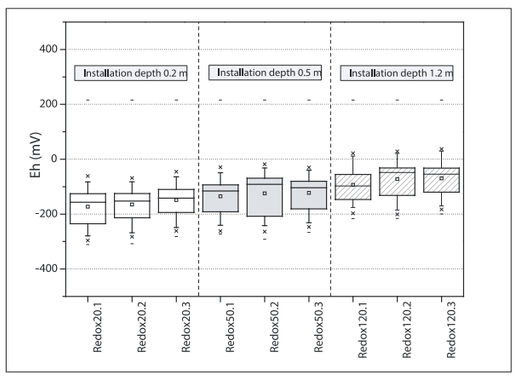
Collecting and counting of seepage water by tipping buckets

**Precision weighing systems**
To realize the exact weight measurements needed to record even dew or rime UGT developed a new weighing system.




Example of the diurnal weight change of a gravitation lysimeter planted with gras showing evapotranspiration, dew formation and rainfall

Online measurement of chemical parameters




Values of redoxpotential

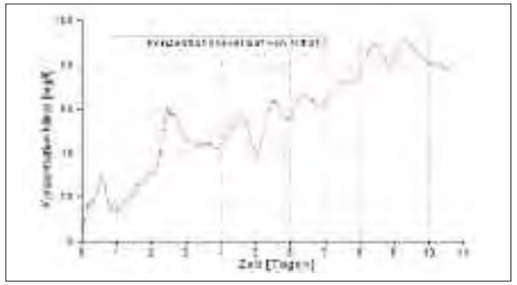
## QUICKLYZER

The Quicklyzer is an online measurement system for the detection of relevant substances in the soil water in low concentrations with minimal sample volume on the basis of photometric measurement methods.
The online measurement provides continuous data in high temporally and qualitatively resolution. Thus enable a high-resolution long-term monitoring of groundwater in the field with minimized costs and effort.
Manual sample taking, the transport to the laboratory and the laboratory analysis itself are omitted. This also prevents influences of thermal, photochemical or oxidative effects caused by wrong storage or long transport times.
Using this real-time measurement ground water aquifers close to potential contamination sources - e.g. pipelines, industrial sites or airports - can be permanently monitored. Therefore a thread to the ground water aquifer due to an unnoticed leak can be detected early and stopped.
The device is constructed in such a way, that it can be used as a mobile device in the field or be permanently installed in measuring stations.

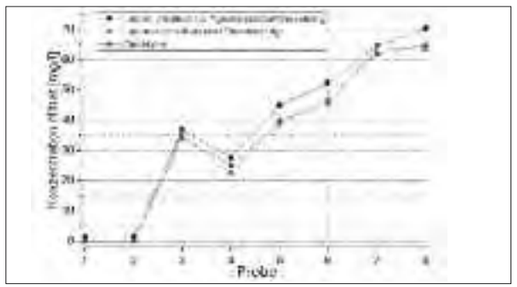
Quicklyzer as laboratory setup


Absorption and Fluorescence measurement principle of the Quicklyzer


Quicklyzer installed at a lysimeter



Nitrate Measurement with the Quicklyzer in a lysimeter station



Quicklyzer-measurement compared to laboratories





Shell of one of two lysimeters stacks

Preparation for the installation of the lysimeter collar

View of the weighable lysimeters in the lysimeter stack

Lysimeters integrated in the crop field

## TLL JENA / BUTTELSTEDT

The lysimeter station Buttelstedt (Thuringia) was built in 1982 with two sites containing two weighable lysimeters each. In 2005 it was enhanced with 12 non-weighable lysimeters.
Today there are two identical sites with two weighable and six non-weighable monolithic lysimeters each.
The lysimeters are located in the centre of a large field which provides reliable results in high quality due to preventing the oasis effect. Purposes of these facilities are optimizations of irrigation and harvesting by researching water demands of crops.
Furthermore also the chemical condition of the soil water is monitored at the weighable lysimeters. In addition to these large-sized lysimeters there are also several small ones installed comparing the amount of harvesting between maize and sweet sorghum using two different soils and applying several irrigation scenarios.

**Facts about the lysimeter station**

- Filled monolithic to keep the soil structure undisturbed, which mainly effects the water and solute fluxes
- A = 2 $m^2$, L = 2,0 m or L = 2,5 m
  To assure a sufficient amount of plants and unrestricted root growth
- Continuous weighable lysimeters (4 vessels) with an accuracy of 0,05 mm to record precipitation and evapotranspiration separately
- Tension controlled (at the weighable lysimeters) respectively gravitative seepage water collection through a quartz silt filter layer

- Aim of this lysimeter station is to derive site specific thresholds for the N-balance analysing the N-balance of an optimized management and to devolve these thresholds to other soils in order to protect the water resources and to realize the aims of the EU Water Framework Directive. Furthermore the water use efficiency, soil water assimilation ability of different soil treatment technologies and the water consumption of different agricultural plantations are analyzed to develop adaption strategies for climate changes.

## SHIXIA / BEIJING

The 2-fold containerized lysimeter station at Shixia was built in June 2010 within a joint German-Chinese research project supported by the Federal Ministry of Education and Research. The aims of the project "Implementation of a scientific based management system for non-point source pollution control in the Miyun basin near Beijing" (support code: 02WM1047) are collecting of water and nutrient balance data for modeling, developing of sustainable management strategies for the drinking water reservoir Miyun and transfer of technical and technological solutions for water treatment in rural areas.

The two weighable lysimeters with a surface area of 1 $m^2$ and a length of 1,70 m are installed at an agricultural used research plot at the Miyun catchment. The lysimeter vessesls are equipped with suction probes, soil moisture probes and tensiometers at different soil depths to get information about the water and nutrient balance of the agricultural used land area mainly affecting the Miyun basin. The soil monoliths have been excavated at maize fields with established plants at the Miyun basin.

Installation of the 2-fold lysimeter station

Cutting of a soil monolith in the maize field

Freshly excavated soil monolith in a stainless steel vessel

Transport of the soil monolith to the lysimeter station in the maize field

View of the newly installed lysimeter station at the Miyun reservoir

Monolith cutting on a terrace

1-fold lysimeter on a terrace

Installation of a lysimeter without heavy equipment

## JINGHE CATCHMENT

Since 2011 water balance components from robinia forestation and grass residues have been collected in the catchment area of Jinghe (Gansu province, tributary of the Yellow River) in a project funded by the DFG. Those data are essential for knowledge about the influence of the vegetation on the infiltration of precipitation into the soil and on the percentage of evaporation, transpiration and interception on the total evapotranspiration as key factor for planning adjustment strategies in land management of the loess plateau.

Amongst other measurement equipment, state-of-the-art UGT lysimeter stations were installed. The two high resolution weighable lysimeters are equipped with a controlled lower boundary condition regarding temperature and tension.

Using the patented UGT cutting technology the soil monoliths with a length of 1,70 m and a surface area of 1 $m^2$ could be cut directly at the difficult to access terraces and in the robinia forestation where they were subsequently installed in containerized HD-PE lysimeter stations.

The parameters of the water balance are measured in three depths.

View on the lysimeter and the terraced hills

## HOMÉCOURT

The large capacity lysimeter station in Homécourt is carried on by our branch in France. Homècourt is a former steel and coal industry site. The aims of this lysimeter station are the analysis of tailings in the soil and providing information about their mobility, their interaction with the soil or with water to develop phy toremediation strategies adjusted to the soil and to the pollutants. The large scale lysimeter station consits of 24 weighable lysimeters each with a surface area of 1 $m^2$ and a depth of 2 m. Water samples for laboratory analysis are taken from different soil layers in the lysimeters using the UGT suction probe technology.

Furthermore UGT equips and maintains 24 plate lysimeters used to test different phytoremediation strategies like different plants and their effect on the reduction of hazardous substances in the soil under well controlled conditions.

View over the lysimeter station Homécourt

Plate lysimeters with different vegetation the data loggers are stored weatherproof in the grey boxes

Lysimeter station under construction

Lysimeter station at Homécourt
shortly after finishing the construction works

UGT suction probe technology

Fully automated by the control unit

## BURE

Near to Bure in East France, the French radioactive waste authority ANDRA (fr. Agence Nationale pour la Gestion des Déchets Radioactifs) is checking the suitability of a 130m thick clay sediment floor as a final disposal site for radioactive waste. 2012 the UGT GmbH installed two 4-fold lysimeter station with 2 cut soil monoliths and two filled lysimeter vessels each. The lysimeters have a surface area of 1m² and a length of 2m. They are equipped with suction probes, tensiometers, temperature sensors and soil moisture sensors UMP1 in 4 depths. four of the eight lysimeters are weighable. The data collected with those lysimeters are used to precicely map the hydrogeological processes in the soil layers near the surface as an important decision making criterion for the suitability assessment.

Lysimeter cut with full groundvegetation

Cutting the lysmeters in a forest
stand, only possible because of the easy moveable UGT technology

Lysimeters with vegetation shortly after installation

Comparison of lysimeters with vegetation and with clay surface

Lysimeters with clay surface after growing of surrounding vegetation





Research facility Piestany

1-fold lysimeter station for Slovakia under construction

## BOROVCE

In 2013 a UGT lysimeter will be erected in Slovakia. In Borovce, around 60 km north east of Bratislava, an extensive agricultural measuring station is planned, to test the effect of various crop rotations and varieties of fertiliser.
A state-of-the-art lysimeter with an area of 1 m² and a length of 2.5 m will be built for the precise determination of the water balance quantities. The lower boundary condition can be controlled both with regard to tension and the temperature. The newest generation of tensiometers and UGT UMP1 moisture sensors provide hydrological data from various depths for this purpose.
Additionally, three vehicle resistant, non weighable lysimeters with 1 m² surface and a length of 1 m will also be installed. These can be managed in the same way as the surrounding soil.
In this way, amongst other things, the influence of heavy agricultural machines on the soil hydrological characteristics can be investigated.
Therefore no oasis effect occurs through separate management of the trial area.

The measuring station will be supplemented by a weather station, as well as 50 suction plates distributed in a grid in the soil for seepage water collection.

Location of the lysimeter station inside a cultivated area

## ZURICH-RECKENHOLZ

At the Zurich-Reckenholz location a new lysimeter station was built at the campus of the Agroscope Reckenholz-Tänikon Research Station ART.
Altogether 72 lysimeters were monolithically excavated, each with 1 $m^2$ surface area and a depth of 1,5 m. Therefore it is the biggest lysimeter station in Europe. All lysimeters can be operated from a walkable basement. 12 lysimeters are weighable and were instrumented with tensiometers, temperature sensors, suction cups and TDR-Probes in four depths (10, 30, 60 and 90 cm), each with two replicates. The other 60 lysimeter are non-weigh-able and the seepage water is measured by a tipping counter.

Lysimeter station under construction

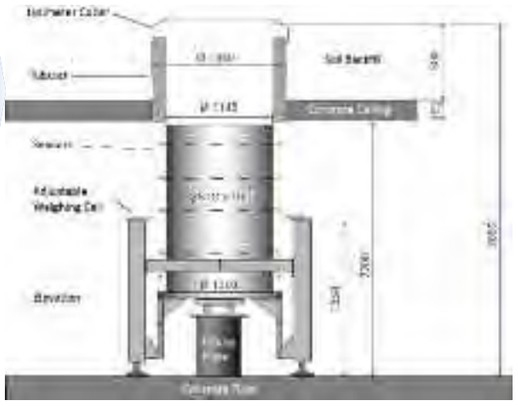
Costruction of the basement for the lysimeter station

Stainless steel lysimeter vessel is installed at the lysimeter station

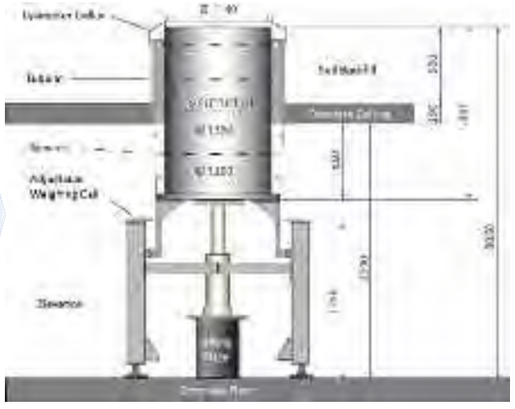
View over the lysimeter station

All lysimeters are used for agronomic experiments. The main focus is on water flows and nitrate leaching under different cropping systems, soil tillage, fertilization and soil types. All experiments have three replicates.

Lysimeter in maintenance position



Lysimeter in working position



The construction of the lysimeter station was finished by the end of 2008.
The first experiments started in spring 2009.
To enable easy acces to the complete lysimeter and all sensors for maintenance or to implement adapted measuring strategies the lysimeters can be lowered by a hydraulic system from their working position (leveled with surface) to a maintenance position.

## RYAZAN

In October 2010 twelve soil monoliths were excavated at the Oka river floodplain near Ryazan about 200 km southeast of Moscow. The Oka is the second largest tributary of the Volga. The UGt GmbH excavated those monoliths within the joint German-Russian research project “Phytoremediation” funded by the German BMBF (Federal Ministry of Education and Research) and the Russian Ministry of Science and Technology. The monolith excavation was carried out with a novel excavation technology jointly developed by UGT GmbH and the UFZ. The monoliths have a diameter of 300 mm and a length of 700 mm and cut in plastic vessels for the laboratory use. They are an essential part within the research program towards heavy metals translocation in soils and plants.
The laboratory Lysimeters are used to investigate the mobility of heavy metals at varying geochemical and flooding conditions in contaminated floodplain soils.
These investigations will be carried out by the associated Russian VNIIGIM - Institute for Hydraulic Engineering and Land-Reclamation - at their research station in Solotscha near Ryazan. The extraction procedure of the soil monoliths was filmed by the local Russian television station Ryazan and broadcasted in a science show on 8th of October 2010.

Cutting technology for laboratory soil colums in plastic vessels in use at the Oka floodplain

Floodplains of the Oka River

View on the cut soil monolith

View in the excavation pit

Gully erosion is evidence of landscape destruction in the agricultural steppes (Photo: Manfred Frühauf)

Lysimeter station ready for transport

Loading of the 2-fold lysimeter station

## KULUNDA STEPPE

In 2013 a further lysimeter station will be erected in Russia near Barnaul. In the Kulunda steppe in West Siberia, the Helmholtz-Zentrum für Umweltforschung GmbH (UFZ) [Helmholtz Centre for Environmental Research (UFZ)] and the Martin-Luther University Halle are developing concepts for sustainable cultivation in this region, in order to prevent structural damages to the steppe soil due to over use, similar to the "Dust Bowls" of the Great Plains in the 30's.
The lysimeter station will be installed on a farm in the steppe region. The parameters of the water and matter balance, about which there have been no reliable statements until now, but which form the basis for sustainable cultivation plans, should be defined in this way.
2 weighable lysimeters of 1 m² surface and 2 m length will be installed in a joint lysimeter station made of plastic, and fitted with sensors at 3 depths.
To guarantee a long-term and fault free operation of the lysimeter station, both the materials and the measuring equipment will be specially adjusted to the dry continental climate with very cold winters.

Lysimeter station under construction

## TALEGHAN

In October 2005 the UGT GmbH installed a lysimeter station in the Iranian Elburz Mountains in Taleghan. It is a 1-fold PE-HD container station with a filled stainless steel Lysimeter with a surface area of 1 m² and a length of 2 m. This Lysimeter was assigned by the University of Tehran to survey the influence of the global warming and the resulting glacier melt, which increased over the past years, on the vegetation and the soil. It is planned to impound the water from the glaciers in a reservoir and use it for irrigation.

Delivery of the lysimeterequipment at the test site in the Elburz Mountains in Taleghan

Installation of the PE-HD lysimeter station

Containerized Lysimeterstation during the installation works

Soil filled lysimeter in the station

Load triangle for weighing system

Collar installation

## UNESCO BIOSPHERE RESERVE SPREEWALD

The water balance of wetlands shows increasing seasonal fluctuations of the groundwater level varying from intermittent flooding during the winter months to water levels of 1,50 m below surface in dry summers and gets more and more affected by the predicted change in climate with rising temperatures and decreasing amounts of summer precipitations.
This is why the water management of large wetlands has to be better adapted to the weather extremes and heterogeneous demands of the landusers.
New strategies for foresighted management of the resource water need to be developed to reduce the consequences of the climate change. Here water balance, land use, environmental protection and the protection of the resources interact closely with each other.

**Aims of the Lysimeter tests:**

- Recording parameters of the water- and matter balance such as precipitation, infiltration, seepage, evapotranspiration and water quality
- Analysing the effect of interventional water management procedures on the water balance such as evapotranspiration, water storage capacity, withdrawl of water from the catchment and retention potential of the lowlands
- Development of fundamentals for water management of the Spreewald-wetlands (320 km$^2$) adapted to the climate
- Concept for a measuring and information system to enable real time operation of water management facilities
- Regulation of water management facilities at the lowlands

Flooded wetland at Spreewald

Area of the steel piling (5 m x 6 m) with groundwater lowering

Completed lysimeter station including a weather station

Extraction of four soil monoliths in the restrained area

Utilization of the monolith extraction pit for the installation of two 2-fold containerized lysimeter stations

Filling of the excavation pit after inserting the station

Lysimeter stations after the installation of the waterproof collars and deinstallation of the groundwater lowering

**Advantages:**

The retrieval technologie of UGT assures an area conservative extraction of large-volume soil monoliths at the biosphere reserve. Using lightweight technique less than 30 m$^2$ are needed to retrieve four soil monoliths with a surface area of 1 m$^2$ and a length of 2 m including auxiliary area for 2 additional monoliths.

Following to the retrieval the extraction pits are used to install the pressure water proof containerized Lysimeter station. The weighable Lysimeters get connected to the groundwater level via level control technique.
Furthermore different groundwater scenarios can be simulated.
A weather station records additional meteorological parameters.

Insertion of the lysimeters into the station

View of the lysimeter station including the weather station

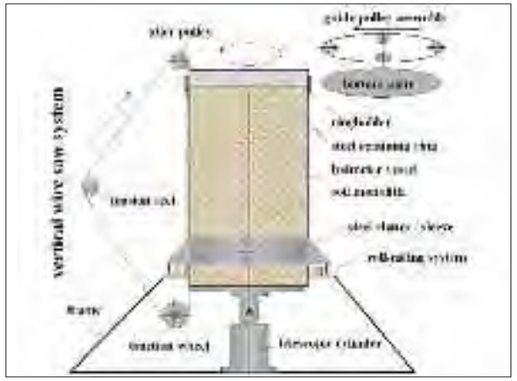
## LYSIMETER SOIL RETRIEVER

(Patent-No.: 102006010158)

Generally research fields of lysimeter studies are scheduled as long term experiments. In the course of the studies, the lysimeters act more or less as a “black box”. Usually the soil material is identified and analyzed at the beginning of the experiments. But there is also a strong need to analyze the soil without disturbance of the soil structure after the experiments in order to obtain information about spatial and structural changes within the soil profile. The new technique of the Lysimeter Soil Retriever for the first time enables studies on the heterogeneous migration of percolating water, and changes of soil structure as well as soil organic matter (SOM) and biomass distribution, as well as the distribution of mycorrhiza and microbes in different depths on intact soil profiles. The main target by using the LSR is the preparation of an intact soil monolith from the field lysimeter and the immediate dissection into slices to enable a direct sampling of its soil environment at several depths. Distribution and composition of SOM, pF-values, soil porosity, as well as degradation of PAH were only a few parameters, which are determined at the different soil depths.

**Scientific targets of the lysimeter soil retrieving**

- comparison of chemical and biological soil functions, which are effected after long term experiments
- clarifying the lysimeter vessel effect on the soil (e.g. side effects)
- changes on the top soil, e.g. packing, root distribution, aeration, water conductance, biological activities
- quantifying of changes on soil physical parameters in long-term experiments




Schematic view of the horizontal wire saw system

Total view of the LSR

LSR in operation

Soil slice with a mass of 335 kg

Soil surface 0 … 20 cm

20 … 40 cm

40 … 60 cm

60 … 80 cm

**Example 1:**
In a lysimeter study the impact of elevated ozone concentration and root pathogen infection on the plant-soil-system of young beech (Fagus sylvatica) trees was assessed down to 2 m depth with a high vertical resolution. Due to the accurate sectioning of the soil monoliths a very dense and intensive soil sampling was possible. As the whole soil space of 8 lysimeters could be sampled, precise spatial information were obtained about the rapid formation of SOM depth gradients within the experiment duration.

**Example 2:**
After the investigation on the mobilization of polycyclic aromatic hydrocarbons (PAH) by the seepage water, the lysimeter soil was retrieved. Investigations on the microbiological degradation of the PAH were possible in the whole soil monolith.

**Conclusions:**

- The technique allows for the first time to analyze the soil without disturbance after a long-term experiment
- The retrieving of intact soil slices allows a much broader range of applications of lysimeters
- Assessment of vertical distribution of fine root biomass was possible by using the LSR
- Lysimeters are a substantial part of a model based up scaling. This requires an object related set-up of a system state and parameter model as well.
  Based on this, a sensitivity analysis of the different migration parameters is essential in order to identify particular sensitive migration parameters
- Conditional on partial complex groundwater contamination and matrix effects migration parameters from literature are very limited usable, mostly for a very first estimation of migration behavior of contaminants in the soil water zone
- The use of the LSR allows the analysis virtually in-situ

## LYSIMETER ON CONTAMINATED SITES

Lysimeters are very suitable for monitoring the migration and chemical reactions of soil contaminants. Especially in combinations with innovative measuring equipment like the Multilyzer for online detection of contaminants in soil water and the Lysimeter Soil Retriever. Therefore the UGT GmbH holds many examples for lysimeters on contaminated sites like Homécourt or Böhlen.
In 2005 and 2006 the UGT GmbH provided the DOW Chemicals in Böhlen within the major ecological project „SOW-Böhlen“ with four specialized lysimeters. Each with a surface area of 1m² and a length of 2 m.
To survey the influence of the different soil layers the lysimeters were cut and put together out of different soil layers from up to 5 m depth. The monoliths were cut up to the desired depth of the first layer then the soil above the next designated layer was excavated, the surface of the new soil layer and the bottom of the monolith were prepared to provide a natural connection between the two soil layers and then the next layer was cut to the designated depth. This way four completely different soil models with naturally structured soils could be realized in the four lysimeters (see scheme below). Monolith 1 shows the natural sequence of soil layers just in smaller dimensions. For monolith 2 the clay layer was left out to survey the influence of this layer. For the monoliths 3 and 4 the natural top layer was replaced by a gravel layer to test the influence of the top layer and vegetation. And again one of the two monoliths is cut with the clay layer and for the other one the clay layer was left out.

Haulege of the lysimeters to the chemical industry site

Loading and transport of the cut soil monoliths

Total view of the containerized lysimeter station with different monolith compositions

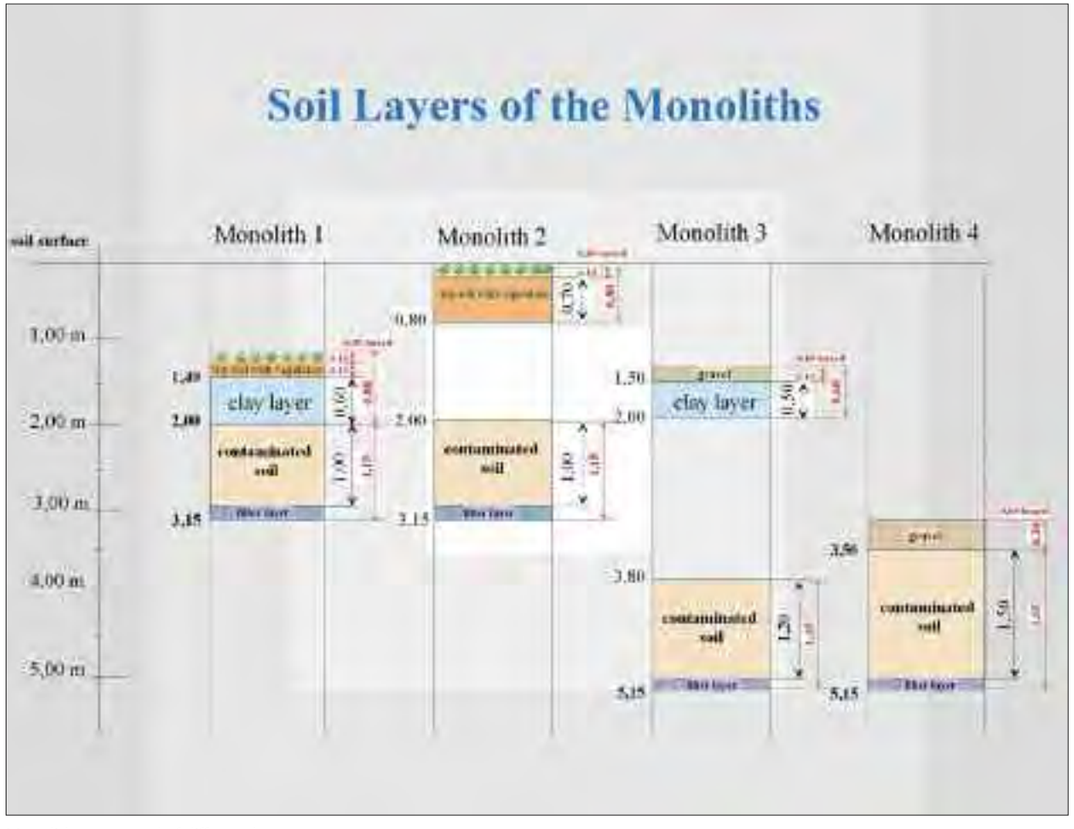




Monolith excavation in 4 m depth

View of the partial monolith

Soil profile of the contaminated site

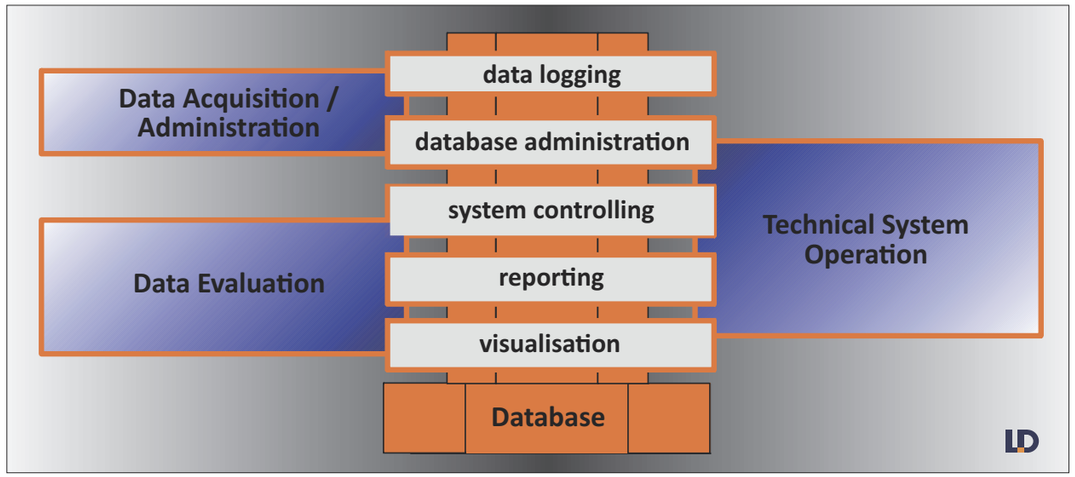



Monoliths composed of different layers

## LYSIDATA - INTEGRATED SOFTWARE SYSTEMS
## for Professional Data Acquisition, Managment and Evaluation

Today any Measurement Unit generates a great amount of data during it's lifetime. Modern computer systems enabled support in plant operating and data processing even in simple or complex environments.

UGT meets this challenge by licensing LysiData™ Software Component Systems to offer our clients an customized solution for it's individual demand.




An intelligent and most flexible database architecture is the fundament of the whole software system.
The software components are self-configuring by the database-system and offers a standardized user interface for all kind of heterogeneous measurement environment.
The software system comes up with many individual selectable applications for your individual requirement:

- Automatic data acquisition
- Visualization
- Database administration
- Logbook, Reporting, Data-/Facility-QM
- Technical controlling like handling of measurement events or alarm notification using email or SMS
- Individual enhancements ...

**LysiData Software Systems offers you Software-Modules for any of your requirement.**
**Your benefit will be one Unified Software Environment with Standard User-Interfaces for all kind of challenges in Data Collection, Management and Analysis.**

### HIGH LEVEL STANDARDS FOR TODAY ...

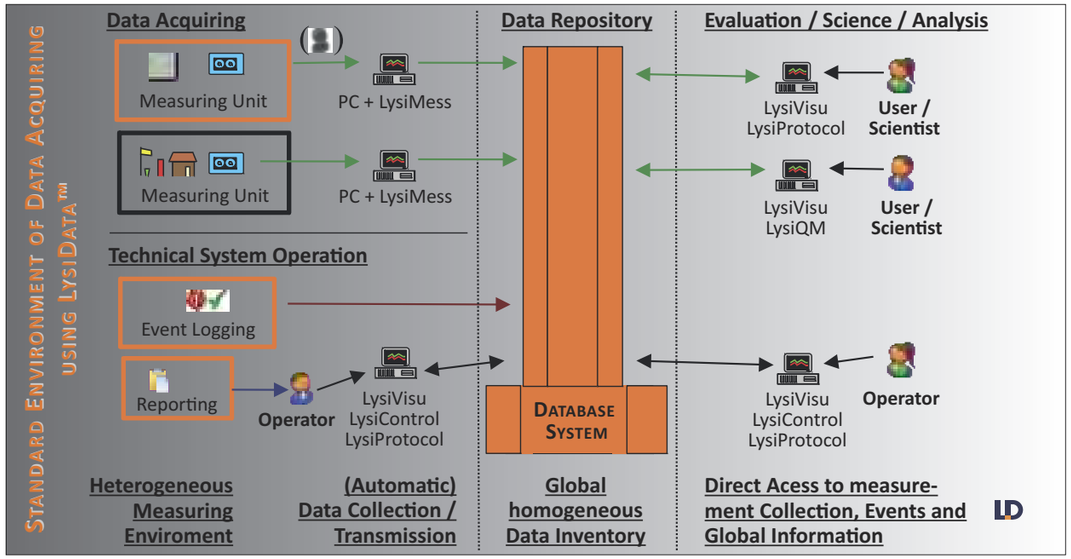
- **Data Availability**
  - Continuous data(sets)
  - Immediately available after data generation
  - Long time storage of data

- **Data Access**
  - Transparency - distinct data allocation
  - Verifiability - distinct data origin
  - Interpretability - saving available measuring circumstances
  - Simply accessible for users and operators

**Using LysiData Software Systems you will recieve a homogeneous data repository in a single, globally accessible database.**



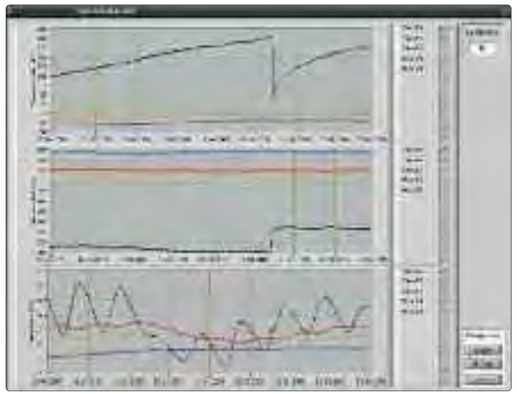


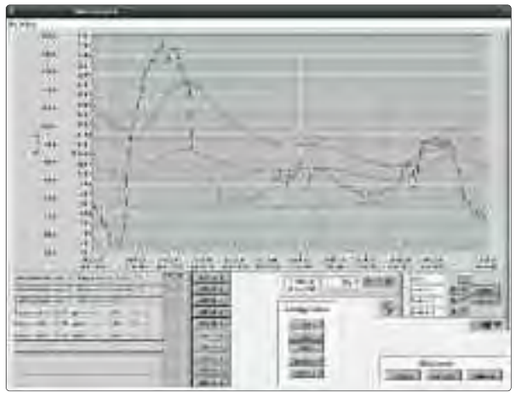



### Work In Progress ...

**Economy and Efficiency**
- Easy to use applications for operation and evaluation
- One software system for all hardware combinations
- Individual customization for your demand

**Visualization and Evaluation**
- Screen and evaluate your acquired data
- Inspect current facility state
- Prepare and export data for use in high level statistic software



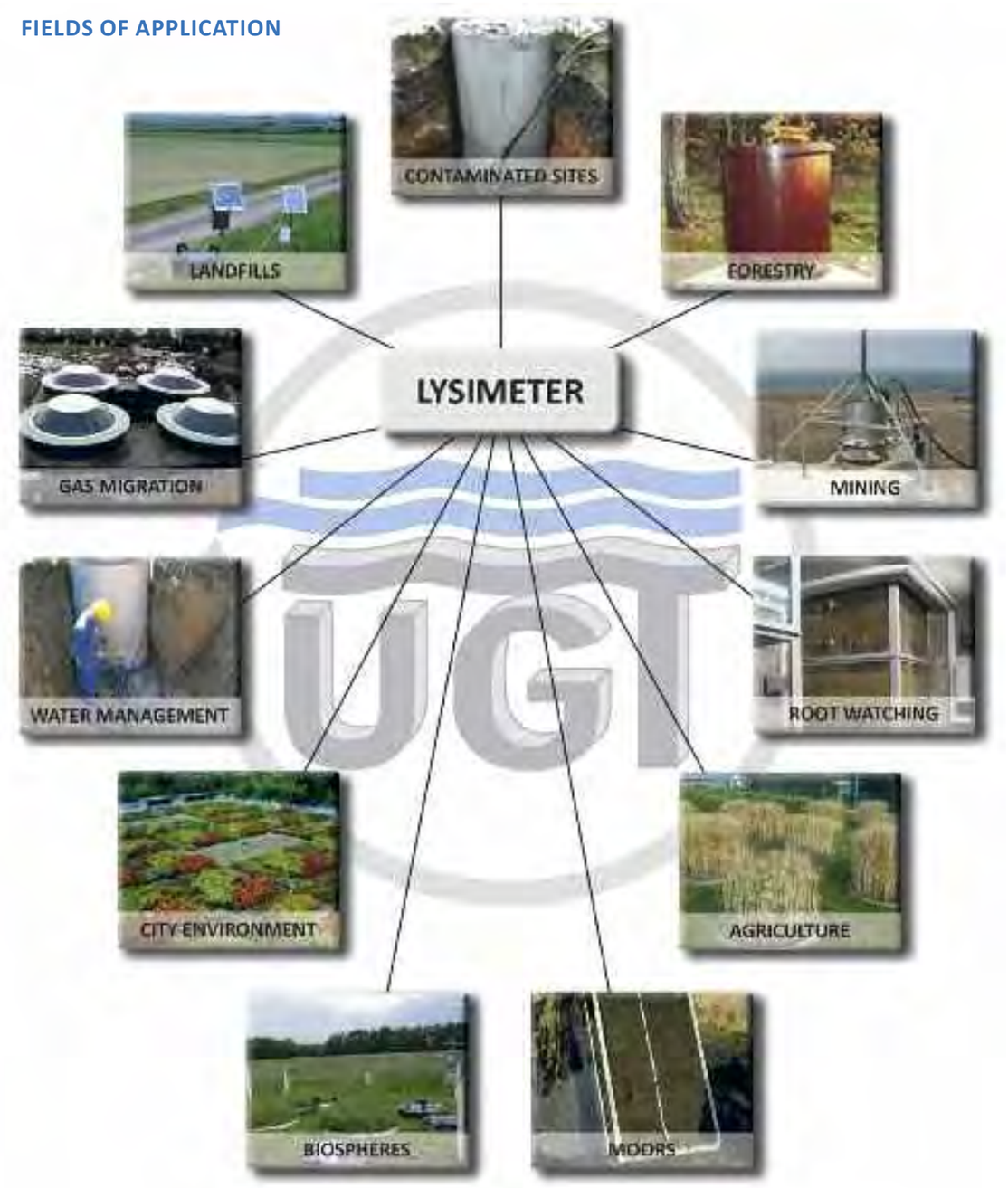


### Ready for the Future ???

**Safekeeping your Data**
- LysiData Software Systems guarantees data availability for many years
- Data quality assurance needs professional data management

**Be Prepared for Future Demands of Data Usage**
Global change of (scientific) data work progress will come with
- Share, interchange and reuse of collected data
- Third party data evaluation of your publication
- Primary data as an own quotable publication

## FIELDS OF APPLICATION








Altai State University
Barnaul, Russia

ART -
Forschungsanstalt Agroscope
Reckenholz-Tänikon

DOW Chemical, Böhlen

DFG Forschungsgruppe
Institut f. Organischen Landbau
Rheinische Friedrich-Wilhelms-
Universität Bonn

INRA - French National Institute
for Agricultural Research

Forschungsinstitut für
Bergbaufolgelandschaften e.V.
Finsterwalde

GISFI - French Scientific Interest
Group - Industrial Wasteland

Helmholtz Zentrum
München -
Deutsches Forschungszentrum
für Gesundheit und Umwelt

Helmholtz-Zentrum für
Umweltforschung GmbH -
UFZ, Leipzig

Hochschule für nachhaltige
Entwicklung Eberswalde

Institut für Agrar- und Stadt-
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Humboldt-Universität zu Berlin

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National Academy of
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Staatliche Betriebsgesellschaft
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Landwirtschaft

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Thüringer Landesanstalt
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Universität Bonn

Universität Bern, Switzerland

Universität Leipzig
Fakultät für Physik und
Geowissenschaften

Université de Lorraine
Nancy, France

VNIIGiM Moskau, Russia

## NATIONAL LOCATIONS

- Location of cutted lysimeter soil columns in Germany by UGT-Technology
- Location of UGT-lysimeter stations in Germany

## INTERNATIONAL LOCATIONS

Beijing,
Shixia,
Jinghe Catchment

**China**

Homécort, Lusignan,
Douai, Pompey,
Bure, Lagney,
Osne-le-Val

**France**

Tehran,
Taleghan

**Iran**

Jeonju

**Republic of Korea**

Mexico City

**Mexico**

Krakow

**Poland**

Moscow,
Rjazan,
Barnaul

**Russia**

Borovce

**Slovakia**

Zürich,
Grafenried,
Schafisheim,
Sierre (Wallis)

**Switzerland**

## UGT-PREVIEW FOR 2014


UGT got the honor to realize the largest Lysimeter Station in Asia, Republic of Korea, Jeonju.

**Imprint**

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