Mountain Lysimeter Station STODERZINKEN (1830 m) in Austria, province of Styria, market-town of Gröbming

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Introduction With a new type of lysimeter, adapted to the specific meteorological situations in these mountain regions 1830 m above sea level, the amount of precipitation, seepage water and nutrient leaching losses should be measured and compared with the situation in Austrian low land.

Materials and methods Stoderzinken is a 2048 m high lime stone mountain. The most widespread soil type here is a chromic cambisol. This mountain reflects a representative alpine site in the Northern Limestone Alps, an Austrian alpine region, well known for it's high amounts of precipitation and huge ground water recharge capacity and is therefore of fundamental interest for drinking water reservoirs. It is of public interest to measure and monitor precipitation and the amount of seepage water passing the soil profile, and to model the water balance. A rain gauge enables not only to receive information of precipitation as a sum parameter, but also to get details about wet deposition.
The seepage water will be continuously analyzed for N, P, S, Na, K, Ca, Mg and Cl in the laboratories at the HBLFA Raumberg- Gumpenstein. Cumulating those parameters, the annual loads caused by seepage losses will be calculated. Also organic substances and parameters like TOC (total organic carbon) and DOC (dissolved organic carbon) as well as TON (total organic Nitrogen) will be determined.
These assays are input parameters for mathematic models which will result in the determination of chemical processes in the chosen environment. The filter effects of this alpine soil will be shown and the soil water situation completed by determination of the solute transport in alpine regions.
The installed lysimeter station corresponds to the lysimeter station at Wagna, Leibnitzer Feld, in Austrian low land, which allows us to compare water balance and solute transport in valleys (pore ground water) with those in alpine regions (karst ground water).
We started the setup of the mountain lysimeter station at the western side, 1830 m above sea level, in July 2005. The setup contains two lysimeters, one with a surface of 1 square meter, the other with a surface of 0.07 square meters. They are combined with a meteorological station and a measuring profile in the non disturbed surrounding soil profile.

Lysimeter
Main part of the station is the patented, monolithic excavated, weighable UMS-Lysimeter, as it can be seen in Figure 1. The cylindrical body with a surface of 1 square meter and a soil depth of 1 meter is mounted above a Y-shaped load frame, which is adjustable in X-Y-Z direction and contains the high precision load cells. Those are measuring the load with a resolution of 10 Grams, according to 0.1 mm of rainfall.
TRIME® -EZ TDR probes measure the volumetric water content at depths of 5 cm, 30 cm, 60 cm and 90 cm. These probes are completely installed in the soil with integrated TDR-electronic in a sealed PVC housing and have been chosen because of the rod lengths of 160 mm, which is important for the heterogeneity of the soil. The patented voltage scanning principle detects the volumetric water content by applying a 2 giga Hz pulse while the response curve is scanned in constant nano second intervals monitoring the voltage levels. This principle is especially used for sandy and loamy soils. Because of the high dielectric constant of water at about 80 in relation to air or soil (>3-5), the volumetric water content can be determined.
The new UMS SIS matrix sensors measure the soil water tension, as all water fluxes depend directly on the matrix potential differences. These are also installed in the upper horizon of 5 cm, as their range goes up to 2000 hPa. They are maintenance free, but as with all porous matrix sensors a relaxation time is given to fill and empty the porous body, which must be considered at soils with low hydraulic conductivity together with the hysteresis of drying and emptying.
Tensiometers type T8 measure the matrix tension and temperature in depths of 30 cm, 60 cm and 90 cm. They are refillable with a syringe from the maintenance well next to the lysimeter.
With the measuring data of these probes the water fluxes in the soil can be calculated. Tensiometers are used as the main water fluxes occur at tensions close to zero, where especially pressure transducer tensiometers are measuring accurate. The soil water tension is transmitted through the porous ceramic cup of the tensiometer to the water inside the tensiometer cup. A temperature

compensated precision pressure transducer measures the water tension directly and delivers a continuous analogue signal.

Surrounding soil measuring profile:
This profile is equipped with the same sensors at the same depths as the 1 square meter lysimeter. Advantage of this instrumentation is the ability to compare the lysimeter water situation with the undisturbed natural soil water situation. Furthermore, we can compare our results with those of other measuring sites installed from the Austrian Hydrological Service in nearly all provinces of Austria.

Summary of sensors & instrumentation inside the lysimeter and the surrounding soil profile:
Volumetric water content measured at depths of 5 cm, 30 cm, 60 cm and 90 cm with TRIME® EZ TDR probes.
Soil matrix water tension measured with SIS Sensors in depth of 5 cm.
Soil matrix water tension measured with UMS Tensiometers type T8 in depths of 30 cm, 60 cm and 90 cm.
Soil temperature measured in 5 cm with UMS soil temperature sensor Th2.
Soil temperature measured in depths of 30 cm, 60 cm and 90 cm with T8 tensiometers.
1 sqm Lysimeter drainage flux measured with 100 ml res. encapsulated KIPP100 module.
0.07 sqm Lysimeter drainage flux measured with 5 ml res. encapsulated KIPP005 module.

Small Lysimeter KL2
The new small lysimeter or drainage sampler is made of a stainless steel pipe with an inner diameter of 300 mm and a height of 60 cm and a high flow porous ceramic bottom plate. The lysimeter cylinder is gently pressed into the soil for monolithic excavation. The capillary contact between soil and ceramic plate is achieved by an additional silica sand between plate and soil. The 0.5 bar high flow ceramic has a 36 times higher flow rate than a standard 1 bar plate. Applying a vacuum according to the soil water tension in 60cm depth, measured with the tensiometer, results in the natural downward flow. The flux rates are measured with a KIPP05 module.
With this new instrument, flux rates and composition can be compared between the 1 sqm gravimetric flux lysimeter and the 0.07 sqm flux tension controlled lysimeter. This is of interest for agricultural advisers as they use small lysimeters with applied vacuum in areas with conflicts between water suppliers and farmers.

Meteorological station:
Instrumented with four RS200 rain samplers with diameter 200 cm, surface 314 sqcm, for observation of the areal precipitation heterogeneity. A rain gauge, using the weighing principle will be installed soon. WMO-standard conform sensors for wind speed, wind direction, global radiation, relative humidity and temperature are installed in two meter height. The air temperature is additionally measured 5 cm and 20 cm above soil surface for determination of frost events.

The service well:
Next to the lysimeters a sealed service well, 3 meter deep with 2 meter diameter, is installed for taking up the data logger, tipping modules KIPP100 and KIPP050, sampling bottles, GSM-modem for data transmission and system check and tensiometer refilling. As all sensors have water protected connectors, the calibration and service can be done from inside this service well.
The station can be controlled via GSM data transmission from Raumberg-Gumpenstein or for technical service from UMS GmbH in Munich, who has provided also instrumentation and installation of the Stoderzinken Mountain Lysimeter Station.

Results The lysimeter station at the mountain Stoderzinken has been installed in July 2005, therefore results as far as now have not been evaluated except the first amounts of drainage.

Conclusions Even in the extreme situation of a mountain soil, situated in 1800 m above sea level with a profile of not more profundity than 1 m to 1,20 m it is possible to install a lysimeter station with a weightable monolithic lysimeter, a small lysimeter and a soil measuring profile.

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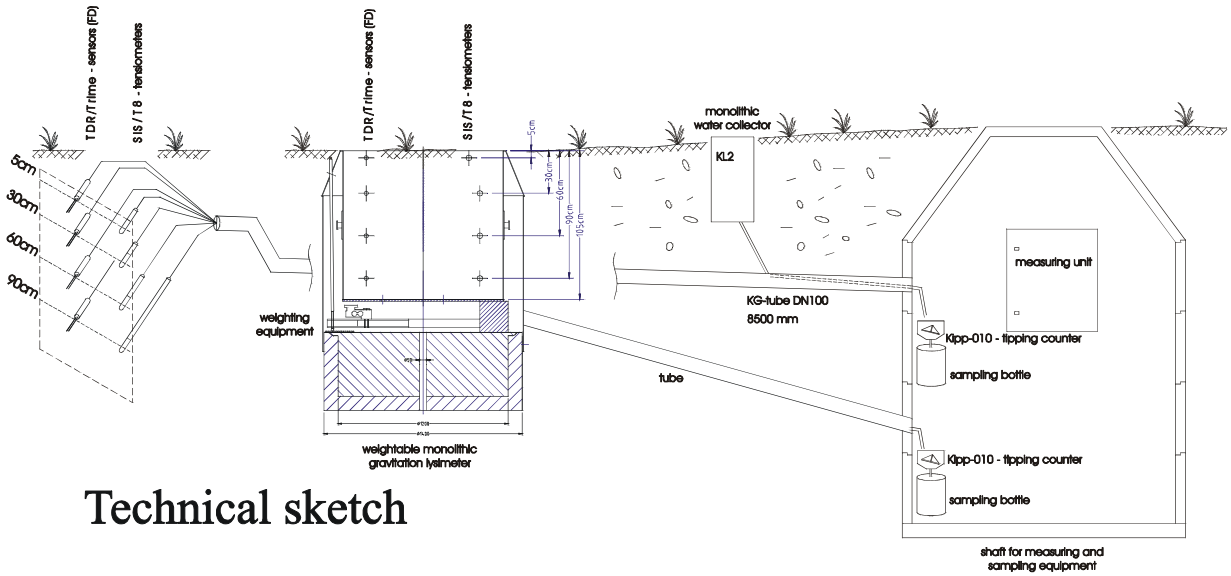

Figure 1: