

“Tension-free” Lysimeters versus „Controlled tension“ Lysimeters - A Simulation Study



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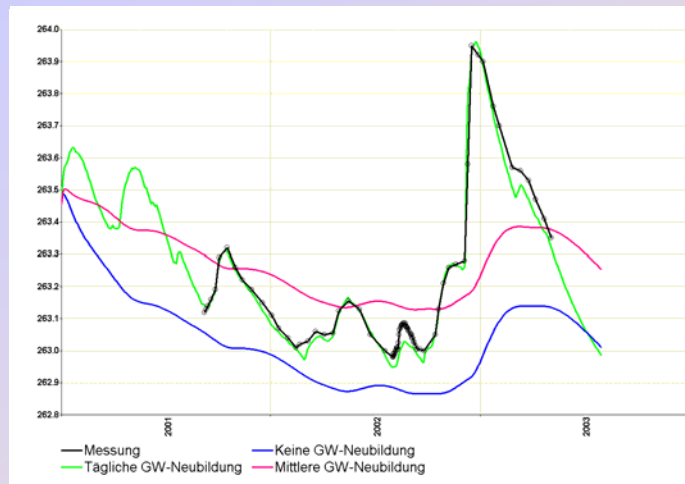


General problem:

**We do need exact data on ground
water recharge for:**

- Definition of the maximum
allowable ground water extraction
in regions with limited ground
water reserves**
- Input data for transient ground
water flow modelling**

Groundwater Recharge and Model calibration

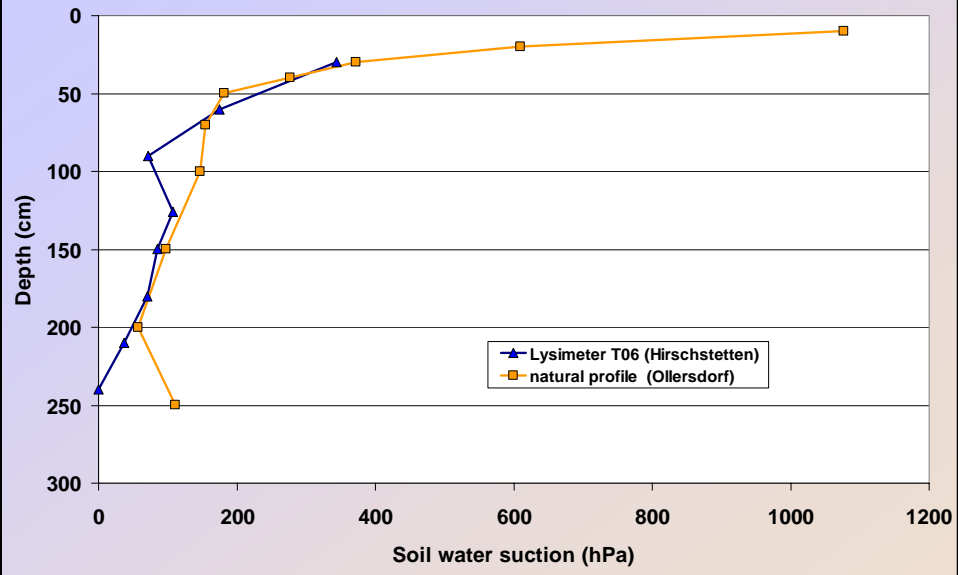


Measurement of ground water recharge using lysimeters



- **Preconditions:**
 - Prevent oasis effects
 - Measurements deeper than rooting depth
 - Soil water potential at lower end of the lysimeter must correspond with soil water potential of the surrounding soil

Comparison of soil suction within a „tension-free lysimeter and a natural soil profile



Installation of the suction cup strip at the bottom of the lysimeter column



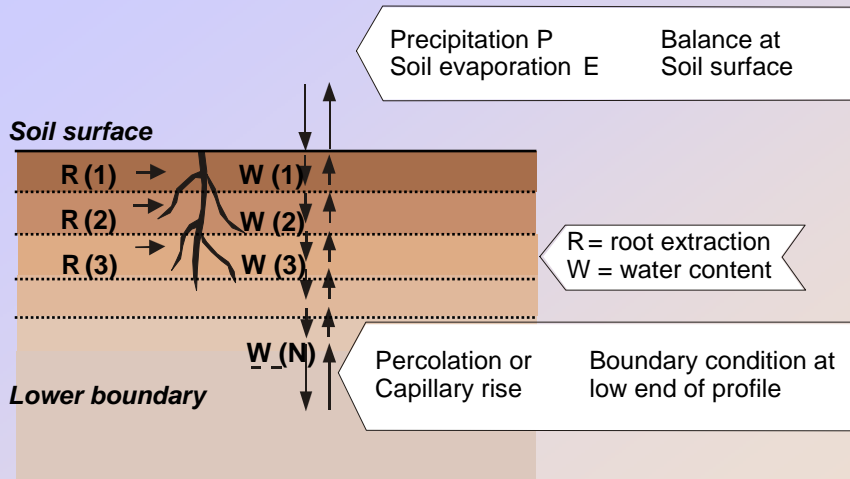
Implementation of controlled suction at the lysimeter bottom is rather expensive! Therefore we are starting with a simulation study to answer following questions:

- **are controlled suction lysimeters needed in every situation?**
- **should – on the other hand – existing tension free lysimeters be converted to suction lysimeters to yield realistic measurements of deep percolation?**

Material and methods

- **Simulation model SIMWASER**
 - Simulation of natural soil profile:
lower boundary = ground water surface
 - Simulation of „controlled tension lysimeter“:
lower boundary = tension applied
 - Simulation of „tension free lysimeter“:
lower boundary condition: $\psi=0$
- **Case study**
 - tension free lysimeter = HIRSCHSTETTEN
 - controlled tension lysimeter = WAGNA

Simulation model SIMWASER



Institut für Kulturtechnik und Bodenwasserhaushalt

Lysimeter HIRSCHSTETTEN

WETTERSTATION

Eingang in den Lysimeterkeller =>

● SANDIGER TSCHERNOSEM
CALCARIC PHAEOZEM

● FEUCHTSCHWARZERDE
GLEVIC PHAEOZEM

● TIEFGRÜNDIGER TSCHERNOSEM
CALCIC CHERNOZEM

AUFSICHT AUF DIE LYSIMETERANLAGE:
Die 18 Lysimetergefäße wurden in zwei parallelen Reihen positioniert, wobei die Anordnung der drei Bodentypen in einer geordneten Variation erfolgte. Die Lysimetergefäße mit starker Umrandung (Reihe 2) kennzeichnen den Teil der Anlage der für den Einsatz radioaktiv markierter Substanzen vorgesehen ist.

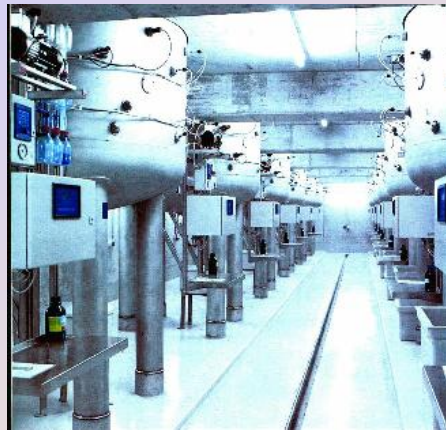
Lysimeter Research Station near Vienna
18 lysimeters with each 6 of them containing typical soils from the Marchfeld (Lower Austria)

Precipitation: ~ 500 mm/a
Temperature: 10.5 °C

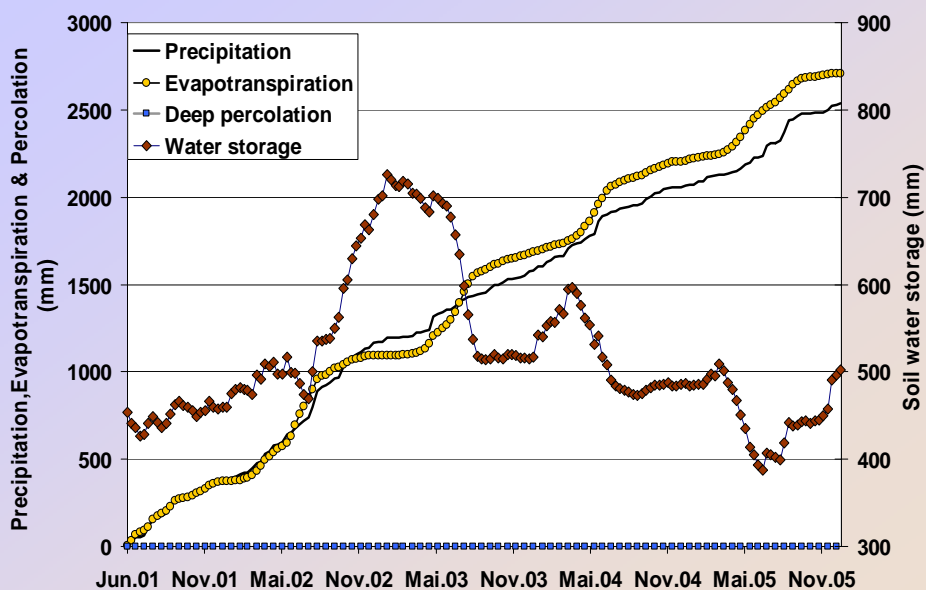
Lysimeter HIRSCHSTETTEN

- Backfilled
- Tension free (gravity)
- Non weighable

- In different depths the lysimeters are equipped with
 - Tensiometers
 - FDR water content sensors
 - Suction cups



Tension free lysimeter at Hirschstetten

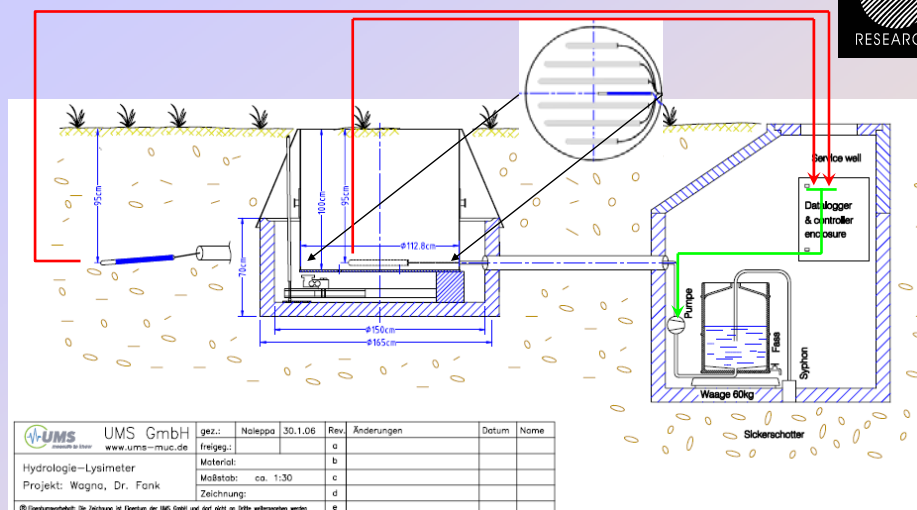


Suction Controlled Lysimeter WAGNA

- Mechanized Cultivated, Precise Weighing Monolithic Lysimeter
- Minimize Lysimeter Measurement Errors
 - Prevent Oasis/Island effects
 - Prevent lower boundary effects



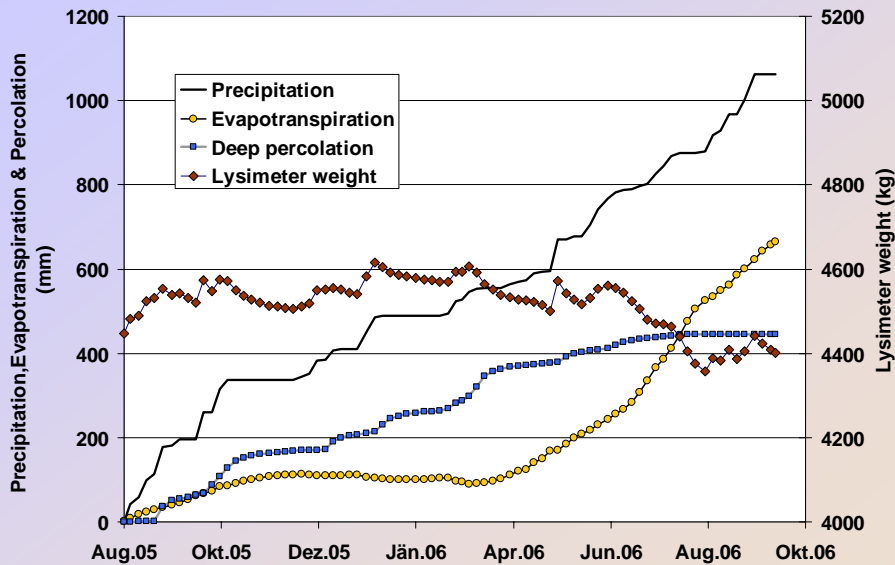
Controlled suction lysimeter WAGNA



UMS GmbH www.ums-muc.de Hydrologie-Lysimeter Projekt: Wagno, Dr. Fank	gez.:	Naleppa	30.1.06	Rev.	a	Anderungen	Datum	Name
	freigez.:				b			
	Material:				c			
	Maßstab:	ca. 1:30			d			
	Zeichnung:				e			

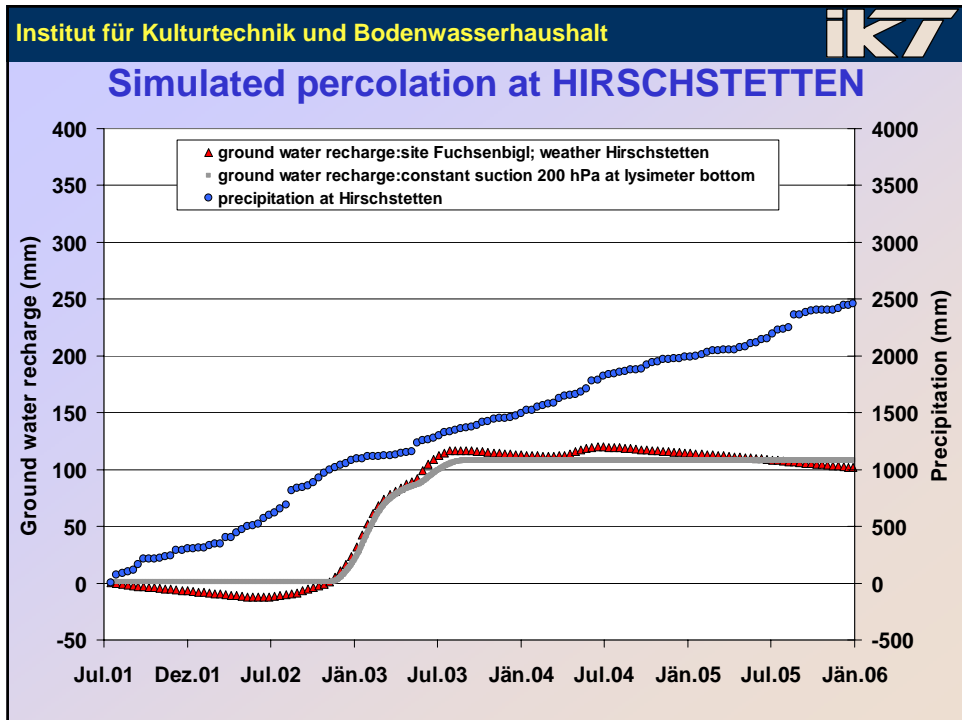
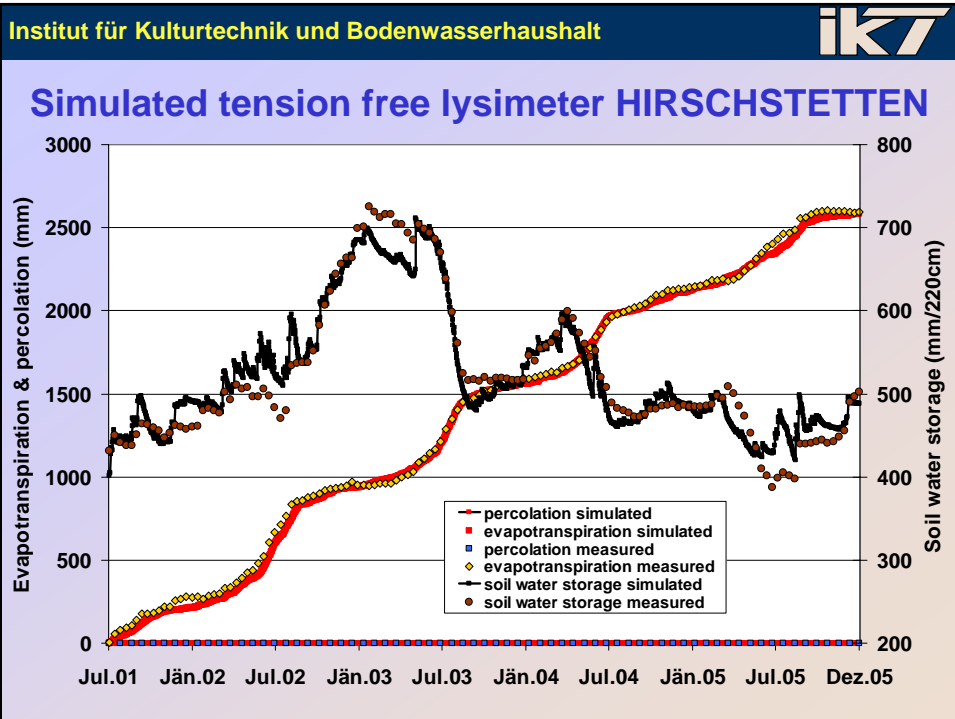
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Controlled tension lysimeter WAGNA

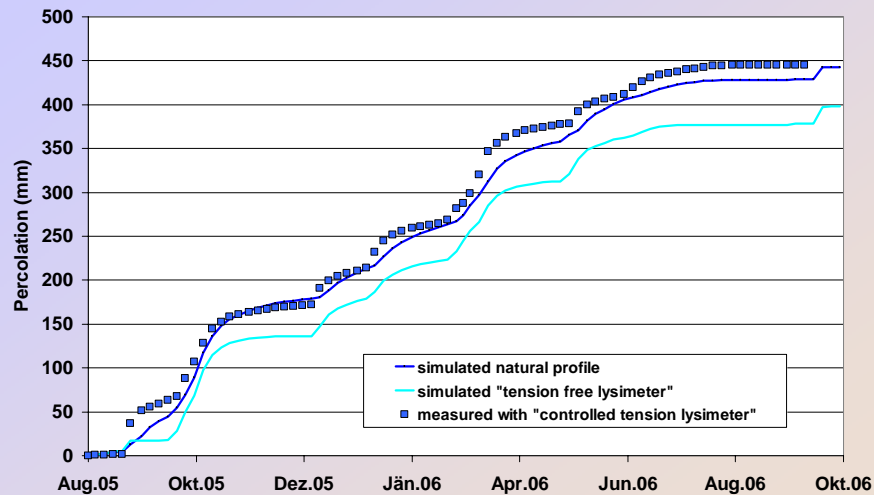


RESULTS

- At the HIRSCHSTETTEN station simulated percolation for the “tension free” lysimeter was zero as the measurements, but was 120 mm for the simulated “natural” soil profile at this site.
- At the WAGNA station simulated ground water recharge of the natural soil profile properly fits with the deep percolation measured by the “controlled tension” lysimeter while simulated percolation of a simple tension free lysimeter is about 10% lower than the simulated “natural” recharge.



Percolation at lysimeter WAGNA



Summary and Discussion

- Using simple tension free lysimeters, deep percolation (and thus ground water recharge) is underestimated at all.
- At sites with high precipitation or groundwater recharge this error may be tolerable (at the WAGNA station it is 10% of the supposed real percolation)
- In dry areas as in the MARCHFELD "controlled suction" lysimeters should be used at least for deep soil types that have high water holding capacity.
- If we use lysimeter data for calibrating soil water models we should use tension lysimeters, otherwise we transfer measurement errors into modelling
- Further investigations are needed to recommend the right lysimeter type for the respective site and soil profile.

**Thank you very
much for your
attention**