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Water balance of two lysimeter sites: Karcag vs. Groß-Enzersdorf

Reinhard Nolz[1*], Gyorgyi Kovacs[2], Jozsef Zsembeli[2] and Peter Cepuder[1]

Zusammenfassung

In den letzten beiden Jahren wurde vom Karcag Forschungsinstitut der Universität Debrecen (HU) und dem Institut für Hydraulik und landeskulturelle Wasserwirtschaft der Universität für Bodenkultur Wien (AUT) ein gemeinsames Projekt zum Thema Lysimeter-Wasserbilanz in Hinblick auf Bewässerung durchgeführt. Beide Institute betreiben eine Lysimeteranlage und können eine langjährige Erfahrung in diesem Bereich vorweisen. Um eine gemeinsame Basis für die Projektumsetzung zu finden war es notwendig, beide Lysimeteranlagen in Hinblick auf Ausstattung, Instrumentierung und Betriebsweise (Forschungsaufgaben) zu vergleichen.

Der Vergleich umfasste die Aufarbeitung von zwei Workshops und die Anpassung der Tätigkeiten und der Methoden, um eine allgemeine Parameter-Datenbank zu schaffen (meteorologische-, Boden-, Pflanzen-), die für weitere Berechnungen notwendig ist. Die Ergebnisse dieses Vergleiches sowie Wetterdaten und die berechnete Evapotranspiration verglichen mit Lysimetermessungen werden in einem Poster dargestellt. Außerdem wurden Lysimeter-Wasserbilanzen für die Jahre 2005 und 2006 ermittelt.

Schlagwörter: Evapotranspiration, Wasserbilanz, Bodenwassergehalt

Summary

A bilateral project on water balance of lysimeters with respect to irrigation was carried out in the past two years between Karcag Research Institute of University of Debrecen (HU) and Institute of Hydraulics and Rural Water Management of the University of Natural Resources and Applied Life Sciences, Vienna (AUT). Both institutes operate a lysimeter site and have a long-term experience with lysimeters. In order to find a common basis for the project implementation, it was essential to compare both lysimeter stations regarding configuration, instrumentation and operation (research objectives). The comparison included the processing of two research workshops and the harmonisation of the activities and methods to create a common database of parameters (meteorological-, soil-, plant production-) necessary for further calculations. The results of this comparison will be shown in a poster as well as weather data and calculated Evapotranspiration ET related to the measured lysimeter ET. Furthermore, lysimeter water balances for the years 2005 and 2006 have been calculated.

Keywords: evapotranspiration, water balance, soil water content

Introduction

During the years 2007 and 2008 a bilateral cooperation between Austria and Hungary took place with respect to the optimisation of irrigation on the base of water balance data determined by weighing lysimeters. The lysimeters of the University of Debrecen and the University of Natural Resources and Applied Life Sciences Vienna (BOKU) were the basis of the work, which was focused on the water balance of the two typical agricultural sites (CEPUDER et al. 1991, CEPUDER 2002).

Materials and Methods

The lysimeter station Karcag (Kg) is part of the Karcag Research Institute of the University of Debrecen. Several types of lysimeters are operated on the station, i.a. six electronic weighing lysimeters with 100 cm depth and a surface area of 2 m². The soil type is a Meadow Chernozem. Basic treatments include different soil surface formations simulating different soil tillage operations and techniques (seed-bed, cloddy, mulch, tarping, shallow cultivation etc.), and different field crops (maize, sorghum, millet, sunflower, grass). Further treatments are set according to actual annual experiments. A nearby meteorological station delivers continuously measured weather parameters. The change of lysimeter weight is read out hourly with a resolution of ±0.5 mm, the measurement range is ±300 kg. The amount of drainage water is detected weekly. Soil moisture content and temperature is measured at the depths of 10, 20, 30, 40 cm every 6 hours.

The lysimeter station Groß-Enzersdorf (GE) is located a few kilometres eastern from Vienna within the agricultural area "Marchfeld" at the experimental farm of the BOKU University in Groß-Enzersdorf. It contains several types of lysimeters, including two weighable, backfilled gravitation lysimeters with 2.9 m² surface area and 2.5 m depth. The soil type is Chernozem, soil texture is sandy loam to loamy sand. The lysimeters are operated by the Institute of Hyd-

[1] Institute of Hydraulics and Rural Water Management of University of Natural Resources and Applied Life Sciences Vienna, Muthgasse 18, A-1190 VIENNA

[2] Karcag Research Institute of University of Debrecen, Centre for Agricultural Sciences, Kisujszallasi ut 166, H-5300 KARCAG

[*] Ansprechpartner: reinhard.nolz@boku.ac.at

Table 1: **Harmonisation of data.**

Similarities	Differences
Lysimeter: type, function, parameters	Measuring frequency
climate and weather	Soil type
scientific approach and objectives	database (basic- versus applied research)
Measuring range (lysimetry, meteorology)	
Vegetation	

Table 2: **Mean annual weather data for Groß-Enzersdorf and Karcag.**

	Rad MJ/cm²	Tmean °C	Tmax °C	Tmin °C	Rain mm	relH %	Wv m/s	PET mm
2005								
GE	4525	10,4	14,8	6,1	522	72	3,2	865
Kg	5144	9,9	15,1	4,7	743	77	1,9	799
2006								
GE	4595	11,0	15,3	6,6	522	71	3,1	902
Kg	4971	10,6	15,8	5,8	585	76	1,9	819

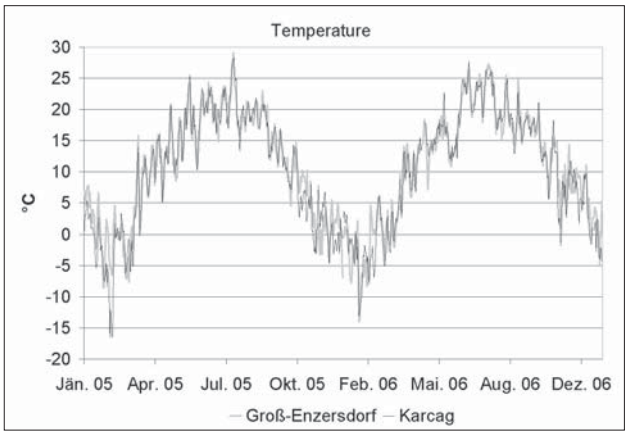

Figure 1: **Daily mean temperatures in Groß-Enzersdorf and Karcag from 2005 to 2006.**

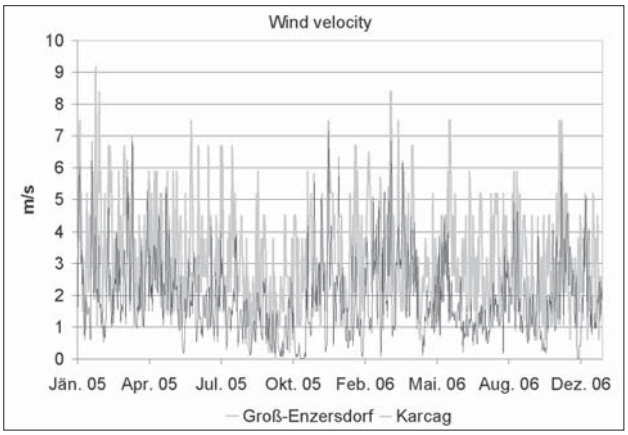

Figure 2: **Daily mean wind velocities, measured in 10 m height, in Groß-Enzersdorf and Karcag, respectively.**

raulics and Rural Water Management. One of the lysimeters is planted with different field crops, e.g. maize, wheat, oat, sugar beet, according to a typical local crop rotation. The other one is planted with grass for determination of potential reference-evapotranspiration ETo. The attached meteorological station is operated by Austria's national weather service agency. The meteorological parameters are recorded in 10-minute-intervals. Currently, the change of weight of the lysimeters is measured every few seconds and stored every 10 minutes. The resolution of the weighing system is ±0.1 mm, the measurement range about ±300 kg. The amount of percolation water is measured by a tipping bucket and stored also every 10 minutes. Furthermore, FDR (Frequency Domain Reflectometry) soil water sensors determine the soil water content every 10 cm depth down to 160 cm.

Results and Discussion

In order to improve the common basis for further work, compliances and differences concerning activities, methods and properties of the lysimeter stations were worked out (*Table 1*).

Climatic conditions are similar for both lysimeter stations (*Table 2*, *Figure 1*, *Figure 2*). The mean temperature (Tmean) is slightly higher in Groß-Enzersdorf, whereas the daily mean maximum and minimum temperatures (Tmax, Tmin) are higher in Karcag. Differences can be found in the wind velocities (Wv), which are higher in Groß-Enzersdorf. That fact seems to cause the higher rates of potential Evapotranspiration (PET).

Figure 3 and *Figure 4* show the change of the soil water content in the lysimeter Groß-Enzersdorf determined based on weighing data (Lys ET), soil water sensor readings (FDR ET) and ET calculation with the Penman-Montieth formula (PM ET; ALLEN et al. 1998). All three graphs show the same trend. The Penman-Montieth formula calculates the potential evapotranspiration and therefore this graph lies below the measured graphs. FDR sensors (CAMPBELL 1990, PALINEANU et al. 1997) just measure up to 10 cm around the installation tube. The readings are really close to the actual measured data of the lysimeter, but with decreasing soil water content the FDR sensors seem to deliver higher soil water contents. Nevertheless, irrigated sugar beet reduced the soil water content from April to October from 380 to 210 mm (*Figure 3*).

Oat in year 2006, grown under rainfed conditions, reduced the soil water content in the period from April to August

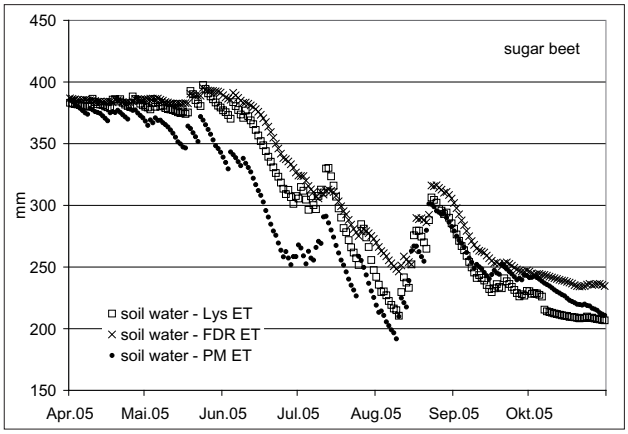

Figure 3: **Soil water content (mm) of the lysimeter Groß-Enzersdorf, sugar beet 2005.**

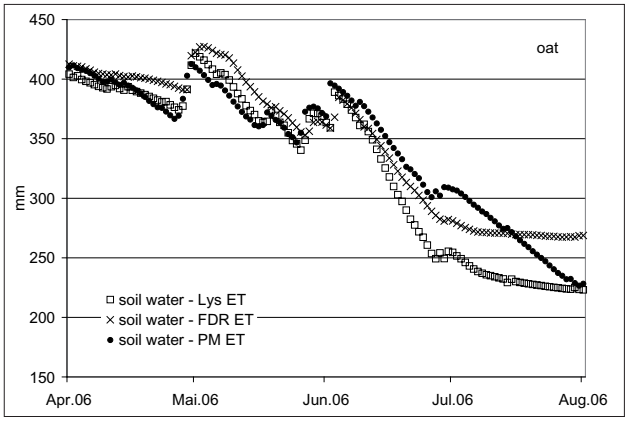

Figure 4: **Soil water content (mm) of the lysimeter Groß-Enzersdorf, oat 2006.**

from 410 to 230 mm, which means that the water consumption of oat was not so high as for sugar beet (*Figure 4*).

In 2006, the Karcag lysimeters were grown with sorghum. *Figure 5* shows the measured (lys ET) and the calculated (PM ET) soil water content of an irrigated lysimeter. Soil water content from May to September was reduced from 410 mm to 380 mm.

The graphs show that with lysimeters and soil water sensors water consumption of the crops can be monitored and

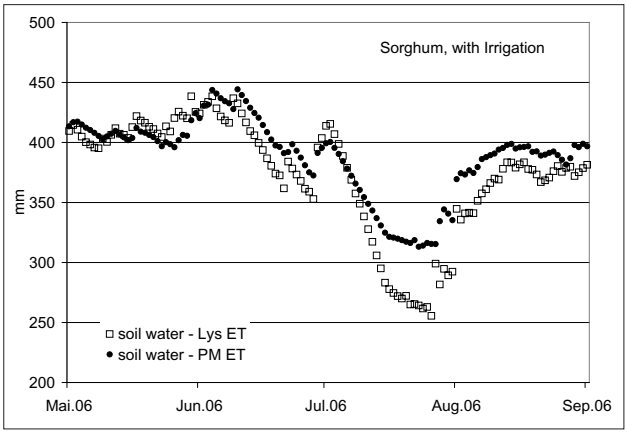

Figure 5: **Relative soil water content (mm) of the lysimeter Karcag, irrigated sorghum 2006.**

controlled, but nevertheless further research has to be done with respect to improvement of irrigation management in the vicinity of the lysimeter station in Groß-Enzersdorf and Karcag, respectively.

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