Water Balance Assessment for Lysimeter Station in Ljubljana Field

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Abstract

For soil water balance measurements two lysimeters were built on Water Pumping Station of Public Water Supply Company in Ljubljana. Outflow measurements systematically showed discrepancy between Lysimeter North and Lysimeter South, in average 300 mm/year. Yearly water balance calculation for the Lysimeter North shows slight decrease in water storage every year. Water balance calculation for Lysimeter South showed positive change in storage, but the results are questionable

Zusammenfassung

Für die Bodenwasser(-haushalts)messungen wurden zwei Lysimeter an der Pumpstation der öffentlichen Wasserversorgungsgesellschaft in Laibach errichtet. Die kontinuierlichen Ausflussmessungen zeigten eine deutliche Diskrepanz von durchschnittlich 300 mm jährlich zwischen den beiden Lysimetern (einerseits Süd anderseits Nord).

Die jährliche Bodenwasserhaushaltskalkulation für den Lysimeter Nord zeigte eine geringfügige Minderung der gespeicherten Wassermenge. Hingegen zeigte die jährliche Bodenwasser(-haushalts)-kalkulation des Lysimeters Süd eine positive Veränderung im Bestand. Es muss jedoch bemerkt werden, dass die Ergebnisse nicht zuverlässig sind.

Introduction

The water balance is defined by the general hydrologic equation, which is basically a statement of the law of conservation of mass as applied to the hydrologic cycle (RITZEMA, 1994). The general equation of the soil-water budget is derived by considering the mechanisms by which water can enter, exit, or be stored in a predefined region of the vadose zone (STEPHENS, 1995). Water balance equations can be assessed for any area and for any period of time (RITZEMA, 1994). Water balance for unsaturated zone is determined by equation

$$I - ET + G - R = \Delta S / \Delta t$$

where I is the rate of infiltration into the unsaturated zone (mm/day), ET evapotranspiration (mm/day), C capillary rise from saturated zone (mm/day), O the rate of percolation to the saturated zone (mm/day), ΔS the change in soil water storage in the unsaturated zone during the computation interval of an equivalent layer of water (mm), Δt the computation interval of time (day). With the assumption that the water flow is mainly vertical and no lateral flow components occur, water balance for lysimeter is defined with equation

$$P - ET - O = \Delta S,$$

where P is precipitation, ET evapotranspiration, O outflow and ΔS change in soil water storage inside the lysimeter.

In order to understand the all - year mechanisms, two lysimeters were built in 1991 for measuring water balance on the water pumping station of public water supply company in Ljubljana, Slovenia. Active measurements of precipitation and lysimeter outflow were reinstated in August 2000.

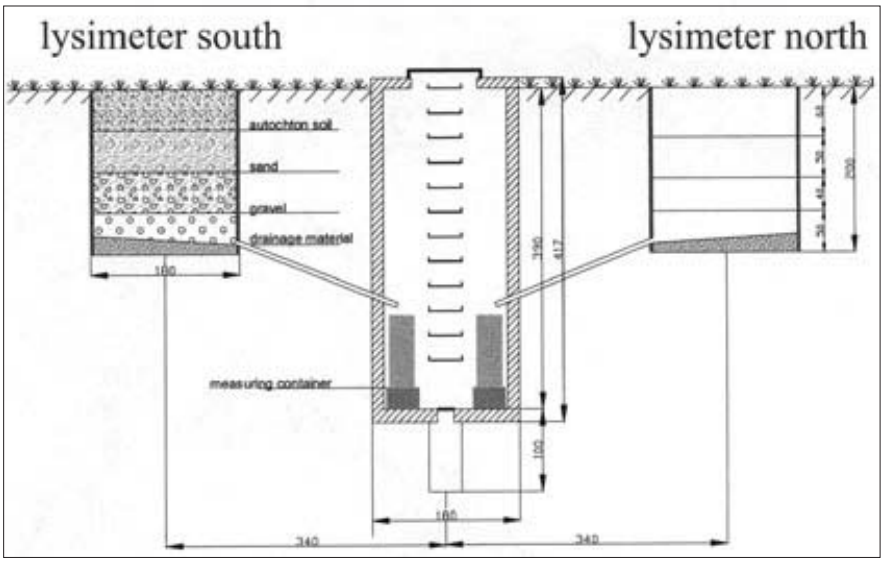
Materials and methods

Lysimeter station in Klece, Ljubljana is situated near the main Water Pumping Station of Public Water Supply Company of the city. Daily measurements of rain, air humidity, average air temperature and lysimeter outflow are measured. Evapotranspiration is calculated using Penman equation using meteorological parameters from the meteorological station 2 km. Vegetation is extensive green grass.

Lysimeters (180 cm diameter) are filled with autochthon soil, sand, gravel and drainage material in 50 cm layers respectively. From the drainage material layer outflow drain leads into bunker. Out flow is measured with tipping bucket in a container inside the bunker (*Picture 1*).

Results

Average yearly precipitation measured on the lysimeter station is 1083 mm, with average air temperature of 12° C. Average monthly evapotranspiration rate



Picture 1: **Lysimeter station profile on Water Pumping Station of Public Water Supply Company in Klece, Ljubljana.**

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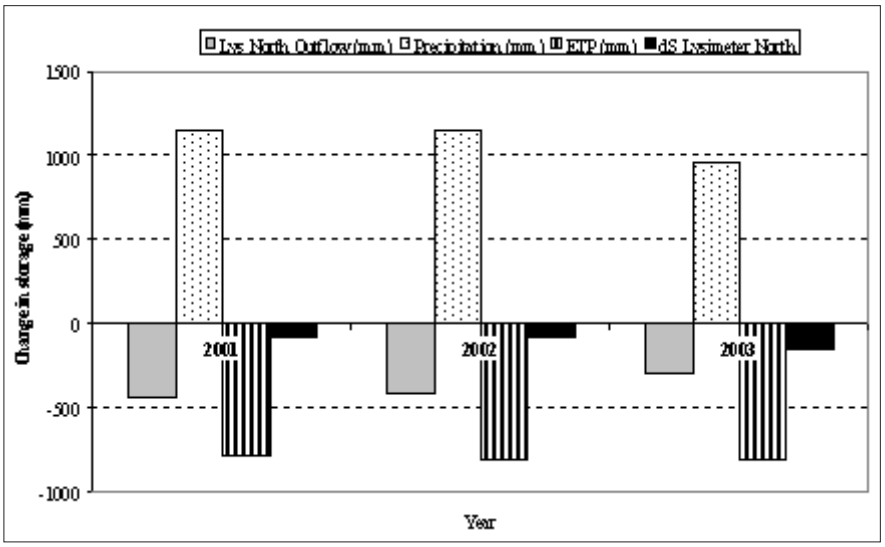
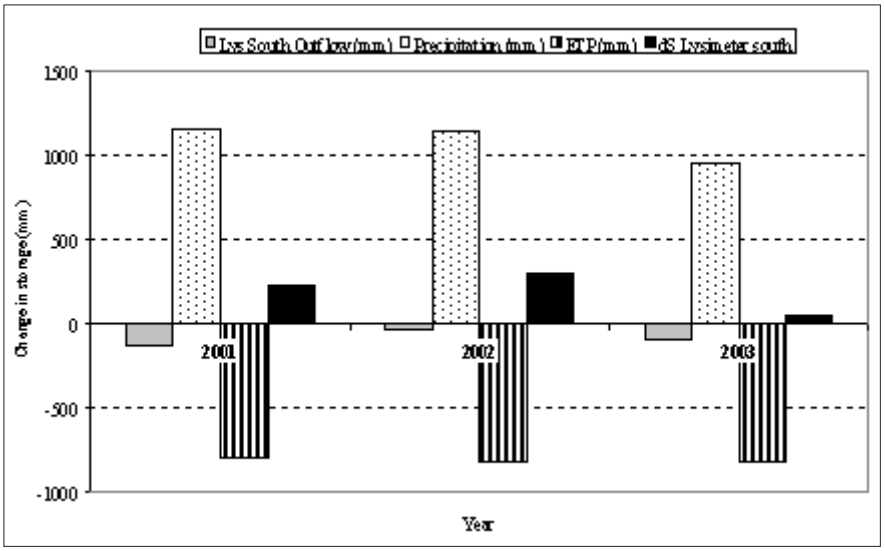


Picture 2: **Yearly water balance for Lysimeter North on Lysimeter station in Klece, Ljubljana 2001 - 2003.**



Picture 3: **Yearly water balance for Lysimeter South on Lysimeter station in Klece, Ljubljana 2001 - 2003.**

calculated with Penman - Monteith equation was 70 mm per year, and 630 mm in vegetation period (beginning of April - end of September).

Lysimeter outflow quantity comparison between Lysimeter North and Lysimeter South showed that there was considerably less outflow from the Lysimeter South (85 mm/year) than from the Lysimeter North (386 mm/year). Vegetation cover comparison between the two lysimeters showed no sign of soil becoming marshy or change in vegetation on the Lysimeter South, therefore outflow pipe clogging has been ruled out. To confirm the hypothesis of Lysimeter South leaking we employed special camera for checking the pipes. Video overview showed functioning pipe till the gravely material inside the Lysimeter South.

Yearly water balance calculation shows slight decrease in water storage every year (*Picture 2*) for the Lysimeter North. Water balance calculation for Lysimeter South showed positive change in storage (*Picture 3*), but the results are questionable due to the unreliable outflow measurements.

Conclusion

Outflow measurements systematically showed discrepancy between Lysimeter North and Lysimeter South, 300 mm in average. Vegetation in the Lysimeter South indicated no excessive water retention due to pipe clogging, therefore it was concluded that there was rapture on the lysimeter construction. Lysimeter South will be renovated in year 2005.

References

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STEPHENS, D.B., 1995: Vadose zone hydrology. Florida, CRC Press, Lewis publishers: 347 str.