

## Review of lysimeter stations in Slovakia

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### Summary

Three new lysimeter stations were built in Slovakia since 2013 and they operate with modern technology in field of agriculture, hydrology and mountain ecology. Agricultural station in Borovce investigates the impact of various tillage technologies on soil properties and crop production. Preliminary results showed theoretical potential of tillage vs. preservation technologies to generate the nitrate nitrogen losses per vegetation season in winter wheat in given condition of experimental locality. Hydrology station in Petrovce deals with various soil which are typical for eastern region of Slovakia. Dynamics of actual evapotranspiration (ETa) was calculated for the first target soil type (silty loam) and compared to the reference evapotranspiration (ET0) for the very short time in July 2015.

**Keywords:** agriculture, evapotranspiration, high mountain ecology, hydrology, nitrogen

### Introduction

Lysimeter research in Slovakia in the past was intensive and it was well connected to international science. But because of economic transformation it was not supported anymore and the stations were closed and ramshackled. The new stations which are introduced in this contribution are the opportunity how to continue in this field of research with the modern equipment fully accepted by scientists in the world. Each of the three stations (*figure 1*) is unique by some specific feature. Agricultural station in Borovce was designed to allow the standard agricultural machinery to work above the lysimeters with no risk of damage. In Petrovce Hydrology Station there are large lysimeters with very reach instrumentation. Tatranská Javorina is special by its location and research of forest regeneration after the natural calamities in alpine region.

### Material and Methods

**Lysimeter Station in Borovce** is operated by National Agricultural and Food Centre – Research Institute of Plant Production (NAFC-RIPP). It is situated in the western part of Slovakia Lysimeter Station Borovce is in operation since 2013. It consists of one weighable lysimeter covered by grass (*table 1*). There are also three non-weighable lysimeters

which are completely embedded into experimental plots and covered by 0.5 m of soil. It allows the standard agricultural machinery to work above them with no risk to damage the equipment. The filling method of the soil is undisturbed soil monolith excavation (Matušek 2016). In general, the agricultural research of RIPP is focused on issues of tillage technologies and their impact on soil quality and crop production. Nitrogen dynamics is one of the main aims in current research activities too. Lysimeters were installed into ongoing long-term field experiment to assess the nitrogen leaching from soil profile. Three types of tillage systems were involved into experiment (conventional, minimisation and no-till technology). They varied in depth of soil preparation, mechanisation and amount of plant litters which were incorporated into the soil. For this moment only the seepage water volume and nitrate nitrogen content is evaluated.

**Lysimeter Station in Petrovce n. Laborcom** is operated by Institute of Hydrology Slovak Academy of Sciences - Research Hydrological Base (SAS-IH-RHB). Petrovce nad Laborcom is situated in the eastern part of Slovakia. There are five hydrological lysimeters, all of them are weighable (*table 1*). They are instrumented every 0.1 m layers. Soil monoliths are chosen from five different types of soils from various locations in the region. The vegetation on the surface is grassland. The special feature about this lysimeter station is the variable groundwater table. It is managed by a special tank system and supports their hydrologic experiments.

**Lysimeter station in Tatranská Javorina** is situated in the northern part of Slovakia. The newly build lysimeter station is in operation since 2015 and it is managed by the



Figure 1: Three lysimeter facilities in Slovakia.

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Table 1: Technical data of lysimeter stations in Slovakia.

Lysimeter Station	Borovce		Petrovce n. Laborcom	Tatranská Javorina
Operated by	NAFC - RIPP		SAS - IH - RHB	UNIZA - IHMB
In operation since	2013		2014	2015
Purpose of lysimeter station	Agriculture		Hydrology	Mountain ecology
Geographical position	48°34'49''N 17°43'52''E		48°45'19''N 21°54'48''E	49°16'0''N 20°8'0''E
Altitude	162 m		115 m	1040 m
Meteorology Station	Yes		Yes	Yes
Number of lysimeters	1	3	5	1
Type of lysimeters	Weighable	Non-weigh.	Weighable	Weighable
Depth/Surface	1.5m/1m <sup>2</sup>	1.5m/2m <sup>2</sup>	2.5m/1m <sup>2</sup>	1.5/1m <sup>2</sup>
Suction control	Yes	No	Yes	Yes
Drainage layer depth (m)	1.4	1.4	2.4	1.4
Groundwater table variability	No	No	Yes	No
Lower boundary system	Yes	No	No	No
Lysimeter collar	Yes	No	Yes	Yes
Run off system	No	No	No	Yes
Surface cover	Grassland	Arable land	Grassland	Forest vegetation
Filling method	Monolith	Monolith	Monolith	Monolith
Tensiometers	Yes	No	Yes	Yes
Suction cups	Yes	Yes	Yes	Yes
Sensors for soil moisture, temperature, conductivity	Yes	Yes	Yes	Yes
Instrumentation depth (m)	0.3, 0.75, 1.2	0.3, 0.75, 1.2	every 0,1	0.3, 0.7, 1.2
Seepage water tipping counter	Yes	Yes	Yes	Yes
Data storing	Lysidata net		Lysidata net	SVADSS SW
Measurement freq. (min)	15		5	5
Data transmission	GSM		Radio	Radio

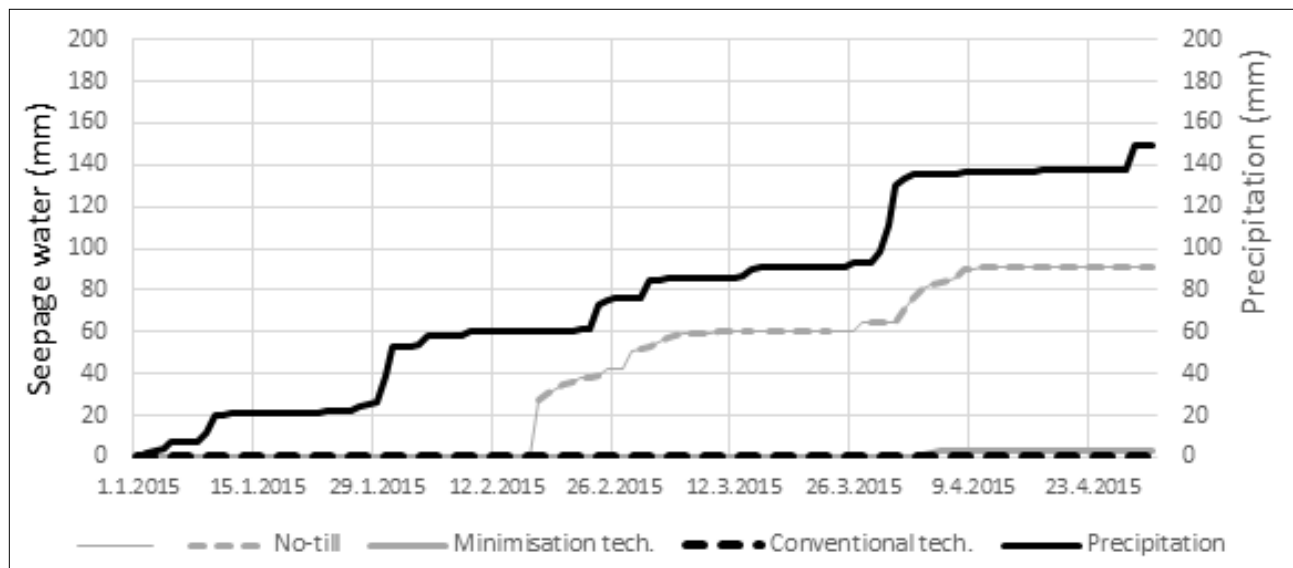


Figure 2: Cumulative precipitation and percolation. Borovce, 2015.

Institute of High Mountain Biology of Žilina University (UNIZA - IHMB). The only lysimeter (table 1) measures the basic parameters of mountain ecosystem. Station deals with changes of water balance and water cycle related to the fast-growing wood species which are the pioneer wood species in damaged forest destroyed by natural calamities and intensive deforestation.

## Results and discussion

**Lysimeter Station in Borovce.** During the initial period the first percolation was recorded in no-till in 2015, twenty months after the installation of lysimeters. Soil was not

tilled after the harvest of winter wheat. It was covered by the stubble and saturated by the water. Initiation of percolation and significant percolation events corresponded to the heavy rainfalls. Percolation period took two month and total volume of seepage water was 90.4 mm.  $\text{N-NO}_3^-$  concentration in seepage water ranged from 18,91-32,30  $\text{mg.l}^{-1}$ . Nitrogen losses via nitrate nitrogen were 24.02  $\text{kg.ha}^{-1}$  per monitored period. Dynamics of percolation depicts figure 2. Meisinger et al. (2015) published similar nitrogen losses in no-till conditions for winter wheat in range of 15-35  $\text{kg.ha}^{-1}.\text{year}^{-1}$ . Minimisation technology showed only the minimal percolation in total volume of 3.5 mm. Data regarding the total nitrogen losses are not

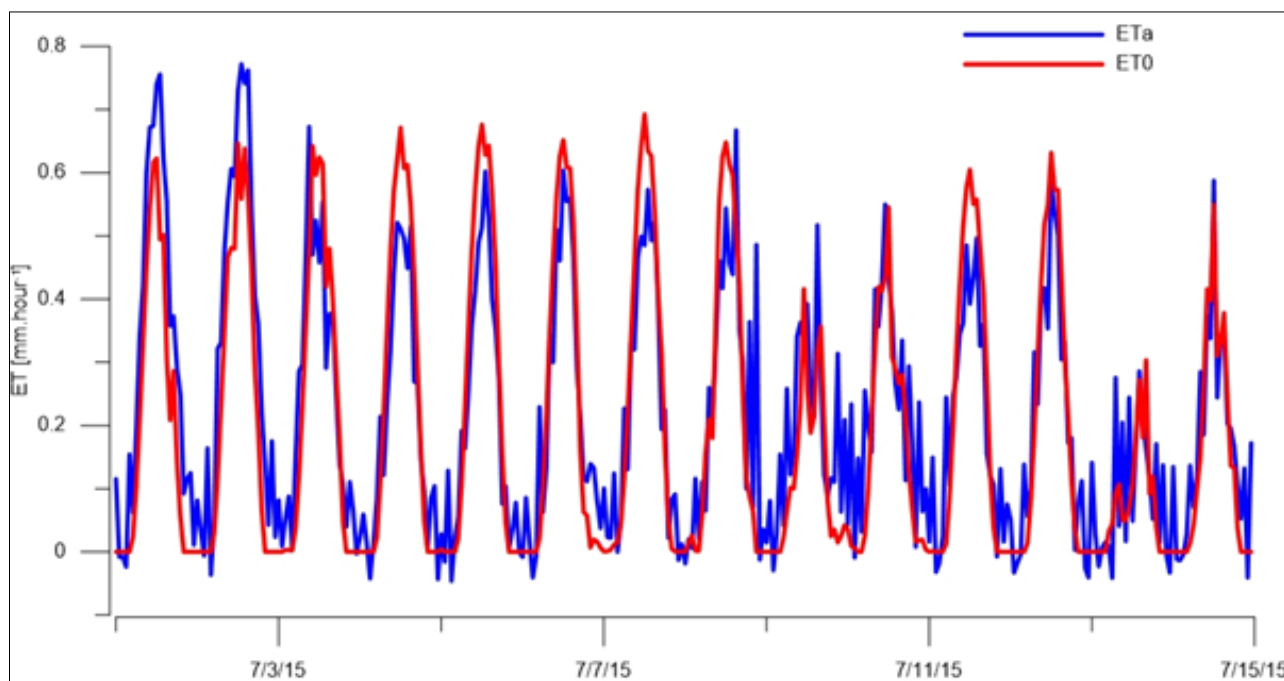


Figure 3: Actual and reference evapotranspiration. Petrovce n. Laborcom, 2015.

available. Unusual percolation was recorded during the vegetation season in 2016 shortly after the harvest of spring barley. Season was characterised by the frequented heavy rain events and storms. Total seepage water volume in minimisation technology (4.0 mm) and nitrate nitrogen leaching ( $0.1 \text{ kg} \cdot \text{ha}^{-1}$ ) was not significant, but the fact that this situation even appeared is a rarity. Definitely no percolation event was recorded for conventional technology since the installation of lysimeters.

**Lysimeter Station in Petrovce n. Laborcom.** One of the first preliminary results from the pilot operation of this station depicts *figure 3*. It deals with the actual evapotranspiration (ETa) during the first two weeks of July 2015. Data from lysimeter with silty loam soil were processed hourly. Values of ETa were calculated from lysimeter data according to the following simple balance equation:

$$ETa = P \pm \Delta W \pm \Delta F$$

where: ETa – actual evapotranspiration [mm]; P – precipitation [mm];  $\Delta W$  – change of water storage [mm];  $\Delta F$  – inflow/outflow of water [mm]

For the comparison also the hourly reference evapotranspiration (ET0) was calculated based on the meteorology parameters according to the FAO standard (Allen 1998).

## Conclusions

Very first results were reached in field of new period of lysimeter research in Slovakia, mostly in field of local climate conditions and their relation to the target elements of environment. Full potential of research facilities has not been utilized yet. Research teams want to extend the measurements to cover more aspects of ecosystem investigations.

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